File Ref.No.234334/GA-IV-K-ASST-2/2022/Admn

UNIVERSITY OF CALICUT

Abstract

General and Academic IV - Faculty of Science - Revised Scheme and Syllabus of B.Sc Chemistry Honours Programme under CUFYUGP Regulations 2024 with effect from 2024 Admission - Approved by the Vice Chancellor, subject to report to the Academic Council- Reg

G & A - IV - K Section

U.O.No. 13302/2024/Admn Dated, Calicut University.P.O, 30.08.2024

Read:-1. U.O.No. 9418/2024/Admn dated, 18/06/2024
2. Minutes of the meeting of the Board of Studies in Chemistry UG held on 11.07.2024
3. Approval of the Dean, Faculty of Science dated 27/07/2024.

ORDER

1. The Scheme and Syllabus for B.Sc Chemistry Honours Programme under CUFYUGP Regulations 2024 with effect from 2024 Admission was implemented in the University of Calicut, vide paper read as (1) above.

2. As per paper (2) referenced above ,the Chairperson,Board of Studies in Chemistry has decided to change course name of Minor courses offered by Chemistry of the implemented scheme and syllabus for the CUFYUGP B.Sc Chemistry Honours programme,effective from the 2024 admission. Additionally board proposed making laboratory practicals mandatory in the FYUGP B.Sc Chemistry major and minor syllabi.

3. The Dean, Faculty of Science, as per paper (3) referenced above, has approved the resolution of Board of Studies in Chemistry UG.

4. Considering the matter in detail, Vice Chancellor has sanctioned the implementation of the revised syllabus of B.Sc Chemistry Honours Programme under CUFYUGP Regulations 2024 with effect from 2024 admission, along with the inclusion of the modifications.

5.Therefore, the revised scheme and syllabus for the B.Sc Chemistry Honours Programme under CUFYUGP Regulations 2024, with effect from 2024 Admission, are implemented, subject to report to the Academic Council.

6. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

1.The Principals of all Affiliated Colleges,
Copy to: PS to VC/PA to PVC/ PA to R/PA to CE/JCE I/JCE IV/EX IV and EG Sections/GA IF/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

B.Sc. CHEMISTRY HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

B.Sc. CHEMISTRY HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, a student would:

PO1	Knowledge Acquisition: Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Communication, Collaboration, Inclusiveness, and Leadership: Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Professional Skills: Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Digital Intelligence: Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Scientific Awareness and Critical Thinking: Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Human Values, Professional Ethics, and Societal and Environmental Responsibility: Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Research, Innovation, and Entrepreneurship: Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BSc ChemistryHonours programme at Calicut University, a student would:

PSO1	Understand theoretical concepts and applications across major chemistry subfields, including inorganic, organic, physical, analytical chemistry, and quantum mechanics.
PSO2	Evaluate complex chemical phenomena and real-world problems by applying principles of theoretical chemistry and computational chemistry.
PSO3	Develop practical skills in handling chemicals safely, preparing solutions, conducting experiments, and analyzing chemical species in the lab.
PSO4	Design and execute a project to solve real-world problems following the needs of society and academic research within a stipulated time frame.

PSO5	Acquire foundational knowledge of chemistry essential for advanced studies in interdisciplinary fields such as Physics, Mathematics, Botany, Zoology, Geology, and other related disciplines.
PSO6	Apply chemistry knowledge to various industries including pharmaceuticals, materials science, energy, polymer, and environmental monitoring.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN CUFYUGP

<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Academic Pathway</th><th>Major</th><th>Minor/ Other Disciplines</th><th>Foundation Courses
AEC: 4
MDC: 3
SEC: 3
VAC: 3</th><th rowspan="2">Intern-ship</th><th rowspan="2">Total Credits</th><th rowspan="2">Example</th></tr>
<tr><td colspan="2">Each course has 4 credits</td><td>Each course has 3 credits</td></tr>
<tr><td>1</td><td>Single Major (A)</td><td>68

(17 courses)</td><td>24

(6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Chemistry + six courses in different disciplines in different combinations</td></tr>
<tr><td>2</td><td>Major (A) with Multiple Disciplines (B, C)</td><td>68

(17 courses)</td><td>12 + 12

(3 + 3 = 6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Chemistry + Mathematics and Physics</td></tr>
<tr><td>3</td><td>Major (A) with Minor (B)</td><td>68
(17 courses)</td><td>24

(6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Chemistry, Minor: Physics</td></tr>
<tr><td>4</td><td>Major (A) with Vocational Minor (B)</td><td>68

(17 courses)</td><td>24

(6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Chemistry, Minor: Vocational Chemistry</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Double Major (A, B)</td><td rowspan="2">A: 48
(12 courses)

B: 44
(11 courses)</td><td>-</td><td>12 + 18 + 9</td><td>2</td><td rowspan="2">133</td><td rowspan="2">Chemistry and Physics double major</td></tr>
<tr><td colspan="3">The 24 credits in the Minor stream are distributed between the two Majors.

2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133)</td></tr>
</table>

			1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)		
Exit with UG Degree / Proceed to Fourth Year with 133 Credits					

B.Sc. CHEMISTRY HONOURS PROGRAMME

COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	CHE1CJ 101/ CHE1MN 100	CORE COURSE 1 IN MAJOR –INORGANIC CHEMISTRY I	75	5	4	30	70	100
		MINOR COURSE 1	60/75	4/5	4	30	70	100
		MINOR COURSE 2	60/75	4/5	4	30	70	100
	ENG1FA 101(2)	ABILITY ENHANCEMENT COURSE 1– ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 2 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
		MULTI-DISCIPLINARY COURSE 1 – OTHER THAN MAJOR	45	3	3	25	50	75
		TOTAL		**23/25**	**21**			**525**
2	CHE2CJ 101/ CHE2MN 100	CORE COURSE 2 IN MAJOR– PHYSICAL CHEMISTRY –I: STATES OF MATTER	75	5	4	30	70	100
		MINOR COURSE 3	60/75	4/5	4	30	70	100
		MINOR COURSE 4	60/75	4/5	4	30	70	100
	ENG2FA 103(2)	ABILITY ENHANCEMENT COURSE 3– ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 4 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
		MULTI-DISCIPLINARY COURSE 2 – OTHER THAN MAJOR	45	3	3	25	50	75
		TOTAL		**23/25**	**21**			**525**

3	CHE3CJ 201	CORE COURSE 3 IN MAJOR –THEORETICAL CHEMISTRY I: BASIC QUANTUM CHEMISTRY	60	4	4	30	70	100
	CHE3CJ 202/ CHE3MN 200	CORE COURSE 4 IN MAJOR – ORGANIC CHEMISTRY 1	75	5	4	30	70	100
		MINOR COURSE 5	60/75	4/5	4	30	70	100
		MINOR COURSE 6	60/75	4/5	4	30	70	100
		MULTI-DISCIPLINARY COURSE 3 – KERALA KNOWLEDGE SYSTEM	45	3	3	25	50	75
	ENG3FV 108(2)	VALUE-ADDED COURSE 1 – ENGLISH	45	3	3	25	50	75
		TOTAL		**23/25**	**22**			**550**
4	CHE4CJ 203	CORE COURSE 5 IN MAJOR – INORGANIC CHEMISTRY-II	75	5	4	30	70	100
	CHE4CJ 204	CORE COURSE 6 IN MAJOR – ORGANIC CHEMISTRY-II	75	5	4	30	70	100
	CHE4CJ 205	CORE COURSE 7 IN MAJOR – PHYSICAL CHEMISTRY –II: CHEMICAL THERMODYNAMICS, KINETICS & SURFACE CHEMISTRY	75	5	4	30	70	100
	ENG4FV 109(2)	VALUE-ADDED COURSE 2 – ENGLISH	45	3	3	25	50	75
		VALUE-ADDED COURSE 3 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	ENG4FS 111(2)	SKILL ENHANCEMENT COURSE 1 – ENGLISH	60	4	3	25	50	75
		TOTAL		**25**	**21**			**525**
5	CHE5CJ 301	CORE COURSE 8 IN MAJOR – THEORETICAL CHEMISTRY II: GROUP THEORY AND MOLECULAR SPECTROSCOPY	60	4	4	30	70	100
	CHE5CJ 302	CORE COURSE 9 IN MAJOR – INORGANIC CHEMISTRY-III	75	5	4	30	70	100
	CHE5CJ 303	CORE COURSE 10 IN MAJOR – ORGANIC CHEMISTRY - III	75	5	4	30	70	100
		ELECTIVE COURSE 1 IN MAJOR	60	4	4	30	70	100

		ELECTIVE COURSE 2 IN MAJOR	60	4	4	30	70	100
		SKILL ENHANCEMENT COURSE 2	45	3	3	25	50	75
		TOTAL		**25**	**23**			**575**
6	CHE6CJ 304/ CHE8MN 304	CORE COURSE 11 IN MAJOR – INORGANIC CHEMISTRY-IV	60	4	4	30	70	100
	CHE6CJ 305/ CHE8MN 305	CORE COURSE 12 IN MAJOR– ORGANIC CHEMISTRY - IV	75	5	4	30	70	100
	CHE6CJ 306/ CHE8MN 306	CORE COURSE 13 IN MAJOR – PHYSICAL CHEMISTRY – III: CHEMICAL AND PHASE EQUILIBRIA, ELECTROCHEMISTRY AND PHOTOCHEMISTRY	75	5	4	30	70	100
		ELECTIVE COURSE 3 IN MAJOR	60	4	4	30	70	100
		ELECTIVE COURSE 4 IN MAJOR	60	4	4	30	70	100
		SKILL ENHANCEMENT COURSE 3	45	3	3	25	50	75
	CHE6CJ 349	INTERNSHIP IN MAJOR (CREDIT FOR INTERNSHIP TO BE AWARDED ONLY AT THE END OF SEMESTER 6)	60		2	50	-	50
		TOTAL		**25**	**25**			**625**
TOTAL CREDITS FOR THREE YEARS					**133**			**3325**
7	CHE7CJ 401	CORE COURSE 14 IN MAJOR – THEORETICAL CHEMISTRY III: ADVANCED QUANTUM CHEMISTRY	75	5	4	30	70	100
	CHE7CJ 402	CORE COURSE 15 IN MAJOR – INORGANIC CHEMISTRY-V	75	5	4	30	70	100
	CHE7CJ 403	CORE COURSE 16 IN MAJOR – ORGANIC CHEMISTRY V	75	5	4	30	70	100
	CHE7CJ 404	CORE COURSE 17 IN MAJOR – PHYSICAL CHEMISTRY IV: STATISTICAL THERMODYNAMICS	75	5	4	30	70	100
	CHE7CJ 405	CORE COURSE 18 IN MAJOR – INSTRUMENTAL METHODS OF ANALYSIS	75	5	4	30	70	100
		TOTAL		**25**	**20**			**500**

	CHE8CJ 406/ CHE8MN 406	CORE COURSE 19 IN MAJOR – INORGANIC CHEMISTRY-VI	60	4	4	30	70	100
	CHE8CJ 407/ CHE8MN 407	CORE COURSE 20 IN MAJOR – ORGANIC CHEMISTRY- VI	75	5	4	30	70	100
	CHE8CJ 408/ CHE8MN 408	CORE COURSE 21 IN MAJOR –PHYSICAL CHEMISTRY- V: ADVANCED TOPICS IN SOLID STATE AND ELECTROCHEMISTRY	60	4	4	30	70	100
	OR (INSTEAD OF CORE COURSES 19- 21 IN MAJOR)							
	CHE8CJ 449	PROJECT (IN HONOURS PROGRAMME)	360*	13*	12	90	210	300
8	CHE8CJ 499	PROJECT (IN HONOURS WITH RESEARCH PROGRAMME)	360*	13*	12	90	210	300
		ELECTIVE COURSE 5 IN MAJOR / MINOR COURSE 7	60	4	4	30	70	100
		ELECTIVE COURSE 6 IN MAJOR / MINOR COURSE 8	60	4	4	30	70	100
		ELECTIVE COURSE 7 IN MAJOR / MINOR COURSE 9 / MAJOR COURSE IN ANY OTHER DISCIPLINE	60	4	4	30	70	100
	OR (INSTEAD OF ELECTIVE COURSE 7 IN MAJOR, IN THE CASE OF HONOURS WITH RESEARCH PROGRAMME)							
	CHE8CJ 489	RESEARCH METHODOLOGY IN CHEMISTRY	60	4	4	30	70	100
		TOTAL		**25**	**24**			**600**
TOTAL CREDITS FOR FOUR YEARS					**177**			**4425**

* The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

CREDIT DISTRIBUTIONFOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Major Courses	Minor Courses	General Foundation Courses	Internship/ Project	Total
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
* instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

DISTRIBUTION OF MAJOR COURSES IN CHEMISTRY FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Hours/ Week	Credits
1	CHE1CJ 101 / CHE1MN 100	CORE COURSE 1 IN MAJOR – INORGANIC CHEMISTRY - I	5	4
2	CHE2CJ 101 / CHE2MN 100	CORE COURSE 2 IN MAJOR –PHYSICAL CHEMISTRY – I: STATES OF MATTER	5	4
3	CHE3CJ 201	CORE COURSE 3 IN MAJOR –THEORETICAL CHEMISTRY – I: BASIC QUANTUM CHEMISTRY	4	4
	CHE3CJ 202 /	CORE COURSE 4 IN MAJOR – ORGANIC CHEMISTRY - I	5	4

	CHE3MN 200			
4	CHE4CJ 203	CORE COURSE 5 IN MAJOR – INORGANIC CHEMISTRY-II	5	4
	CHE4CJ 204	CORE COURSE 6 IN MAJOR – ORGANIC CHEMISTRY-II	5	4
	CHE4CJ 205	CORE COURSE 7 IN MAJOR – PHYSICAL CHEMISTRY-II: CHEMICAL THERMODYNAMICS KINETICS AND SURFACECHEMISTRY	5	4
5	CHE5CJ 301	CORE COURSE 8 IN MAJOR – THEORETICAL CHEMISTRY – II: GROUP THEORY AND MOLECULAR SPECTROSCOPY	4	4
	CHE5CJ 302	CORE COURSE 9 IN MAJOR – INORGANIC CHEMISTRY - III	5	4
	CHE5CJ 303	CORE COURSE 10 IN MAJOR – ORGANIC CHEMISTRY - III	5	4
		ELECTIVE COURSE 1 IN MAJOR	4	4
		ELECTIVE COURSE 2 IN MAJOR	4	4
6	CHE6CJ 304 / CHE8MN 304	CORE COURSE 11 IN MAJOR – INORGANIC CHEMISTRY - IV	4	4
	CHE6CJ 305 / CHE8MN 305	CORE COURSE 12 IN MAJOR–ORGANIC CHEMISTRY - IV	5	4
	CHE6CJ 306 / CHE8MN 306	CORE COURSE 13 IN MAJOR – PHYSICAL CHEMISTRY – III: CHEMICAL AND PHASE EQUILIBRIA, ELECTROCHEMISTRY AND PHOTOCHEMISTRY	5	4
		ELECTIVE COURSE 3 IN MAJOR	4	4
		ELECTIVE COURSE 4 IN MAJOR	4	4
	CHE6CJ 349	INTERNSHIP IN MAJOR	-	2
TOTAL FOR THE THREE YEARS				**70**
	CHE7CJ 401	CORE COURSE 14 IN MAJOR –THEORETICAL CHEMISTRY III: ADVANCED QUANTUM CHEMISTRY	5	4

7	CHE7CJ 402	CORE COURSE 15 IN MAJOR – INORGANIC CHEMISTRY-V	5	4
	CHE7CJ 403	CORE COURSE 16 IN MAJOR – ORGANIC CHEMISTRY V	5	4
	CHE7CJ 404	CORE COURSE 17 IN MAJOR – PHYSICAL CHEMISTRY IV: STATISTICAL THERMODYNAMICS	5	4
	CHE7CJ 405	CORE COURSE 18 IN MAJOR – INSTRUMENTAL METHODS OF ANALYSIS	5	4
8	CHE8CJ 406 / CHE8MN 406	CORE COURSE 19 IN MAJOR – INORGANIC CHEMISTRY -VI	4	4
	CHE8CJ 407 / CHE8MN 407	CORE COURSE 20 IN MAJOR – ORGANIC CHEMISTRY- VI	5	4
	CHE8CJ 408 / CHE8MN 408	CORE COURSE 21 IN MAJOR – PHYSICAL CHEMISTRY V: ADVANCED TOPICS IN SOLID STATE AND ELECTROCHEMISTRY	4	4
	OR (INSTEAD OF CORE COURSES 19 - 21 IN MAJOR)			
	CHE8CJ 449	PROJECT (IN HONOURS PROGRAMME)	13	12
	CHE8CJ 499	RESEARCH PROJECT (IN HONOURS WITH RESEARCH PROGRAMME)	13	12
		ELECTIVE COURSE 5 IN MAJOR	4	4
		ELECTIVE COURSE 6 IN MAJOR	4	4
		ELECTIVE COURSE 7 IN MAJOR	4	4
	OR (INSTEAD OF ELECTIVE COURSE 7 IN MAJOR, IN HONOURS WITH RESEARCH PROGRAMME)			
	CHE8CJ 489	RESEARCH METHODOLOGY IN CHEMISTRY	4	4
TOTAL FOR THE FOUR YEARS				**114**

ELECTIVE COURSES IN CHEMISTRY

Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
1	CHE5EJ 301	GREEN CHEMISTRY	5	60	4	4	30	70	100
2	CHE5EJ 302	NANOSCIENCE AND NANOTECHNOLOGY	5	60	4	4	30	70	100
3	CHE5EJ 303	BIO CO-ORDINATION CHEMISTRY	5	60	4	4	30	70	100
4	CHE5EJ 304	FOOD CHEMISTRY	5	60	4	4	30	70	100
	Among the four elective courses two can be selected in the fifth semester								
5	CHE6EJ 311	POLYMER CHEMISTRY	6	60	4	4	30	70	100
6	CHE6EJ 312	INDUSTRIAL CHEMISTRY	6	60	4	4	30	70	100
7	CHE6EJ 313	ADVANCED ENERGY MATERIALS	6	60	4	4	30	70	100
8	CHE6EJ 314	MATERIAL SCIENCE	6	60	4	4	30	70	100
	Among the four Elective Courses two can be selected in the Sixth semester								
9	CHE8EJ 409	INDUSTRIAL CATALYSIS	8	60	4	4	30	70	100
10	CHE8EJ 410	ADVANCED ORGANIC CHEMISTRY	8	60	4	4	30	70	100
11	CHE8EJ 411	MODERN ORGANIC SYNTHESIS	8	60	4	4	30	70	100
12	CHE8EJ 412	COMPUTATIONAL CHEMISTRY	8	60	4	4	30	70	100
13	CHE8EJ 413	PETROCHEMICALS AND COSMETICS	8	60	4	4	30	70	100
14	CHE8EJ 414	ADVANCED TOPICS IN INORGANIC CHEMISTRY	8	60	4	4	30	70	100
	Among the Six Elective Courses three can be selected in the Eighth semester								

GROUPING OF MINOR COURSES IN CHEMISTRY

(Title of the Minor:**INTRODUCTORY CHEMISTRY**)

The minor courses given below should not be offered to students who have taken chemistry as the major discipline. They should be offered to students from other major discipiline only

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Inte	Exte	Total

								rnal	rnal	
1		**GENERAL AND THEORETICAL CHEMISTRY** (Preferable for Physics students)								
	1	CHE1MN 101	BASIC INORGANIC AND NANO CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2MN 101	QUANTUM MECHANICS , SOLID STATES AND GASEOUS STATES	2	75	5	4	30	70	100
	3	CHE3MN 201	BASIC ORGANIC CHEMISTRY	3	75	5	4	30	70	100
2		**GENERAL CHEMISTRY AND BIOMOLECULES** (Preferable for Zoology, Botany, Microbiology, Biotechnology and Plant science students)								
	1	CHE1MN 102	BASIC INORGANIC AND BIO-INORGANIC CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2MN 102	LIQUID STATE, GASEOUS STATE AND ELECTROCHEMISTRY	2	75	5	4	30	70	100
	3	CHE3MN 202	BIOORGANIC CHEMISTRY	3	75	5	4	30	70	100
3		**FUNDAMENTALS OF CHEMISTRY AND PHYTOCHEMISTRY** (Preferable for Botany and zoologystudents)								
	1	CHE1MN 103	BASIC INORGANIC AND GREEN CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2MN 103	PHYSICAL PROPERTIES OF SOLUTIONS, GASES AND COLLOIDS	2	75	5	4	30	70	100
	3	CHE3MN 203	ORGANIC AND PHYTOCHEMISTRY	3	75	5	4	30	70	100
4		**FUNDAMENTAL CHEMISTRY OF MATERIALS** (Preferablefor Geology and physics students)								
	1	CHE1MN 104	BASIC INORGANIC CHEMISTRY AND METALLURGY	1	75	5	4	30	70	100
	2	CHE2MN	STATES OF MATTER	2	75	5	4	30	70	100

		104	AND NUCLEAR CHEMISTRY							
	3	CHE3MN 204	ORGANIC CHEMISTRY IN DAILY LIFE	3	75	5	4	30	70	100
5		**BASIC CHEMISTRY AND POLYMER SCIENCE** (Preferable for Environmental science and physics students)								
	1	CHE1MN 105	BASIC INORGANIC AND NUCLEAR CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2MN 105	SOLUTIONS AND SURFACE CHEMISTRY	2	75	5	4	30	70	100
	3	CHE3MN 205	ORGANIC CHEMISTRY AND POLYMERS	3	75	5	4	30	70	100
6		**FUNDAMENTALS OF CHEMISTRY** (Preferable for Physics, Botany, Zoology,and Geology students)								
	1	CHE1MN 100/ CHE1CJ 101	INORGANIC CHEMISTRY – I	1	75	5	4	30	70	100
	2	CHE2MN 100 / CHE2CJ 101	PHYSICAL CHEMISTRY – I: STATES OF MATTER	2	75	5	4	30	70	100
	3	CHE3MN 200/ CHE3CJ 202	ORGANIC CHEMISTRY – I	3	75	5	4	30	70	100
7		**BASIC AND APPLIED CHEMISTRY** (Preferable for Physics, Zoology and Botany students)								
	1	CHE1MN 106	COORDINATION CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2MN 106	FUNDAMENTALS OF PHYSICAL CHEMISTRY	2	75	5	4	30	70	100
	3	CHE3MN 206	APPLIED ORGANIC CHEMISTRY	3	75	5	4	30	70	100

(*Students who are opting for a single minor pathway can choose any two set of minors from groups 1-7)

GROUPING OF VOCATIONAL MINOR COURSES IN CHEMISTRY

(Title of the Vocational Minor: **CHEMISTRY IN TECHNOLOGY)**

The minor courses given below should not be offered to students who have taken chemistry as the major discipline. They should be offered to students from other major discipiline only

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**INDUSTRIAL CHEMISTRY**								
	1	CHE1VN 101	INTRODUCTION TO INDUSTRIAL CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2VN 101	PERSPECTIVES OF INDUSTRIAL CHEMISTRY	2	75	5	4	30	70	100
	3	CHE3VN 201	INDUSTRIAL POLLUTION AND CONTROL	3	75	5	4	30	70	100
	4	CHE8VN 301	INDUSTRIAL QUALITY MANAGEMENT	8	60	4	4	30	70	100
2		**POLYMER CHEMISTRY**								
	1	CHE1VN 102	INTRODUCTION TO POLYMER CHEMISTRY	1	75	5	4	30	70	100
	2	CHE2VN 102	COMMERCIAL POLYMERS	2	75	5	4	30	70	100
	3	CHE3VN 202	PLASTICS AND FIBER TECHNOLOGY	3	75	5	4	30	70	100
	4	CHE8VN 302	POLYMERS IN INDUSTRY	8	60	4	4	30	70	100

(i). Students in Single Major pathway can choose course/courses from any of the Minor/ Vocational Minor groups offered by a discipline other than their Major discipline.

(ii). Students in Major with Multiple Disciplines pathway can choose all the three courses from any one of the Minor/ Vocational Minor groups offered by any discipline, other than his Major discipline as one of the multiple disciplines.

(iii). Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline. Students in Major with Vocational Minor pathway can choose all the courses from any two Vocational Minor groups offered by any discipline. If the students choose any two Vocational Minor groups in Chemistry as given above, then the title of the Vocational Minor will be **Chemistry in Technology**

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN CHEMISTRY

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	CHE1FM105	MULTI-DISCIPLINARY COURSE 1 – ENVIRONMENTAL CHEMISTRY	45	3	3	25	50	75
2	CHE2FM 106	MULTI-DISCIPLINARY COURSE 2 – CHEMISTRY IN DAILY LIFE	45	3	3	25	50	75
3	CHE3FV 108	VALUE-ADDED COURSE 1 – CHEMISTRY OF CONSUMER PRODUCTS	45	3	3	25	50	75
4	CHE4FV 110	VALUE-ADDED COURSE 2 – SOLID WASTE MANAGEMENT	45	3	3	25	50	75
5		SKILL ENHANCEMENT COURSE 2*						
	CHE5FS 112	CHEMISTRY IN EVERYDAY LIFE	45	3	3	25	50	75
	CHE5FS 113	CHEMISTRY OF COSMETICS	45	3	3	25	50	75
*Among the two Skill Enhancement Courses, one course can be selected in the Fifth semester								
6		SKILL ENHANCEMENT COURSE 3*						
	CHE6FS 114	ANALYTICAL TECHNIQUES IN WATER QUALITY ASSESMENT	45	3	3	25	50	75
	CHE6FS 115	SCIENTIFIC COMMUNICATION, PUBLIC OUTREACH AND	45	3	3	25	50	75

		ENTREPRENEURIAL SKILLS						
*Among the two Skill Enhancement Courses, one course can be selected in the Sixth semester								

COURSE STRUCTURE FOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Chemistry (Major A) ***B1: 68 credits in Major B***

A2: 53 credits in Chemistry (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

SEMESTER	**COURSE CODE**	**COURSE TITLE**	**TOTAL HOURS**	**HOURS/ WEEK**	**CREDITS**	**MARKS**		
						INTERNAL	**EXTERNAL**	**TOTAL**
1	CHE1CJ 101/CHE 1MN100	CORE COURSE 1 IN MAJOR CHEMISTRY-INORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB1CJ 101	CORE COURSE 1 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
	CHE1CJ 102/CHE 2CJ102/ CHE2MN 106	CORE COURSE 2 IN MAJOR CHEMISTRY-FUNDAMENTALS OF PHYSICAL CHEMISTRY (FOR BATCH A1 ONLY)	75	5	4	30	70	100
	ENG1FA 101(2)	ABILITY ENHANCEMENT COURSE 1 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 2 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	CHE1FM 105	MULTI-DISCIPLINARY COURSE 1 IN CHEMISTRY-ENVIRONMENTAL CHEMISTRY (FOR BATCH A1 ONLY)	45	3	3	25	50	75
		TOTAL		**24/ 25**	**21**			**525**
2	CHE2CJ 101/ CHE2MN 100	CORE COURSE 3 IN MAJOR CHEMISTRY-PHYSICAL CHEMISTRY – I: STATES OF MATTER	75	5	4	30	70	100
	BBB2CJ 101	CORE COURSE 2 IN MAJOR B	60/ 75	4/ 5	4	30	70	100

	BBB2CJ 102 / BBB1CJ 102	CORE COURSE 3 IN MAJOR B – (FOR BATCH B2 ONLY)	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	ABILITY ENHANCEMENT COURSE 3 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 4 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	CHE2FM 106/CHE 3FM106	MULTI-DISCIPLINARY COURSE 2 IN CHEMISTRY-CHEMISTRY IN DAILY LIFE	45	3	3	25	50	75
		TOTAL		**23 - 25**	**21**			**525**
3	CHE3CJ 201	CORE COURSE 4 IN MAJOR CHEMISTRY-THEORETICAL CHEMISTRY – I: BASIC QUANTUM CHEMISTRY	60	4	4	30	70	100
	CHE3CJ 202 / CHE3MN 200	CORE COURSE 5 IN MAJOR CHEMISTRY-ORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB3CJ 201	CORE COURSE 4 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	CORE COURSE 5 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	MULTI-DISCIPLINARY COURSE 1 IN B	45	3	3	25	50	75
	CHE3FV 108	VALUE-ADDED COURSE 1 IN CHEMISTRY-CHEMISTRY OF CONSUMER PRODUCTS (FOR BATCH A1 ONLY)	45	3	3	25	50	75
		TOTAL		**23 - 25**	**22**			**550**
4	CHE4CJ 203	CORE COURSE 6 IN MAJOR CHEMISTRY- INORGANIC CHEMISTRY - II	75	5	4	30	70	100
		CORE COURSE 6 IN MAJOR B	60/ 75	4/ 5	4	30	70	100

	CHE4CJ 204	CORE COURSE 7 IN MAJOR CHEMISTRY- ORGANIC CHEMISTRY - II (FOR BATCH A1 ONLY)	75	5	4	30	70	100
	CHE4FV 110	VALUE-ADDED COURSE 2 IN CHEMISTRY- SOLID WASTE MANAGEMENT	45	3	3	25	50	75
	BBB4FV 110	VALUE-ADDED COURSE 1 IN B	45	3	3	25	50	75
	CHE4FS 113/CHE 5FS113	SKILL ENHANCEMENT COURSE 1 IN CHEMISTRY- CHEMISTRY OF COSMETICS	45	3	3	25	50	75
		TOTAL		**23/ 24**	**21**			**525**
5	CHE5CJ 302/ CHE6CJ3 08	CORE COURSE 8 IN MAJOR CHEMISTRY INORGANIC CHEMISTRY - III	75	5	4	30	70	100
		CORE COURSE 7 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
	CHE5CJ 301/CHE 6CJ307	CORE COURSE 9 IN MAJOR CHEMISTRY THEORETICAL CHEMISTRY - II- GROUP THEORY AND MOLECULAR SPECTROSCOPY (FOR BATCH A1 ONLY)	60	4	4	30	70	100
		ELECTIVECOURSE 1 IN MAJOR CHEMISTRY*	60	4	4	30	70	100
		ELECTIVECOURSE 1 IN MAJOR B *	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	SKILL ENHANCEMENT COURSE 1 IN B	45	3	3	25	50	75
		TOTAL		**24/ 25**	**23**			**575**
6	CHE6CJ 309/CHE 5CJ303	CORE COURSE 10 IN MAJOR CHEMISTRY- ORGANIC CHEMISTRY – III	75	5	4	30	70	100
		CORE COURSE 8 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100

	BBB6CJ 305	CORE COURSE 9 IN MAJOR B – (FOR BATCH B2 ONLY)	60	4	4	30	70	100
		ELECTIVECOURSE 2 IN MAJOR CHEMISTRY *	60	4	4	30	70	100
		ELECTIVECOURSE 2 IN MAJOR B *	60	4	4	30	70	100
	CHE6FS 114	SKILL ENHANCEMENT COURSE 2 IN CHEMISTRY – ANALYTICAL TECHNIQUES IN WATER QUALITY ASSESMENT (FOR BATCH A1 ONLY)	45	3	3	25	50	75
	CHE6CJ 349	INTERNSHIP IN MAJOR CHEMISTRY (CREDIT FOR INTERNSHIP TO BE AWARDED ONLY AT THE END OF SEMESTER 6)	60		2	50	-	50
		TOTAL		**24/ 25**	**25**			**625**
TOTAL CREDITS FOR THREE YEARS					**133**			**3325**
FOR BATCH A1(B2), THE COURSE STRUCTURE IN SEMESTERS 7 AND 8 IS THE SAME AS FOR PATHWAYS 1 – 4, EXCEPT THAT THE NUMBER OF THE CORE AND ELECTIVE COURSES IS IN CONTINUATION OF THE NUMBER OF COURSES IN THE TWO CATEGORIES COMPLETED AT THE END OF SEMESTER 6.								

* Choose any one elective course each in Major Chemistry from the course basket of four elective courses in Chemistry in semester 5 and four elective courses in Chemistry in semester 6, as listed above in the two tables of elective courses. Choose any one elective course each in Major B from the course basket of elective courses in Major B in semester 5 and semester 6.

CREDIT DISTRIBUTION FOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in Chemistry	General Foundation Courses in Chemistry	Internship/ Project in Chemistry	Major Courses in B	General Foundation Courses in B	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	3	-	4 + 4	-	3 + 3	21
3	4 + 4	3	-	4 + 4	3	-	22
4	4 + 4	3 + 3	-	4	3	-	21
5	4 + 4 + 4	-	-	4 + 4	3	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25

Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in Chemistry	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
* Instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

COURSE STRUCTURE FOR BATCH B1(A2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Chemistry (Major A) ***B1: 68 credits in Major B***

A2: 53 credits in Chemistry (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

SEMESTER	**COURSE CODE**	**COURSE TITLE**	**TOTAL HOURS**	**HOURS / WEEK**	**CREDITS**	**MARKS**		
						INTERNAL	**EXTERNAL**	**TOTAL**
1	CHE1CJ 101/ CHE1MN 100	CORE COURSE 1 IN MAJOR CHEMISTRY- INORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB1CJ 101	CORE COURSE 1 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
	BBB1CJ 102 / BBB2CJ 102	CORE COURSE 2 IN MAJOR B – (FOR BATCH B1 ONLY)	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	ABILITY ENHANCEMENT COURSE 1 – ENGLISH	60	4	3	25	50	75

		ABILITY ENHANCEMENT COURSE 2 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	BBB1FM 105	MULTI-DISCIPLINARY COURSE 1 IN B – (FOR BATCH B1 ONLY)	45	3	3	25	50	75
		TOTAL		**23 – 25**	**21**			**525**
2	CHE2CJ 101/CHE 2MN100	CORE COURSE 2 IN MAJOR CHEMISTRY- PHYSICAL CHEMISTRY – I: STATES OF MATTER	75	5	4	30	70	100
	BBB2CJ 101	CORE COURSE 3 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
	CHE2CJ 102/CHE 1CJ102/C HE2MN 106	CORE COURSE 3 IN MAJOR CHEMISTRY- FUNDAMENTALS OF PHYSICAL CHEMISTRY (FOR BATCH A2 ONLY)	75	5	4	30	70	100
	ENG2FA 103(2)	ABILITY ENHANCEMENT COURSE 3 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 4 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	CHE2FM 106/CHE 3FM106	MULTI-DISCIPLINARY COURSE 2 IN CHEMISTRY- CHEMISTRY IN DAILY LIFE	45	3	3	25	50	75
		TOTAL		**24/ 25**	**21**			**525**
3	CHE3CJ 201	CORE COURSE 4 IN MAJOR CHEMISTRY- THEORETICAL CHEMISTRY – I: BASIC QUANTUM CHEMISTRY	60	4	4	30	70	100
	CHE3CJ 202/ CHE3MN 200	CORE COURSE 5 IN MAJOR CHEMISTRY-ORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB3CJ 201	CORE COURSE 4 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	CORE COURSE 5 IN MAJOR B	60/ 75	4/ 5	4	30	70	100

	BBB3FM 106 / BBB2FM 106	MULTI-DISCIPLINARY COURSE 2 IN B –	45	3	3	25	50	75
	BBB3FV 108	VALUE-ADDED COURSE 1 IN B – (FOR BATCH B1 ONLY)	45	3	3	25	50	75
		TOTAL		**23 – 25**	**22**			**550**
4	CHE4CJ 203	CORE COURSE 6 IN MAJOR CHEMISTRY -INORGANIC CHEMISTRY - II	75	5	4	30	70	100
		CORE COURSE 6 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
		CORE COURSE 7 IN MAJOR B – (FOR BATCH B1 ONLY)	60/ 75	4/ 5	4	30	70	100
	CHE4FV 110	VALUE-ADDED COURSE 1 IN CHEMISTRY-SOLID WASTE MANAGEMENT	45	3	3	25	50	75
	BBB4FV 110	VALUE-ADDED COURSE 2 IN B –	45	3	3	25	50	75
	CHE4FS 113/CHE 5FS113	SKILL ENHANCEMENT COURSE 1 IN CHEMISTRY-CHEMISTRY OF COSMETICS	45	3	3	25	50	75
		TOTAL		**22 – 24**	**21**			**525**
5	CHE5CJ 304/CHE 4CJ204	CORE COURSE 7 IN MAJOR CHEMISTRY-ORGANIC CHEMISTRY - II	75	5	4	30	70	100
		CORE COURSE 8 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
		CORE COURSE 9 IN MAJOR B – (FOR BATCH B1 ONLY)	60	4	4	30	70	100
		ELECTIVECOURSE 1 IN MAJOR CHEMISTRY*	60	4	4	30	70	100
		ELECTIVECOURSE 1 IN MAJOR B *	60	4	4	30	70	100

	BBB5FS 112 / BBB4FS 112	SKILL ENHANCEMENT COURSE 1 IN B	45	3	3	25	50	75
		TOTAL		**24/ 25**	**23**			**575**
6	CHE6CJ308/CHE5CJ302	CORE COURSE 8 IN MAJOR CHEMISTRY- INORGANIC CHEMISTRY - III	75	5	4	30	70	100
		CORE COURSE 10 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
	CHE6CJ307/CHE5CJ301	CORE COURSE 9 IN MAJOR CHEMISTRY-THEORETICAL CHEMISTRY – II GROUP THEORY AND MOLECULAR SPECTROSCOPY (FOR BATCH A2 ONLY) SPECTROSCOPY AND GROUP THEORY (FOR BATCH A2 ONLY)	60	4	4	30	70	100
		ELECTIVECOURSE 2 IN MAJOR CHEMISTRY*	60	4	4	30	70	100
		ELECTIVECOURSE 2 IN MAJOR B*	60	4	4	30	70	100
	BBB6FS 113	SKILL ENHANCEMENT COURSE 2 IN B – (FOR BATCH B1 ONLY)	45	3	3	25	50	75
	BBB6CJ 349	INTERNSHIP IN MAJOR B (CREDIT FOR INTERNSHIP TO BE AWARDED ONLY AT THE END OF SEMESTER 6)	60		2	50	-	50
		TOTAL		**24/ 25**	**25**			**625**
TOTAL CREDITS FOR THREE YEARS					**133**			**3325**

TO CONTINUE TO STUDY CHEMISTRY IN SEMESTERS 7 AND 8, BATCH B1(A2) NEEDS TO EARN ADDITIONAL 15 CREDITS IN CHEMISTRY TO MAKE THE TOTAL CREDITS OF 68. SUPPOSE THIS CONDITION IS ACHIEVED, AND THE STUDENT OF BATCH B1(A2) PROCEEDS TO THE NEXT SEMESTERS TO STUDY CHEMISTRY. THE COURSE STRUCTURE IN SEMESTERS 7 AND 8 IS THE SAME AS FOR PATHWAYS 1 – 4, EXCEPT THAT THE NUMBER OF THE CORE AND ELECTIVE COURSES IS IN CONTINUATION OF THE NUMBER OF COURSES IN THE TWO CATEGORIES COMPLETED AT THE END OF SEMESTER 6, TAKING INTO ACCOUNT THE NUMBER OF COURSES IN CHEMISTRY TAKEN ONLINE TO EARN THE ADDITIONAL 15 CREDITS.

*Choose any one elective course each in Major Chemistry from the course basket of four elective courses in Chemistry in semester 5 and four elective courses in Chemistry in semester 6, as listed above in the two tables of elective courses. Choose any one elective course each in Major B from the course basket of elective courses in Major B in semester 5 and semester 6.

CREDIT DISTRIBUTION FOR BATCH B1(A2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in B	General Foundation Courses in B	Internship/ Project in B	Major Courses in Chemistry	General Foundation Courses in Chemistry	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	-	-	4 + 4	3	3 + 3	21
3	4 + 4	3 + 3	-	4 + 4	-	-	22
4	4 + 4	3	-	4	3 + 3	-	21
5	4 + 4 + 4	3	-	4 + 4	-	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in B	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
* Instead of three Major courses							
Total for	**88 + 12 =**						**177**

Four Years	**100**	**12**					

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
   - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
   - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.
3. All the 3-credit courses (General Foundational Courses) in chemistry are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practical	On the other 4 modules		
1	4-credit	only theory	10	20	70	100

	course	(5 modules)				
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
		20	10	10	20*
	Total	30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- Combining the rough and fair records into a single record for lab experiments is sufficient; there's no need to maintain them separately. The consolidated record can be submitted for evaluation at the end of the semester.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.

- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who have done 75% of the experiments alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students. (Performance in the lab - 7 Marks, Attendance in the lab - 3 Marks)	10	50%
2	Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
3	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10

Total Marks	70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Chemistry or allied disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. In BSc. Chemistry Honours programme, institute/ industryvisit or study tour is a requirement for the completion of Internship. Visit to minimum one national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the study tour has to be submitted with photos and analysis.
5. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
6. The log book and the typed report must be submitted at the end of the Internship.

7. The institution at which the Internship will be carried out should be prior-approved by the Department Councilof the college where the student has enrolled for the UG Honours programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Councilof the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

<table>
<tr><th>Sl. No.</th><th colspan="2">Components of Evaluation of Internship</th><th>Marks for Internship 2 Credits</th><th>Weightage</th></tr>
<tr><td>1</td><td rowspan="3">Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council</td><td>Acquisition of skill set</td><td>10</td><td rowspan="3">40%</td></tr>
<tr><td>2</td><td>Interim Presentation and Viva-voce</td><td>5</td></tr>
<tr><td>3</td><td>Punctuality and Log Book</td><td>5</td></tr>
<tr><td>4</td><td colspan="2">Report of Institute Visit/ Study Tour</td><td>5</td><td>10%</td></tr>
<tr><td>5</td><td rowspan="3">End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council</td><td>Quality of the work</td><td>6</td><td rowspan="3">35%</td></tr>
<tr><td>6</td><td>Presentation of the work</td><td>5</td></tr>
<tr><td>7</td><td>Viva-voce</td><td>6</td></tr>
<tr><td>8</td><td colspan="2">Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council</td><td>8</td><td>15%</td></tr>
<tr><td></td><td colspan="2">Total Marks</td><td>50</td><td></td></tr>
</table>

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution / any other higher educational institution (HEI) / research centre/ training centre.
- The project in Honours programme can be a short research work or an extended internship or a skill based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ST/OBC(non creamy layer)/ Differently-Abled/Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three core courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty member with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximumfive students in Honours with Research stream.

- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Chemistry or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ theoretical/ computational in nature.
4. There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as Honours with Research programme
5. There should be minimum 13 hrs./ week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme
6. The various steps in project works are the following:

   Wide review of a topic.

   Investigation on a problem in systematic way using appropriate techniques.

   Systematic recording of the work.

   Reporting the results with interpretation in a standard documented form.

   Presenting the results before the examiners.
7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.

9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The Project in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Councilof the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through	90	30%

interim presentations and reports by the committee internally constituted by the Department Council		
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	60	20%
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours / Honours with Research programme)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours / Honours with Research programme)
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Chemistry are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General Foundation Course in Chemistry	Internal Marks of a General Foundation Course of 3-credits in Chemistry	
		4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
		20	5
	Total	25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

5.LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.

- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):

The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

i.e. SGPA (Si) = Σi (Ci x Gi) / Σi (Ci)

where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.
  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

CORE COURSES IN MAJOR

CALICUT UNIVERSITY – FOUR-YEAR UNDERGRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**INORGANIC CHEMISTRY I**				
Type of Course	**MAJOR/MINOR**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Scope of chemistry, Interdisciplinary areas involving chemistry. Fundamentals of periodic properties of elements, Atoms and molecules, Need for chemical bonding and its types, Awareness on nature of experiments and health risk, hazard associated with chemicals, Mole concept				
Course Summary	This course explores the importance of chemistry as a central discipline of science. It introduces the periodic properties of elements, concept of chemical bonding and explanation of inorganic molecular structure using hybridization and MO theory. A few basic topics of the emerging area of Nanochemistry are also introduced in this course. The basic laboratory safety, concepts in volumetric analysis and related practical experiments are also covered.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the role of chemistry in science and scientific research with emphasis on analytical data evaluation	U	C	Instructor- created exams/ Quizzes/Assignments
CO2	Conceptualize and predict chemical bonding, molecular structures using	An	P	Instructor- created exams/ Quizzes/assignments

	dipole moment, hybridisation, and MO Theory			
CO3	Develop a basic understanding of the extraordinary properties of nanomaterials and its applications.	U	C	Instructor- created exams/ Quizzes/Assignments
CO4	Apply the concepts of lab safety measurements and volumetric analysis	Ap	M	Instructor- created exams/ Assignments/problem solving
CO5	Enable students to develop analytical skills in inorganic quantitative volumetric analysis.	Ap	P	Group work /Viva Voce// Observation of practical skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks
I	**CHEMISTRY AS A SCIENCE DISCIPLINE & SCIENTIFIC ANALYSIS**		**8**	**17**
	1	Science- Chemistry as a branch of science, History of chemistry, Involvement of chemistry in daily life (Mention only)	**1**	
	2	Introduction to analytical chemistry, Classification of analytical methods: Qualitative and Quantitative analysis (Mention with examples)	**1**	
	3	Treatment of analytical data - Significant figures – Accuracy – Precision – Methods of representing Accuracy, Absolute error, Relative error, Types of errors, Constant errors, Proportional errors, Correction of determinate errors	**3**	
	4	Methods of representing Precision –Mean, Average deviation, Standard deviation, Relative standard deviation, Coefficient of variation, Variance, Rejection of a result: Q test, Methods of least squares	**3**	
II	**CHEMICAL BONDING AND MOLECULAR STRUCTURE**		**17**	**38**
	5	Periodic Properties and their Periodic Trends: (a) Atomic and Ionic radius (include isoelectronic species in discussion) (b) Ionisation energy: (c) Electron	**2**	

		affinity (d) Electronegativity (Pauling, Mulliken Allred & Rochow scales).		
	6	Classification of bonds: Ionic bond - Definition, Factors affecting the formation of ionic bond. Characteristics of ionic compounds. Lattice energy	**1**	
	7	Born Haber cycle - Born Lande equation (derivation not needed) - Covalent –(Mention polar and non polar compounds) and Coordinate bond	**2**	
	8	Dipole moment and its applications: (Prediction of linearity and symmetry of polyatomic molecules, Prediction of position of substituents in aromatic compounds, Measurement of bond angle)	**2**	
	9	Covalent Bond, Lewis concept of covalent bond, Atomic orbital overlap, Concept of covalency, Variable covalency and Maximum covalency	**2**	
	10	Prediction of Covalent character in ionic bond using Fajans rule. Prediction of Ionic character in Covalent bond using Hannary Smidth equation.	**1**	
	11	Structure of molecules by the concept of Hybridisation: NO_3^-, CO_3^{2-}, SO_4^{2-} ,IF_7, XeO_3, XeO_4, XeF_2, XeF_4, XeF_6, ClF_3, BrF_5, SF_4	**3**	
	12	Introductory MO Theory: Homoatomic molecules in N_2 and O_2 and their ions (comparison of bond order, bond length and stability), MO Theory: Heteroatomic molecules like NO, CO, HCl, HF, LiF.	**4**	
III	**INTRODUCTION TO NANOMATERIALS**		**10**	**21**
	13	Definition of Nanomaterials, Historical revolution of Nanochemistry , Nanochemistry and Nanotechnology, Classification of nanostructures based on electron confinement (0D, 1D and 2D)	**2**	
	14	Synthesis of Nanomaterials: Bottom Up and Top down approaches (Elementary idea with examples)	**1**	
	15	Metal nanoparticles (gold and silver nanoparticles), Semiconductor nanoparticles (CdS and CdSe nanoparticles), Metal oxide nanoparticles (zinc oxide, iron oxide, silica and titania nanoparticles), Nanocomposites, Nanoceramics (Definition with examples), Carbon Based Nanomaterials: Graphene, Carbon Nanotubes, Fullerenes, Carbon dots (elementary idea only)	**2**	
	16	Characteristics of Nanomaterials: Surface area to volume ratio and its significance, Novel properties of Nanomaterials, Size dependent optical (surface	**3**	

		plasmon resonance), Electronic, Mechanical, magnetic and catalytic properties (No deep discussion is needed)		
	17	Applications of nanomaterials: Electronics (Batteries, Solar cell), Biomedical (Drug Delivery) and Environmental based applications (Water Purification, Dye Removal) (General idea only)	**2**	
IV	**FUNDAMENTALS OF ANALYTICAL CHEMISTRY**		**10**	**22**
	18	Lab safety measurements: Awareness of material safety data sheet (MSDS), Safe storage and handling of hazardous chemicals, Simple first aids; Electric shocks, fire, Cut by glass and inhalation of poisonous gas.	**2**	
	19	Accidents due to acids and alkalis, Burns due to phenol and bromine, Disposal of waste chemicals, Disposal of sodium and broken mercury thermometer, -R and S phrases (elementary idea only), Personal protective Equipment (PPE)	**1**	
	20	Mole concept - Equivalent mass - Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles - Numerical Problems related to basic concepts.	**2**	
	21	Volumetric Analysis: Introduction - Primary and secondary standards – Standard solutions – Theory of titrations involving acids and bases, Permanganometry, Dichrometry, Iodometry, Iodimetry Precipitation and Complexometric titrations.	**3**	
	22	Indicators: Theory of acid-base, redox, adsorption and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
V	**INORGANIC CHEMISTRY PRACTICAL I- VOLUMETRIC ANALYSIS**		**30**	
	1	**General Instructions:** Use a safety coat, gloves, shoes and goggles in the laboratory. For weighing electronic balance must be used. Double burette titration method may be used for titrations. Standard solution must be prepared by the student. A minimum of 7 experiments must be done from Section B and C.		

Section D is open-ended and the experiments can be selected by the teacher

SECTION A

Importance of lab safety – Burns, Eye accidents, Cuts, Gas poisoning, Electric shocks, Treatment of fires, Precautions and Preventive measures.

Weighing using electronic balance, Preparation of standard solutions.

SECTION B

Neutralization Titrations

1. Acidimetry and Alkalimetry: Strong acid Vs Strong base
2. Acidimetry and Alkalimetry: Strong acid Vs Weak base

SECTION C

Redox Titrations

1. Permanganometry: Estimation of $Fe^{2+}/FeSO_{4.}$ 7H2O/Mohr's salt
2. Permanganometry: Estimation of Oxalic acid
3. Permanganometry: Estimation of Calcium using std KMnO4
4. Dichrometry: Estimation of Fe^{2+}/ $FeSO_{4.}$ 7H2O /Mohr's salt
5. Dichrometry: Estimation of Ferric iron
6. Iodometry and Iodimetry: Estimation of Copper
7. Iodometry and Iodimetry: Estimation of Iodine

SECTION D

Open Ended (Any two experiments are to be conducted. may be selected from the below list or the teacher can select related experiments)

1. Determination of acetic acid content in vinegar by titration with NaOH.

		2. Determination of alkali content in antacid tablets by titration with HCl. 3. Determination of available chlorine in bleaching Powder. 4. Estimation of Cu in Brass		

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Further Reading

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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3			2	1	1	3				3	1	1
CO 2	2	2					2				2		1
CO 3	2		1	2	2	3	2			1	2	1	2
CO 4			3		2	2	2		1		1	1	1
CO 5			3		2	3	3		1		2	1	2

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/ Viva/ Seminar	Practical skill evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓	✓	

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

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**PHYSICAL CHEMISTRY – I: STATES OF MATTER**				
Type of Course	**MAJOR/MINOR**				
Semester	**II**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NCERT or equivalent chemistry syllabus of XI and XII, https://onlinecourses.swayam2.ac.in/nce24_sc07/preview				
Course Summary	Atoms and molecules form the matter that is recognisable for us in the real world, as gases, liquids and solids. Why would they exist as they are? And why would they behave as they do? This course is designed to introduce first year UG students, the physical chemistry of matter in different states of its existence through theory and laboratory experiments. The course explains the various types of interactions between atoms and molecules and their important role in physical and chemical characteristics of the different states of matter. The course introduces the theory and experimental methods that are commonly used to study the various states of matter.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basic nature of real gases and understand interactions at molecular levels	U	C	Assignments/Quiz designed by the instructor
CO2	To recognise the significance of various interactions in condensed matter	U	C	Assignments/Quiz designed by the instructor

CO3	To analyse the physical properties of liquids through theory and practical experiments	An	P	Seminars and exams
CO4	To explain the regular, periodic arrangement of atoms in solids and appreciate the concept of unit cells	An	P	Seminars/ exams
CO 5	To evaluate and understand the importance of the X-ray diffraction technique for characterisation of crystalline solids	Ap	P	Lab/Discussion/Assignments
CO 6	To execute experiments to determine and tune the various colligative properties of dilute solutions	C	P	Lab/Viva voce exams
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks
I		**GASEOUS STATE**	**15**	**33**
	1	Kinetic theory of gasses: derivation	**1**	
	2	Maxwell-Boltzmann distribution of molecular velocities -– Average velocity, RMS velocity and most probable velocity (derivations not required)	**2**	
	3	Collision theory – Collision diameter- Collision number-Collision frequency - Mean free path – Molecular beams (Mention only)	**2**	
	4	Real gas- Deviation from ideal behavior- Compressibility factor – Virial equation and Virial coefficients- van der Waals equation of state (derivation required)-features of van der Waals equation - Expression of van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gasses – Andrews' experiments - Continuity of states - Isotherm of van der Waals equation	**6**	

	5	Critical phenomena - Critical constants - Relationship between critical constants and van der Waals constants - Experimental determination of critical constants - Supercritical carbon dioxide and its applications.	**4**	
II		**LIQUID STATE**	**8**	**17**
	6	Discussion of different types (with suitable examples) of molecular interactions- dipole-dipole, dipole-induced dipole, induced dipole-induced dipole interactions, Lennard-Jones 6-12 potential.	**2**	
	7	Properties of liquids- Vapour pressure, Refractive index, Surface tension- Interfacial tension and viscosity - Poiseuille's equation – Explanation of these properties on the basis of intermolecular forces.	**3**	
	8	Hydrogen bonding in water and other polar molecules, its relevance in biological systems.	**2**	
	9	Liquids on solid surfaces- Hydrophobic and Hydrophilic, Superhydrophilic and Superhydrophobic surfaces- simple explanation by using the water drop contact angles on surfaces	**1**	
III		**SOLID STATE**	**15**	**33**
	10	Crystalline and amorphous solids- atomic and molecular solids- nucleation and growth of crystals.	**2**	
	11	Crystalline Materials – Periodicity- Types of Close packing and packing fraction.	**1**	
	12	Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended).	**4**	
	13	X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor,	**3**	
	14	Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction.	**3**	
	15	Structural transitions in TiO_2- anatase, rutile and brookite phases	**1**	
	16	Concepts of melting point/boiling point and molecular/atomic/ionic interactions, Examples: CO_2, N_2, H_2O, NH_3, NaCl, TiO_2	**1**	
IV		**SOLUTIONS**	**7**	**15**

	17	Solubility of gases in liquids – Henry's law and its applications	**1**	
	18	Colligative properties - Relative lowering of vapour pressure	**1**	
	19	Colligative properties- Elevation in boiling point and depression in freezing point	**1**	
	20	Colligative properties- Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its technological relevance	**1**	
	21	Determination of molecular mass using colligative properties	**1**	
	22	Solid Solutions: Substitutional and interstitial solid solutions, Differences between Alloys, Mixtures and Composites. Colloids: Dispersed phase and dispersing medium, Sol, Emulsion, Foam, and Aerosol, Tyndall effect, Nephelometry	**2**	
V	**PHYSICAL CHEMISTRY PRACTICALS**		**30**	
		A minimum of 5 practical experiments out of which ONE EACH from sections 1, 2 and THREE from section 3 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-typed printed form. **Section 1** 1. Determination of cryoscopic constant (K_f) of solid solvent using a solute of known molecular mass. (Solvent: Naphthalene, biphenyl Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) 2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (K_f). (Solvent: Naphthalene, biphenyl Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) **Section 2** 3. Determination of molal transition point depression constant (K_t) of salt hydrate using solute of known molecular mass. (Salt hydrates: $Na_2S_2O_3.5H_2O$, $CH_3COONa.3H_2O$. Solutes: Urea, Glucose) 4. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (K_t). (Salt hydrates: $Na_2S_2O_3.5H_2O$, $CH_3COONa.3H_2O$. Solutes: Urea, Glucose)	**3** **3** **3** **3**	

		Section 3 5. Determination of viscosity of various liquids using Ostwald's viscometer. 6. Study of glycerine-water system and determination of percentage of glycerine using viscometer [plot composition (c) *versus* time of flow x density of the solution (td)]. 7. Determination of the surface tension of a liquid or a dilute solution (NaCl / surfactant) using a stalagmometer (drop number method). 8. Determination of composition of glycerine-water mixture by refractive index method. 9. Determination of refractive indices of KCl solutions of different concentrations and unknown concentration of KCl solution. 10. Indexing powder XRD patterns and determination of unit cell parameters of simple and/or bcc and/or fcc systems (Instructors must provide the powder XRD patterns and ask students to index it and calculate unit cell parameters)	**3** **3** **3** **3** **3** **3**	
		References: **Module I o IV** 1. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) 2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) 3. Solid State Chemistry and its Applications, 2nd Edition, A R West, (Wiley, 2014) **Module V** 4. Findlay's Practical Physical Chemistry, Ninth Edition, Revised and Edited by B P Levitt, (Longman, London, 1973) 5. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.. 6. R. C. Das, B. Behra, Experiments in Physical Chemistry, Tata McGraw Hill, New Delhi, 1983.		

		Further reading 7. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013. 8. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006. 9. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Edn.,John Wiley and Sons, Canada, 1980. 10. D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill Book Company, New York, 1962. 11. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, Cambridge, 2009		

Mapping of COs with PSOs and POs :

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

Correlation Levels:

Level	Correlation
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

CALICUT UNIVERSITY – FOUR-YEAR UNDERGRADUATE PROGRAMME (CU-FYUGP)

B. Sc. CHEMISTRY

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

Course Outcomes (CO):

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

CO1	*recognize* the importance and the impact of quantum revolution in science.	R	F	Assignment
CO2	*identify* the wave functions of hydrogen atom as atomic orbitals.	U	C	Class tests/Viva
CO3	*apply* the concept of atomic orbitals in chemical bonding (the mixing of wave functions of the two combining atoms).	Ap	C	Seminar/ Class tests
CO4	*relate* the concept of hybridization as linear combination of atomic orbitals of the same atom.	An	P	Class tests/Assignment
CO5	*instill* an atomic/molecular level philosophy in the minds of the students.	C	M	Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks
I	**The Quantum revolution and its early impact in atomic structure**		**8**	**21**
	1	Experiments which led to the development and generalisation of quantum theory – black body radiation, Planck’s quantum hypothesis, photoelectric effect, Einstein’s generalisation of quantum theory	3	
	2	Atomic model partly based on quantum theory – Bohr’s theory of the atom, calculation of Bohr radius, velocity and energy of an electron.	3	
	3	Atomic spectra of hydrogen and explanation using Bohr’s theory; Limitations of Bohr’s theory; Louis de Broglie's matter waves – wave-particle duality; Davisson and Germer experiment.	2	
	Sections from References: **Section A**			

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

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

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

Books and References:

Section A

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

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

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

Section B

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

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

Further reading

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

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

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

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basics of Organic chemistry	U	C	Test /Seminar
CO2	To understand the basic concepts of reaction mechanisms	U	p	Discussion/ Assignment
CO3	To recognize the various types of organic reactions and reaction intermediates	An	P	Quizzes/Test
CO4	To realise the importance of stereoisomerism, optical activity and chirality	Ap	P	Discussion/Seminar /Assignment
CO5	To enable the students to improvise Molecular models	Ap	P	Assignment/Test

CO6	To empower students in various separation and purification techniques	Ap	P	Lab work/Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

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

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

References

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

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

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

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

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

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

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

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

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

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

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

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**INORGANIC CHEMISTRY-II**				
Type of Course	**MAJOR**				
Semester	**4**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Classification of elements to different blocks, Comparative study of s and p block elements based on electronic configuration and atomic size, General idea about transition and inner transition elements, Concept of coordinate bond, Differences between double salts and complexes, Ligands, Coordination number. Concept of catenation and polymerization. Theoretical and practical knowledge about volumetric analysis.				
Course Summary	This course explains characteristics of s, p, d and f block elements. It also gives an insight into various theories in coordination compounds. It explores the application of inorganic chemistry in daily life. It covers practical application of complex formation in quantitative analysis.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Elucidate the trends in physical and chemical properties of s and p block elements	U	C	Instructor- created exams/ Quizzes/assignments
CO2	To Evaluate the general characteristics of Transition and Inner Transition elements, their comparison and applications	U	C	Instructor- created exams/ Quizzes/assignments

CO3	To demonstrate knowledge of coordination chemistry, isomerism and theories of bonding in coordination compounds	U	M	Instructor- created exams/ Quizzes/assignments
CO4	To analyze different types of inorganic polymers their structures, properties and applications	An	C	Instructor- created exams/ Quizzes/assignments
CO5	To Appreciate the utility of inorganic compounds in day to day life	Ap	M	Instructor- created exams/ Quizzes/assignments
CO6	To Apply the knowledge of complex formation and gain hands on experience in in quantitative analysis with some day to day application	Ap	P	Group work /Viva Voce// Observation of practical skill

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**s & p BLOCK ELEMENTS**	**15**	**33**
	1	s block General properties: Ionization Energy, Flame coloration, Photoelectric effect, Metallic character, Hydration energy.	2	
	2	p block elements: Comparative study- Halides, Sulfates, Carbonates and bicarbonates (solubility and thermal stability)	1	
	3	Oxidation number and inert pair effect, Comparison of Lewis acidity of boron halides.	2	
	4	Preparation, Properties, Structure and uses of Diborane, Boric acid, Borazine and Boron nitride, Structure of $AlCl_3$	3	
	5	Structure and bonding of oxides of N (N_2O, NO, N_2O_3,NO_2,N_2O_4,N_2O_5) and S (SO_2 and SO_3)	2	
	6	Oxo acids of P (H_3PO_2, H_3PO_3, H_3PO_4) and Cl (HOCl, $HOCl_2$, $HOCl_3$,$HOCl_4$) (Structure and Acid strength), Colour and Bond Dissociation energy of halogens.	1	
	7	Interhalogen compounds: Preparation, Properties, Uses and Structure (One example each for AB,AB_3,AB_5 and AB_7 types), Electropositive character of iodine, Pseudo	3	

		halogen: Comparison of Pseudo halogen (Cyanogen as example) and halogens and structure of Poly halide ions.		
	8	Noble gases: Isolation of noble gases: Dewar's method- Separation by charcoal adsorption method, Uses of He, and Ne	1	
II		**TRANSITION AND INNER TRANSITION ELEMENTS**	**8hr**	17
	9	Electronic configuration and General characteristics, Ionization energy, Colour, Magnetic properties, Reducing properties, Catalytic properties.	**2**	
	10	Non-stoichiometric compounds, Complex formation and Alloy formation. Comparison of 3d, 4d and 5d transition series. Important application of transition metals. Isopoly and heteropoly anions of W and Mo.	**2**	
	11	Lanthanides and Actinides- Electronic configuration and General properties. Isolation of Lanthanides from monazite sand, Separation by ion exchange method.	**2**	
	12	Magnetic properties. Lanthanide contraction, causes and consequences. Industrial importance of Lanthanides. Comparison of Actinides & Lanthanides [Mention only].	**2**	
III		**COORDINATION CHEMISTRY**	**15 hr**	**33**
	13	IUPAC Nomenclature of complexes, Types of ligands: (mono, bi, tri, tetra, hexa, ambidentate, chelate and macrocyclic ligands), Isomerism-Structural and Stereoisomerism,	**2**	
	14	Review of Werner's theory and Sidwick concept of coordination-EAN rule,	**1**	
	15	Factors affecting stability of complexes, Application of coordination complexes in quantitative and qualitative analysis.	**2**	
	16	Theories of bonding, VBT (valence bond theory), Geometry of coordination numbers 4 & 6, Limitation of VBT.	**2**	
	17	Crystal field Theory: CFT-splitting of d orbitals in Octahedral and Tetrahedral complexes. CFSE of low spin and high spin octahedral complexes- Normal and inverse	**3**	

		spinel compounds, Factors affecting crystal field splitting, Spectrochemical series.		
	18	CFT-splitting of d orbitals in Tetragonal and Square planar Complexes. Magnetism (spin only magnetic moment) and Colour (d-d transition), Distorted octahedral complexes-Jhan-Teller theorem, CFSE calculation and its applications, Merits and demerits of CFT.	**5**	
IV		**INDUSTRIALLY IMPORTANT INORGANIC COMPOUNDS AND THEIR APPLICATION IN DAILY LIFE**	**7 hr**	**15**
	19	Inorganic Polymers: Homochain Polymers and Heterochain Polymers.	**1**	
	20	Structure and Applications of Silicones, Silicates, Zeolites, Phosphazenes, Preparation, Properties and Structure of di and tri phosphonitrilic chlorides, SN compounds: Preparation Methods, Properties and Structure of S_2N_2,, S_4N_4 and $(SN)_x$,,	**3**	
	21	Refractory materials: Borides and Carbides, Inorganic fertilizers: Essential Nutrients to plants- Nitrogenous, Phosphate and Potash fertilizers-Examples with formula, Rocket Propellants: Classification with examples.	**2**	
	22	Cement: Ingredients, Setting of cement, Role of gypsum Glass: Varieties of glass.	**1**	
V		**INORGANIC CHEMISTRY PRACTICAL II: COMPLEXOMETRIC TITRATIONS AND INORGANIC PREPARATIONS**	**30 hr**	
		From Section A Minimum of 3 experiments must be done and from Section B Minimum 3 experiments must be done **Section A** **Complexometry** 1. Estimation of magnesium 2. Estimation of Zinc 3. Determination of hardness of water 4. Determination of COD of water samples **Section B** **Inorganic preparations:** (a) Ferric alum,		

		(b)Nickel (II) dimethylglyoximate, (c)Tetraammine copper (II) sulfate, (d)Potash alum **Open Ended:** Any two experiments related to complexometry can be selected by the teacher		

References :

1. B.R. Puri L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi,2010.

2. S. Prakash, G. D. Tuli, S. K. Basu, R. D.Madan, Advanced Inorganic Chemistry,5th Edn.,Vol.I,S Chand,2012.

3. J.D. Lee, Concise Inorganic Chemistry,5th Edn.,Wiley India Pvt.Ltd.,2008.

4. R. Gopalan, V.Ramalingam, Concise Coordination Chemistry, 1st Edn.,Vikas Publishing House, New Delhi,2001.

5. G. S. Manku ,Theoretical Principles of Inorganic Chemistry. McGraw-Hill Education; New edition (1 August 1982)

6. M.C. Day, J.Selbin,Theoretical Inorganic Chemistry,East West Press,New Delhi,2002.

7. J. E. Huheey, E.A.Keitler,R.L.Keitler,Inorganic Chemistry-Principles of Structure and Reactivity,4TH Edn.,Pearson Education, New Delhi,2013.

8. M.N. Greenwood, A. Earnshaw, Chemistry of elements, 2nd Edn., Butterworth,1997.

9. B.K. Sharma, Industrial chemistry, 11th Edn., Goel publishing House, Meerut, 2000.

10. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

11. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Further Reading

1. W.U.Malik, G.D.Tuli, R.D. Madan, selected Topics in Inorganic Chemistry, S. Chand and Co., New Delhi,2010(Reprint)

2. F.A.Cotton,G.Wilkinson,Advanced Inorganic Chemistry,6^{TH} Edn.,Wiley India Pvt.Ltd., New Delhi,2009.

3. James E. House, Inorganic Chemistry, academic press, 2008.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO1	3			-	2	2	3				2		1
CO2	3		-	-	2	2	3				1	1	2
CO3	3	-		-	-	-	2		1		1		2
CO4	3	-			3	3	3		2	1	2		2
CO5	2		-	-	3	2	2		1	1	2	2	2
CO6	2	-	2		3	3	2		2	1	3	1	2

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ORGANIC CHEMISTRY-II**				
Type of Course	**MAJOR**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Concept of isomerism: Types of isomerism - constitutional isomerism (chain, position and functional) 2. Basic idea about organic addition reactions, substitution and elimination reactions, aromatic substitution reactions etc.				
Course Summary	The concepts of chirality, Optical isomerism, Relative and absolute configuration and racemic mixture and its separation are included in the first module. The course is designed to provide a comprehensive understanding of addition, substitution and elimination reactions of organic chemistry. The practical component of the course helps to acquire skills in organic synthesis and Column chromatographic techniques.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the concepts of chirality, optical isomerism and relative and absolute configuration.	U	C	Seminar presentation /Assignment
CO2	To provide a comprehensive understanding of addition reactions in organic chemistry, To understand the mechanisms and stereochemistry of addition reactions.	Ap	P	Class test /Quiz /Assignment

CO3	Understanding the mechanism and stereochemical aspects of substitution reaction at sp3 carbon.	An	P	Seminar Presentation / Instructor created exam
CO4	To provide a comprehensive understanding of elimination reactions.	U	C	Instructor-created exams / Home Assignments
CO5	Examine the mechanisms and factors influencing aromatic substitution reactions.	Ap	P	Assignment /Seminar presentation /Class test
CO6	Execute practical lab techniques in organic synthesis. Acquire skills in conducting column Chromatography for the separation mixtures. Chromatography for the separation mixtures.	Ap	P	Lab work /Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours	Marks
I	**Stereochemistry II**		13	29
	1	Optical Isomerism: Optical activity – Concept of chirality – Chirality in organic molecules.	2	
	2	Enantiomers, Diastereomers and Meso compounds.	2	
	3	Optical isomerism in glyceraldehyde, lactic acid and tartaric acid.	1	
	4	Relative and absolute configuration - DL system, RS system of nomenclature for acyclic optical isomers with one and two asymmetric carbon (Amino acids ,Tartaric acids)– sequence rules. Erythro and threo representations (basic idea only)	4	
	5	Racemic mixture – Resolution methods (Chemical and biochemicals methods)	2	
	6	Enantiomeric excess, Optical purity. Common approaches in asymmetric synthesis. (mention only)	2	
II	**Addition reactions**		12	27

	7	Addition reactions to carbon-carbon multiple bonds: Origin of reactivity, regioselectivity (Markownikov's and anti-Markownikov's additions) and stereoselectivity of addition reactions	2	
	8	Examples of addition reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration-demercuration,	2	
	9	hydroboration-oxidation, epoxidation, dihydroxylation, ozonolysis.	1	
	10	Addition to C≡C: Mechanism, reactivity, regioselectivity (Markownikov's and anti-Markownikov's additions) and stereoselectivity	3	
	11	Reactions: Complete hydrogenation, Partial hydrogenation, Electrophilic addition of halogens and hydrogen halides, Ozonolysis	2	
	12	Acidity of alkynes – test for terminal alkynes – Oxidation– (Ozonolysis and reaction with alkaline $KMnO_4$). Chemistry of the tests for unsaturation: Bromine water and Baeyer's reagent test.	2	
III	**Substitution and Elimination Reactions**		10	21
	13	Nucleophilic substitution reactions: Substitution at sp^3 centre (systems: alkyl halides and alcohols)- Origin of reactivity, SN1, SN2 with stereochemical aspects, types of leaving groups (Oxygen-based and halogen-based).	3	
	14	Effects of substrate structure, solvent, nucleophile, and leaving group on Nucleophilic aliphatic substitution reactions.	3	
	15	Elimination reactions: E1, E2 & E1CB mechanisms. formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann), and stereoselectivity;	3	
	16	competition between substitution and elimination reactions. Syn elimination	1	
IV	**Aromatic Substitution Reactions**		10	21
	17	Aromatic Electrophilic Substitution: Mechanism of nitration, halogenation, sulphonation, Friedel-Crafts alkylation, and acylation	3	

	18	Synthesis of Aspirin. Ring activating and deactivating groups- Orientating effect of common substituents in aromatic electrophilic substitution.	2	
	19	Electrophilic substitution reactions of Phenols (bromination, nitration and sulphonation)	2	
	20	Preparation of phenolphthalein and Fluorescein	1	
	21	Aromatic nucleophilic substitution: Bimolecular displacement mechanism	1	
	22	Elimination-addition (benzyne intermediate) mechanism.	1	
V	PRACTICALS		30	
	I	1. Separation of binary mixture using solvent extraction (strong acid neutral, basic+neutral and weak acid+neutral compound combinations) 2. Bromination of Cinnamic acid (Green method- Bromide -Bromate mixture) 3. Preparation of dibenzal acetone 4. Nitration of acetanilide 5. Reduction of ethyl acetoacetate by yeast and measurement of optical rotation. 6. Drawing structures using software. 7.Visualization of SN2 reaction using software	24	
		Open Ended: 1.Making models of enantiomers and diastereomers	6	

References:

1. R. T. Morrison, R. N. Boyd, Organic Chemistry, Pearson Education, New Delhi.
2. I. L. Finar, Organic Chemistry, Vol. I, Pearson Education, New Delhi.
3. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, Vikas Publishing House.
5. P. Y. Bruice, Essential Organic Chemistry, 3rd Edn., Pearson Education, 2015.

6. John McMurry, Organic Chemistry, 5th Edn., Thomson Asia Pvt. Ltd.
7. C. N. Pillai, Organic Chemistry, Universities Press.
8. Vogel’s practical organic chemistry.
9. John McMurry, Eric Simanek, Fundamentals of organic chemistry, 6th Edn., Thomson India Edition.
10. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, S D Sarkar and L Nahar, John Wiley and sons, Ltd.

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Assessment Rubrics:

Quiz / Assignment/ Quiz/ Discussion / Seminar

Midterm Exam

Programming Assignments (20%)

Final Exam (70%)

Mapping of COs to Assessment Rubrics:

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

CALICUT UNIVERSITY – FOUR-YEAR UNDERGRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**PHYSICAL CHEMISTRY –II: CHEMICAL THERMODYNAMICS, KINETICS AND SURFACE CHEMISTRY**				
Type of Course	**MAJOR**				
Semester	**IV**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	[Prerequisites: NCERT or equivalent chemistry syllabus of XI and XII, https://onlinecourses.swayam2.ac.in/nce24_sc07/preview Fundamentals of Chemical Thermodynamics. Path function and state function - Thermodynamic terms for defining System - Surroundings - Types of systems]				
Course Summary	We witness, feel and create physical and/or chemical change(s) everyday. What drives these changes? This course deals with the principles of chemical thermodynamics and chemical kinetics to answer these questions. The subject matter covered will enable the student to understand the relation between heat, work, temperature, and energy. Here, the various tools to evaluate chemical systems in equilibrium and rates of chemical reactions are also introduced. Further, the concept of catalysis and its importance in industrial processes is also included in this course.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Understand the fundamental concepts of	U	F	Assignments/Quiz/Seminars

	thermodynamics and identify it with the real world			
CO2	To apply thermochemical principles to chemical reactions	Ap	C	Work out problems/assignments/Test
CO3	To apply the concept of kinetics and catalysis to various chemical and physical processes	Ap	C	Work out problems/assignments/Test
CO4	To interpret kinetic data using graphical representations and evaluate the rate of a reaction	An	P	Quiz/Discussion
CO5	To evaluate the surface area of catalysts using various adsorption isotherms	Ap	P	Quiz/Discussion
CO6	To apply the theories of kinetics and adsorption through laboratory experiments	C	P	Lab work/Viva voce exams
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs (45+30)	Marks
I	**FIRST LAW OF THERMODYNAMICS AND THERMOCHEMISTRY**		**15**	**33**
	1	Intensive and extensive properties - Steady state and equilibrium state. Concept of thermal equilibrium	**1**	
	2	Zeroth law of thermodynamics. Intensive, extensive and state variables (state functions), Introduction to partial derivatives and line integrals, Euler theorem, Exact and Inexact	**3**	

		differential, Illustration of exact differential using molar volume of ideal gas.		
	3	First law of thermodynamics – Concept of heat (q), work, internal energy(U) and enthalpy (H) - Heat capacities at constant volume and at constant pressure & their relationship - Expansion of an ideal gas under isothermal and adiabatic conditions - Work done in reversible isothermal and adiabatic expansion.	**4**	
	4	Joule-Thomson effect- significance of term $(dU/dV)_T$ - Liquefaction of gasses - Derivation of the expression for Joule Thomson coefficient – Inversion temperature.	**3**	
	5	Thermochemistry: Heat changes during physical and chemical changes. Hess's Law.	**2**	
	6	Temperature dependence of reaction enthalpies- Kirchoff's law. Bond dissociation energies. Resonance energy from thermochemical data.	**2**	
II	**SECOND & THIRD LAWS OF THERMODYNAMICS**		**10**	**21**
	7	Limitations of first law and Need for the second law – Kelvin and Clausius statements. Carnot's theorem and Heat engine and its efficiency.	**2**	
	8	Concept of Entropy. Calculation of entropy change for reversible and irreversible processes. Statement of first law in terms of entropy. Entropy change during the isothermal mixing of ideal gasses.	**2**	
	9	Energy functions (Gibbs free energy (G) and Helmholtz energy (A)) and their variation with T and P.	**2**	
	10	Maxwell's relations. Gibbs-Helmholtz equation - Criteria for spontaneity and equilibrium - Significance of Clausius inequality.	**2**	
	11	Partial molar free energy - Concept of chemical potential - Gibbs-Duhem equation.	**1**	
	12	Third law of thermodynamics - Nernst heat theorem - Statement of third law.	**1**	
III	**CHEMICAL KINETICS**		**15**	**33**
	13	Rate of a reaction - Factors influencing the rate of a reaction- Concentration, Temperature, Surface area and Catalyst - Rate law - Order and molecularity -	**2**	
	14	Derivation of rate constants for first, second (with same and different reactants), third (with same reactants only) and zero	**4**	

		order reactions with examples. Data interpretation including graphical representations		
	15	Half-life period (derivation for first and n^{th} order reactions) - Methods to determine the order of a reaction.	**1**	
	16	Effect of temperature on reaction rates - Arrhenius equation - Determination and significance of Arrhenius parameters	**1**	
	17	Theories of reaction rates - Collision theory - Derivation of rate equation for bimolecular reactions using collision theory - Transition state theory - Expression for rate constant based on equilibrium constant and thermodynamic aspects – Eyring equation (derivation not required)	**5**	
	18	Unimolecular reactions - Lindemann mechanism.	**2**	
IV	**SURFACE CHEMISTRY, ADSORPTION AND CATALYSIS**		**5**	**11**
	19	Solid surfaces, microstructure and elementary idea about microscopic techniques for studying the surface of solids (SEM, TEM, STM, AFM)	**1**	
	20	Physisorption, Chemisorption. Adsorption isotherms – Langmuir, Freundlich and BET (No derivation required). Determination of Surface area, Particle size and surface area, Activated charcoal and its uses	**2**	
	21	Homogeneous and heterogeneous catalysis - Theories of homogenous and heterogenous catalysis with examples	**1**	
	22	Enzyme catalysis - Michaelis-Menten equation (derivation not required). Application of enzyme technology for environmental, medical, agricultural, and industrial benefits.	**1**	
V	**PHYSICAL CHEMISTRY- PRACTICALS-2**		**30**	
		A minimum of 5 practical experiments out of which TWO EACH from sections 1 and 2 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-typed printed form. Section 1 1. Determination of rate constant of the Acid Hydrolysis of ethyl acetate 2. Determination of effect of temperature on the rate of acid hydrolysis of ethyl acetate 3. Determination of order of the reaction between crystal violet dye and NaOH (or Fuchsin and NaOH) by using	**3** **3** **3**	

		a colorimeter/spectrophotometer 4. Kinetics studies of reaction between $KMnO_4$ and Oxalic acid 5. Open ended Section 2 6. Adsorption of oxalic acid on activated charcoal and thereby determining the adsorption isotherm. 7. Observation of decolourisation of a suitable dye on activated charcoal or filter paper via visual or colorimetry/spectrophotometry 8. Verification of Hess's law by using Mg, MgO and HCl reactions. 9. Effect of Mn2+ catalyst on reaction kinetics of $KMnO_4$ vs Oxalic acid 10. Open ended	**3** **3** **3** **3** **3** **3** **3**	
		References **Module I and II** 1. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) 2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) 3. T. Engel, P. Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, Inc: New Delhi, 2007. 4. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013. **Module III and IV** 5. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) 6. K. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education, New Delhi, 2004. **Module V** 7. Findlay's Practical Physical Chemistry, Ninth Edition, Revised and Edited by B P Levitt, (Longman, London, 1973)		

		8. Advanced Physical Chemistry: Practical Guide, C. Arora and S. Bhattacharya, Bentham Books, UAE, 2022 9. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.. 10. R. C. Das, B. Behra, Experiments in Physical Chemistry, Tata McGraw Hill, New Delhi, 1983 ***Further reading*** 11. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Edn., John Wiley and Sons, Canada, 1980. 12. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013. 13. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006. 14. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Edn.,John Wiley and Sons, Canada, 1980. 15. D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill Book Company, New York, 1962. 16. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, Cambridge, 2009		

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	3	2	3	2	2	-	2	-	1
CO 2	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 3	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 4	3	2	-	-	3	3	3	2	1	-	1	-	1

CO 5	3	2	-	1	3	3	3	2	1	-	3	-	1
CO 6	3	-	2	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

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

B.Sc. CHEMISTRY

<table>
<tr><td>Programme</td><td colspan="5">B. Sc. Chemistry</td></tr>
<tr><td>Course Title</td><td colspan="5">THEORETICAL CHEMISTRY II - GROUP THEORY AND MOLECULAR SPECTROSCOPY</td></tr>
<tr><td>Type of Course</td><td colspan="5">MAJOR</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Academic Level</td><td colspan="5">300 – 399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>4</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">● Elementary awareness of degrees of freedom in molecules including translation, rotation and vibration.
● Basic understanding of quantum chemistry and the concept of quantised energy levels.
● Review the concept of electron spin introduced in the course, CHE3CJ201
● Familiarity with the relationship between structure of molecules and their properties.</td></tr>
<tr><td>Course Summary</td><td colspan="5">The course introduces the theoretical aspects of two fundamental topics of theoretical chemistry which find a wide range of practical applications - Group theory and Molecular Spectroscopy.

Group theory is a topic of mathematics which suggests that sets of elements (whatever be their nature) can be grouped into mathematical groups if they obey certain conditions. The course brings to light how group theory can be used for systematizing the study of structures of molecules based on their symmetry. This can be done by grouping the millions and millions of molecules that we come across into only a few mathematical groups called point groups based on the symmetry operations possessed by them. Such groupings help in simplifying the study of structure related properties of molecules.</td></tr>
</table>

	Molecular Spectroscopy: The interaction of electromagnetic radiation with matter forms the basis for the different spectroscopic techniques used for the structural elucidation of molecules. The course brings to light the underlying principles involved in each of these spectroscopic techniques. The allowed energy states of molecules and the transitions between them are unique and are decided by the laws of quantum mechanics. Radiations having different frequencies (and hence different energy) interact with molecules and bring about characteristic transitions which help to identify the exact structure of molecules.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	*understand* the principles of constructing mathematical groups..	U	F	Assignment
CO 2	*realise* point groups as collections of symmetry operations of molecules	Ap	C	Class tests/Viva
CO 3	*identify* each spectroscopic method as the interaction of molecules with a characteristic radiation of the electromagnetic spectrum	An	P	Seminar/ Class tests
CO 4	*apply* various spectroscopic techniques for the structural elucidation of molecules.	Ap	P	Class tests/Assignment
CO 5	*justify* spectroscopic methods as unique tools for identifying molecules.	E	M	Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks
I	**Mathematical Preliminaries of Group Theory**		**6**	**12**
	1	Conditions for sets of elements to form mathematical groups - closure rule, associativity, existence of identity and inverse elements.	2	

	2	Order of a group, Definitions of finite, infinite, Abelian and cyclic groups.	1	
	3	Binary combination of elements of a group - the group multiplication table and its features - general group multiplication tables of groups up to order 4.	2	
	4	Sub groups, similarity transformation and classes.	1	
	Sections from References: **Section A**			
II	**Group Theory as a Means for the Systematic Study of Molecular Symmetry**		**12**	**25**
	4	Tools for studying molecular symmetry – symmetry elements, symmetry operations and their classification.	2	
	5	Mathematical groups of symmetry operations - the point groups, nomenclature of point groups - Schoenflies notations.	2	
	6	Assigning point groups to molecules based on their symmetry elements.	2	
	7	Binary combinations of symmetry operations - the group multiplication tables of C_{2v}, C_{3v} and D_{2h} point groups.	3	
	8	Identifying classes of symmetry operations in point groups (C_{2v} and C_{3v} as examples)	2	
	9	Matrix representation of symmetry operations. Matrices for the symmetry operations of C_{2v}, C_{3v} and D_{2h}.	1	
	Sections from References: **Section A**			
III	**Molecular Spectroscopy-I**		**18**	**36**
	14	Energy levels in molecules – Born-Oppenheimer approximation. Electromagnetic spectrum - wavelength, frequency, wavenumber.	2	
	15	Interaction of electromagnetic radiation with matter - factors affecting line width and intensity of signal.	2	
	16	***Rotational Spectroscopy:*** Introduction – Rigid rotor – Expression for energy – Selection rules – Intensities of spectral lines – Determination of bond lengths of diatomic molecules.	3	
	17	***Vibrational Spectroscopy:*** Simple harmonic oscillator – Energy levels – Force constant – Selection rules - Anharmonicity – Fundamental frequencies – Overtones – Fingerprint region – Group frequency concept – Degree of freedom for polyatomic molecules – Modes of vibrations of CO_2 and H_2O.	4	

	18	***Raman Spectroscopy:*** Basic principles – Rayleigh scattering - Raman scattering-Stokes & anti-stokes lines and their intensity difference - classical theory of Raman effect: polarizability - quantum theory of Raman scattering, selection rules for Raman spectra- Qualitative treatment of rotational Raman effect – Vibrational Raman spectra — Selection rules – Mutual exclusion principle. Resonance Raman scattering, Raman and IR spectroscopy,	4	
	19	***Electronic Spectroscopy:*** Basic principles – Frank-Condon principle – Electronic transitions – Beer Lambert's law - Dissociation energy of diatomic molecules – Chromophore and auxochrome – Bathochromic and hypsochromic shifts.	3	
	Sections from References: **Section B**			
IV	**Molecular Spectroscopy-II**		**12**	**25**
	20	***Nuclear Magnetic Resonance (NMR) Spectroscopy:*** Proton NMR spectroscopy – nuclei in a static magnetic field - basic principle of NMR spectroscopy - resonance; spectral parameters - chemical shift - nuclear shielding - spin-spin coupling - origin of coupling - coupling constants - NMR spectra of simple molecules.	6	
	21	**^{13}C NMR *Spectroscopy:*** C-13 - relative abundance, chemical shift, spin-spin coupling. Factors affecting chemical shifts. Proton coupled and decoupled ^{13}C NMR.	3	
	22	***Electron Spin Resonance (ESR) Spectroscopy***: Principle - comparison between NMR and EPR - g factor - electron-nuclear interactions - hyperfine interactions – Hyperfine structure – ESR of methyl, phenyl and cycloheptatrienyl radicals.	3	
	Sections from References: **Section B**			
V	**Open Ended Module: Learning through problem solving and plots**		**12**	
	1	● Categorize molecules into point groups based on symmetry elements ● Solving problems involving various spectroscopic data ● Deducing the structure of various compounds from different spectra		

	Sections from References: **Section A & Section B**		

Books and References:

Section A

1. F. A. Cotton, *Chemical Applications of Group Theory*, 3rd Edn., John Wiley & Sons, New York, 1990.
2. A. Salahuddin Kunju & G. Krishnan, Group Theory & its Applications in Chemistry, PHI Learning Pvt. Ltd.2010.

Section B

1. C. N. Banwell, *Fundamentals of molecular spectroscopy*, McGraw-Hill, 1994.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8th Edn., Oxford University Press 2006.
3. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46. Edn., Vishal Publishing Company, New Delhi, 2013.
4. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

Further reading

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2. H. H. Jaffe and M. Orchin, Symmetry in Chemistry, John Wiley &Sons Inc., 1965.
3. G. M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.
4. Thomas Engel, Quantum Chemistry & Spectroscopy, Pearson education, 2006.

Mapping of COs with PSOs and POs :

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

CO 4	-	-	2	3	-	-	3			2	3		2
CO 5	-	1	-	-	-	-	3		1	2	2		2

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**INORGANIC CHEMISTRY-III**				
Type of Course	**MAJOR**				
Semester	**V**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Different segments of environment, Environmental pollution, Different types of pollution, health effect and hazards associated with chemicals, Acid-base concepts, basic idea about chemical analysis				
Course Summary	This course explains different types of environmental pollution, its causes, consequences, remedies of prevention and develop concerns for the environment It reveals the importance of need of green chemistry and green synthesis It gives an idea about major acid base concepts and reactions in nonaqueous solvents It initiates the students for exploitation of advanced materials in the demand of changing trends of modern industry. This course explores students to the role and opportunities of Chemistry as a discipline in the modern era and develops skills in qualitative and quantitative analysis of inorganic compounds.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To critically evaluate issues in environment	An	C	Instructor-created exams / Assignments
CO2	To gain insights into the economic and environmental aspects of green chemistry and to contribute the advancement of sustainable practices in the field of chemistry	Ap	C	Assignment / seminar/quizes
CO3	To understand the theories of acids and bases and reactions in non aqueous solvents and to identify compounds as acids and bases	Ap	C	Assignment/Seminar/Class test
CO4	To understand and apply principles of material chemistry and its facets	Ap	C	Assignment/Seminar/Class test
CO5	To equip the students with familiarization in separation and identification of ions	Ap	P	Group work /Assignment/class test/
CO6	Practicum in inorganic qualitative analysis with hands on familiarity with various ions	An	P	Group work /Assignment/ Viva, Observation of practical skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I	ENVIRONMENTAL CHEMISTRY AND GREEN CHEMISTRY		15	33

	1	Environment and Environmental pollution, pollutant and contaminant, Segments of Environment	1	
	2	Air Pollution : Types of air pollutants, Gaseous air pollutants (oxides of carbon, nitrogen and sulphur), Particulates.	2	
	3	Effects of air pollution: Smog (London and Los Angeles Smog), Global warming, ozone depletion, acid Rain,	2	
	4	Control of air Pollution, alternative refrigerants	1	
	5	Water Pollution : Sources of water pollution, Eutrophication, Bioaccumulation, bioMagnification,	2	
	6	Water quality parameters (DO,BOD and COD and their determination), Toxic metals in water(Pb, Cd and Mg), control of water pollution	2	
	7	Soil pollution, Thermal pollution, noise pollution, light pollution, radiation pollution (Sources and effects)	3	
	8	Introduction to Green chemistry – Goals of Green chemistry, Twelve basic principles of green chemistry- Atom economy- Green solvents- water, supercritical fluids, ionic liquids [mention with examples).	2	
II	**ACID BASE CONCEPTS AND NON-AQUEOUS SOLVENTS**		**5**	**10**
	9	Major acid-base concepts, Arrhenius, Bronsted-Lowry, Solvent system, Lux-Flood, Lewis and Usanovich concepts.	2	
	10	Non - aqueous Solvents: Classification – General Properties	1	
	11	Reactions in Liquid Ammonia, liquid SO_2 and Liquid HF	2	
III	**MATERIAL CHEMISTRY**		**15**	**33**
	12	Introduction and scope of material chemistry-	1	
	13	Ceramic materials: Definition, classification(traditional and advanced ceramics) , Composition- oxides and nitrides- general	5	

		properties- applications- structural, Electronics, thermal and biomedical applications		
	14	Catalytic materials : zeolites, alumina- surface properties, supporting materials	3	
	15	Composite materials: Definition and types of composite materials (polymer matrix composites, metal matrix composites, carbon matrix composites- explanation with examples	3	
	16	Inorganic solids :Perovskites- ABX_3- $CaTiO_3$, $LaCoO_3$, spinel compounds- AB_2O_4- $MgAl_2O_4$	3	
IV	**INORGANIC QUALITATIVE AND QUANTITATIVE ANALYSIS**		**10**	**22**
	17	Inorganic qualitative analysis: Need for elimination of interfering acid radicals and their elimination methods – oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate	1	
	18	Principles of separation of basic radicals into various groups – Solubility product and Common Ion effect – Their application in the qualitative inorganic analysis.	2	
	19	Micro analysis: merits and application, preparation of sodium carbonate extract and its merits	1	
	20	Inorganic Quantitative Analysis – Gravimetric analysis – Introduction – Types of gravimetric analysis, Precipitation, Advantages and disadvantages of gravimetric analysis –	2	
	21	Properties of precipitates and precipitating agents, Mechanism of precipitate formation- Von Weimarn equation and its applications– Co-Precipitation and post precipitation –	2	
	22	Homogeneous and heterogeneous precipitation – gravimetric factor - Inorganic and Organic precipitating agents and their applications - NH_3, H_2SO_4, NH_4 SCN, oxine, cupron, cupferron, 1-nitroso-naphthol, dithiocarbamates.	2	

V	**INORGANIC CHEMISTRY PRACTICAL III:INORGANIC QUALITATIVE AND QUANTITATIVE ANALYSIS**		**30**	
		1. **Inorganic qualitative analysis:** a) Study of reactions of following ions, *Anions*: carbonate, sulphate, fluoride, chloride, acetate, borate, oxalate, phosphate and nitrate *Cations:* Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel manganese, zinc, barium, calcium, strontium, magnesium and ammonium b) Systematic analysis of mixtures containing two cations and two anions from the above list (Na_2CO_3 extract procedure may be adopted)		
		2. **Inorganic quantitative analysis** : Gravimetric analysis (**Open ended**) a) Estimation of barium as barium sulphate or sulphate as barium sulphate can be done		

References:

1. A.K. De, Environmental Chemistry, 6th Edn., New Age International Pvt. Ltd., New Delhi, 2006.

2. S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, 8th Edn., S. Chand and Sons, New Delhi, 2008.

3. K. Ahluwalia, Environmental Chemistry, Ane Books India, New Delhi, 2008.

4. Paul T. Anastas, T. C. Williamson, Green Chemistry – Designing Chemistry for the Environment, 2nd Edn., 1998.

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6. Anthony R. West, Solid State Chemistry and its Applications, 2 nd Edn., Wiley-Blackwell, 2014.

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8. N.N. Greenwood and A.Earnshaw, *Chemistry of Elements, 2/e, Elsevier* Butterworth-Heinemann, 2005.

9. J.E.Huheey, E.A.Keiter, R.L.Keiter. O.K.Medhi. *Inorganic Chemistry, principles of structure and reactivity*, Pearson Education, 2006.

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11. M.J. Starfield and Shrager, Introductory Material Science, McGraw Hill.

12. K.K. Chowla, Composite Materials, Springer – Verlag, NY,1987.

13.. M. Tinkham, Introduction to Superconductivity, McGraw Hill, 1975.

14. A.V. Narlikar and S.N. Edbote, Superconductivity and Superconducting Materials, South Asian Publishers, New Delhi, 1983.

15. G. Svehla, Vogel’s Qualitative Inorganic Analysis, 7th Edn., Prentice Hall, New Delhi, 1996.

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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ORGANIC CHEMISTRY - III**				
Type of Course	**MAJOR**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Methods of preparation of aldehydes, ketones and carboxylic acids. 2. Nomenclature, isomerism and general physical properties of aldehydes, ketones, carboxylic acids and amines. 3. Acidity of carboxylic acids and basicity of amines.				
Course Summary	To give the students a thorough knowledge about the reactivity, nucleophilic addition and substitution reactions of carbonyl compounds and chemistry of nitrogen containing functional groups and their applications in organic preparations.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyze and compare the reactivity of aldehydes and ketones in nucleophilic addition reactions using various carbon, nitrogen, oxygen and sulphur nucleophiles	An	P	Instructor-created exams / Quiz /Assignment
CO2	Explain the origin of reactivity of carboxylic acids and their derivatives and analyse nucleophilic acyl substitution reactions and hydrolysis of carboxylic acid derivatives	U	C	Class test /Assignment /Quiz
CO3	Demonstrate the oxidation and reduction reactions of alkenes, alkynes, alcohols, aldehydes, ketones and carboxylic acids using various oxidising and reducing agents	Ap	P	Assignment/ Class test

CO4	Identify the preparation methods and important reactions of nitro compounds, amines and sulpha drugs and explain the properties and synthetic transformations of aryl diazonium salts	Ap	P	Assignments /Seminar presentation
CO5	Evaluate reactions involving α-carbons of carbonyl compounds and conjugated addition reactions of α,β-unsaturated carbonyl compounds and apply active methylene compounds in organic preparations	E	C	Class test /Assignment /Quiz
CO6	Conduct qualitative tests to identify specific functional groups, such as aldehydes, ketones, carboxylic acids, phenols, nitro compounds, amines, amides, esters etc. and synthesis of some organic compounds like aspirin, cinnamic acid, iodoform, biodiesel etc	An	P	Lab work/Viva Voce

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

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Chemistry of Carbonyl Compounds-I**	**15**	**32**
	1	Origin of reactivity of the carbonyl group. Comparison of reactivity of aldehydes and ketones	2	
	2	Nucleophilic addition reactions of aldehydes and ketones (Mechanism expected) - Carbon nucleophiles (Addition of HCN, Grignard reagents), Nitrogen nucleophiles (NH_3, amine, hydroxylamine, hydrazine, semicarbazide and DNP reagent), Oxygen nucleophiles (H_2O, alcohols), Sulphur nucleophiles (sodium bisulphite)	3	
	3	Keto-enol tautomerism. Reactions involving α carbons of carbonyl compounds - Aldol condensation, Cannizzaro reaction and Benzoin condensation (mechanism expected), Perkin’s reaction, Knoevenagel reaction and Haloform reaction (mechanism not expected)	5	
	4	Conjugate addition reactions of α,β-unsaturated carbonyl compounds – 1,2 and 1,4 – addition reactions	2	

	5	Active Methylene Compounds: Examples – Preparation of ethyl acetoacetate by Claisen condensation (mechanism expected) – Synthetic applications of ethyl acetoacetate	3	
II		**Chemistry of Carbonyl Compounds-II**	**8**	**18**
	6	Origin of reactivity in the carboxylic acid family. Nucleophilic acyl substitution reactions and Mechanism	2	
	7	Comparison of reactivity of Carboxylic Acids and derivatives, Hydrolysis of carboxylic acid derivatives	2	
	8	Fischer esterification (mechanism expected), HVZ reaction, Decarboxylation – Kolbe electrolysis (mechanism expected)	2	
	9	Interconversion of Carboxylic acid derivatives. Introductory idea about β-lactam antibiotics – Structure and action of Penicillin- G	2	
III		**Oxidation & Reduction reactions**	**7**	**16**
	10	Oxidation and reduction of alkenes and alkynes	1	
	11	Oxidation of alcohols with PCC and CrO_3	1	
	12	Oxidation of aldehydes and ketones with acidified $K_2Cr_2O_7$, $KMnO_4$, CrO_3; Oppenauer oxidation. Distinguishing aldehydes and ketones (Tollen's reagent, Fehling's solution)	2	
	13	Reduction of aldehydes and ketones – Catalytic hydrogenation, Wolf-Kishner, Clemmensen, metal hydride ($LiAlH_4$ and $NaBH_4$) and MPV reduction	2	
	14	Reduction of carboxylic acids ($LiAlH_4$, BH_3)	1	
IV		**Nitrogen containing compounds**	**15**	**32**
	15	Nitro compounds: Preparation and important reactions of nitro compounds, Ketones from nitro compounds – Nef reaction (mechanism not required)	2	
	16	Reduction products of nitrobenzene in acidic, neutral and alkaline media	2	
	17	Amines: Preparation – Gabriel phthalimide synthesis, from reduction of nitriles and isonitriles.	1	
	18	Amines: Properties - Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction (with mechanism and stereochemistry)	3	
	19	Electrophilic substitution reactions of aniline (Nitration, Bromination and Benzoylation)	2	

	20	Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid	1	
	21	Preparation and uses of sulpha drugs – Structural formula of sulphapyridine, sulphadiazine, sulphathiazole and sulphaguanidine	2	
	22	Synthetic transformations of aryl diazonium salts, azo coupling. Preparation of methyl orange	2	
V		**Practicals - Reactions of Organic Compounds**	**30**	
	I	Analysis of organic compounds from the following list (also prepare the derivatives). 1. Phenols (phenol, α-naphthol). 2. Nitro compounds (nitrobenzene, o-nitrotoluene). 3. Amines (aniline, N,N-dimethylaniline). 4. Aldehydes and ketones (benzaldehyde, benzophenone). 5. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid). 6. Carbohydrates (glucose, sucrose). 7. Amides (benzamide, urea). 8. Esters (ethyl benzoate, methyl salicylate). Analysis of about 7 organic compounds containing the above functional groups.	16	
	II	Organic Preparations (Any two) Synthesis of aspirin, cinnamic acid, iodoform and biodiesel	8	
	III	Open Ended	6	

References:

1. R. T. Morrison, R. N. Boyd, Organic Chemistry, Pearson Education, New Delhi.
2. I. L. Finar, Organic Chemistry, Vol. I, Pearson Education, New Delhi.
3. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, Vikas Publishing House.
5. P. Y. Bruice, Essential Organic Chemistry, 3rd Edn., Pearson Education, 2015.
6. John McMurry, Organic Chemistry, 5th Edn., Thomson Asia Pvt. Ltd.
7. C. N. Pillai, Organic Chemistry, Universities Press.
8. Vogel’s practical organic chemistry.
9. John McMurry, Eric Simanek, Fundamentals of organic chemistry, 6^{th} Edn., Thomson India Edition.

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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

Quiz / Assignment/ Quiz/ Discussion / Seminar

Midterm Exam

Programming Assignments (20%)

Final Exam (70%)

Mapping of COs to Assessment Rubrics:

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**INORGANIC CHEMISTRY-IV**				
Type of Course	**MAJOR**				
Semester	**VI**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Solid foundation in Coordination Chemistry. Uniqueness of carbon, covalent bond, and coordinate bond. Bonding in carbon monoxide. Knowledge about minerals and ores. Importance of metal ions in biological systems. Atomic number, mass number, isotopes, basic idea about nuclear radioactivity, Nuclear fission and fusion.				
Course Summary	This course enables the students to develop knowledge about theories of bonding in coordination compounds, stability constants, chelating effects. It covers the detailed study on structure, bonding and applications of organometallic compounds. It gives basic understanding of different metallurgical processes. It enables the students to familiarise with various metal ions, their compounds and their important in biological systems. It covers various aspects of nuclear chemistry including nuclear stability and reactions.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Understand and apply theories of bonding in coordination compounds	U	C	Instructor-created exams / Assignments

CO2	To Classify , interpret and create organometallic compounds, including their applications in synthesis and as catalysts	U	C	Instructor-created exams / Assignments
CO3	To Describe and perform steps in metallurgy and recognize the composition and uses of various alloys	Ap	C	Assignment / seminar/quizzes
CO4	To Identify the role of metal ions in biological systems and understand their significance in biological processes	Ap	C	Assignment/Seminar/Class test
CO5	To describe knowledge of the fundamental aspects and practical applications of nuclear chemistry.	Ap	U	Assignment/class test/
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I	**THEORIES OF BONDING IN COORDINATION COMPOUNDS**		**15**	**30**
	1	Molecular orbital theory-Composition of ligand group orbitals.	2	
	2	MO diagram of octahedral tetrahedral and square planar complexes with and without π-bonding.	4	
	3	Stepwise and overall formation constant and relationship between them, Trends in stepwise formation constants.	3	
	4	Determination of stability constants by spectrophotometric methods. Stabilization of unusual oxidation state.	3	
	5	Thermodynamic origin of chelating effect, Macrocyclic and Template effect.	3	

II		**ORGANOMETALLIC CHEMISTRY**	**12**	**25**
	6	Definition, Classification of organometallic compounds on the basis of M-C bond with examples. Classification of organic ligands based on hapticity.	2	
	7	Metal carbonyls-Definition- Classification, 18 electron rule and deviation from 18 electron rule, Electron count of mononuclear and polynuclear metal carbonyls (calculation by oxidation number method and covalent method). MOT and the basis for the 18 electron rule.	2	
	8	General methods of preparation properties and structures of mono and binuclear carbonyls of Cr, Mn, Fe, Co and Ni.	2	
	8	Bonding in metal carbonyls (MO diagram of CO to be discussed). Synergic effect and use of IR spectra to explain the extent of back bonding.	2	
	9	Preparation, Structure, Bonding and Reactions : Zeise's salt, Metallocenes- Ferrocene (VBT and MOT).	3	
	10	Applications of organometallic compounds in synthesis and as catalysts, Hydrogenation using Wilkinson's catalyst and Polymerization of alkenes using Ziegler Natta catalyst (mechanism not needed).	1	
III		**METALLURGY**	**11**	**23**
	11	Discuss the terms: Mineral, Ore, Gaunge, Flux, slag, Electrometallurgy – Hydrometallurgy.	2	
	12	Steps in metallurgy:(a)Pulverization of the ore (b)Concentration of the ore (Physical and chemical) (c)Treatment of the concentrated ore-Calcination and roasting (d)Reduction-different methods: Smelting, Gold smith alumino thermic process, Kroll's process, Electrolytic reduction, Self reduction. (e) Refining :Liquation, Distillation.	2	
	13	Vapour Phase refining, Zone refining, Oxidative refining, Electrolytic refining, Poling, Cupellation, Parting process, Ion exchange method.	2	

	14	Ellingham diagrams for metal oxides – Extractive metallurgy of Fe, Ni and Ti.	3	
	15	Alloys: Definition – Composition and uses of German silver, Brass, Bronze, Gunmetal and Alnico. Steel: Open hearth process, Classification of steel, Composition and uses of alloy steels, Composition, Properties and Applications of industrially important stainless steel types, (AISI) (a brief study).	2	
IV	**BIOINORGANIC CHEMISTRY**		**10**	**20**
	16	Discuss various elements present in the biological system, Essential and Non-essential elements, Metal ions in biological system, Trace and bulk metal ions, Role of alkali metal ions in biological systems, Sodium-potassium pump, Structural role of calcium.	2	
	17	Ligands present in biological systems, Structure of Porphyrin and Corrin.	1	
	18	Structure of heme - Oxygen transport by heme proteins, Hemoglobin and Myoglobin, Structure of the oxygen binding site, Nature of heme- dioxygen binding, Cooperativity.	2	
	19	Structure of Hemerythrin and Hemocyanin.	1	
	20	Metalloenzymes and Metal activated enzymes, Biochemistry of Zn – structure and functions of Carboxypeptidase, Carbonic Anhydrase, Biochemistry of Cobalt, Vitamin B 12 and Deficiency diseases.	2	
	21	Chlorophyll and Photosynthesis (mechanism not expected).	1	
	22	Anticancer drugs. Cis-platin, Oxaliplatin, Carboplatin and Auranofin – Structure and Significance.	1	
V	**NUCLEAR CHEMISTRY**		**12**	
	23	The teacher can choose the important topics in the area nuclear chemistry: Nuclear stability, N/P ratio, Mass defect (numerical problems) , Packing Fraction, Binding Energy per Nucleons, Radioactivity, Group displacement law, Disintegration series, Nuclear fission, Fusion, Reactors: Applications, RadioCarbon dating, Rock dating, Isotopes as tracers.	12	

		Must cover Nuclear stability, n/p ratio, Fission, Fusion, Separation of isotopes, Application of isotopes.		

References:

1. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 5th Edn., Oxford University Press,New York, 2010.
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3. J. E. Huheey, E. A. Keitler, R. L. Keitler, Inorganic Chemistry – Principles of Structure and Reactivity, 4 th Edn., Pearson Education, New Delhi, 2013.
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11. P. Powell, Principles of Organometallic Compounds, 2nd Edn., Chapman and Hall, London, 1988.

Mapping of COs with PSOs and POs :

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CO1	3	1	-	-	-	1	3				1		1
CO2	2		-	-	1	2	2		1		2	1	2
CO3	3	-		-	2	2	3			1			1
CO4	2				2	1	3					1	1
CO5	2		-	-	1	3	3					1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
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Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

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

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ORGANIC CHEMISTRY - IV**				
Type of Course	**MAJOR**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Distillation and chromatographic techniques 2. Essential and non-essential amino acids 3. Chemistry of Fehling's solution test and Tollen's reagent test 4. CHE5CJ301				
Course Summary	To give the students a thorough knowledge about the heterocyclic chemistry and polymer chemistry, a basic knowledge about the natural products, biomolecules, dyes, pharmaceuticals and cleansing agents				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate the nomenclature, structure, methods of preparation, reactivity and common reactions of heterocycles including Furan, Pyrrole, Thiophene, Pyridine, Indole, Quinoline and Isoquinoline and demonstrate the structure of Imidazole, Pyrazole, Oxazole, Pyrimidine and Purine.	Ap	P	Seminar presentation /Assignment/Class test
CO2	Examine the classification, isolation, purification and physiological activities of alkaloids and terpenes. Evaluate the classification, structural	U	C	Class test /Quiz /Assignment

	features, reactions and tests of carbohydrates.			
CO3	Understand the concepts of classification, structural features and the significant role of biomolecules like amino acids, proteins, nucleic acids, lipids, steroids and hormones, in nature/human body.	U	C	Seminar Presentation / Instructor created exam
CO4	Analyse the classification, types of polymerisation, and commercially important polymers as well as the importance of glass transition temperature and molecular weight determination of polymers.	An	P	Instructor-created exams / Home Assignments
CO5	Elucidate the structure of simple organic compounds using spectral techniques.	Ap	P	Assignment /Seminar presentation /Class test
CO6	Prepare polymers and heterocyclic compounds, isolate and purify natural products and interpretation of spectral data of simple organic compounds.	Ap	P	Lab work /Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Heterocyclic Compounds**	**10**	**22**
	1	**Common Heterocycles:** Pyrrole, thiophene, furan, pyridine, indole, quinoline, isoquinoline -Structure (with aromaticity), IUPAC Nomenclature Imidazole, Pyrazole, Oxazole, Pyrimidine and Purine (Structure only)	3	
	2	Furan: Preparation from furfural (Industrial method), Feist-Benary synthesis and Paal-Knorr synthesis, Reactivity and reactions of furan. Furan in nature and medicine – rose furan and ranitidine Pyrrole: Hantzsch pyrrole synthesis, Knorr pyrrole synthesis, biosynthesis (general awareness only). Reactivity and reactions of pyrrole. Ring expansion reaction, Porphobillinogen, chlorophyll and heme.	7	

		Pyridine: Industrial preparation from coal tar, Chichibabin pyridine synthesis, Bonnemann cyclization, Krohneke pyridine synthesis Reactivity of pyridine- Electrophilic substitution (Nitration, sulphonation, halogenation, alkylation, acylation), Nucleophilic substitution, lewis basicity and coordination compounds, pyridinium chloro chromate (PCC). Indole: Industrial method for the preparation of indole from aniline, Fischer indole synthesis Reactivity of indole- Electrophilic substitution (Nitration, sulphonation, halogenation, alkylation, acylation), oxidation, Diels alder reaction, Indole derivatives in nature- tryptophan Quinoline: Skraup synthesis and Doebner reaction Reactivity of quinoline: Electrophilic substitution, reduction of quinoline, quinoline containing antimalarial drugs (General awareness only) Isoquinoline: Bischler-Napieralski synthesis, Isoquinoline in nature- papaverine and tyrosine, isoquinoline derivatives as pharmaceuticals as well as neurotoxins		
II		**Natural Products**	**9**	**20**
	3	**Alkaloids**: Common alkaloids present in nature, Classification based on structure of heterocyclic ring, isolation and purification, physiological actions of nicotine, quinine and coniine	2	
	4	**Terpenes**: Common Terpenes present in nature, isoprene rule and special isoprene rule, Classification, isolation and purification, significances	2	
	5	**Carbohydrates**: Classification, Common carbohydrates in nature and their structural features, epimers, anomers, reducing sugars and non-reducing sugars, relative and absolute configurations	2	
	6	Examples for monosaccharides, Disaccharides- Cyclic structure of maltose, lactose and sucrose, oligosaccharides and polysaccharides, Structure of cellulose, starch and glycogen (structure elucidation not required)	2	
	7	Chemistry of Benedict's test and Molisch's test. Tests for blood sugar and urine sugar	1	

III		**Biomolecules and Polymers**	**16**	**34**
	8	**Amino acids**: Structure of essential amino acids and their classifications **Proteins and peptides:** Structure of proteins and peptides – Primary, secondary, tertiary and quaternary structure. Common proteins and their role in the body. Determination of primary structure of proteins. Protein sequencing methods	3	
	9	**Nucleic Acids**: Constituents of nucleic acids - nitrogenous bases, nucleosides and nucleotides DNA and RNA – structure and their significance, Vital role of DNA and RNA in nature. DNA fingerprinting and applications	2	
	10	**Lipids:** Classification- Simple lipids, Complex lipids and derived lipids and Biological functions of lipids Oils and Fats - Acid value, Saponification value and Iodine value, Reichert-Meissl (RM) number of butter.	2	
	11	***Steroids***: Classification of steroids – corticosteroids and anabolic-androgenic steroids or sex hormones, examples (Structure is not expected), ***Cholesterol***: Structure, LDL and HDL, significances **Hormones**: Classification – lipid hormones (eg: testosterone, estradiol), Amine hormones (eg: epinephrine from tyrosine, melatonin from tryptophan), peptide hormone (eg: oxytocin and vasopressin).	2	
	12	**Polymers:** Classification of polymers, Biodegradable polymers, Conducting polymers (Introduction only)Types of Polymerisation - Chain and step growth polymerizations – Free radical, ionic and coordination polymerizations with mechanism – Ziegler-Natta polymerization and its advantages	**4**	
	13	Glass Transition Temperature (Tg), Importance of Tg	**1**	
	14	Molecular Weight of Polymers, Determination of number average, weight average and viscosity average molecular weight	**1**	
	15	Commercially important polymers-Polyethylene, PVC, Teflon, PMMA, phenol-formaldehyde resin -properties and uses	**1**	

IV	**Basic Organic Spectroscopy**		**10**	**22**
	16	Introduction- Spectroscopy-Applications of spectral techniques in the structural elucidation of organic compounds.	1	
	17	UV-Visible Spectroscopy: Electronic transitions in molecules ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$) – Chromophore and auxochrome. Study of the UV spectra of butadiene, acetone, methyl vinyl ketone and benzene. λ_{max} calculation for dienes and α,β-unsaturated carbonyl compounds	2	
	18	IR Spectroscopy: Concept of group frequencies – fingerprint region – IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides	3	
	19	^{1}H NMR: Chemical shift – Spin-spin splitting – Interpretation of ^{1}H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, acetone, 1, 1, 2-tribromoethane, propanoic acid, ethyl acetate, toluene and acetophenone.	3	
	20	Structure elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic techniques (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate	1	
V	**Practicals - Reactions of Organic Compounds (Any seven)**		**30**	
	I	1. Preparation of polymers eg: phenol formaldehyde, glyptal resin, nylon-6,6(Any two) 2. Preparation of heterocycles like tetrahydrocarbazole, pyrazole(Any one) 3. Preparation by multicomponent reactions-Biginelli Reaction 4. Preparation of furfural from corn cobs 5. Isolation of natural products - β-carotene /caffeine /Lycopene /Casein 6. Determination of acid value, saponification value and iodine value of fats and oils. 7. Determination of blood and urine sugar by chemical methods 8. Preparation of soap by saponification of oils and fats. 9. Preparation of hand sanitizer 10. Interpretation of spectral data of simple organic compounds.	24	

		11. Identification of λ_{max} of organic compounds (eg:Azo Dye)		
	II	Open ended	6	

References

1. I. L. Finar, Organic Chemistry, Vol. I & II, Pearson Education.

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

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

4. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Edn., Pearson Education, New Delhi, 2013.

5. S. P. Bhutani, Chemistry of Biomolecules, Ane Books Pvt. Ltd., 2009.

6. O. P. Agarwal, Chemistry of Organic Natural Products, 30th Edn., Goel Publications, 2006.

7. V. R. Gowarikar, Polymer Chemistry, New Age International (P) Ltd., New Delhi, 2010.

8. Fred. W. Billmeyer, Textbook of Polymer Science, 3rd Edn., Wiley India, Delhi, 2008.

9. Jeol R. Fried, Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, 1999.

10. M. S. Bhatnagar, Polymer Chemistry, S Chand and Company Pvt. Ltd., New Delhi, 2014

11. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.

12. K. Singh, Chemistry in Daily Life, Prentice Hall of India, New Delhi, 2008.

13. Vogel's practical organic chemistry.

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

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/Seminar/Viva/Quiz	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓	✓	✓

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

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**PHYSICAL CHEMISTRY – III- CHEMICAL AND PHASE EQUILIBRIA, ELECTROCHEMISTRY AND PHOTOCHEMISTRY**				
Type of Course	**MAJOR**				
Semester	**VI**				
Academic Level	**300 – 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	CHE2CJ102 and CHE4CJ205. The students must be familiar with the basic concepts in electrochemistry and must have taken NCERT plus-two chemistry course similar to https://onlinecourses.swayam2.ac.in/nce19_sc17/preview				
Course Summary	The chemical reactions tend to reach a state of dynamic equilibrium, i. e., the forward and reverse reactions occur at equal rates. This course introduces the underlying thermodynamic principles that can explain this state of equilibrium. Similarly, thermodynamics of phase transitions and phase equilibria are also explained as the second module. In the third module, electrochemical processes are explained which also involves thermodynamic concepts. In the fourth module, interaction of light with molecules and corresponding chemical as well as physical processes are explained. The final module consists of practical experiments related to these four important topics of chemistry.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To comprehend the concepts of law of mass action and chemical equilibria	U	F	Assignment/Test

CO2	To understand various phase transitions, construction of phase diagram and its importance in industry	Ap	P	Assignment/Quiz
CO3	To apply the basic concepts of electrochemistry in constructing electrochemical cells	Ap	P	Assignment/Quiz
CO4	To evaluate the pH of buffers, conduct potentiometric titrations and conductivity measurements	An	P	Lab work/Quiz
CO5	To know the theory and working of new generation electrochemical power storage systems	U	C	Assignment/Test
CO6	To understand the photochemical principles and to apply the unknown concentration a given sample solution using colorimetry	Ap	P	Discussion/Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs (45+30)**	**Marks**
I		**CHEMICAL EQUILIBRIUM**	**10**	**21**
	1	Law of mass action, thermodynamic derivation of law of chemical equilibrium.	**1**	
	2	Relation between Gibbs free energy of reaction and reaction quotient.	**1**	
	3	Equilibrium constants and their quantitative dependence on temperature, pressure and thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x (using chemical potential).	**3**	
	4	Van't Hoff's equation - Le Chatelier principle and its application. Homogeneous and heterogenous equilibria. Clausius-Clapeyron equation - Applications to solid-liquid, Liquid-vapour, Solid- vapour equilibria	**3**	

	5	Ionic equilibrium: Ionic product of water, pH and pOH, Buffer action, pH of buffer solutions	**2**	
II		**PHASE EQUILIBRIUM**	**15**	**33**
	6	Concept of phase, Components and Degrees of freedom, Gibbs Phase Rule – Thermodynamic derivation.	**3**	
	7	Phase diagram for one component systems – Water, CO_2	**2**	
	8	Two Component Systems - Phase diagrams for systems involving eutectic – KI/Ice – Freezing mixtures; Pattinson's process. Two-component systems with formation of congruent melting compound-$MgZn_2$. Fractional distillation. Azeotropes.	**4**	
	9	Partial miscibility of liquids, CST, Miscible pairs, steam distillation Three component systems, water-chloroform-acetic acid system, triangular plots, tie lines	**4**	
	10	Nernst distribution law: its derivation and applications in solvent extraction.	**2**	
III		**ELECTROCHEMISTRY**	**15**	**33**
	11	Electrochemical cells. Origin of electrode potentials-half cell potential-standard hydrogen electrode, reference electrodes	**2**	
	13	Electrochemical series, applications	**1**	
	14	Cell potential, Nernst equation for electrode and cell potentials. Nernst equation for electrode potential and EMF of a cell	**2**	
	15	Relationship between free energy and electrical energy. Gibbs Helmholtz equation to galvanic cells.	**2**	
	16	Concentration cells: Concentration cells with and without transference – Liquid junction potential (LJP).	**2**	
	17	Application of EMF measurements- Solubility of sparingly soluble salt, determination of pH, Potentiometric titrations	**2**	
	18	Electrochemical power storage and sources- Primary batteries- Dry cell, Storage batteries- Lead acid battery, Ni-Cd battery, Li-ion battery (basic idea only), Fuel cells-Hydrogen-Oxygen fuel cell, Electrochemical capacitors and supercapacitors (basic idea only)	**3**	
	19	Corrosion of metals- electrochemical theory- Methods to prevent corrosion	**1**	

IV	**PHOTOCHEMISTRY**		**5**	**11**
	20	Interaction of light with matter and Beer-Lambert's law, Photochemical process and quantum yield	**1**	
	21	Photochemical hydrogen-chlorine and hydrogen-bromine reactions-Reasons for high and low quantum yield	**2**	
	22	Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion, inter system crossing and vibrational relaxation. Quenching of fluorescence – Stern – Volmer equation;	**1**	
	22	Photosensitization - Chemiluminescence. Bioluminescence, thermoluminescence.	**1**	
V	**PHYSICAL CHEMISTRY- PRACTICALS-3**		**30**	
		A minimum of 5 practical experiments out of which at least one each from sections 1, 2 and 3 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-printed form.		
		Section 1		
		1. Construction of phase diagram & determination of eutectic composition and eutectic temperature: *Naphthalene-biphenyl system, Naphthalene-diphenylamine system, Biphenyl– diphenylamine system.*	**3**	
		Section 2		
		2. Influence of KCl/NaCl impurity on miscibility temperature of phenol–water system and determination of concentration of given KCl/NaCl solution.	**3**	
		Section 3		
		3. Verification of Beer-Lambert law for $KMnO_4$ and $K_2Cr_2O_7$ & determination of concentration of the given solution.	**3**	
		4. Colorimetric Estimation of iron (in ferric alum solution)	**3**	
		5. Colorimetric Estimation of chromium (in potassium dichromate solution)	**3**	
		Section 4		
		6. Conductometric titration of strong acid and strong base.	**3**	
		7. Potentiometric titration of strong acid and strong base.	**3**	
		8. Preparation of Acidic Buffer and recording pH using pH meter.	**3**	

		9. Open ended 10. Open ended	**3** **3**	
		References 1. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry* 8th Ed., Oxford University Press, 2006. 2. P. W. Atkins, J. de Paula *The Elements of Physical Chemistry* 7thEdn., Oxford University Press, Oxford, 2016. 3. B.R. Puri, L.R. Sharma,M.S. Pathania, *Principles of Physical Chemistry*, 46th Edn., Vishal Publishing Company, New Delhi, 2013. ***Further Reading*** **(Module II)** 4. S. Glasstone and D H Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan & Company, UK, 1962. 5. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997. **(Module III)** 6. S. Glassstone, *An Introduction to Electrochemistry*. East-West Press Pvt. Ltd., New delhi, 2007. 7. Praveen Tyagi, *Electrochemistry*, Discovery Publishing House,2006. **(Module III)** 8. K.K. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, New Age International, 1978.		

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

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

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

BSc CHEMISTRY

Programme	B. Sc. CHEMISTRY				
Course Title	**THEORETICAL CHEMISTRY III - ADVANCED QUANTUM CHEMISTRY**				
Type of Course	**MAJOR**				
Semester	**VII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	A good understanding of the concepts learned in the course, **CHE3CJ201 - Theoretical Chemistry 1 – Basics of Quantum Chemistry** - Postulates of quantum mechanics and related concepts, Application of these concepts to particle in a 1D box and 3D box.				
Course Summary	In the course, **CHE3CJ201**, students learned the basic concepts of Quantum Chemistry including the postulates of quantum mechanics and also learned how to apply these concepts to different systems. This course further develops the concepts by applying them to other systems of chemical relevance. While doing so, the subject matter can be related to other application level topics like Molecular Spectroscopy and Group Theory. Students also realize that for systems having more than one electrons (atoms other than hydrogen and molecules) time-independent Schrodinger equation could not be exactly solved. To overcome this difficulty, excellent approximate techniques are formulated and they can be employed with the help of computer programmes for solving any system of chemical relevance. Thus students are equipped with the basic concepts and methods of a very significant research area called Computational Chemistry. Hands on experience in computational chemistry can be gained through the practical sessions given in module V.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	*recall* the quantum mechanical postulates as the fundamental principles of quantum chemistry.	R	F	Quiz/MCQ Test

CO2	*realize* the wave functions of hydrogen atom as atomic orbitals.	U	C	Assignment/Viva
CO3	*apply* 1D Simple Harmonic Oscillator as a preliminary model for deriving the quantised energy levels of normal modes of vibration in molecules.	Ap	P	Class Test/Problem solving sessions
CO4	*relate* particle on a sphere as a starting model for deducing the quantised energy levels of rotation in diatomic molecules**.**	An	P	Class Test/Problem solving sessions
CO5	*justify* the use of approximate methods for deducing the wave functions and energy values of multi-electron systems.	E	P	Class Test/Problem solving sessions
CO6	*propose* computational methods for solving real world problems in chemistry	C	M	Assignment/Seminar
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (40+30)	Marks
I	**Quantum Mechanics of Vibrational and Rotational Motions**		**15**	**31**
	1	Review of the postulates of quantum mechanics.	1	
	2	One-dimensional simple harmonic oscillator (complete treatment):- Method of power series, Hermite equation and Hermite polynomials, recursion relation, wave functions and their plots, energy eigenvalues, important features of the problem, harmonic oscillator model and molecular vibrations.	3	
	3	Cartesian and spherical polar coordinates and their relationships.	1	
	4	Planar rigid rotor (or particle on a ring), the Phi-equation, solution of the Phi-equation.	2	
	5	One particle Rigid rotator (non-planar rigid rotator or particle on a sphere) (complete treatment): The wave	3	

		equation in spherical polar coordinates, separation of variables, the Phi-equation and the Theta-equation and their solutions, Legendre and Associated Legendre equations, Legendre and Associated Legendre polynomials.		
	6	Spherical harmonics (imaginary and real forms), polar diagrams of spherical harmonics.	2	
	7	Quantization of angular momentum, space quantization, quantum mechanical operators corresponding to angular momenta ($\hat{L}_x$, $\hat{L}_y, \hat{L}_z, \hat{L}^2$), commutation relations between these operators, Ladder operator method for angular momentum.	3	
	Sections from References: **Section A**			
II	**Quantum Mechanics of Hydrogen-like Atoms**		**10**	**25**
	8	Potential energy of hydrogen-like systems, the wave equation in spherical polar coordinates, separation of variables, the R, Theta and Phi equations and their solutions, Laguerre and associated Laguerre polynomials, atomic orbitals/wave functions of hydrogen-like atoms and their corresponding energy.	4	
	9	Radial and angular parts of atomic orbitals - Radial functions and radial plots, radial distribution functions and their plots, angular functions (spherical harmonics) and their plots.	2	
	10	The postulate of spin by Uhlenbeck and Goudsmith - Spin orbitals, construction of spin orbitals from orbitals and spin functions.	2	
	11	Pauli's principle of anti-symmetric wave functions - Slater determinants.	2	
	Sections from References: **Section A**			
III	**Approximation Methods in Quantum Mechanics**		**12**	**28**
	12	Many body problem and the need of approximation methods;	1	
	13	Independent particle model – Application to the ground state of helium atom.	1	
	14	Variation method – Variation theorem with proof, illustration of variation theorem using the trial function x	3	

		(a-x) for particle in a 1D-box, variation treatment of the ground state of helium atom.		
	15	Perturbation method – Time-independent perturbation method (non-degenerate case only), perturbation treatment of the ground state of helium atom.	3	
	16	Hartree's Self-Consistent Field method for atoms, Fock modification using spin orbitals & Hartree -Fock Self-Consistent Field (HF-SCF) method for atoms, the Fock operator;	4	
	Sections from References: **Section A**			
IV	**Introduction to Computational Chemistry**		**8**	**14**
	17	Classification of Computational Chemistry methods – Molecular mechanics methods (the concept of the force field) and Electronic structure methods, ab initio and semi-empirical methods (Basic idea only).	2	
	18	Roothan's concept of basis functions - Slater type orbitals (STO) and Gaussian type orbitals (GTO).	1	
	19	Concept of electron correlation and post HF methods. (Elementary idea)	1	
	20	Basis set approximation in ab initio methods - classification of basis sets – minimal, double zeta, triple zeta, split-valence, polarization & diffuse basis sets, Pople-style basis sets, and their nomenclature.	2	
	21	Gaussian programme – The structure of a Gaussian input file, Types of keywords.	1	
	22	Specification of molecular geometry using a) Cartesian coordinates and b) Internal coordinates. The Z-matrix, Z-matrices of some simple molecules like H_2, H_2O, HCHO and NH_3.	1	
	Sections from References: **Section B**			
V	**Computational Chemistry Practical**		**30**	
	1	1. Single point energy calculations of simple molecules like H_2O and NH_3 at the HF/3-21G level of theory. 2. The effect of basis set on the single point energy of H_2O and NH_3 using the Hartree-Fock method (3-21G, 6-31G, 6-31+G, 6-31+G* basis sets can be used).	10	

		3. Geometry optimization of molecules like H_2O, NH_3, HCHO & C_2H_4 at the HF/6-31G level of theory. 4. Computation of dipole and quadrupole moments of HCHO & C_2H_4 at the HF/6-31G level of theory.		
	2	5. Effect of basis set on the computation of H-O-H bond angle in H_2O using the HartreeFock method (3-21G, 6-31G, 6-31+G, 6-31+G* basis sets can be used). 6. Computation of the energy of HOMO and LUMO of formaldehyde and ethylene at the HF/6-31G level of theory. 7. Effect of substituent (F & Cl) on the geometric parameters (like C-C bond length) of ethylene at the HF/6-31G level of theory.	8	
	3	8. Comparison of stability of cis-planar and trans-planar conformers of H_2O_2 at the HF/6- 31G level of theory. 9. Comparison of stability of cis- and trans-isomers of difluoroethylene at the HF/6-31G* level of theory.	6	
	Open - ended	● Determination of hydrogen bond strength of H_2O dimer and H_2O trimer at the HF/6- 31+G* level of theory. ● Computation of the frequencies of normal modes of vibration of molecules like H_2O, NH_3 and CO_2 at the HF/6-31+G* level of theory.	6	
	Sections from References: **Section C**			

Books and References:

Section A

1. I. N. Levine, *Quantum Chemistry*, 6th Edn., Pearson Education Inc., 2009.
2. P. W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, 4th Edn., Oxford University Press, 2005
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Section B

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Section C

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Further reading

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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

<table>
<tr><td>Programme</td><td colspan="5">B. Sc Chemistry</td></tr>
<tr><td>Course Title</td><td colspan="5">INORGANIC CHEMISTRY-V</td></tr>
<tr><td>Type of Course</td><td colspan="5">MAJOR</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>3</td><td>-</td><td>2</td><td>75</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Theories of acids and bases, Bonding in diborane, Atomic number, mass number, isotopes, Basic idea about nuclear radioactivity, Nuclear fission and fusion, Basic concepts in Coordination Chemistry, Knowledge about magnetic properties of complexes</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course enables the students to develop knowledge about HSAB principle, Concepts of superacids, Bonding and structure in higher boranes.
It deals with detailed nuclear shell models, Nuclear reactions, Neutron activation analysis and Radiation chemistry
It covers the electronic spectra of complexes and explanation of d-d transition
It gives understanding about the various magnetic properties and its calculation
It enables the students to familiarise with various spectral techniques that is used to characterise the metal complexes like ESR, NMR and Mossbauer
It covers the different types of reactions that takes place in complexes and their explanations
This course enables the students to apply knowledge in the qualitative analysis of mixture of ions and develop skill for separation and estimation of mixture of ions</td></tr>
</table>

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate a deep understanding of HSAB principle, Super acid concepts and bonding structure in higher boranes and boron cluster compounds.	U	C	Instructor-created exams / Assignments/Quiz
CO2	Explain detailed nuclear shell models, nuclear reactions, neutron activation analysis and radiation chemistry.	U	C	Instructor-created exams / Assignments/ seminar presentations
CO3	Comprehend electronic spectra of complexes and understand various magnetic properties of complexes.	U	C	Class test /Assignment / seminar/Quiz
CO4	Grasp the reactions of coordination compounds, the mechanisms and apply theoretical understandings.	Ap	C	Assignment/Seminar/Test
CO5	To understand chemistry of excited state coordination compounds	U	C	Assignment/Seminar/ Test
CO6	Apply practical skills in the analysis of mixture of metal ions, specifically rare earth elements and separation and estimation of binary mixture of ions in solution.	An	P	Viva Voce/Observation of practical skill

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks
I		**ACID BASE CONCEPTS AND COMPOUNDS OF BORON**	**10**	**21**
	1	Classification of acids and bases as Hard and Soft	1	
	2	HSAB principle. The theoretical basis of hardness and softness	1	
	3	The Drago-Wayland equation, E and C parameters- Symbiosis, Applications of HSAB concept, Super acids	2	
	4	Electron-deficient compounds- Boron hydrides- Preparation, Reactions, Structure, and Bonding. Styx numbers-Closo, nido, arachno polyhedral structures.	3	
	5	Boron cluster compounds-Wade's rule, Polyhedral borane anion- Carboranes, Metallaboranes and Metallacarboranes.	3	
II		**NUCLEAR AND RADIATION CHEMISTRY**	**7**	**16**
	6	Structure of nucleus: Shell, liquid drop, Fermi gas, Collective and Optical models. Nuclear reaction: Bethe`s notation of nuclear process	2	
	7	Types- Reaction cross section, Photonuclear and Thermonuclear reactions. Nuclear fission: Theory of fission, Neutron capture cross section and Critical size, Nuclear fusion.	2	
	8	Neutron activation analysis.	1	
	9	Detection and measurement of radiation- GM and Scintillation counters, Radiolysis of water, Radiation hazards, Radiation dosimetry.	2	
III		**SPECTRAL AND MAGNETIC PROPERTIES OF COORDINATION COMPOUNDS**	**18**	**40**
	10	Spectroscopic ground state, Terms for d^n configuration, Selection rule for d-d transition , Effect of ligand field on R S terms, O_h and T_h complexes.	2	

	11	Orgal diagram, Spectra of 3d (d^1,d^2,d^3) metal ions complexes, Racah parameter, Charge transfer parameter (LMCT. MLCT) with example.	2	
	12	Types of Magnetic properties: Paramagnetism and Diamagnetism, Curie and Curie- Weiss laws. The μ_J, μ_{L+S}, and μ_S expressions..	2	
	13	Orbital contribution to magnetic moment and its quenching, Spin-orbit coupling, Temperature independent Paramagnetism, Anti ferromagnetism- Types and exchange pathways. Determination of magnetic moment by Gouy method.	3	
	14	ESR spectra – Application to copper complexes.	3	
	15	NMR spectroscopy for structural studies of diamagnetic metal complexes from chemical shift and spin- spin coupling.	3	
	16	Mossbauer spectroscopy- the Mossbauer Effect, Hyperfine interactions (qualitative treatment). Application to Iron and Tin compounds	3	
IV		**REACTIONS OF COORDINATION COMPOUNDS**	**10**	**21**
	17	Ligand substitution reactions, Labile and Inert complexes, Rate law, Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes.	2	
	18	The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes	2	
	19	The Trans effect- Applications and theories of Trans effect, The cis effect.	1	
	20	Classification of redox reaction mechanisms. Outer sphere and Inner sphere mechanisms, Marcus equation, Effect of the bridging ligand.	1	
	21	Methods for distinguishing outer- and inner-sphere redox reactions, Photochemical reactions of metal complexes.	2	
	22	Prompt and delayed reactions, Excited states of metal complexes- Inter ligand, ligand field, charge transfer, and delocalized states Properties of ligand field excited states. Photosubstitution-Prediction of substitution lability by Adamson`s rules.	2	

V	**QUALITATIVE MIXTURE ANALYSIS INCLUDING LESS COMMON CATIONS and ESTIMATION OF BINARY MIXTURES**		**15*2 (30)**	
	23	**1. Inorganic Cation Mixture Analysis** Separation and identification of four metal ions including less common elements like W, Se Te, Mo, Ce, , Zr, V, and Li. (Eliminating acid radicals not present). Confirmation by Spot tests. **0. Estimation of ions in mixture (Open ended)** a) Separation and estimation of binary mixtures of ions in solution [Cu^{2+}, Ni^{2+}, Fe^{2+}, Ca^{2+}, Mg^{2+} and $(Cr_2O_7)^{2-}$] by volumetric, colorimetric or gravimetric methods. Only one of the components to be estimated. Any two combinations can be performed		

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11. B.Douglas, D.McDaniel, J.Alexander, *Concepts and Models of Inorganic Chemistry,*Wiley Student Edition,2006.

12. A.W.Adamson and P.D.Fleischauer, *Concepts of Inorganic Photochemistry,Wiley.*

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16. A.E. Martell, *Coordination Chemistry, Vol.I*

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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ORGANIC CHEMISTRY V**				
Type of Course	**MAJOR**				
Semester	**VII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Preliminary idea about basics of stereochemistry, C-C bond formation, photochemistry, free radical mechanisms, organic reactions and reagents.				
Course Summary	This course explores the basics of stereochemistry, C-C bond formation, photochemistry, free radical mechanisms, organic reactions and reagents.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand and apply concepts of stereochemistry, conformations and asymmetric synthesis	U	C	Test /Seminar
CO2	To apply principles of physical organic chemistry including acidity, basicity and reaction mechanisms	U	p	Discussion/ Assignment
CO3	To demonstrate ability to generate carbanions and conduct a variety of condensation and other organic reactions	An	P	Quizzes/Test
CO4	To analyze the role of photochemistry in chemical	Ap	P	Discussion/Seminar /Assignment

	reactions and apply concepts to radical chain reactions			
CO5	To Conduct common organic reactions and apply select reagents in redox and substitution reactions	Ap	P	Assignment/Test
CO6	To empower students in setting up the reaction and purification process	Ap	P	Lab work/Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Stereochemistry III**	**13**	**28**
	1	Optical isomerism shown by molecules have stereocenters other than C, N, P, S. Axial chirality - Planar chirality and helicity. Nomenclature - Prochirality, Re, Si Nomenclature.	3	
	2	Stereoselective and stereospecific reaction - Effect of configuration on Substitution - Addition and Elimination reactions.	2	
	3	Conformations of 1,2 disubstituted compounds - Carbonyl compounds - Mono and disubstituted cyclohexanes, A-value -Decalin, Bridged bicyclic systems, Anomeric effect, The effect of conformation on reactivity.	4	
	4	Asymmetric synthesis: - Resolution methods - Chiral pool approach - Chiral auxiliary approach - Chiral reagents - Chiral catalyst. (SAMP/RAMP method - Sharpless epoxidation)	4	
II		**Physical Organic Chemistry**	**10**	**22**
	5	Acidity and basicity of organic compounds - Equilibrium - Rate- Rate limiting step - Intermediates and transition states, Reaction profile diagrams, Kinetic and Thermodynamic control of reactions.	5	
	6	Hammond postulate Curtin-Hammett principle.	1	
	7	Methods of determining Reaction Mechanisms	1	
	8	Isotopic labeling, Kinetic isotopic effects, Crossover studies, Detection of intermediates	3	
III		**Formation of C-C bonds**	**13**	**28**
	9	Generation of carbanions from carbonyl compounds, Lithium enolates, Enamines and Silyl enol ethers, O and C-alkylation.	2	

	10	Crams's rule and Felkin Ahn model	2	
	11	Aldol condensation from enolates - Enamine and silyl enol ethers, Mukyamma aldol reaction - Zimmerman Traxler model, Intramolecular reactions.	3	
	12	Claisen condensation - Perkin Reaction - Knovenagel reaction, Conjugate addition	2	
	13	Robinson annulation - Wittig and related reactions, Reactions of enols - Acid-mediated reactions of aldehydes and ketones.	2	
	14	**Organometallic reagents**- Grignard reagents - Alkyl lithium agents, Preparation and its reaction with carbonyl compounds and nitriles.	2	
IV		**Photochemistry and free radical reactions**	**9**	**20**
	15	**Photochemistry**: Fate of an excited molecule - Chemical reactions of excited molecules,	1	
	16	Photochemistry of carbonyl compounds: Norrish type I and II cleavage – α-cleavage, γ-hydrogen abstraction, Paterno Buchi reaction.	2	
	17	Isomerization (cis-trans isomerization in retina, isomerization in benzene), Photosensitization, Di-pi-methane rearrangement, Oxa-di-pi-methane rearrangement.	2	
	18	**Free radical reactions:** Radical chain reaction, NBS allylic bromination, Acyloin reaction, HLF reaction, Hunsdiecker-Borodin reaction	2	
	19	Generation of C radicals from alkyl halides using AIBN-tributyltin hydride and their cyclizations (5-exo mode only). Radical inhibitors, methods of detecting radical intermediates.	2	
V		**Practicals**	**30**	
	1.	**Introduction to organic lab**	4	
	2	1. Double stage preparations (iodobenzene from aniline/benzil benzilic acid/triphenyl imidazole and its dimerization/ Hydroquinone-benzoquinone anthracene/ caprolactam/ bromoaniline from acetanilide or any reaction based on oxidation/reduction/condensation/rearrangement (purification of the prepared compounds by recrystallization and measurement of melting point) 2. Column chromatography 3. Steam distillation 4. Thin layer chromatography	20	
	3	Open ended	6	

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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-	3		2		2		2
CO 2	2		-	-	-	-	3		2		3		2
CO 3	2	-		-	-	-	3		2		3		3
CO 4	2	-			1	-	3		2		2		3
CO 5	3		-	-	-	-	3		1		2		3
CO 6	-	-	3		-	-	3		2		2		3

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

Programme	B. Sc. Chemistry
Course Title	**PHYSICAL CHEMISTRY IV – STATISTICAL THERMODYNAMICS**
Type of Course	**MAJOR**
Semester	**VII**
Academic Level	**400 - 499**

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75

Pre-requisites	CHE2CJ102, CHE3CJ201 and CHE4CJ205. Preliminary idea about quantum chemistry, classical thermodynamics and kinetics
Course Summary	The bulk properties of matter are linked with its microscopic properties and it is important to consider a molecular approach to quantitatively explain the physical and chemical properties. This course explores the basics of statistical thermodynamics and thermodynamics of irreversible processes and solutions, molecular dynamics theories.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Understand and apply concepts of statistical thermodynamics and quantum statistics in chemical applications	U	C	Test /Seminar/Assignment
CO2	To Calculate thermodynamic properties using partition functions	U	P	Test/ Assignment/Seminar
CO3	To Apply thermodynamic principles to solutions	An	P	Quiz/Seminar/Assignment

	and comprehend irreversible processes			
CO4	To understand theories of molecular reaction dynamics	U	C	Test/Seminar /Assignment
CO5	To analyse potential energy surfaces in order to understand reaction dynamics	An	C	Assignment/Test
CO6	To apply concepts of statistical thermodynamics in simulation experiments	Ap	M	Lab work/Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**STATISTICAL THERMODYNAMICS- I**	**15**	**26**
	1	Fundamentals: Concept of distribution, thermodynamic probability and most probable distribution.	2	
	2	Ensembles, statistical mechanics for systems of independent particles and its importance in chemistry	2	
	3	Thermodynamic probability & entropy, idea of microstates and macrostates, statistical weight factor (g)	2	
	4	Sterling approximation, and Maxwell- Boltzmann distribution of molecular energies.	2	
	5	The molecular partition function and its relation to the thermodynamic properties, derivation of third law of thermodynamics, equilibrium-constant & equi-partition principle in terms of partition functions, factorisation of the molecular partition function into translational, rotational, vibrational and electronic parts, the corresponding contributions to the thermodynamic properties.	4	
	6	Relation between molecular & molar partition functions, Evaluation of partition functions and thermodynamic properties for ideal mono-atomic and diatomic gases.	3	
II		**STATISTICAL THERMODYNAMICS- II**	**10**	**26**
	7	Quantum Statistics: Bose-Einstein distribution law, Bose-Einstein Condensation, application to liquid helium.	3	

	8	Fermi - Dirac distribution law, application to electrons in metals.	2	
	9	Relationship between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.	2	
	10	Heat capacities of solids: Classical and quantum theories, Einstein's theory of atomic crystals and Debye's modification.	3	
III	**THERMODYNAMICS OF SOLUTIONS AND IRREVERSIBLE PROCESSES**		**15**	**30**
	11	Fugacity, Activity, Activity coefficient, Standard state of substance (for solute and solvents), Duhem-Margules equation and its applications	3	
	12	Thermodynamics of ideal solutions, Deduction of the laws of Raoult's ebullioscopy, cryoscopy, and osmotic pressure.	2	
	13	Non ideal solutions, Deviations from Raoult's law.	2	
	14	Excess functions: Excess free energy, excess entropy, excess enthalpy, excess volume.	2	
	15	Simple examples of irreversible processes, general theory of non-equilibrium processes	2	
	16	Entropy production, The phenomenological relations, Onsager reciprocal relations	2	
	17	Application to the theory of diffusion, thermal diffusion, thermo-osmosis and thermo- molecular pressure difference, electro-kinetic effects, the Glansdorf-Pregogine equation.	2	
IV	**MOLECULAR REACTION DYNAMICS**		**5**	**16**
	18	Reactive encounters: Collision theory	1	
	19	Diffusion controlled reactions	1	
	20	The material balance equation	1	
	21	Potential energy surfaces: Attractive and repulsive surfaces	1	
	22	Theories of unimolecular reactions: Rice -Ramsperger and Kassel (RRK) model.	1	
V	**Practicals** A minimum of three experiments/simulations must be performed and recorded		**30**	
			5	

	1. By using MS Excel, Scilab, Python or any other suitable programs, simulate and plot the probability of macrostates in coin tossing experiments 2. By using a suitable computer program (MS Excel, Scilab or other) determine and plot Maxwell speed distribution function for different gases 3. By using a suitable computer program (MS Excel, Scilab or other), determine and plot Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac distribution functions 4. Simulation of specific heat of solids (diamond) using Dulong Petit, Einstein and Debye model 5. Scan around a single bond in N_2 molecule to find out the minimum energy in the PE diagram by using Gaussian, ORCA, Gamess or similar packages. (HF method, 6-31G basis set) 6. Calculation of Potential energy surface of H_2O molecule with respect to change of bond angles and bond distances by using Gaussian, Gamess or similar packages (HF method, 6-31G basis set) 7. Calculation of Potential Energy Surface of ethane by changing the dihedral angle, in order to understand the most stable conformation by using Gaussian, Gamess or similar packages 8. Calculation of Potential Energy Surface of n-butane by changing the dihedral angle, in order to understand the most stable conformation by using Gaussian, Gamess or similar packages 9. Open ended 10. Open ended		5 5 5 5 5 5 5 5 5	
		References **Module I and II** 1. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) 2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) 3. T. Engel, P. Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, Inc: New Delhi, 2007. 4. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Classical, Statistical and irreversible, Pearson Education, New Delhi, 2013. 5. A. Ben-Naim, Statistical Thermodynamics Based on Information: A Farewell to Entropy, World Scientific, Singapore		

Module III and IV

6. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York)
7. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.)
8. T. Engel, P. Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, Inc: New Delhi, 2007.
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Module V

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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**INSTRUMENTAL METHODS OF ANALYSIS**				
Type of Course	**MAJOR**				
Semester	**VII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Electrochemistry. 2. Fundamentals of Spectroscopy. 3. Fundamentals of Analytical Chemistry.				
Course Summary	This course provides a thorough overview of essential analytical techniques in chemistry and materials science, covering separation, spectroscopy, surface characterization, and thermal/electroanalytical methods. The course emphasizes practical applications, preparing students for precise chemical analysis in various scientific and industrial fields. The practical module ensures hands-on-training on some of the important methods.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basic principles and instrumentation of chromatographic techniques for the separation of mixture of chemicals (products)	Ap	P	Instructor-created exams / Quiz /Assignment
CO2	To identify the instrumentation and applications of important spectroscopic methods for chemical analysis.	Ap	P	Class test /Assignment /Quiz
CO3	To know the role of imaging techniques to study various materials and surfaces.	U	C	Assignment/ Class test
CO4	To understand and analyse the principles and instrumentation of various thermal analytical methods	An	C	Assignments /Seminar presentation

CO5	To understand and apply electroanalytical methods	Ap	C	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Separation techniques**		**6**	**10**
	1	Brief outline of Paper and Thin-Layer Chromatography (TLC),	1	
	2	Ion exchange chromatography: Principle, cation and anion exchange resins, its application in separation of ions.	1	
	3	Gas Chromatography (GC) – Principle, GC Instrumentation – Injectors, column, detectors (TCD, FID, ECD) and applications.	1	
	4	Hyphenated GC Technique - GC-MS	1	
	5	High Performance Liquid Chromatography (HPLC): Principle, instrumentation - Column, stationary phases, column packing, mobile phase, detectors. Effects on Separation of Composition of the Mobile Phase and applications	2	
II	**Spectroscopic and related methods**		**15**	**36**
	6	UV-Visible Spectrometry: Beer-Lambert's law, Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments. Difference between Colorimeter & spectrophotometer.	2	
	7	Flame emission and Atomic Absorption Spectroscopy (AAS): Introduction, principle. Instrumentation and Analytical applications.Inductively Coupled Plasma-Atomic/Optical emission spectroscopy (ICP-AES or ICP-OES)- theory, instrumentation and applications. ICP-MS method. Analytical Applications	3	
	8	Fourier transform-Infrared spectroscopy (FT-IR)- FT-IR instrumentation and analytical applications. Raman spectroscopy, Principle, instrumentation, Surface enhanced Raman Spectroscopy (SERS), Raman microscopy	3	

	9	Fluorescence spectroscopy, Theory, Instrumentation and Analytical applications, Confocal laser-scanning microscopy	2	
	10	FT-NMR spectroscopy, basic principle, instrumentation, spectrometers with different frequencies of operation, ESR/EPR spectroscopy, ENDOR (Electron-Nuclear double resonance) technique	3	
	11	Mass spectrometry, Instrumentation and applications, MALDI-TOF method and instrumentation	2	
III	**Microscopy, Photoelectron spectroscopy and X-ray diffraction techniques**		**14**	**32**
	12	Scanning Electron Microscopy (SEM) Instrumentation, Operating Principle, Secondary - Electron Images, Backscattered- Electron Images, operating conditions and sample preparation.	2	
	13	Transmission Electron Microscopy (TEM): Instrumentation, General Design, Resolution, Electron Sources, TEM grids, electron lenses, Bright and Dark field images, Applications.	2	
	14	Scanning probe microscopy methods: Principle, instrumentation and applications of Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM).	3	
	15	Photoelectron Spectroscopy Techniques - X-Ray Photoelectron Spectroscopy - Instrumentation for XPS, Sample Introduction and Handling for Surface Analysis, Analytical Applications of XPS, Auger Electron Spectroscopy – Instrumentation and Applications.	3	
	16	Powder and Single crystal X-ray diffraction, basic principle, instrumentation and applications.	4	
IV	**Thermal and Electroanalytical methods of analysis (12 h)**		**10**	**20**
	17	Thermogravimetry - TGA Instrumentation, Analytical Applications of Thermogravimetry, Derivative Thermogravimetry, Sources of Error in Thermogravimetry.	2	
	18	Differential Thermal Analysis (DTA) - Instrumentation - Analytical Applications of DTA.	1	
	19	Differential Scanning Calorimeter (DSC), Instrumentation and applications.	1	
	20	Classification of electroanalytical methods, Potentiometry- Three and Two electrode systems, Types of indicator Electrodes. Analytical Applications of Potentiometry.	2	
	21	Coulometry – Electrogravimetry, Instrumentation for Electrogravimetry and Coulometry, Applied Potential, Analytical Determinations Using Faraday’s Law.	2	

	22	Cyclic Voltammetry, Theory Instrumentation and applications	2	
V	**Practicals**		**30**	
	Open Ended	At least 5 practical experiments must be performed from the given below list. 1. Evaluation of the refractive index of the given liquid and also find its molar refractivity 2. Determination of the order of a reaction and velocity constant for the inversion of cane sugar by acid by polarimetric method 3. Study of the complex formation between ferric ion and salicylic acid to find the formula and stability constant of the complex via colorimetry 4. Preparation and characterization of silver/gold nanoparticles by uv-vis spectroscopy 5. Estimation of band-gap for Cu nanoparticles using absorption spectroscopy 6. Estimation of glucose via enzymatic method by using colorimetry 7. Determination of Na and K ions in unknown solutions via flame photometric method 8. Determination of calcium content of milk samples/unknown Calcium salt solutions using flame photometer 9. Thermogravimetric analysis of a salt hydrate (such as $CaC_2O_4.H_2O$, $CuSO_4.5H_2O$)		

		10. Powder X-ray diffraction measurement, indexing of patterns and determination of unit cell parameters of crystalline solids (like NaCl, KCl or any other) 11. Synthesis of nanoparticles and estimation of crystallite size from powder X-ray diffraction patterns by Scherrer equation. 12. Determination of the formal reduction potential (E_0) and n values for the $[Fe(CN)_6]^{3-}$/ $[Fe(CN)_6]^{4-}$ couple in 0.1M KNO_3 from the 2mM cyclic voltammogram 13. Determination of the concentration of unknown $K_3[Fe(CN)_6]$solution using a calibration graph of concentration vs. peak height from cyclic voltammogram 14. Separation of a mixture of amino acids by Thin Layer Chromatography (TLC) and identify the test amino acids by measuring their R_f values. 15. Preparation of Silica nanoparticles by a one-sep process (Stöber process) and morphological analysis via scanning elecron microscopy 16. Open ended 17. Open ended 18. Open ended		

References:

1. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, a. 9th Edn ., Cengage Learning., 2014.

2. D.A. Skoog, F.J. Holler, T.A. Nieman, Principles Of Instrumental Analysis, Engage Earning India Edn.
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4. Vogel's Text Book of Quantitative Organic Analysis, 2th ed. ELBS
5. Dr. *B. K. Sharma, Instrumental Methods* of *Chemical Analysis, 3rd Edition 2004.*
6. James W. Robinson, Eileen M. Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, Seventh Edition, CRC Press.

Mapping of COs with PSOs and POs :Correlation Levels:

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**INORGANIC CHEMISTRY-VI**				
Type of Course	**MAJOR/MINOR**				
Semester	**VIII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-		60
Pre-requisites	Bonding in Coordination compounds Classification of ligands Bonding in CO molecule Basic idea of IR spectroscopy Metal ions in biological systems				
Course Summary	This course explains in detail the structure, bonding and reactions of organometallic compounds. It deals with the bonding in metal carbonyls and provides application skill in evaluating the bonding and structural characteristics of metal carbonyls using IR spectroscopy. It identifies the application of organometallic compounds. It describes different organometallic polymers. It evaluates bioinorganic compounds and their biological actions				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Equip with comprehensive understanding of organometallic compounds	U	C	Instructor-created exams / Assignments/Quiz
CO2	Identify bonding, synthesis, reactions and applications of metal carbonyls and apply IR spectroscopy to analyse structure and bonding characteristics of metal carbonyls	An	P	Assignment / seminar/quizzes/Class test

CO3	Apply organometallic compounds in synthetic chemistry	Ap	C	Assignment/Seminar/Class test
CO4	Provide with deep understanding of the interplay between bio inorganic compounds and biological systems	U	C	Class Test/ Assignment/Viva Voce
CO5	Identify and distinguish different categories of organometallic polymers and understand their applications	U	C	Assignment/class test/Seminar
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Mark
I		**ORGANOMETALLIC COMPOUNDS**	**10**	**21**
	1	Organometallic compounds. Classification and nomenclature.	1	
	2	Zeise's salt, The 16 and 18 electron rules. Electron counting-covalent and ionic models	1	
	3	Main group organometallics-alkyl and aryl groups 1, 2, 12, 13, 14 and 15, Synthesis, Structure and Applications.	2	
	4	Transition metal to carbon multiple bond-the metal carbenes and carbynes.	2	
	5	Transition metal complexes with chain π ligands–synthesis, structure, bonding and reactions of complexes of ethylene, allyl, butadiene and acetylene.	4	
II		**METAL CARBONYLS**	**15**	**31**

	6	Metal carbonyls- Bonding modes of CO.	1	
	7	IR spectroscopy as a tool to study bonding and structure of metal carbonyls.	1	
	8	Synthesis of Metal carbonyls, Direct and reductive Carbonylation	3	
	9	Reactions of Metal carbonyls-Activation of metal carbonyls,	2	
	10	Disproportion, Nucleophilic addition, electrophilic addition to the carbonyl oxygen, Carbonyl cation, anions and hydrides	3	
	11	Collmann's reagent, Migratory insertion of carbonyls	2	
	12	Oxidative decarbonylation. Photochemical substitution. Microwave assisted substitution.	3	
III	**APPLICATIONS OF ORGANOMETALLIC COMPOUNDS IN ORGANIC SYNTHESIS AND HOMOGENEOUS CATALYSIS**		**11**	**22**
	13	Complex formation and activation of H_2, N_2, O_2, NO by transition metals	3	
	14	Catalytic steps, Oxidative addition, Reductive elimination and Insertion reactions.	2	
	15	Hydrozirconation of alkenes and alkynes	1	
	16	Homogeneous catalysis. Hydrogenation, Isomerization of alkenes, alkyne, Cycloadditions, Ziegler-Natta catalysis	3	
	17	Hydroformylation of alkenes, Monsanto acetic acid process and Wacker process. Metal complexes in enantioselective synthesis	2	
IV	**BIOINORGANIC COMPOUNDS AND THEIR FUNCTIONS**		**12**	**24**
	18	Metallo enzymes, Iron enzymes: Structure and functions of Cytochrome P-450, catalase and peroxidase	3	
	19	Copper enzymes: Oxidase, superoxide dismutase and tyrosinase.	2	
	20	Lewis acid role of Zn (II), Structure and functions of Carboxypeptidase and Carbonic anhydrase	2	
	21	Chlorophyll, Photosynthesis, Photosystem I and II. Nitrogen fixation - Nitrogenases.	3	
	22	Storage and transport of metal ions- ferritin, transferrin and siderophores. Toxic effect of metals	2	
V	**ORGANOMETALLIC POLYMERS (Open ended)**		**12**	

		The following topics related with organometallic polymers can be selected by the teacher 1.Polymers with organometallic moieties as pendant groups. Polymers with organometallic moieties in the main chain 2. Condensation polymers based on ferrocene, rigid rod polyynes, Poly (ferrocenyl silane)s and their application 3. Polygermanes and Polystannanes 4. Polymers prepared by ring opening polymerisation 5. Organometallic dendrimers		

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3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry. 5th edition, John and Wiley, 1999.

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14. I. Bertini, H.B. Grey, S.J. Lippard and J.S.Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd., 1998.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2				2	1	2				1		1
CO2							2				1		2
CO3				1	1	2					1	1	2
CO4	2				2	1	3				2	1	1
CO5	2					1	2				2	1	2

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/ Seminar/ vivavoce	Practical skill evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ORGANIC CHEMISTRY VI**				
Type of Course	**Major/Minor**				
Semester	**VIII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Preliminary ideas about common rearrangement reactions, pericyclic reactions and gives an insight to various spectroscopic techniques.				
Course Summary	This course explores common rearrangement reactions, pericyclic reactions and gives an insight to various spectroscopic techniques.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand and apply various rearrangement reactions to electron deficient Carbon, Nitrogen and Oxygen	U	C	Test /Seminar
CO2	Comprehend and utilize pericyclic reactions, specifically electrocyclic, cycloaddition and sigmatropic rearrangement reactions	U	p	Dicussion/ Assignment
CO3	Able to explain the principles of UV-Visible-Spectroscopy, IR spectroscopy, interpret their spectra and use Mass spectrometry in molecular mass determination	An	P	Quizes/Test

CO4	Understand and analyze both H NMR and C NMR spectra of simple organic molecules for structure elucidation of organic compounds	Ap	P	Discussion/Seminar /Assignment
CO5	Perform various chemistry practicals including preparation, estimation techniques, column chromatography and identification of unknown molecule via spectroscopic analysis	An	P	Viva Voce/Observation of practical skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Common rearrangement reactions**	**8**	**18**
	1	Rearrangement to electron deficient Carbon-Wagner - Meerwin rearrangement, Pinacol-Pinacolone rearrangement, Tiffeneau-Demjanov, Dienol-Phenol.	2	
	2	Rearrangement to electron-deficient Nitrogen - Beckmann, Lossen, Hofmann, Curtius.	2	
	3	Rearrangement to electron-deficient Oxygen - Baeyer-Villiger, Dakin reaction.	2	
	4	Acyl carbene rearrangements - Wolff, Arndt-Eistert synthesis.	1	
	5	Anionic rearrangements - Favorskii and Benzilic acid rearrangements.	1	
II		**Pericyclic reactions**	**11**	**24**
	6	Electrocyclic reaction – ring-opening reaction and ring closure reactions in butadiene and hexatriene, con rotation and disrotation of HOMO and LUMO of butadiene and hexatriene for product formation.	2	
	7	Cycloaddition reactions - 2+2 and 4+2 cycloadditions – antarafacial and suprafacial additions, Examples for thermal and photochemical cyclo addition reactions.	2	
	8	Diels alder reaction - dienes and dienophiles in Diels alder reaction, distereoslectivity, hetero Diels-Alder reaction.	2	
	9	Dipolar cycloaddition - Huisgen cycloaddition, Click chemistry (azide-alkyne cycloaddition as example).	1	

	10	Sigmatropic rearrangement - Sigmatropic rearrangements: 1,3 and 1,5 and 1,7 shifts of hydrogen atoms (explanation based on frontier molecular orbitals).	2	
	11	Cope rearrangement and Claisen rearrangement, 2,3-rearrangement, chelotropic reaction, FMO and Moebius-Hückel Approach.	2	
III		**UV-Visible-spectroscopy and Mass spectrometry**	**13**	**28**
	12	UV-Visible-spectroscopy- basic principles, Factors affecting redshift and blueshift, λmax calculation for dienes and α,β-unsaturated carbonyl compounds and polyenes.	3	
	13	IR spectroscopy- basic principles, Factors affecting absorption frequencies, Fingerprint and functional group region.	2	
	14	IR spectra of functional groups-alkenes, Alkynes, Aromatic compounds, Alcohols, Phenols, Carbonyl, Carboxylic acid derivatives, nitro, cyano, sulfoxide.	2	
	15	Mass spectrometry- Theory, Molecular ion peak, Fragment ions, Molecular mass determination, Metastable ion.	3	
	16	Isotopic effect, N Rule, Index of hydrogen deficiency, McLafferty rearrangement, Ionization methods.	3	
IV		**NMR Spectroscopy**	**13**	**28**
	17	NMR Spectroscopy - Basic principles, Chemical shift values in low resolution spectra	3	
	18	High resolution H NMR spectra: Spin-spin splitting, Pascals triangle for Splitting patterns and calculation of coupling constant, Factors affecting coupling constant	3	
	19	Interpretation of 1H NMR and C NMR spectra of simple organic molecules	3	
	20	Structure elucidation of simple organic compounds using UV, IR and 1H NMR spectroscopic techniques.	4	
V		**Practicals**	**30**	
	1.	Introduction to organic lab	4	
	2	1. Estimation of aniline/phenol 2. Estimation of glucose organic compounds by colorimetry 3. Estimation of drug molecules by titration/colorimetry 4. Double stage preparations (Synthesis of dihydroxy triptycene from anthracene and hydroquinone, reductive amination and its structure analysis) - any one 5. Cannizzaro reaction of p-chlorobenzaldehyde and isolation of products	20	

		6. Column chromatography 7. Identification of unknown molecule via spectroscopic analysis (measure the spectra and analyse if the instruments are accessible, otherwise analyse the provided the spectra)		
	3	Open ended	6	

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3. Organic Chemistry Paperback, Francis Carey, McGraw-Hill Education
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Mapping of COs with PSOs and POs :

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

CO 5	-		3	-	3	3	3		3	2	3		3

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**PHYSICAL CHEMISTRY V- ADVANCED TOPICS IN SOLID STATE AND ELECTROCHEMISTRY**				
Type of Course	**MAJOR /MINOR**				
Semester	**VIII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Preliminary ideas about structure and bonding in solids, Physical properties of solids, Dynamic electrochemistry, Solid surfaces: Adsorption and heterogenous catalysis It is desirable for the students to familiarise with the previous physical and theoretical chemistry courses, CHE2CJ102, CHE3CJ201, CHHE4CJ205, CHE5CJ301, CHE6CJ306, CHE7CJ401, and CHE7CJ401				
Course Summary	Physical properties of solids are intriguing and they are of huge technological interest. In fact, our everyday life in the modern times is intimately connected to these exciting solid materials. First two modules of this course are designed to appreciate the science of structure-property relations in solids. The third module deals with the kinetics of electrochemical processes and basic idea of some electroanalytical methods. The fourth module gives a deeper insight to the importance of surface of solids in heterogeneous catalysis.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the importance of structure and bonding in solids	U	C	Test /Seminar/Assignment
CO2	To analyse and correlate the structure with various physical properties in solids	Ap	P	Test /Seminar/Assignment
CO3	To comprehend the concepts of equilibrium electrochemistry	U	F	Test /Seminar/Assignment

CO4	To apply the knowledge of electrode kinetics in electrochemical processes and electroanalytical techniques	Ap	P	Test /Seminar/Assignment
CO5	To understand theory of multilayer adsorption of molecules on solid surfaces	U	C	Test /Seminar/Assignment
CO6	To apply the knowledge of adsorption for the development of heterogeneous catalysts	Ap	P	Test/Labwork/Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**STRUCTURE AND BONDING IN SOLIDS**	**12**	**26**
	1	Ionic bonding, radius ratio rules and structure of simple Ionic solids (NaCl, KCl, CsCl, ZnS, NiAs, CaF_2 etc.), Partial covalent bonding in solids, Perovskite and Spinel-type structures	**2**	
	2	Qualitative MO diagram of hypothetical cyclic molecules of Hydrogen- H_2, H_4, H_5, H_6, …. H_n. Orbital interactions in solids and Band theory as applied to hypothetical one dimensional H-atom crystal, Brillouin zone, Band dispersion curves, Density of States (DOS), The Fermi level	**2**	
	3	Band width and nature of band dispersion and DOS in 1D H-atom crystal with varying H-H distances, Peirls distortion, Crystal orbital overlap population,	**2**	
	4	Band dispersion curves of 1D- chain of *p*- and *d* orbitals (1D-chain of eclipsed PtL_4 complexes), Band theory extended to two dimensions- 1*s* orbitals, sigma and pi-interactions of 2*p* orbitals	**2**	
	5	Band structure of 3D solids: Qualitative idea of band gap,, direct and indirect band gaps, metals, insulators and semiconductors, Ohm’s law, definition of resistivity and conductivity of solids, Topological Insulators (basic idea only)	**2**	
	6	Bandwidth and its slope, electrical conductivity in solids and charge carriers, electrons and holes, mobility of charge carriers, charge carrier concentration, effective mass, concept of polarons, Structure-property relation in solids	**2**	
II		**PHYSICAL PROPERTIES OF SOLIDS**	**12**	**26**
	7	Semiconductors: p- and n-type doping, transistors-Photovoltaic effect and Solar energy conversion	**3**	

		materials, Examples: Si, $CuInSe_2$, and Methylammonium lead bromide, Solar cells Thermoelectric materials for heat to electricity direct conversion, Seebeck and Peltier effects, Examples: Bi_2Te_3, PbTe		
	8	Dielectrics, Ferroelectrics, Ferroelectricity in $BaTiO_3$, Piezoelectrics, Piezoelectricity in (Pb,Zr)TiO3, Transducers	**2**	
	9	Optical properties of solids: Luminescence and phosphors, Lasers- Ruby Laser, Semiconducting lasers, Light emitting diodes (LED)	**2**	
	10	Magnetic materials: Theory and examples of Ferromagnetic, Antiferromagnetic, and Ferrimagnetic materials, Classification of Hard and Soft magnets with examples, their crystal structures and their uses, Ferrites, $Nd_2Fe_{14}B$, $SmCo_5$, Multiferroics and examples	**2**	
	11	Superconductivity, BCS theory, Critical temperature and critical field, Type-1 and Type-2 superconductors, Meissner effect, Oxide-based superconductors.	**3**	
III	**DYNAMIC ELECTROCHEMISTRY**		**18**	**30**
	12	The nature of electrolytes, Ion activity, Ion-ion and ion-solvent interaction, The electrical potential in the vicinity of an ion- Ionic thickness.	**2**	
	13	The Debye-Hückel equation (derivation), Limiting and extended forms of the Debye- Hückel equation, Applications of the Debye-Hückel equation to calculate the effect of ionic strength on ion reaction rates in solution - Primary and secondary salt effect	**3**	
	14	Electrical double layer: Helmholtz -Perrin theory, Gouy Chapman Model and Stern theory. Electrokinetic phenomena – zeta potential	**2**	
	15	Electrode kinetics of electrode processes, Overpotential, the Butler-Volmer equation-The relationship between current density and overvoltage, the Tafel equation.	**3**	
	16	Polarization: electrolytic polarization, dissolution and deposition potentials, concentration polarization	**2**	
	17	Determination of hydrogen overvoltage and oxygen overvoltage. Metal deposition over voltage, Principles of Polarography- the half-wave potential	**2**	
	18	Basic idea of Electrocatalysis, Application of electrocatalysis in Hydrogen Evolution Reactions (HER)	**2**	
	19	Basic principles of Galvanostatic and Potentiostatic methods in electrochemistry: Chronoamperometry,	**2**	

		Coulometry, Cyclic voltammetry, Chronopotentiometry, Impedance spectroscopy		
IV		**SOLID SURFACES: ADSORPTION AND HETEROGENEOUS CATALYSIS**	**6**	**16**
	20	Adsorption at solid surfaces: Adsorption isotherms, BET equation – derivation, Determination of surface area and pore structure of adsorbents- physical adsorption methods, X-ray methods, mercury intrusion method, chemisorption methods,	**2**	
	21	Features of heterogeneous catalysis: Langmuir - Hinshelwood mechanism and Eley-Rideal mechanism – illustration using the reaction $2CO + O_2 \text{---›} 2CO_2$	**2**	
	22	Basic idea of experimental methods to determine surface composition of catalysts: X-ray and UV photoelectron spectroscopy (XPS, UPS), Electron energy loss spectroscopy (EELS), Surface extended X-ray absorption fine structure spectroscopy (SEXAFS)	**2**	
V	**Open ended**		**12**	
	1. Computer simulations of crystal structures of various structure types from available cif files, Simulation of reciprocal lattice using suitable computer programs 2. Demonstration of band dispersion curves of simple systems such as graphene, band structure calculation of Si by using Quantum Espresso or other software packages. 3. Explanation of electrical conductivity measurements of semiconductors via four-point probe method, Magnetic hysteresis in soft and hard magnets, Optical band gap by using diffuse reflectance spectroscopy 4. (Virtual lab) demonstration of Cyclic voltammetry and impedance spectroscopy 5. Adsorption experiments on activated charcoal and other solid surfaces			
	References **Modules I and II** 1. Solid State Chemistry and Applications by A. R. West, 2nd edition, 2014, Wiley 2. How Chemistry and Physics Meet in the Solid State, Roald Hoffmann, Angew. Chem. Int. Ed. Engl. 26 (1987) 846-878 **Module III** 3. Electrochemical methods: Fundamentals and Applications, by Allen J. Bard and Larry R. Faulkner, 2nd Edition			

4. Volume 2a, Modern Electrochemistry, 2nd edition, Fundamentals of Electrodics by John O'M Bockris, Amulya K. N. Reddy, and Maria Gamboa-Aldeco,
5. Volume 1, Modern Electrochemistry, 2nd edition, Ionics by John O'M Bockris, and Amulya K. N. Reddy

Module IV

6. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York)
7. K. Laidler, Chemical Kinetics, 3rd Ed., Pearson Education, New Delhi, 2004.

Further reading

8. C. N. R. Rao and J. Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Ed., Cambridge University Press, 2004.
9. Introduction to Surface Physical Chemistry, K. Christmann, Springer-Verlag, Berlin, 1991
10. Direct Energy Conversion, Andrea M. Mitofsky, 2018

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	3	2	3	2	2	-	2	-	1
CO 2	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 3	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 4	3	2	-	-	3	3	3	2	1	-	1	-	1
CO 5	3	2	-	1	3	3	3	2	1	-	3	-	1
CO 6	3	-	2	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**RESEARCH METHODOLOGY IN CHEMISTRY**				
Type of Course	**MAJOR**				
Semester	**VIII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. A strong grasp of foundational chemistry principles and terminology. 2. Understanding of basic research concepts.				
Course Summary	This course provides a comprehensive overview of research methodology in chemistry, covering the processes involved in conducting research, data analysis techniques, the role of computers in chemistry research, analytical techniques, scientific writing, and research ethics. Students will develop essential skills and knowledge to conduct research effectively and ethically in the field of chemistry.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the sequential processes involved in research, from topic formation to publication, encompassing hypothesis development, data collection, analysis, hypothesis revision, and effective communication of findings.	U	F	Instructor created exams / Quiz /Assignment
CO2	Develop proficiency in analyzing chemical data, including error classification, measurement accuracy, precision assessment, and statistical analysis application.	An	C	Class test /Assignment /Quiz
CO3	Acquire competency in utilizing computers for chemistry research, covering hardware, software, programming languages, operating	U	P	Assignment/ Class test

	systems, and specific applications like MS Office and scientific software.			
CO4	Apply various analytical techniques, such as chromatography, spectroscopy, electroanalysis, and thermal analysis, effectively in chemical research.	Ap	C	Assignments /Seminar presentation
CO5	Gain proficiency in scientific writing, including report structuring, language usage, and citation styles, while adhering to ethical standards like plagiarism avoidance and responsible data handling.	U	M	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Research Methodology**		**12**	**24**
	1	Formation of the Topic	1	
	2	Hypothesis: Conceptual Definitions, Operational Definition	2	
	3	Gathering of Data, Analysis of Data, Revising of Hypothesis, Conclusion	3	
	4	Literature Survey: Journals, Books, and E-resources	3	
	5	Presentation and Publication of Research Output	3	
II	**Data Analysis and Interpretation**		**12**	**24**
	6	Errors in Chemical Analysis: Classification of Errors, Accuracy, Precision, and Reproducibility of Measurement	3	
	7	Methods of Analysis in Chemistry: Instrumental and Non-Instrumental	2	
	8	Presentation of Data: Mean, Standard Deviation	2	
	9	Comparison of Results: "t" Test, "f" Test, Chi-Square Test	2	
	10	Least Squares Analysis, Weighted Least Squares Analysis, Regression Coefficient, Rejection of Results	3	
III	**Applications of Computers in Chemistry**		**12**	**24**

	11	Types of Computers: Mainframe, Mini, Micro, Supercomputers, Personal Computers	2	
	12	Computer Hardware: CPU, Input and Output Devices, Memory, Peripheral Devices, Auxiliary Storage Devices	2	
	13	Computer Software: System Software, Application Software, Programming Languages: Machine Language, Assembly Language, High-Level Languages, Interpreter and Compiler	3	
	14	Operating Systems: Disk Operating System, Windows, macOS, Linux	2	
	15	Use of Internet in Research: Websites, Search Engines, e Journals, e-Libraries, INFLIBNET	1	
	16	Software Packages and Scientific Applications in Chemistry: Origin, Chemsketch, Chemdraw	2	
IV		**Analytical Techniques for Chemical Research**	**12**	**26**
	17	Chromatography: Thin layer chromatography, Column chromatography, Paper chromatography	2	
	18	Gas liquid chromatography, High pressure liquid chromatography (HPLC)	3	
	19	Spectroscopic methods: UV-Visible, IR,	1	
	20	NMR, Mass and ESR	2	
	21	Electroanalytic methods: Polarography, Coulometry, Cyclic voltammetry	2	
	22	Thermal analysis: thermogravimetry (TG)- differential thermal analysis (DTA) and differential scanning calorimetry (DSC)	2	
V		**Scientific Writing and Ethics of Research**	**12**	
	Open Ended	Significance of Report Writing, steps in Writing Report: Introduction, review of literature, scope, Materials and methods, Results and discussion, conclusions, Bibliography, Citation, Acknowledgements, Layout, Structure, and Language of typical reports, use of Illustrations, and tables, Overview of popular citation styles: APA, MLA, ASA, Chicago Manual of Style, Oral presentation: Planning, Preparation, Practice, Making presentation, Use of visual aids, Importance of effective communication. Environmental Impacts, Ethical Issues, Commercialization, Copyright, Intellectual Property Rights, Reproduction of Published Material, Plagiarism, Citation and Acknowledgement, Reproducibility, Accountability		

References:

1. Leedy, Paul D., Jeanne E. Ormrod, and Jeanne Ellis Ormrod. Practical Research: Planning and Design. Prentice Hall, 2004.

2. Graziano, Anthony M., and Michael L. Rau. Research Methods: A Process of Inquiry. Prentice Hall, 2006.

3. Smith, Robert V. Graduate Research: A Guide for Students in the Sciences. University of Washington Press, 1998.

4. Skoog, D. A., and M. West. Principles of Instrumental Analysis. Saunders Golden Sunburst Series.

5. Vogel, A. I. A Textbook of Quantitative Inorganic Analysis. ELBS Longman's Green and Co Ltd., London, 1962.

6. Jurs, Peter C. Computer Software Applications in Chemistry. 2nd ed., John Wiley & Sons, New York, 1996.

7. Madric, and Donevan. Understanding Computers. McGraw Hill.

8. Raman, KV. Computers in Chemistry. Tata McGraw Hill, 1993.

9. Wendlandt, WW. Thermal Methods of Analysis. Interscience, New York, 1964.

10. RA, DA. How to Write and Publish a Scientific Paper. Cambridge University Press, London, 1992.

11. Chandra, A., and T.P. Sexena. Style Manual. Metropolitan Book Company Ltd., New Delhi, 2000.

12. Bouchoux, D. E. Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/viva /seminar/Quiz	Project Evaluation	End Semester Examinations
CO 1	✓	✓ ✓		✓
CO 2	✓	✓✓		✓
CO 3	✓	✓		✓
CO 4		✓✓		✓
CO 5		✓✓		✓

ELECTIVE COURSES IN MAJOR

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**GREEN CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**V**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Proficiency in chemistry principles and terminology. 2. Familiarity with environmental issues. 3. Understanding of synthetic organic chemistry principles and methods.				
Course Summary	The course provides a comprehensive overview of the fundamental principles, techniques, and applications of Green Chemistry, empowering students with the knowledge and skills to address environmental challenges through the adoption of sustainable chemical practices				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understanding of fundamental principles of green chemistry and their socio-environmental significance.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Ability to employ alternative starting materials and green reagents in chemical processes, emphasizing sustainability.	Ap	C	Class test /Assignment /Quiz
CO3	Understand and apply knowledge about green solvents and catalysts in the context of sustainable chemical practices.	U	P	Assignment/ Class test

CO4	Apprehend the role of Green Energy and techniques such as microwave and ultrasound assisted reactions in environment-friendly chemical reactions.	An	P	Assignments /Seminar presentation
CO5	Evaluate the practical applications and limitations of green chemistry, and its influence on the world.	E	P	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Introduction to Green Chemistry**	**12**	**20**
	1	Green Chemistry - Some important environmental laws (The water (prevention and control of pollution) act, 1974, The environmental protection act of 1986, The air (prevention and control of pollution) act 1981) pollution prevention Act of 1990.	2	
	2	Emergence of green chemistry	1	
	3	Need for Green Chemistry (Prevention and minimization of hazardous products, Reduction of chemical waste and byproducts).	2	
	4	Goals of Green Chemistry. Anastas' twelve principles of green chemistry	2	
	5	Detailed explanation of each postulate with suitable examples	5	
II		**Alternative starting materials and reagents in green chemistry**	**12**	**20**
	6	Use of renewable starting materials: Illustrate with examples such as biodiesel, bioethanol	3	
	7	Polymers from renewable resources.	2	
	8	Green synthesis using Dimethyl carbonate	2	
	9	Green oxidants [Hydrogen peroxide (H_2O_2), Oxygen(O_2)]	3	
	10	Photochemical synthesis of vitamin D, Advantages compared to conventional synthesis	2	

III		**Green solvents and catalysts**	**12**	**20**
	11	Ionic liquid -Definition and design.	2	
	12	Use of ethyl ammonium nitrate, Ethyl-3-methylimidazolium (EMIM) Chloride and EMIM dicyanamide	2	
	13	Green synthesis using water as solvent	1	
	14	Green synthesis using supercritical carbon dioxide as solvents	1	
	15	Solid state synthesis	2	
	16	Comparison of green solvents and conventional organic solvents. Green catalysis	2	
	17	Biocatalysis and photocatalysis.	2	
IV		**Green Energy and techniques**	**12**	**20**
	18	Mechanism of microwave assisted reaction	2	
	19	Microwave assisted solvent free synthesis of copper phthalocyanine	1	
	20	Microwave assisted reactions in water (Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction).	4	
	21	Mechanism of ultrasound assisted reactions, sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)	3	
	22	Comparison of green and conventional method for one important molecule (oxidation of toluene to benzoic acid by microwave assisted method)	2	
V		**Open Ended**	**12**	**20**
	I	Click chemistry, waste management, renewable energy, can suggest experiments, awareness about presidential green chemistry awards, Limitations of green chemistry.	12	

References:

1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005
2. Anastas, P.T, Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998
3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
4. Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000
5. Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society, Washington, 2002

6. Lancaster, Mike, Green Chemistry an Introductory Text 2nd Ed., RSC Publishing,. ISBN: 9781-84755-873-2
7. Anastas, P.T and Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press, 1998
8. Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC, 2002
9. Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC, 2002.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		1		1	3	
CO 2	1						3		1		3	2	2
CO 3						3	3		1		1	3	
CO 4						3	3		1		3	3	2
CO 5			3				3		1		1	3	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

<table>
<tr><td>Programme</td><td colspan="5">B. Sc. Chemistry</td></tr>
<tr><td>Course Title</td><td colspan="5">NANOSCIENCE AND NANOTECHNOLOGY</td></tr>
<tr><td>Type of Course</td><td colspan="5">ELECTIVE IN MAJOR</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Academic Level</td><td colspan="5">300-399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>4</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. A strong grasp of foundational chemistry principles and terminology.
2. Understanding of key physics concepts relevant to materials science.</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course offers a comprehensive introduction to the interdisciplinary field of nanoscience, covering the fundamental principles, synthesis methods, structural properties, and diverse applications of nanomaterials. Through a blend of theoretical lectures and practical demonstrations, students will gain insight into the unique properties and potential applications of materials at the nanoscale.</td></tr>
</table>

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the history, scope, definitions, and fundamentals of nanoscience and nanotechnology, including the study of nanomaterials	U	F	Instructor-created exams / Quiz /Assignment
CO2	Apply various methodologies for nanoparticle synthesis and characterization, gaining practical understanding and applications	Ap	C	Class test /Assignment /Quiz
CO3	Grasp the structures and properties of diverse nanomaterials, including carbon, organic, and inorganic	U	P	Assignment/ Class test

	nanomaterials, and understand their applications			
CO4	Examine and apply the principles of photovoltaic energy conversion, targeted drug delivery, and other applications of nanomaterials	An	C	Assignments /Seminar presentation
CO5	Construct ideas about size and shape-dependent catalysis, interactions between biomolecules and nanoparticle surfaces and applications in biology	Ap	M	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Nanoscience**		**12**	**20**
	1	History and Scope - Feynman’s Vision, Moore's Law, Faraday's experiment and Lycurgus cup.	2	
	2	Definitions of Nanoscience and Nanotechnology. Energetics of nanomaterials – kinetic stability, need for surface modification.	2	
	3	Classification of Nanomaterials – 3D, 2D, 1D and 0D, confinement of electrons and phonons, quantum dots.	3	
	4	Surface to volume ratio, Quantum size effect, Surface Effect.	2	
	5	Size-dependent variation in physical- chemical- electronics-catalytic properties.	3	
II	**Methods for nanoparticle synthesis and characterization**		**12**	**20**
	6	Top-down approach - Ball milling, nanolithography.	1	
	7	Bottom-up approach - Growth of nanocrystals in solution – Nucleation and Ostwald ripening. Capping agents – Dispersibility, -OH and -SH based capping agents.	2	
	8	Methods of synthesis - precipitation, sol-gel, hydrothermal, microemulsion, chemical reduction, chemical vapour deposition and self-assembly.	3	

	9	Characterization of nanomaterials by XRD - Theory, factors affecting line broadening, Scherrer equation.	2	
	10	SEM & TEM- Electron wavelength by De-Broglie relation, resolution and resolving power, electron-sample interaction, components, schematic diagram, bright and dark field imaging	2	
	11	AFM- Introduction to scanning probe methods - components, schematic diagram, tapping and scanning modes of AFM)	2	
III	**Structure and Properties of Nanomaterials**		**12**	**20**
	12	Carbon Nanomaterials and the nature of carbon bonds.	1	
	13	Fullerenes - structure of C60, laser ablation synthesis, doping and superconductivity in M3C60.	2	
	14	CNT- chiral, zig-zag and armchair CNT, arc discharge synthesis, electrical and mechanical properties	2	
	15	Graphene- Dependence of edge geometry on electrical, magnetic and optical properties. Oxidative exfoliation synthesis, properties and uses.	2	
	16	Organic nanomaterials – Structure and applications of dendrimers and liposomes. Inorganic nanomaterials	2	
	17	Electrical and optical properties (Eg: TiO_2, CdS) Nanomagnetism – Superparamagnetism (Eg: Fe_3O_4). Nanocomposites and their advantages	3	
IV	**Applications of nanomaterial**		**12**	**20**
	18	Principle of photovoltaic energy conversion, TiO_2 based DSSC-Components and mechanism.	3	
	19	Targeted Drug Delivery using magnetic nanoparticles - functionalization using drug molecules, dispersibility, drug release.	3	
	20	Photodegradation of dyes using TiO_2 - mechanism	2	
	21	Carbon nanomaterials as adsorbents for remediation and hydrogen storage.	2	
	22	Surface Plasmon Resonance (Eg: Ag or Au nanoparticles) and its application	2	
V	**Nanocatalysis and Nanobiology (Open Ended)**		**12**	**20**
	Open Ended	Size and shape dependent catalysis by nanomaterials, Interaction Between Biomolecules and Nanoparticle Surfaces, Applications of Nanomaterials in Biology.	12	

References:

1. Poole, C. P., & Owens, F. J. *Introduction to nanotechnology*. Wiley-Interscience
2. Vollath, D. *Nanomaterials: An Introduction to Synthesis, Properties and Applications*. John Wiley & Sons.
3. Pradeep, T. *Textbook of nanoscience and nanotechnology*. McGraw-Hill Education.
4. Rao, C. N. R., Müller, A., & Cheetham, A. K. (Eds.). *Nanomaterials chemistry: recent developments and new directions*. Wiley-VCH Verlag GmbH
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6. Kamat, P. V., Murakoshi, K., Wada, Y., & Yanagida, S. *Semiconductor nanoparticles. In Handbook of Nanostructured Materials and Nanotechnology (pp. 291-344).* Academic Press.
7. Pathak, Y. V. (Ed.). *Surface modification of nanoparticles for targeted drug delivery. Cham, Switzerland:* Springer
8. Thomas, S., Kalarikkal, N., Oluwafemi, O. S., & Wu, J. (Eds.). *Nanomaterials for solar cell applications.* Elsevier.
9. Varin, R. A., Czujko, T., & Wronski, Z. S. *Nanomaterials for solid state hydrogen storage.* Springer.

Mapping of COs with PSOs and POs :

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

CO 5				1	1		3		1		1		3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**BIO CO-ORDINATION CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**V**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Understanding on Chemical bonding- Coordination bond 2. Interaction of ligands with metal ions 3. Brief idea on Bio-Inorganic Chemistry				
Course Summary	The course provides Understanding on the classification, significance, effects of ligands in biological systems. Analyze the interactions between ligands and metal ions, comprehend stability of complexes. Evaluate the functions and impacts of bulk metals (Na, K, Ca, Mg) in biological systems. Demonstrate knowledge of trace and ultratrace metals (Fe, Cu, Zn) roles in biological systems. Evaluate the applications of coordination compounds in medical therapy				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand classification and significance of ligands and summarise ligand effects in biological systems	U	F	Instructor-created exams / Quiz /Assignment
CO2	Analyze ligand interactions with metal ions in biological systems	An	C	Class test /Assignment /Quiz
CO3	Evaluate the functions and impacts of bulk metals (Na, K, Ca, Mg) in biological systems	E	P	Assignment/ Class test
CO4	Demonstrate knowledge of trace and ultratrace metals (Fe, Cu, Zn) roles in biological systems	An	P	Assignments /Seminar presentation

CO5	Evaluate the applications of co-ordination compounds in medical therapy	E	P	Assignments /Seminar presentation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**LIGANDS IN BIOLOGICAL SYSTEMS**	**12**	**20**
	1	Classification of ligands	1	
	2	Biologically significant ligands- H_2O, NH_3, Amino acids, peptides, proteins and DNA- RNA bases	4	
	3	Chelate effect and Macrocyclic effect	2	
	4	Significance of Chelate and Macrocyclic and macrobicyclic effects in biological systems.	5	
II		**LIGAND INTERACTIONS IN BIOLOGICAL SYSTEMS**	**12**	**20**
	5	Classification of metal ions into bulk, trace and ultra-trace elements	1	
	6	Concept of hard and soft acids and bases	2	
	7	Selectivity of ligands to different metals	2	
	8	Essentials of Crystal-Field splitting	2	
	9	Stability of complexes- thermodynamic and kinetic stability. Stability constant. Factors affecting stability of metal complexes, metal centered and ligand centered properties	4	
	10	Inert and Labile complexes	1	
III		**ROLE OF BULK METALS IN BIOLOGICAL SYSTEMS: (Na. K, Ca and Mg)**	**12**	**20**
	11	Ionophores and its classification. Selectivity of ionophores.	1	
	12	Active and passive transport	1	
	13	Sodium potassium pump-mechanism- enzymes responsible for Na-K pump	2	
	14	Potassium deficiency and K excess effects in biological systems.	1	

	15	Structural role of Calcium in Muscle contraction, bone management and teeth management (qualitative).	3	
	16	Role of Ca in blood clotting, Storage and transfer of Calcium (Brief idea)	2	
	17	Role of Magnesium- structural and functional role in biological systems.	2	
IV	**ROLE OF TRACE AND ULTRATRACE METALS IN BIOLOGICAL SYSTEMS (Fe, Cu and Zn)**		**12**	**20**
	18	Oxygen management Fe proteins (Haemoglobin and myoglobin), Metal management Fe proteins (ferritin and transferrin), electron management Fe proteins (cytochromes and Fe-S proteins)	3	
	19	Oxygen management Cu proteins (Hemocyanin), Metal management Cu proteins (ceruloplasmin), electron management Cu proteins (cytochromes and plastocyanin)	3	
	20	Biological role of Zn- Lewis acids role, structural role, and functional role- Zinc enzymes (carbonic anhydrase)	3	
	21	Biological role of cobalt- Vitamin B12 co-enzymes	1	
	22	Bioinorganic aspects of Photosynthesis and nitrogen fixation (Brief discussion). Nitrogenase enzyme (qualitative)	2	
V	**APPLICATION OF COORDINATION COMPOUNDS IN MEDICINE AND THERAPY- OPEN ENDED**		**12**	**20**
	23	Arthritis drugs (Gold based), Diabetic drugs (Vanadium based). Chelation therapy – Use of Dimercapto propanol. Chemotherapy- Cis platin and new generation Pt drugs- Drug resistance and DNA repair mechanism of Pt drugs.	12	

References

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry- Principles of structure and reactivity, Pearson education.
2. D.E. Fenton, Bi- Coordination Chemistry, Oxford, 1995
3. D.F. Shriver and P.W. Atkins, Inorganic Chemistry, Oxford University Press
4. Rosette M. Roat- Malone- Bioinorganic Chemistry-A short Course- John Wiley & Sons, INC., Publication.

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**FOOD CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**V**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. A brief understanding on composition of various foodstuffs 2. Chemical changes in food during processing and storage				
Course Summary	The Course provides an understanding on structure, classification and properties of food nutrients. Comprehend the chemistry of food spoilage, methods of food preservation. Identify the role of natural and artificial food additives and adulterants, their types, and methods of detection. Apply techniques to analyze food samples for adulteration and pesticide residues using gas chromatography, liquid chromatography and mass spectrometry.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand structure, classification, and properties of food nutrients including carbohydrates, proteins, lipids, vitamins and minerals	U	F	Instructor-created exams / Quiz /Assignment
CO2	Comprehend the chemistry of food spoilage, methods of food preservation, and the concept and impact of food packaging and storage	Ap	C	Class test /Assignment /Quiz
CO3	Identify the role of natural and artificial food additives and	An	P	Assignment/ Class test

	adulterants, their types, and methods of detection			
CO4	Apply techniques to analyze food samples for adulteration and pesticide residues using gas chromatography, liquid chromatography and mass spectrometry.	Ap	P	Assignments /Seminar presentation
CO5	Open ended- Evaluate the impact of modern eating habits on health and wellbeing, classifying fast foods, junk foods, instant foods and condiments, and their health effects	E	P	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Introduction to Food Chemistry- food nutrients**	**12**	**20**
	1	Carbohydrates: Classification of carbohydrates. Structure and properties of Glucose and Fructose (monosaccharides), Maltose, lactose and sucrose (oligosaccharide) and starch and cellulose (polysaccharide)	3	
	2	Proteins: Introduction to food protein. Structure, classification and physicochemical properties of protein. denaturation, protein determination	3	
	3	Lipids: Classification – Fats and oils – Hydrogenation – Analysis of fats and oils – Acid value, Saponification value and Iodine value.	3	
	4	Minerals: Food minerals, minerals containing Calcium, Iron, Iodine, Sodium and Potassium. Deficiency and toxicity disorders.	2	
	5	Vitamins: Classification, Sources and deficiency diseases.	1	
II		**Food Preservation**	**12**	**20**
	6	Microorganism in food-chemistry of food spoilage: Definition, types of spoilage - physical, enzymatic, chemical and biological spoilage. Mechanism of spoilage.	3	

	7	Methods of food preservation -traditional (drying, smoking, sugaring, freezing, salting, fermentation)	1	
	8	modern methods of food preservation (HPP, PEF, pasteurisation, vacuum packaging, MAP, ohmic heating)	2	
	9	Physical and chemical Additives: – definition, types, Class I and Class II preservatives	2	
	10	Food Packaging and storage - Biodegradable and edible packaging. Environmental concerns, recycling and disposal of packaging waste, Desirable materials for packaging	2	
	11	Shelf life of foods – Definition, intrinsic and extrinsic factors controlling shelf life.	1	
	12	Storage conditions, nutrition value.	1	
III		**Food Additives and Adulterants**	**12**	**20**
	13	Natural and artificial additives for colour and taste- synthetic and natural sweeteners, acidulants, buffering salts, anticaking agents.	4	
	14	Food adulteration - definition and reasons for food adulteration	3	
	15	Methods of adulteration	2	
	16	Common Food Adulterants in Chilli Powder, Tea dust, turmeric powder, milk, vegetable oil, coffee powder	3	
IV		**Chemical analysis of food**	**12**	**20**
	17	Detection of adulteration in various foods-Jam, Tea, Coffee Wheat Flour, Butter, Milk powder, Jelly, Cocoa powder	4	
	18	Analysis of pesticides and insecticides in food	1	
	19	Qualitative Analysis: Gas Chromatography (GC) Liquid Chromatography (LC)	2	
	20	Introduction to HPLC-Separation mechanisms. UV and MS detection	2	
	21	Chromatogram interpretation	2	
	22	Mass Spectrometry (MS)	1	
V		**Open Ended- Modern Food Habits**	**12**	**20**
	23	Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates and soft drinks. Harmful effects of modern food habits, Healthy cooking methods	12	

References

1. Dr. Ling, H D Belitz, Dr. Ing, W. Grosch, Food Chemistry, Springer, Newyork, 1987.
2. John M. Deman, Principles of Food Chemistry, Springer International edition, Third edition, 2007.
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4. Fenema. R, Food Chemistry, Fourth edition, CRC Press Taylors and Francis groups.
5. B. Srilakshmi, Food Science, 5th Edition, New Age Publishers, New Delhi, 2010.
6. Robertson GL, Food Packaging – Principles and Practice, CRC Press Taylor and Francis Group, 2012
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11. "Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.
12. Pearson, D, 2002, the Chemical Analysis of Foods, Churchill Livingstone, New York.
13. O.R. Fennema (2003) Food Chemistry, 3rdEd, Tata McGraw-Hill, New York.
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16. Nielsen, S.S. Introduction to the chemical analysis of foods. Jones and Bartlett Publishers, Boston, London. 2003.
17. Plummer D T (1998) An Introduction to Practical Biochemistry, Third edition, Tata McGraw Hill, New Delhi.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1						3		2		1		
CO2	2				1	2	3		2		1		1
CO3				1	3	1	3		3		1		
CO4				2	3	1	3		3		1		1
CO5				3		3	3		2		1		1

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**POLYMER CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VI**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of organic chemical reactions and molecular structure.				
Course Summary	The course covers polymers comprehensively, including classification, polymerization methods, properties, processing, and commercial applications. Students classify polymers by origin, synthesis, and structure, analyzing chain and step growth polymerizations. They apply polymer property knowledge to control performance and explore processing techniques like bulk and suspension polymerizations, calendering, and injection molding. Additionally, students evaluate commercial polymers for industrial use, gaining a thorough understanding of their importance in various industries.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the classification of polymers based on origin, synthesis, structure, and intermolecular forces.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Analyze chain and step growth polymerizations, discerning mechanisms and factors influencing polymerization processes.	An	C	Class test /Assignment /Quiz
CO3	Apply knowledge of polymer properties such as molecular weights, viscosity, and rheological behaviour to predict and control polymer performance.	Ap	C	Assignment/ Class test

CO4	Understand various polymer processing techniques including bulk, solution, and suspension polymerizations.	U	C	Assignments /Seminar presentation
CO5	Evaluate the suitability of different commercial polymers for specific industrial applications, utilizing understanding of polymer properties and processing techniques	E	C	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Polymers Types of Polymerisation**		**12**	**20**
	1	Polymers and macromolecules – Monomers – Homo and hetero polymers – Copolymers.	1	
	2	Classification based on origin (natural, semi synthetic and synthetic) and synthesis (addition and condensation).	2	
	3	Classification based on structure (linear, branched chain and cross linked) and intermolecular forces (elastomeres, fibres, thermoplastics and thermosetting polymers)	2	
	4	Tacticity in polymers- polymer chain flexibility- factors affecting chain flexibility	2	
	5	Glass transition temperature and crystalline melting points- variation and structures- molecular interpretation of glassy state of polymers	2	
	6	Chain and step growth polymerizations – Free radical, ionic and coordination polymerizations with mechanism – Zeigler-Natta polymerization	3	
II	**Properties of Polymers**		**12**	**20**
	7	Molecular weights of polymers: Average molecular weights – Number average and Weight average molecular weights	2	
	8	Sedimentation average (Method of determination not required) and Viscosity average molecular weight – determination of viscosity average molecular weight	3	
	9	Polydispersity index and molecular weight distribution; Molecular weight and Degree of polymerization.	3	
	10	Introduction to polymer melt rheology Newtonian fluids- non-Newtonian fluids. Bingham plastics, pseudo plastics- rheopectic and thixotropic behaviour- rheological measurements	4	

III	**Polymerisation Techniques and Polymer Processing**		**12**	**20**
	11	Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerizations.	2	
	12	Calendering, rotational moulding, compression, injection moulding, blow moulding and thermoforming.	1	
	13	Additives for compounding rubbers- mastication, two roll milling, internal mixing, compounding ingredients, pigments.	2	
	14	Processing aids- processing methods for manufacture of products: blending, calendaring, extrusion and moulding.	3	
	15	Different elastomer curing systems: efficient, semi efficient, conventional and sulphurless cure mechanism of vulcanization, sulphur vulcanizing systems, non-sulphur vulcanizing systems for olefin rubbers	3	
	16	Polymer composites, Properties and its different types- Process of tailoring properties	1	
IV	**Polymer Testing and Commercial Polymers (12 hrs)**		**12**	**20**
	17	Importance of standards and standard organizations- processability and performance- testing of plastics and rubbers material characterization tests such as hardness, tensile stress/strain, compression stress/strain, shear stress/strain, flexural stress/strain, tear tests, rebound resilience, friction, creep, fatigue.	2	
	18	Pollution due to plastics – Recycling of plastics - Plastic identification codes.	2	
	19	Preparation, Structure, properties and applications of: Polyolefins (HDPE, LDPE, PP and PS); Vinyl polymers (PVC, PVP and EVA, Saran); fluoro polymers (Teflon); Acrylic polymers (PAN and PMMA)	2	
	20	Preparation, Structure, properties and applications of: Aromatic polyamides: (kevlar); Polyester (terylene); Polycarbonate (lexan); Polyurethanes; Resins- Glyptal and formaldehyde resins (UF, MF and PF).	2	
	21	Preparation, Structure, properties and applications of: Rubbers (natural rubber, silicone rubber, and polyurethane elastomers, EPDM, BR, SBR, nitrile rubber, Neoprene, Butyl rubber).	2	
	22	Preparation, Structure, properties and applications of: Fibers: (nylon 66 and nylon 6,). Adhesives: (cyanoacrylate, epoxy adhesives, and polyvinyl acetate (PVA) adhesives). Biodegradable Polymers (polylactic acid (PLA) and polyhydroxyalkanoates (PHA)). Conductive Polymers (polyaniline and polyacetylene-concept of doping.	2	
V	**Experiments in Polymer Chmeistry (12 hrs)**		**12**	**20**
	Open Ended	Synthesis of Polyaniline Synthesis of Phenol Formaldehyde Resin	12	

		Molecular weight determination using viscometric method Problem solving related to molecular weight calculation		

References:

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2. V. R. Gowarikar, Polymer Chemistry, New Age International Pvt. Ltd., New Delhi, 2010.
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11. P. Ghosh, Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
12. R. W. Lenz, Organic Chemistry of Synthetic High Polymers, Interscience Publishers, New York, 1967.
13. M. P. Stevens, Polymer Chemistry: An Introduction, 3rd Edn., Oxford University Press, 2005.

Mapping of COs with PSOs and POs :

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

CO 5				3		3	3		2		1		1

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**INDUSTRIAL CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VI**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Prior understanding of basic chemistry principles and chemical reactions. 2. Introductory knowledge of industrial processes and terminology.				
Course Summary	The course provides a comprehensive overview of chemical industries, covering industrial processes, waste management, petrochemicals, pharmaceuticals, fertilizers, and Kerala's chemical industries. Students learn about water treatment, safety measures, and the production of synthetic petrol, pharmaceuticals, and fertilizers. By examining various industries, students gain valuable insights into their operations, preparing them for roles in the chemical sector.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Comprehend industrial requirements, including water treatment methods, waste management, and safety protocols.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Investigate natural gas, coal, and crude oil composition, as well as the distillation processes involved	An	C	Class test /Assignment /Quiz
CO3	Analyse drug classifications, terminology, and the preparation of common drugs like paracetamol and aspirin.	An	C	Assignment/ Class test

CO4	Evaluate the production methods of nitrogenous, phosphatic, and potash fertilizers, including NPK fertilizers.	E	P	Assignments /Seminar presentation
CO5	Scrutinize chemical industries in Kerala, focusing on their location, raw materials, and the chemistry involved in product preparation	E	M	Assignments /Seminar presentation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction (12 hrs)**		**12**	**20**
	1	Requirements of an industry – location – water – industrial water treatment.	2	
	2	Water softening methods: Clark’s process - lime soda process - Ion exchange process)	2	
	3	Safety measures – pilot plants – ISO certification.	2	
	4	Solid waste management -incineration method, Composting process, disposal.	2	
	5	Liquid waste management- Dewatering, sedimentation, Root-Zone Treatment.	2	
	6	Gaseous waste management-absorption, adsorption, combustion.	2	
II	**Petrochemical Industry (12 hrs)**		**12**	**20**
	7	Introduction. Natural gas – CNG, LNG and LPG. Coal: Classification based on carbon content – carbonisation of coal – composition and uses of various fractions.	2	
	8	Crude Oil: Constitution and distillation – composition and uses of different distillates – ignition point, flash point and octane number – cracking.	2	
	9	Catalysts used in Petroleum Industries: Structure, selectivity and applications. Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes.	3	

	10	Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates.	3	
	11	Usage and depletion of petroleum products – need for alternative fuel – hydrogen as the future fuel.	2	
III	**Pharmaceutical Industry (12 hrs)**		**12**	**20**
	12	Drugs: Definition – History of drugs – Terminology: Prodrug, pharmacy, pharmacology, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	13	Antipyretics, analgesics and antacids (definition and examples, structures not expected)	2	
	14	Antihistamines, antibiotics, antiseptics and disinfectants, (definition and examples, structures not expected)	2	
	15	Anti-inflammatory agents, Sedatives, Tranquilizers, Hypnotics and Antidepressant drugs (definition and examples, structures not expected) – Preparation of paracetamol and aspirin.	3	
	16	Drug toxicity – Thalidomide tragedy (a brief study) – Effective use of drugs – Over dosage – Prescription and non-prescription drugs – Definition, examples, uses and side effects	2	
	17	Drug abuse- Medical applications of metal and metal oxide nanomaterials.	1	
IV	**Fertilizer Industry (12 hrs)**		**12**	**20**
	18	Introduction- Nitrogeneous, phosphatic and potash fertilizers, NPK fertilizers, NPK value, Manufacturing methods of ammonium nitrate- Prilling method, Stengel method.	3	
	19	Urea–Manufacture from ammonia and carbon dioxide.	1	
	20	Monoammonium Phosphate (MAP) and Diammonium Phosphate (DAP)- Manufacture from ammonia and phosphoric acid.	2	
	21	Potassium Chloride (muriate of potash)- main steps involved in the manufacture. Mining of the K mineral, Separation of the main ingredient and purifying.	3	
	22	Potassium Sulphate (sulfate of potash) - Manufacture from langbeinite (K_2SO_4. $MgSO_4$) and KCl. NPK (17-17-17)- Granulation method of manufacture.	3	
V	**Chemical industries in Kerala: (12 hrs)**		**12**	**20**
	Open ended	Location, raw materials, chemistry involved in the preparation and uses of the following, caustic soda and chlorine – Travancore	12	

	.	Cochin Chemicals Ltd., TiO2 pigment from ilmenite – Travancore Titanium Products Ltd.		

References:

1. Industrial Chemistry (including chemical - engineering) - B.K. Sharma - Goel publishing house, Meerut.

2. Pollution control in process industries - S.P. Mahajan - Tata McGraw - Hill Publishing Company Ltd., New Delhi.

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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		2		2		1
CO 2	2						3		2		2		1
CO 3					1	1	3		2		2		1
CO 4						1	3		2		3		12
CO 5						1	3		1		2		1

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Programme	B. Sc. Chemistry				
Course Title	**ADVANCED ENERGY MATERIALS**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VI**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Completion of an introductory organic chemistry or material science course is required. 2. Prior knowledge of semiconductor physics, particularly related to energy bands and semiconductor devices, is necessary.				
Course Summary	This course covers essential components and technologies for sustainable energy production. Starting with global energy needs and renewable sources, it explores electrode processes and solar cell materials. Students learn about photovoltaic principles, fuel cell types, and energy storage methods like batteries and supercapacitors. The course also discusses emerging technologies for renewable energy conversion, such as solar thermal and water splitting. Through this, students gain a solid understanding of materials vital for sustainable energy solutions and future energy technologies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Comprehend the basic principles of energy harvesting and conversion technologies and the significance of materials in these processes.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Assess the performance of different energy harvesting materials and devices, considering factors like efficiency and environmental impact	An	C	Class test /Assignment /Quiz

CO3	Engineer and refine systems for energy production using various materials	Ap	C	Assignment/ Class test
CO4	Grasp how energy storage technologies operate, including batteries and supercapacitors	U	C	Assignments /Seminar presentation
CO5	Evaluate the strengths and weaknesses of energy storage materials and technologies, focusing on factors such as lifespan and energy capacity	An	C	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Energy Requirement**		**8**	**14**
	1	World energy requirement. Need for sustainable energy sources.	1	
	2	Sustainable Sun's energy. Current status of renewable energy sources.	2	
	3	Overview of electrode processes. Reversible cells and irreversible cell reactions.	3	
	4	Primary and Secondary cells.	2	
II	**Materials for Energy Harvesting**		**16**	**26**
	5	Solar Cells: Solar spectra, Semiconductors as Solar cell materials. P-N junction diode – Energy band diagram.	2	
	6	Principles of photovoltaic energy conversion – generation of photovoltage. I-V curves of solar cells.	3	
	7	Types of photovoltaic Cells. First generation solar cell materials - Single and polycrystalline Silicon, Amorphous silicon.	3	
	8	Second generation solar cell materials: CdSe, CdTe, Copper Indium Gallium Selenide.	3	
	9	Third generation solar cell materials - Quantum Dots, Organic materials, Dyes.	3	

	10	Types of Organic solar cells - Dye-sensitized solar cell (DSSC) and Polymer solar cells – General overview only.	2	
III	**Materials for Energy Conversion**		**12**	**20**
	11	Fuel Cells: General overview of fuel cell technology.	1	
	12	Types of fuel cells - Alkaline, solid oxide, proton exchange membrane, and Direct methanol. Materials for electrodes, electrolytes in Fuel Cells.	4	
	13	Working principles of H_2-O_2 fuel cell.	1	
	14	Hydrogen economy. Hydrogen generation and storage; limitations. Recent progress in fuel cells.	3	
	15	Piezoelectric and Pyroelectric materials – Energy conversion mechanism with examples.	2	
	16	Thermo-electrics materials – Energy conversion mechanism with examples.	1	
IV	**Materials for Energy Storage**		**12**	**20**
	17	Different types of batteries	1	
	18	Electrode materials, electrolyte and cell reactions of Dry/Alkaline cell and Mercury cell battery. Discharge characteristics, Energy density.	2	
	19	Electrode materials, electrolyte and cell reactions of Lead-acid battery and Ni-Cd battery, Discharge characteristics, Energy density.	2	
	20	Electrode materials, electrolyte and cell reactions of Ni-Hydrogen battery and Lithium-ion/Lithium-polymer battery. Discharge characteristics, Energy density.	2	
	21	Supercapacitors- Types of Electrochemical Supercapacitors.	2	
	22	Electrode and electrolyte interfaces and their capacitances, Charge-Discharge characteristics, Energy/power density.	3	
V	**Renewable energy conversion methods**		**12**	**20**
	Open Ended	Solar thermal technologies, Water splitting and photocatalysis, Energy-related environmental aspects: CO_2 capture, utilization, and conversion; recovery and recycling of energy materials.	12	

References:

1. Chetan Singh Solanki, Solar photovoltaics : fundamentals, technologies and applications - Third ed. - New Delhi PHI Learning Private Limited, 2011.

2. P.H. Rieger, Electrochemistry, Prentice-Hall, 1987.
3. B.K. Hodge, Alternate Energy Systems and Applications, John Wiley & sons, 2010.
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5. C. Brabec, Organic Photovoltaics, Wiley-VCH, 2008.
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7. V. Hacker, S. Mitsushima (Eds.), Fuel Cells and Hydrogen: From Fundamentals to Applied Research, Elsevier, 2018
8. K.E. Aifantis, S.A. Hackney, and R. V. Kumar (Ed.) High Energy Density Lithium Batteries Materials, Engineering, Applications, WILEY-VCH Verlag GmbH & Co. KGaA, 2010
9. Yu, A., Chabot, V., & Zhang, J. (2013). Electrochemical Supercapacitors for Energy Storage and Delivery: Fundamentals and Applications (1st ed.). CRC Press

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1					1	3		1		2		1
CO2	2				1	2	3		1		3		2
CO3				1	2	1	3		2				3
CO4					3	1	3		2		3		3
CO5				2		3	3		2		2		3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Programme	B. Sc. Chemistry				
Course Title	**MATERIAL SCIENCE**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VI**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basics of solid-state chemistry 2. Brief idea about material properties				
Course Summary	The course in Material Science provides a comprehensive overview of various materials and their properties, focusing on applications in different fields. It covers the classification of materials based on structure and function, mechanical properties, testing methods, and specialized materials such as ferroelectric, piezoelectric, magnetic, and superconducting materials. Additionally, it discusses composite materials, including their definition, classification, processing methods, and applications. Through this course, students gain a solid understanding of different materials and their significance in modern technology.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	Develop an understanding of the classification of materials based on structure and function.	U	F	Instructor-created exams / Quiz /Assignment
CO 2	Acquire knowledge of mechanical properties and testing methods to evaluate material behavior.	U	C	Class test /Assignment /Quiz
CO 3	Explore specialized materials such as ferroelectric, piezoelectric, magnetic, and	E	C	Assignment/ Class test

	superconducting materials and their applications.			
CO 4	Gain insight into composite materials, including their classification, processing techniques, and real-world applications.	E	P	Assignments /Seminar presentation
CO 5	Develop the ability to analyze and predict material behavior in various environments and applications	E	M	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Material Science**		**12**	**20**
	1	Scope and importance of materials science. Classification of materials. Functional classification. Classification based on structure.	2	
	2	Mechanical properties – significance and terminology, the tensile test, true stress and true strain, bend test, hardness of materials.	3	
	3	Definition of ceramics. Traditional and new ceramics. Structure of ceramics. Atomic interactions and types of bonds.	2	
	4	Phase equilibria in ceramic systems, one component and multi component systems.	2	
	5	Use of phase diagrams in predicting material behavior.	1	
	6	Electrical, Magnetic, and Optical properties of ceramic materials.	2	
II	**Materials for Special Purposes – I**		**12**	**20**
	7	Production of ultra-pure materials - zone refining, vacuum distillation and electro refining.	2	
	8	Ferroelectric and piezoelectric materials - general properties. Classification of ferroelectric materials.	2	

	9	Theory of ferroelectricity, ferroelectric domains, applications.	3	
	10	Theory of Piezoelectricity. Piezoelectric materials and applications.	3	
	11	Metallic glasses - preparation, properties and applications.	2	
III	**Materials for Special Purposes – II**		**12**	**20**
	12	Magnetic materials, ferri, ferro and antiferromagnetism.	2	
	13	Metallic magnets, soft, hard & superconducting magnets.	2	
	14	Ceramic magnets, low conducting and superconducting magnets.	2	
	15	Superconducting materials - metallic and ceramic superconducting materials.	2	
	16	Theories of superconductivity, Meissner effect.	2	
	17	High temperature superconductors - structure and applications.	2	
IV	**Composite Materials**		**12**	**20**
	18	Definition and classification of composites, fibres and matrices.	2	
	19	Composites with metallic matrices – processing, solid and liquid state processing, deposition.	3	
	20	Ceramic matrix composite materials – processing, mixing & Pressing, liquid state processing, sol-gel processing & vapor deposition technique.	3	
	21	Interfaces in composites - mechanical & microstructural characteristics.	2	
	22	Applications of composites.	2	
V	Materials for Energy Harvesting and Storage		**12**	**20**
	Open Ended	Detailed study of materials used in data storage devices, light harvesting, energy storage, lasers and bioengineering.	12	

References:

1. W.D. Eingery, H.K. Dowen and R.D. Uhlman, Introduction to Ceramics, John Wiley.
2. A.G. Guy, Essentials of Material Science, McGraw Hill.
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7. A.V. Narlikar and A.N.Endnote, Superconductivity and Superconducting Materials, South

Asian Publishers, New Delhi, 1983.
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10. C.M. Srivastava and C. Srinivasan, Science of Engineering Materials, Wiley Eastern Ltd., 1987. R.J. Young, Introduction to Polymer Science, John Wiley and Sons.
11. K.K. Chowla, Composite Materials, Springer-Verlag, NY, 1987.

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**INDUSTRIAL CATALYSIS**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VIII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. Basic understanding of surface chemistry 2. A sound knowledge in reaction kinetics and thermodynamics				
Course Summary	The catalysis course covers catalyst preparation, deactivation, and applications across various fields. It includes fundamental principles, preparation methods, deactivation mechanisms, and regeneration techniques. Additionally, it explores phase transfer catalysis, biocatalysis, and industrial catalysis, focusing on their principles, mechanisms, and applications such as oil-based chemistry, hydrocarbon synthesis, and environmental protection. Ultimately, students gain a comprehensive understanding of catalytic processes and their applications in chemistry, environmental science, and materials science.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts in catalysis, including catalyst preparation, mechanisms of catalytic reactions, and catalyst deactivation processes.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Apply various preparative methods, such as phase transfer catalysis, biocatalysis, and industrial catalysis, in the synthesis and transformation of chemical compounds.	Ap	C	Class test /Assignment /Quiz

CO3	Analyze and classify catalyst deactivation processes, including poisoning, coke formation, and sintering, and explore methods for catalyst regeneration.	An	C	Assignment/ Class test
CO4	Evaluate the principles and applications of industrial catalytic processes in oil-based chemistry, hydrocarbon synthesis, environmental protection, and polymerization reactions.	E	P	Assignments /Seminar presentation
CO5	Explore emerging catalytic technologies such as biodiesel production, photocatalysis, and electrocatalysis, and understand their potential applications and challenges in contemporary industries and research fields.	E	M	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Catalyst Preparative Methods and Deactivation**		**12**	**20**
	1	Support materials -Preparation and structure of supports, Surface properties.	2	
	2	Preparation of catalysts- Introduction of precursor compound, Pre-activation treatment, Activation process.	2	
	3	General methods of synthesis of zeolites. Mechanism of nuclear formation and crystal growth. Structures of some selected zeolites. Zeolites A, X and Y. Shape selective catalysis.	3	
	4	Deactivation of catalysts- Classification of catalyst deactivation processes, Poisoning of catalysts, Coke formation on catalysts, Sintering of catalysts.	3	

	5	Regeneration of deactivated catalysts. Feasibility of regeneration. Description of coke deposit and kinetics of regeneration	2	
II	**Phase Transfer Catalysis**		**12**	**20**
	6	Basic concepts in phase transfer catalysis. Phase transfer catalyzed reactions and their basic steps.	2	
	7	Effect of reaction variables on transfer and intrinsic rates. Outline of compounds used as phase transfer catalysts. Use of quaternary salts.	3	
	8	Macrocyclic and macrobicyclic ligands. PEG’s and related compounds.	3	
	9	Use of dual phase transfer catalyst or co-catalyst in phase transfer systems.	2	
	10	Separation and recovery of phase transfer catalysts. Insoluble phase transfer catalysts.	2	
III	**Biocatalysis**		**12**	**20**
	11	Enzymes. An introduction to enzymes. Enzymes as proteins.	2	
	12	Classification and nomenclature of enzymes. Structure of enzymes. Working of enzymes. Effect on reaction rate. Thermodynamic definitions.	2	
	13	Catalytic power and specificity of enzymes. Optimization of weak interactions between enzyme and substrate in the transition state.	3	
	14	Binding energy, reaction specificity and catalysis. Specific catalytic groups contributing to catalysis. Immobilized biocatalysts.	3	
	15	Definition and classification of immobilized biocatalysts. Immobilization of coenzymes.	2	
IV	**Industrial Catalysis**		**12**	**20**
	16	Oil based chemistry- Catalytic reforming, Catalytic cracking, Paraffin cracking, Steam cracking.	1	
	17	Hydrocarbons from synthesis gas. Fisher-Tropsch process. Mobil process for conversion of methanol to gasoline hydrocarbons.	2	
	18	Catalysis for environmental protection, removal of pollutants from exhausts, mobile and static sources.	2	

	19	Hydroformylation of olefins. Carbonylation of organic substrates.	2	
	20	Conversion of methanol to acetic acid. Synthesis of vinyl acetate and acetic anhydride. Palladium catalyzed oxidation of ethylene.	3	
	21	Acrylonitrile synthesis. Zeigler-Natta catalysts for olefin polymerization.	1	
	22	Propene polymerization with silica supported metallocene/MAO catalysts	1	
V	**Open Ended Module**		**12**	**20**
	Open Ended	Biodiesel via catalytic process, Photocatalysis, Electrocatalysis, A survey of important Indian catalytic industries and their products. Experiments involving preparation of catalysts and catalytic reactions.	12	

References:

1. J.R. Anderson and M. Boudart (Eds), "Catalysis, Science and Technology", Vol 6, Springer- Verlag, Berlin Heildberg, 1984.

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8. R.J. Farrauto and C.H. Bartholomew, "Fundamentals of Industrial Catalytic Processes", Blackie Academic and Professional – Chapman and Hall, 1997.

9. R. Pearce and W.R. Patterson, "Catalysis and chemical processes", Academic press, Leonard Hill, London, 1981

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry
Course Title	**ADVANCED ORGANIC CHEMISTRY**
Type of Course	**ELECTIVE IN MAJOR**
Semester	**VIII**
Academic Level	**400 – 499**

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-		60

Pre-requisites	1. Prior knowledge of chemical bonding and structure of molecules 2. Understanding the reaction mechanism of different reactions and rearrangements.
Course Summary	This course covers reactions, synthesis planning, supramolecular chemistry, and drug design

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand and apply named reactions and reagents in organic synthesis	U	P	Quizzes /Seminar
CO2	To formulate synthetic strategies employing synthons, protecting groups, and reagents	An	C	Discussion/ Assignment
CO3	To conceptualize non-covalent interactions and applications in supramolecular chemistry	An	C	Seminar / Discussion
CO4	To Comprehend the principles of drug design and understand the	Ap	F	Discussion/Seminar /Assignment

	stages of drug development			
CO5	To Rationalize the mechanisms of redox reactions and substitution reactions involved in organic synthesis	Ap	An	Seminar/discussion
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Named Reactions and Reagents**	**9**	**18**
	1	Reformatsky reaction, Baeyer-Villiger oxidation, Beckman rearrangement,	3	
	2	Benzilic acid rearrangement, Benzoin Condensation, Claisen rearrangement,	2	
	3	Clemmenson reduction, Dies-alder reaction, Knoevenagel condensation,	2	
	4	Pictet-Spengler reaction, Strecker amino acid synthesis, Simmons-Smith reaction,	2	
II		**Synthesis and Synthetic Planning**	**13**	**26**
	5	Target molecules, Synthons, synthetic equivalents (anionic and cationic)	1	
	6	Disconnection	1	
	7	Protecting groups-alcohols (Bn, PMB, Ac, TBS) explain the concept with a reaction	2	
	8	Protecting groups-aldehydes (cyclic acetal) explain the concept with a reaction	2	
	9	Protecting groups-amines (Bz, Boc, Fmoc) explain the concept with a reaction	2	
	10	Protecting groups-acids (Me and t-Bu ester) explain the concept	2	

		with a reaction		
	11	Convergent and linear synthesis (demonstrate with an example)	1	
	12	Functional inter-group conversions (Any one example), retrosynthesis of chalcones.	2	
III		**Supramolecular Chemistry**	**13**	**26**
	13	Various types of non-covalent interactions (H bonding, van der Waals interactions, cation-pi interaction, pi-pi stacking) bonding and applications of addition compounds,	4	
	14	Crown ethers	2	
	15	Cyclodextrins	2	
	16	Cryptands, catenanes and rotaxanes.	2	
	17	Importance of supramolecular chemistry in living systems.	3	
IV		**Principles of Drug Design**	**13**	**28**
	18	Introduction to medicinal chemistry	2	
	19	Therapeutic index, solubility, Intermolecular binding forces in drug target interactions- (electrostatic, H bonding, van der Waals, dipole-dipole).	3	
	20	Introduction to various drug targets; Proteins- Enzymes- Receptors- their roles, neurotransmitters, receptor activation and regulation.	3	
	21	Introduction to Pharmacodynamics and pharmacokinetics (ADME); affinity and efficacy.	3	
	22	Types of drugs, stages of drug development (basic concept only).	2	
V		**Open ended**	12	
	Modern Techniques in Organic Synthesis/Asymmetric Synthesis/Total synthesis			

References

1. Organic Chemistry, by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press
2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Wiley
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8. Name reactions J J Li, Springer.
9. Medicinal Chemistry, Sriram and Yogeeswari, Pearson Education India; 2nd edition.
10. An Introduction to Medicinal Chemistry, Graham Patrick, Oxford University Press; International edition.
11. Organic Chemistry, Morrison Boyd & Bhattacharjee, Pearson Education India; 7th edition .

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**MODERN ORGANIC SYNTHESIS**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VIII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Preliminary idea about Reaction mechanism, reagents, organometallic chemistry, and Green methods				
Course Summary	This course explores various name reactions in organic chemistry, reagents, multistep synthesis, biochemical synthesis and modern trends in synthesis.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To develop an understanding and application of different named organic reactions	U	C	Test /Seminar
CO2	To gain expertise in the usage and reactions of various reagents, focusing on catalysis and substitution	U	C	Dicussion/ Assignment
CO3	To master the skills for multistep synthesis and biochemical synthesis with an emphasis on retrosynthetic analysis	An	C	Quizes/Test
CO4	To examine modern trends in synthesis, stressing on non-conventional methods,	Ap	E	Discussion/Seminar /Assignment

	catalysts and eco-friendly approaches			
CO5	To evaluate the role of organic compounds and reactions in pharmaceutical chemistry with open-ended, practical outcomes	Ap	P	Assignment/Test
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Named organic reactions**	**12**	**26**
	1	Peterson Reaction, Julia Reaction, Ugi Reaction, Passerini reactions	1	
	2	Ene reaction, Ritter Reaction, Biginelli reaction, Skraup quinoline synthesis	2	
	3	Dess Martin oxidation, Baylis Hillman reaction, Eschenmoser–Tanabe fragmentation	2	
	4	Nazarov cyclization, McMurry coupling, Pauson–Khand reaction	2	
	5	Pummerer rearrangement, Ramberg–Bäcklund reaction, Rubottom oxidation, Rupe rearrangement	3	
	6	Staudinger reduction, Vilsmeier–Haack reaction, Wacker oxidation	2	
II		**Reagents and reactions**	**12**	**26**
	7	Reactions of carbene, umpolung, N-heterocyclic carbenes	1	
	8	Organocatalysis, Pd catalyzed reactions-Heck, Suzuki,	1	
	9	Suzuki, Stille Coupling	1	
	10	Cu catalyzed reactions- Buchwalds coupling	2	
	11	Synthesis of heterocycles by dipolar cycloaddition	2	
	12	Asymmetric hydrogenation	1	
	13	Alkenyl, allyl and ary silanes and their substitution reaction	2	
	14	Silanes and organo boron reagents and their reactions.	2	
III		**Multistep synthesis and biochemical synthesis**	**12**	**30**

	15	Reterosynthetic analysis and Total synthesis of Longifoline (Corey, year),	3	
	16	Pencillin V (author, year) and cephallosporin (author, year), Tamiflu (author year)	3	
	17	Biosynthesis of mono and diterpenes,	2	
	18	Biosynthesis of morphine	2	
	19	Bio synthesis of lipids, fatty acids.	2	
IV		**Modern Trends in Synthesis**	**12**	**16**
	20	E factor, Non-conventional and eco-friendly reaction media- ionic liquids, supercritical CO_2.	4	
	21	Non-conventional energy sources- microwave, sonochemistry, electroorganic synthesis, visible light photocatalysis. Biomass valorisation, organocatalysis.	4	
	22	Reactions on solid acids bases, reactionson solid support, flow chemistry, enzyme catalyzed reactions, mechanochemistry, fluorous chemistry.	4	
V	Open ended-		**12**	
	23	Advanced spectroscopic methods/organo main group chemistry		

References

1. ORGANIC CHEMISTRY, by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press.
2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Wiley.
3. Organic Chemistry Paperback, Francis Carey, McGraw-Hill Education
4. Advanced Organic Chemistry, David E. Lewis, Oxford Univ Pr; Illustrated edition
5. Principles of Organic Synthesis, R. O. C. Norman & J. M. Coxon, 3rd Ed., CRC Press, 2000.
6. Name reactions J J Li, Springer.
7. Spectrometric Identification of Organic Compounds, 8ed Paperback – 1 March 2022 Robert M. Silverstein, Francis X. Webster, David J. Kiemle, Wiley
8. Introduction to Spectroscopy, D. L. Pavia, 5th Ed., Cengage, 2015.
9. Organic Synthesis Special Techniques, V. K. Ahluwalia and Renu Aggarwal, Narosa Publishing house, Second Edn, 2015.
10. Organic chemistry, Stereochemistry and chemistry of natural products, I. L. Finar Vol. 2, Pearson.
11. Volgel's practical organic chemistry.

12. The Ritter Reaction: Trapping a Carbocation with a Nitrile, R. David Crouch, Journal of Chemical Education 1994 71 (8), A200, DOI: 10.1021/ed071pA200
13. Advanced methods of organic synthesis, W. Carruthers and Iain Colgham, Cambridge University Press; 4th edition (10 April 2015)

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		1	1	1	1	3		1		1		2
CO 2	2		1	1	1	1	3		2		3		3
CO 3	2	-	2	2	1	2	3		2		3		3
CO 4	2	-	2	2	2	2	3		2		3		3
CO 5	1	-	1	1	1	1	3		2		3		3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**COMPUTATIONAL CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VIII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. A solid understanding of fundamental chemistry principles, including atomic structure, chemical bonding, molecular geometry, and chemical reactions. 2.Knowledge of basic physics principles, particularly classical mechanics and electromagnetism, as well as an understanding of quantum mechanics at an introductory level.				
Course Summary	This course provide students with theoretical knowledge and practical skills in using computational methods to solve chemical problems. The course covers a range of topics, including introduction to computational methods, molecular modeling, and molecular dynamics simulations, and emphasizes hands-on experience with computational tools and software.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category #	Evaluation Tools used
CO1	Understand the history, scope, definitions, and fundamentals of computational chemistry including computational methods and Molecular modelling Techniques.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Apply a variety of computational methods used in chemistry, such as molecular mechanics (MM), and Monte Carlo	Ap	C	Class test /Assignment /Quiz

	simulations, to solve chemical problems and analyze molecular systems.			
CO3	Effectively utilize computational software package Guassian commonly employed in chemical research, to perform calculations, analyze data, and visualize molecular structures and properties.	U	P	Assignment/ Class test
CO4	Interpret computational results obtained from simulations and calculations, including molecular structures, energetics, spectroscopic properties, and reaction mechanisms, and relate them to experimental observations.	An	C	Assignments /Seminar presentation
CO5	Explore applications of computational chemistry in various fields, such as drug discovery, materials science, catalysis, and environmental chemistry, and understand how computational methods contribute to advancing scientific research and solving real-world problems.	Ap	M	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Computational Chemistry**		**9**	**15**
	1	Theory, computation & modeling – Definition of terms.	2	
	2	Need of approximate methods in quantum mechanics. Computable Quantities – structure, potential energy surfaces and chemical properties.	3	
	3	Cost & Efficiency – relative CPU time, software & hardware.	2	
	4	Classification of computational methods.	2	
II	**Computer Simulation Methods- I**		**9**	**15**

	6	Introduction – molecular dynamics and Monte Carlo methods.	2	
	7	Calculation of simple thermodynamic properties - energy, heat capacity, pressure and temperature, phase space, practical aspects of computer simulation.	3	
	8	Periodic boundary conditions, Monitoring the equilibration.	2	
	9	Analyzing the results of a simulation, error estimation.	2	
III	**Computer Simulation Methods- II**		**12**	**20**
	10	Molecular dynamics (MD) method – molecular dynamics using simple models	2	
	11	MD with continuous potentials, finite difference methods, choosing the time step, setting up and running a MD simulation.	3	
	12	Monte Carlo (MC) method - calculating properties by integration, .	3	
	13	Metropolis method, random number generators.	2	
	14	MC simulation of rigid molecules.	2	
IV	**ab intio Methods and basic concepts of Density Functional Theory in Computational Chemistry**		**18**	**30**
	15	Review of Hartree – Fock method for atoms, SCF treatment of polyatomic molecules.	2	
	16	Closed shell systems - restricted HF calculations;Open shell systems – ROHF and UHF calculations; The Roothan – Hall equations, Koopmans theorem	2	
	17	HF limit & electron correlation, Introduction to electron correlation (post -HF) methods	3	
	18	Basics of DFT- Applications of computational chemistry in various fields, such as drug discovery, materials science, catalysis, and environmental chemistry, and understand how computational methods contribute to advancing scientific research and solving real-world problems.	3	
	19	Hydrogen-like, Slater-type & Gaussian type basis functions, classification of basis sets – minimal, double zeta, triple zeta, split-valence, polarization & diffuse basis sets, even tempered &well-tempered basis sets, contracted basis sets,	3	

	20	Pople-style basis sets and their nomenclature, correlation consistent basis sets, basis set truncation error, effect of choice of method/ basis set (model chemistries) on cpu time.	3	
V	**Representation of Molecular Geometry and Guassian Calculatins (Open Ended)**		**12**	**20**
	Open Ended	Specification of molecular geometry using a) Cartesian coordinates and b) Internal coordinates. The Z-matrix, Z-matrices of some simple molecules like H2, H2O, formaldehyde ammonia and methanol. Simple calculations using Gaussian programme	12	

References:

1. C. J. Cramer, Essentials of computational Chemistry: Theories and models, John Wiley & Sons 2002.
2. Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons LTD1999.
3. J. Foresman &Aelieen Frisch, Exploring Chemistry with Electronic Structure Methods, Gaussian Inc., 2000.
4. David Young, Computational Chemistry- A Practical Guide for Applying Techniques to Real- World Problems", Wiley -Interscience, 2001.
5. Errol G. Lewars, Computational Chemistry: Introduction to the theory and applications of molecular quantum mechanics, 2 nd edn, Springer2011.
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7. P.W. Atkins & R.S. Friedman, Molecular quantum mechanics, 4th Edition, Oxford University Press, 2005.
8. W. Koch, M.C. Holthausen, "A Chemist's Guide to Density Functional Theory", Wiley VCH Verlag2000.

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**PETROCHEMICALS AND COSMETICS**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VIII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	1. A fundamental understanding of general chemistry is essential. 2. Proficiency in organic chemistry is crucial, as petrochemicals and cosmetics are primarily composed of organic compounds. 3. Knowledge of analytical chemistry techniques used for the characterization and analysis of petrochemicals and cosmetic products, such as chromatography, spectroscopy, and mass spectrometry, may be beneficial.				
Course Summary	This course aim to provide students with a comprehensive understanding of petroleum products and their purification processes, as well as the skills necessary for careers in petroleum refining, petrochemicals, quality control, and environmental compliance. Study of the various ingredients used in cosmetics, including their sources, functions, properties, and effects on the skin and hair.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	A comprehensive understanding of the petrochemical industry, including its role in the global economy, key players, and major processes involved.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Understanding of the composition of petroleum, including the various hydrocarbon compounds present and their physical and chemical properties. Understanding of synthetic methods for producing	Ap	C	Class test /Assignment /Quiz

	organic compounds from hydrocarbons.			
CO3	Realizing the physical and chemical properties of different hydrocarbon fractions in crude oil, including their boiling points, densities, viscosities, and reactivities. Familiarity with the principles of distillation. Understanding of the equipment and processes used in crude oil distillation.	U	P	Assignment/ Class test
CO4	Familiarise with the diverse range of products derived from petroleum refining and the purification techniques employed to remove impurities from petroleum products.	An	C	Assignments /Seminar presentation
CO5	Explore applications of petro chemistry in various fields, such as cosmetic and perfume industry and also the various ingredients used in perfumes and cosmetics, including natural and synthetic fragrances, essential oils, emollients, surfactants, preservatives, colorants, and other functional additives.	Ap	M	Assignments /Seminar presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Petrochemistry**		**9**	**15**
	1	Introduction. Petroleum. Refining of crude oil.	2	
	2	Fuels for internal combustion engines. Knocking, Octane number. Unleaded petrol. Diesel Engine and Cetane number.	3	
	3	Cracking. Thermal, Catalytic. Mechanism of cracking process.	2	
	4	Reforming Activation Gasoline. Petrochemicals.	2	
II	**Hydrocarbons from Petroleum and Industrial organic synthesis**		**12**	**20**
	6	Introduction. Raw materials. Saturated hydrocarbons from natural gas. Uses of saturated hydrocarbons. Unsaturated hydrocarbons – Acetylene, Ethylene, Propylene.	2	
	7	Aromatic hydrocarbons - Benzene. Toluene. Chemical processing of paraffin hydrocarbons. Chemical processing of ethylene hydrocarbons. Chemical processing of acetylene. Chemical processing of aromatic hydrocarbons.	3	

	8	Introduction to industrial organic synthesis from Petroleum. The raw materials and basic processes. Chemical process used in industrial organic synthesis.	2	
	9	Petrochemicals- Methanol. Important points. Ethanol. Important points. Rectified spirit from beer. Methylated spirit. Proof spirit. Preparation of the absolute alcohol from rectified spirit.	3	
	10	Acetaldehyde. Acetic acid. Isopropanol. Ethylene glycol. Glycerine. Acetone. Phenol. Formaldehyde. Important points.	2	
III	**Composition of Petroleum Crude and Distillation of Crude Petroleum**		**15**	**25**
	11	Composition of petroleum crude. Composition of the petroleum products. Isomeric compounds. Classification of petroleum crude	2	
	12	Physical Properties and Test Methods. 1. Viscosity: Other methods for finding out viscosity. Viscosity of an oil blend. Use of the figure for finding out viscosity. Viscosities of hydrocarbons. 2. Density, 3. Surface and interfacial tensions. 4. Refractive Index. 5. Flash and fire points. 6. Cloud and pour points. 7. Aniline point. 8. Diesel index. 9. Cetane number. 10. Octane number and knock characteristics.	5	
	13	Preparation of petroleum for processing. Destruction of petroleum emulsion. Electric desalting plants. Methods of petroleum distillation. Distillation of crude petroleum. .	3	
	14	Treatment of the residual liquid processing of liquid fuels such as petroleum and petroleum products. Storage tanks. Rectification columns. Cap tray or bubble tray columns.	3	
	15	Heat exchange apparatus. Steam space heaters or boilers. Condensers. Pipe furnaces. Pipelines. Fitting Compressors and pumps.	2	
IV	**Petroleum products and their purification**		**12**	**30**
	16	Introduction. Classification of petroleum products. Liquefied hydrocarbons, gases and fuels. Fuel oils or boiler oils. Fuel for Jet engines and gas turbine engines.	2	
	16	Lubricants, Paraffins, ceresins, petroleum. Miscellaneous petroleum products.	2	
	17	Products of petrochemical and basic organic synthesis. Dye intermediates. Lacquers. Solvents. Thinners.	2	
	18	Absorptive and adsorptive purification. Sulphuric acid purification.	3	
	19	Hydrorefining. Purification in a DC electric field. New methods of purification. De mercaptanisation.	3	
V	**Perfumes and Cosmetics (Open Ended)**		**12**	**20**
	Open Ended	Perfumes: Introduction. Esters. Alcohols. Ketones. Ionones. Nitromusks. Aldehydes. Diphenyl compounds. Production of natural perfumes. Flower perfume. Fruit flavours. Artificial flavours. Colognes and after shave preparation. Deodorants and Antiperspirants. Cosmetics: Introduction. Shampoos. Ingredients. Recipe. Hair dyeing. Materials used. Colour and	12	

		Curl of Hair. Creams and Lotions. Skin Chemicals. Their ingredients. Preparation and recipe. Lipsticks. Ingredients. Preparation and recipe.		

References:

1. B. K. Sharma, Industrial Chemistry, Goel Publication, Goa.
2. N. K. Sinha, Petroleum Refining and petrochemicals,
3. John W. Hill, Chemistry for Changing times, Surjeet Publication
4. Uttam Ray Chaudhuri, "Fundamentals of Petroleum and Petrochemical Engineering", Boca Raton London New York.
5. S ukumar Maiti, "Introduction to Petrochemicals" India Book House Pvt Ltd.
6. Gabriella Baki, Kenneth S. Alexander, "Introduction to Cosmetic Formulation and Technology", Wiley.
7. Tony Curtis, David Williams, "Introduction to Perfumery", Micelle Press; 2nd edition ., 2000.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		1	2				3		1		2		1
CO 2		1		1	2		3		1		1		1
CO 3						3	3		2		2		1
CO 4						3	3		2				1

CO5						3	3		2		2		1

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**ADVANCED TOPICS IN INORGANIC CHEMISTRY**				
Type of Course	**ELECTIVE IN MAJOR**				
Semester	**VIII**				
Academic Level	**400-499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	IR spectroscopy Types of ligands Preliminary idea about ESR, Mossbauer and NMR spectra of complexes Ligand exchange reactions Types of magnetic properties of complexes				
Course Summary	This course gives an insight to the application of IR spectroscopy in coordination complexes This course helps to analyse complexes using ESR, Mossbauer and NMR spectra It provides the knowledge of fascinating applications of complexes in medical field This course explains the anomalous magnetic properties of complexes This course enables the student to analyse different characteristics of a complex using various spectroscopic techniques				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand and apply infrared spectroscopy techniques for characterizing coordination compounds	Ap	C	Instructor-created exams / Assignments
CO2	Interpret the role of ESR and Mossbauer spectroscopic techniques in	Ap	C	Assignment / seminar/Quiz

	elucidating complex structures			
CO3	Evaluate the application of metal complexes in the medicinal field and their interaction with biological entities	E	C	Assignment/Seminar/Class test
CO4	Analyze the significance of anomalous magnetic moments in understanding complex structures and dynamics	An	C	Class Test/ Assignment/Viva Voce
CO5	Perform spectral analysis of complexes and solve related problems using IR, ESR and Mossbauer techniques	Ap	P	Group work /Assignment/class test/
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Mark
I	**CHARACTERIZATION OF COORDINATION COMPLEXES USING IR SPECTROSCOPIC TECHNIQUES**		**13**	26
	1	Infrared spectra of metal complexes. Group frequency concept.	1	
	2	Changes in ligand vibrations on coordination-	2	
	3	Effect of complex formation on symmetry, electronic structure and bonding characteristics of ligands –	4	
	4	Coordination of nitrate ion, sulphate ion, acetate ion, perchlorate ions, cyano group - metal ligand vibrations – water as a ligand –	3	
	5	IR spectroscopy of carbonyl complexes -	1	

	6	Application of IR spectroscopy in coordination complexes –	2	
II		**CHARACTERIZATION OF COORDINATION COMPLEXES USING ESR AND MOSSBAUER SPECTROSCOPIC TECHNIQUES**	**10**	22
	1	ESR spectra- Introduction	1	
	2	Importance of g values in structure elucidation of complexes	1	
	3	Application of ESR measurements to magnetically dilute and concentrated complexes -	2	
	4	Mossbauer spectra - application to iron complexes –	2	
	5	Factors affecting the chemical shift in coordination complexes	2	
	6	NMR spectra of diamagnetic copper complexes	2	
III		**APPLICATIONS OF METAL COMPLEXES IN MEDICINAL FIELD**	**15**	28
	1	Introduction – DNA-metal complex interaction –	**2**	
	2	Effect of Ligand exchange reactions and redox reactions in biological activity of metal complexes -	**2**	
	3	Effect of catalytic activity and photo physical activity on biological activity	**2**	
	4	Virtual screening of pharmacological behaviour - Drug likeness and bioavailability	**2**	
	5	Lipinski's Rule of 5 - Pharmacokinetic analysis of a drug molecule –ADMET	**2**	
	6	Analysis – In vitro and in vivo studies	**2**	
	7	Molecular docking.	**1**	
	8	Biological activities of transition metal complexes of Schiff bases, aromatic hydrazones	**2**	
IV		**ANOMALOUS MAGNETIC MOMENTS OF METAL COMPLEXES**	**10**	22
	1	Introduction – Equilibrium between two spin states	**1**	
	2	Magnetically non-equivalent sites in the metal ions – solute-solvent interactions	**1**	
	3	solute-solute interaction – configurational equilibrium – Antiferromagnetism – types –	**2**	
	4	antiferromagnetic exchange pathways –examples of antiferromagnetic binuclear complexes (Cu(II), V(IV))	**2**	

	5	Binuclear complexes with non-equivalent ions	**2**	
	6	Ferromagnetism – Trinuclear complexes	**2**	
V	**SPECTRAL ANALYSIS OF COMPLEXES (Open ended)**		**12**	
	IR, ESR and Mossbauer spectral analysis of some complexes (problem solving)			

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2. C.N. Banwell, Fundamentals of molecular Spectroscopy, 3rd ed. TMH, New Delhi, 1983.
3. . E.A.V. Ebsworth, Structural Methods in Inorganic Chemistry, 3rd ed., ELBS, Great Britain, 1987.
4. Drago, R. S. Physical Methods in Chemistry W. B. Saunders: Philadelphia, 1977.
5. Elements of Magnetochemistry by R L Dutta and A Shyamal, Edition, 2 ; Publisher, Affiliated East-West Press, 1993 ; ISBN, 818533692X, 9788185336923
6. Textbook of Drug Design and Discovery, Edited by Kristian Strømgaard Povl Krogsgaard-Larsen Ulf Madsen, CRC Press Taylor & Francis Group.
7. A Closer Look at Coordination Complexes, Sandeep Kaur-Ghumaan, Series: Chemistry Research and Applications, BISAC: SCI013030, DOI: https://doi.org/10.52305/ENZL4915

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO1	3	1	2				3		1		1		1
CO2	3	1		1	2		3		1		1		2
CO3	3				2	2	3		1		2		3
CO4						2	3		1		2		3
CO5						2	3		1		3		3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

MINOR COURSES

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

BSc CHEMISTRY

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

Course Outcomes (CO):

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

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

Detailed Syllabus:

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

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

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

References

1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
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6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
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10. G. Svehla, *Vogel's Qualitative Inorganic Analysis,* 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

<table>
<tr><td>Programme</td><td colspan="5">B.Sc Chemistry</td></tr>
<tr><td>Course Title</td><td colspan="5">BASIC INORGANIC AND BIO-INORGANIC CHEMISTRY</td></tr>
<tr><td>Type of Course</td><td colspan="5">MINOR</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
<tr><td>Academic Level</td><td colspan="5">100-199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>3</td><td>-</td><td>2</td><td>75</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Concept of atom and molecule
Constituents of the atom, Rutherford's model of the atom.
Periodic table and classification of elements to different blocks,
Basic knowledge of qualitative and quantitative analysis
Titration and use of indicators</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is intended to provide basic knowledge in inorganic chemistry and nanochemistry. The student gets an understanding of the Bohr model of the atom and the modern quantum mechanical model of the atom through the first module of this course. Different types of chemical bonding are also included in the first module. General properties of the atom and the variation of these properties in the periodic table are also discussed in this course. Basic principles of analytical chemistry are included in the third module of this course which includes acid-base titration, redox titration, complexometric titration, and mixture analysis. This course also tries to explain the roles of metal ions in biological systems and understand the biochemistry of certain key elements. To master the laboratory skills acid-base titration, and redox titration experiments are incorporated into this course structure.</td></tr>
</table>

Course Outcomes (CO):

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

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Class test /Assignment / Quiz
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Class test /Assignment / Quiz
CO5	**To Explain roles of metal ions in biological systems and understand the biochemistry of certain key elements**	U	F	Class test /Assignment / Quiz
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Atomic structure and Chemical Bonding**	**15**	**34**
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	
	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation	2	

		of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henry Mosley, Moseley's periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Bio-inorganic Chemistry**	**10**	**20**
	18	Metal ions in biological systems - Biochemistry of iron, Haemoglobin and myoglobin,	**2**	
	19	O_2 and CO_2 transportation (mechanism not required) - Chlorophyll and photosynthesis (mechanism not expected)	**2**	
	20	Elementary idea of structure and mechanism of action of sodium potassium pump	**2**	
	21	Biochemistry of zinc and cobalt. Toxicity of metal ions (Pb, Hg and As).	**2**	
	22	Anticancer drugs: *Cis*-platin, oxaliplatin,– Structure and significance.	**2**	
		Basic Inorganic Chemistry Practical: **Acid-Base titrations and Redox titrations**	**30**	

		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts, gas poisoning, Electric shocks, Treatment of fires, Precautions and preventive measures. Weighing using electronic balance, Preparation of standard solutions.		
	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
V	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
	III	**Open-ended experiments - Suggestions** Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching powder.		

References

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9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

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Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	**2**				**2**		**1**				**1**		
CO 2	**2**				**2**		**1**				**1**		
CO 3	**1**				**2**		**1**				**1**		
CO 4	**1**		**1**		**2**		**1**				**1**		
CO 5	**1**				**2**		**1**				**1**		
CO 6			**2**		**1**		**1**		**1**		**2**		

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

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

Course Outcomes (CO):

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

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Class test /Assignment / Quiz
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Class test /Assignment / Quiz
CO5	**To Grasp the importance of green chemistry, its principles and applications, including alternative energy sources**	U	F	Class test /Assignment / Quiz
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

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

	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories	2	
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Green Chemistry**	**10**	**20**
	18	Introduction- Definition of green Chemistry, need of green chemistry, Twelve principles of Green Chemistry with their explanations .	**3**	
	19	Applications of green chemistry in daily life. Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids (Brief explanation with example).	**2**	
	20	Alternative sources of energy: use of microwaves and ultrasonic energy.	**2**	
	21	Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.	**2**	

	22	Selection of starting materials; avoidance of unnecessary derivatization.	**1**	
V		**Basic Inorganic Chemistry Practical:** **Acid-Base titrations and Redox titrations**	**30**	
		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
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	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
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Mapping of COs with PSOs and Pos

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2				2		1				1		
CO 2	2				2		1				1		
CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

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

Course Outcomes (CO):

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

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Class test /Assignment / Quiz
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Class test /Assignment / Quiz
CO5	**To** Comprehend **the process in metallurgy including extraction of metals and alloy formation**	U	F	Class test /Assignment / Quiz
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Atomic structure and Chemical Bonding**	**15**	**34**
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli’s Exclusion principle - Hund’s rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	
	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of	2	

		bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Metallurgy**	**10**	**20**
	18	Ores and minerals, Concentration of ores – Calcination and roasting – Reduction to free metal.	**2**	
	19	Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, zone refining	**2**	
	20	Extractive metallurgy of Al, Fe	**2**	
	21	Alloys: Definition – Composition and uses of German silver, brass, bronze, gunmetal and alnico. Steel: Open hearth process (brief description only)	**2**	
	22	Classification of steel – Composition and uses of stainless steels, and applications of industrially important stainless steel types- (AISI Grade mention only)	**2**	
		Basic Inorganic Chemistry Practical: **Acid-Base titrations and Redox titrations**	**30**	

		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts, gas poisoning, Electric shocks, Treatment of fires, Precautions and preventive measures. Weighing using electronic balance, Preparation of standard solutions.		
	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
V	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
	III	**Open-ended experiments - Suggestions** Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching powder.		

References

1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.

5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry,* S. Chand and Co., New Delhi, 2010.

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7. A. Cottrel, *An introduction to metallurgy*, 2nd Edn., University press, 1990.

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9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis,* 6th Edn., Pearson Education, Noida, 2013.

10. G. Svehla, *Vogel's Qualitative Inorganic Analysis,* 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2				2		1				1		
CO 2	2				2		1				1		
CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

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

Course Outcomes (CO):

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

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Class test /Assignment / Quiz
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Class test /Assignment / Quiz
CO5	**To Examine nuclear chemistry, the N/P ratio and the application of radioactive isotopes**	U	F	Class test /Assignment / Quiz
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**Atomic structure and Chemical Bonding**	**15**	**34**
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	
	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation	2	

		of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Nuclear Chemistry**	**10**	**20**
	18	Nuclear stability – N/P ratio – Packing fraction – Mass defect – Binding energy	**2**	
	19	Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb.	**1**	
	20	Nuclear forces - Exchange theory and liquid drop model - Nuclear reactors. Decay series – group displacement law	**2**	
	21	Isotopes, Separation of isotopes by gaseous diffusion method and thermal diffusion method	**2**	
	22	Application of radioactive isotopes – ^{14}C dating – Rock dating – Isotopes as tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy	**3**	
		Basic Inorganic Chemistry Practical: **Acid-Base titrations and Redox titrations**	**30**	
		General Instructions		

V		For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts, gas poisoning, Electric shocks, Treatment of fires, Precautions and preventive measures. Weighing using electronic balance, Preparation of standard solutions.		
	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
	III	**Open-ended experiments - Suggestions** Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching powder.		

References

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7. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 5th Edn., Pearson, 2009.
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edn., New Age International (P) Ltd.,

9. New Delhi, 1995.J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

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CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**COORDINATION CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Classification of elements to different blocks, comparative study of s, p, d and f block elements based on electronic configuration. General idea about transition and inner transition elements, Concept of coordinate bond, valency. Concept of covalent bond, and organic compound. Theoretical and practical knowledge about volumetric analysis				
Course Summary	This course explains the characteristics of s, p, d and f block elements and familiarises some of the important compounds of main group elements. It also gives insight into coordination compounds and various theories to explain the bonding in coordination compounds. It covers the practical application of complex formation in quantitative analysis A brief discussion of Organometallic compounds, complexometric titration, preparation of complex compounds and colourimetry is also included in this course.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Elucidate the trends in physical and chemical properties of s and p block elements	U	F	Instructor-created exams / Quiz
CO2	To Evaluate the general properties of transition metals and to distinguish between lanthanides and actinides	U	F	Class test /Assignment / Quiz
CO3	To Unlock the Complexity of Coordination Compounds: Structures, Properties, and Applications	U	F	Class test /Assignment / Quiz
CO4	To demonstrate different theories to explain the formation of coordination compounds	U	C	Class test /Assignment / Quiz

CO5	To explore the characteristics of organometallic compounds	U	F	Class test /Assignment / Quiz
CO6	To Perform complexometric titrations, colourimetry experiments and preparation of complex compounds.	Ap	P	Lab Work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**s & p BLOCK ELEMENTS**	**15**	**33**
	1	s block elements - General properties: Ionization Energy, Flame coloration, photoelectric effect, metallic character, hydration energy.	2	
	2	p-block elements: comparative study- halides, sulphates, carbonates and bicarbonates (solubility and thermal stability).	2	
	3	Oxidation number and inert pair effect, Comparison of Lewis acidity of boron halides.	1	
	4	Preparation, properties, structure and uses of Diborane, Boric acid, Borazine and Boron nitride. Structure and bonding of oxides of N (N_2O, NO, NO_2, N_2O_4) and S (SO_2 and SO_3)	3	
	5	Oxo acids of P (H_3PO_2,H_3PO_3, H_3PO_4) and Cl (HOCl, $HOCl_2$, $HOCl_3$,$HOCl_4$) (structure and acid strength).	2	
	6	Colour and bond dissociation energy of halogens. Interhalogen compounds: Preparation, properties uses and structure (One example each- ClF, ClF_3, ClF_5 and IF_7), Electropositive character of iodine	2	
	7	Pseudo halogen: Comparison of pseudo halogen (Cyanogen as example) and halogens. structure of poly halide ions (ICl_2^-, ICl_4^- and I_5^-). Noble gases: Isolation of noble gases: Dewar's method- Separation by charcoal adsorption method, Uses of He, and Ne	3	
		TRANSITION AND INNER TRANSITION ELEMENTS	**8**	**17**
	8	Transition Metals: General characteristics: Metallic character, oxidation states, size, density, melting	**2**	

II		point, boiling point. ionization energy, colour, magnetic properties, catalytic properties		
	9	non-stoichiometric compounds, complex formation and alloy formation. Difference between first row and other two rows.	**2**	
	10	Lanthanides: Electronic configuration and general characteristics. Occurrence of lanthanides – Importance of beach sands of Kerala – Isolation of lanthanides from monazite sand – Separation by ion exchange method.	**2**	
	11	Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides. Actinides: Electronic configuration and general characteristics – Comparison with lanthanides [Mention only].	**2**	
III		**COORDINATION COMPOUNDS**	**15**	**34**
	12	Double salt and complex, ligand, type of ligands: (mono, bi, tri, tetra, hexa, ambidentate, chelate and macrocyclic ligands) coordination number,	**2**	
	13	Isomerism - structural and stereoisomerism, IUPAC Nomenclature of complexes,	**2**	
	14	Postulates of Werner's theory, EAN rule, application of co-ordination complexes in quantitative and qualitative analysis.	**2**	
	15	Theories of bonding, VBT (valence bond theory) , geometry of co-ordination numbers 4 and 6,	**2**	
	16	Limitations of VBT, Crystal field Theory: CFSE of low spin and high spin octahedral complexes, Factors affecting crystal field splitting.	**2**	
	17	Spectrochemical series, Crystal field splitting of d orbitals in Tetragonal and Square planar Complexes.	**2**	
	18	Magnetism (spin only magnetic moment) and colour (d-d transition),	**1**	
	19	Distorted octahedral complexes, merits and demerits of CFT.	**2**	
IV		**Organometallic Compounds**	**7**	**14**
	20	Definition – Classification based on the nature of metal-carbon bond, Zeise's salt. 18-electron rule.	**2**	
	21	Metal carbonyls - Mononuclear and Polynuclear carbonyls of Fe, Co and Ni (structure only) – Bonding in metal carbonyls.	**2**	

	22	Ferrocene: Preparation, properties and bonding (VBT only). Catalysis: Zeigler Natta catalyst in the polymerization and Wilkinson catalyst in the hydrogenation of alkene.	**3**	
V		**PRACTICAL :** **Complexometric titrations and Inorganic Preparations**	**30**	
	I	A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher 1. Estimation of zinc. 2. Estimation of magnesium. 3. Estimation of calcium. 4. Determination of total hardness of water.		
	II	Preparation of complex compounds 5. Preparation of tetramminecopper(II) sulphate. 6. Preparation of Nickel (II) dimethylglyoxime 7. Preparation of trithioureacopper(I) sulphate		
	III	Colorimetry 8. Verification of Beer-Lambert law for $KMnO_4$ & determination of concentration of the given solution. 9. Estimation of iron. 10. Estimation of chromium.		
	IV	**Open-ended experiments - Suggestions** 1. Preparation of double salt/Complex compounds. 2. Determination of alkali content in antacid tablets by titration with HCl. 3. Determination of available chlorine in bleaching powder. 4. Analysis of Ores		

References

1. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd., 2008.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, Pearson, 2006.
4. F. A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn., John Wiley, New York. 1999.
5. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 3rd Edn., Oxford University Press, 2009.
6. R. Gopalan, V. Ramalingam, *Concise Coordination Chemistry*, 1st Edn., Vikas Publishing House, New Delhi, 2001.
7. P. Powell, *Principles of Organometallic Compounds*, 2nd Edn., Chapman and Hall, London, 1988.

8. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
9. D. N. Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry; For I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012.

Mapping of COs with PSOs and POs

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

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry
Course Title	**QUANTUM MECHANICS, SOLID STATE AND GASEOUS STATE**
Type of Course	**MINOR**
Semester	**II**
Academic Level	**100 - 199**

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75

Pre-requisites	1. Basic idea the structure of atom 2. Fundamentals of states of matter 3. Basic knowledge in analytical principles
Course Summary	1. This course aims to introduce the failures of classical theories in explaining many experiments and the emergence of quantum theory. 2. This course also aims to realise the theories of different states of matter and their implications. 3. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments

Course Outcomes (CO):

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

CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

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

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

Reference Books

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

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

Mapping of COs with PSOs and POs

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

Correlation Levels :

Level	Correlation
0	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**LIQUID STATE, GASEOUS STATE AND ELECTROCHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Gaseous and Liquid states of matter 2. Basic principles of Electrochemistry 3. Basic knowledge in analytical principles				
Course Summary	1. This course provides the students a thorough knowledge about gaseous and liquid states of matter and the continuity between them. 2. This course aims to impart an idea about electrochemistry 3. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To apply the postulates of kinetic theory of gases.	Ap	F	Instructor-created exams / Quiz /Assignment
CO2	To describe the properties of liquids.	E	C	Instructor-created exams / Quiz /Assignment
CO3	To analyse the behaviour of gases and liquids	An	C	Instructor-created exams / Quiz /Assignment
CO4	To illustrate the basic concepts of electrochemistry and its applications	U	C	Instructor-created exams / Quiz /Assignment
CO5	To perform the cation analysis on a provided mixture containing two cations.	An	P	Lab work

CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (75)	Marks
I		**Liquid State**	**15**	**34**
	1	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	4	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point,– Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	5	– Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor	2	
	6	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	7	Applications of liquid crystals.	1	
II		**Gaseous State - I**	**10**	**20**
	8	Characteristics of gases	1	
	9	Postulates of kinetic theory of gases	2	
	10	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	
	11	Collision number – Mean free path – Collision diameter	1	
	12	Viscosity of gases, including their temperature and pressure dependence,	1	

	13	Relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.	2	
III	**Gaseous State - II**		**10**	**22**
	14	Behaviour of real gases - Deviation from ideal behaviour – Compressibility factor	3	
	15	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	16	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	17	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) – Relationship between critical constants and van der Waals constants.	2	
IV	**Electrochemistry**		**10**	**22**
	18	Specific conductance, equivalent conductance and molar conductance	2	
	19	Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes	2	
	20	Application of conductance measurements – Conductometric titrations.	1	
	21	Galvanic cells – emf of cell and electrode potentials - IUPAC sign convention – Reference electrodes – Standard Hydrogen electrode – Calomel electrode - Standard electrode potential - Nernst equation	2	
	22	H_2-O_2 fuel cell. Ostwald's dilution law – Buffer solutions – Buffer action [acetic acid/sodium acetate & NH_4OH/NH_4Cl], applications of buffers.	3	
V	**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		**30**	
	1	a) Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and	25	

		confirmation. NH_4^+, Pb^{2+}, $Cu^{2+,}$ Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)		
	2	b) Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
5. S. Glasstone, Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi, 2007.
6. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
7. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
8. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
9. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

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

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**PHYSICAL PROPERTIES OF SOLUTIONS, GASES AND COLLOIDS**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Gases and Liquids 2. Colloids – Definition and classification 3. Basic knowledge in analytical principles				
Course Summary	1. This course provide the students a thorough knowledge about various properties of gases and liquids 2. This course aims to develop an idea about the applications of colloids 3. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	To explain the characteristics of gases.	U	F	Instructor-created exams / Quiz /Assignment
CO 2	To analyse the intermolecular attractions and explain the properties of liquids	An	C	Instructor-created exams / Quiz /Assignment
CO 3	To evaluate the behaviour of solutions	E	C	Instructor-created exams / Quiz /Assignment
CO 4	To apply the theories of different states of matter and understand their implications.	Ap	F	Instructor-created exams / Quiz /Assignment

CO 5	To appreciate the importance of colloids in chemistry	U	C	Instructor-created exams / Quiz /Assignment
CO 6	To perform qualitative analysis of cations and determine physical constants	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (75)	Marks
I	**Solutions and Colligative Properties**		**15**	**32**
	1	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	4	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point,– Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	5	– Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor	2	
	6	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	7	Applications of liquid crystals.	1	
II	**Properties of Gases**		**10**	**22**
	8	Characteristics of gases	1	
	9	Postulates of kinetic theory of gases	2	
	10	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	

	11	Collision number – Mean free path – Collision diameter	1	
	12	Viscosity of gases, including their temperature and pressure dependence,	1	
	13	Relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.	2	
III		**Ideal and Real Gases**	**10**	**22**
	14	Behaviour of real gases - Deviation from ideal behaviour – Compressibility factor	3	
	15	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	16	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	17	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) – Relationship between critical constants and van der Waals constants.	2	
IV		**Colloids**	**10**	**22**
	18	True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples.	2	
	19	Purification of colloids by electrodialysis and ultrafiltration	2	
	20	Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis.	2	
	21	Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions.	2	
	22	Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.	2	
V		**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher	**30**	

	1	Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH_4^+, Pb^{2+}, $Cu^{2+,}$ Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)	25	
	2	Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
5. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
6. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
7. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
8. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

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

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**STATES OF MATTER AND NUCLEAR CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Gaseous and Liquid states of matter 2. Basic idea about nucleons 3. Basic knowledge in analytical principles				
Course Summary	1. This course provides the students a thorough knowledge about gaseous and liquid states of matter and the continuity between them. 2. This course aims to introduce the applications of nuclear chemistry 3. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts and the properties of gaseous state and how it relates to thermodynamic systems.	U	F	Instructor-created exams / Quiz /Assignment
CO2	To understand the behaviour of ideal and non-ideal solutions	E	C	Instructor-created exams / Quiz /Assignment
CO3	To analyse the properties of gases and liquids.	An	C	Instructor-created exams / Quiz /Assignment
CO4	To apply the theories of different states of matter and understand their implications.	Ap	F	Instructor-created exams / Quiz /Assignment

CO5	To describe various processes in nuclear chemistry	U	C	Instructor-created exams / Quiz /Assignment
CO6	To analyse cations from a given mixture and enable the students to determine the physical constants.	An	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (75)	Marks
I		**Gaseous State - I**	**10**	**22**
	1	Characteristics of gases	1	
	2	Postulates of kinetic theory of gases	2	
	3	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	
	4	Collision number – Mean free path – Collision diameter	1	
	5	Viscosity of gases, including their temperature and pressure dependence,	1	
	6	Relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.	2	
II		**Gaseous State - II**	**10**	**22**
	7	Behaviour of real gases - Deviation from ideal behaviour – Compressibility factor	3	
	8	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	9	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	10	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) –	2	

		Relationship between critical constants and van der Waals constants.		
III		**Solutions and Liquid crystals**	**15**	**32**
	11	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	12	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	13	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	14	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapor pressure – Elevation of boiling point,– Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	15	– Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor	2	
	16	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	17	Applications of liquid crystals.	1	
IV		**Nuclear Chemistry**	**10**	**22**
	18	Natural radioactivity – Modes of decay – Group displacement law.	2	
	19	Nuclear forces - n/p ratio - Nuclear stability - Mass Defect - Binding energy	2	
	10	Isotopes, isobars and isotones with examples. Nuclear fission - Atom bomb - Nuclear fusion – Hydrogen bomb	1	
	21	Nuclear reactors	1	
	22	Application of radioactive isotopes – ^{14}C dating, Rock dating, Isotopes as tracers, Radio diagnosis, Radiotherapy. Problems	4	
V		**Practical**	**30**	

	A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher			
	1	a) Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH_4^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)	25	
	2	b) Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5	

Reference Books

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017 G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
4. 1. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn., New Age International (P) Ltd., New Delhi, 1995
5. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
6. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
7. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
8. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2				2		1						
CO 2	2				2		1						
CO 3	2				2		1						
CO 4	2				2		1						
CO 5	2				2		1						
CO 6			2		2		1				1		

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**SOLUTIONS AND SURFACE CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic idea of solutions 2. Colloids – Definition and classification 3. Fundamentals of surface phenomena 4. Basic knowledge in analytical principles				
Course Summary	1. This course provide the students a thorough knowledge about various properties of liquids 2. This course aims to impart an idea about importance of colloids 3. This course aims to develop the concept of adsorption and separation techniques 4. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts and the properties of liquids	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the importance of colligative properties.	E	C	Instructor-created exams / Quiz /Assignment
CO3	To differentiate different types of colloids and explain their properties and applications.	U	C	Instructor-created exams / Quiz /Assignment
CO4	To appreciate the importance of surface phenomena in chemistry	U	C	Instructor-created exams / Quiz /Assignment

CO5	To perform the cation analysis on a provided mixture containing two cations.	An	P	Lab work
CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Solutions**	**15**	**32**
	1	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	4	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point,– Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	5	– Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor	2	
	6	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	7	Applications of liquid crystals.	1	
II		**Colloids**	**10**	**22**
	8	True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples.	2	
	9	Purification of colloids by electrodialysis and ultrafiltration	2	
	10	Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis.	2	
	11	Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions.	2	
	12	Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.	2	
III		**Adsorption and Catalysis**	**10**	**22**
	13	Adsorption, Physical and chemical adsorption, factors affecting adsorption.	2	
	14	Adsorption isotherms: Freundlich and Langmuir isotherms (derivation not required) –	2	
	15	Applications of adsorption.	1	

	16	Catalysis: Homogeneous and heterogenous catalysis – Theories of homogenous and heterogenous catalysis	3	
	17	Enzyme catalysis – Michaelis-Menten equation (derivation not required).	2	
IV	**Separation Techniques**		**10**	**22**
	18	Chromatography- Introduction - Adsorption and partition chromatography - Development of chromatogams: frontal, elution and displacement methods	2	
	19	Qualitative and quantitative aspects of principle and applications of column, thin layer, paper and gas chromatography	2	
	20	Rf value – Relative merits of different techniques	2	
	21	Solvent extraction: Classification, principle and efficiency of the technique.	2	
	22	Extraction of metal ions from aqueous solution,	2	
V	**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		**30**	
	1	Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH_4^+, Pb^{2+}, $Cu^{2+,}$ Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)	25	
	2	Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc]	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.

4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
5. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
6. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
7. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
8. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
10. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
11. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
12. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

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

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**FUNDAMENTALS OF PHYSICAL CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Thermodynamics 2. General idea about state of equilibrium 3. Basic idea about order of reaction 4. Basic knowledge in analytical principles and structure of molecules				
Course Summary	1. This course aims to familiarise the students with the concepts of thermodynamics, kinetics and photochemistry. 2. This course also aims to impart an idea about ionic and phase equilibrium 3. This course also aims to develop proficiency in analytical tools and to draw molecular structures using softwares				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts thermodynamic processes	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the importance of ionic and phase equilibrium.	E	C	Instructor-created exams / Quiz /Assignment
CO3	To analyse the order of different reactions	An	C	Instructor-created exams / Quiz /Assignment
CO4	To appreciate the importance of photochemistry	U	C	Instructor-created exams /

				Quiz /Assignment
CO5	To create structures of different molecules and calculation of different parameters	C	P	Lab work
CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Thermodynamics**	**10**	**22**
	1	Definition of thermodynamic terms – System – Surroundings – Types of systems,	1	
	2	First law of Thermodynamics – Internal energy – Significance of internal energy change –Enthalpy	2	
	3	Second law of Thermodynamics – Entropy and spontaneity – Statement of second law based on entropy.	2	
	4	Entropy change in phase transitions (derivation not required) – Entropy of fusion, vaporization and sublimation.	2	
	5	The concept of Gibbs free energy – Physical significance of free energy –	1	
	6	Conditions for equilibrium and spontaneity based on ΔG values – Effect of temperature on spontaneity of reaction. Third law of Thermodynamics.	2	
II		**Ionic and Phase Equilibria**	**10**	**22**
	7	Introduction to acid base theories – pKa, pKb and pH	1	
	8	Buffer solutions Mechanism of buffer action – Buffer index – Henderson equation – Applications of buffers	2	
	9	Hydrolysis of salts of all types – Degree of hydrolysis – Hydrolysis constant and its relation with Kw	1	
	10	Solubility product and common ion effect.	2	
	11	Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs phase Rule	2	
	12	Phase diagrams of one-component systems – e.g.: water	2	
III		**Chemical Kinetics**	**15**	**32**
	13	The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction.	3	

	14	Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).	5	
	15	Half-life of a reaction. General methods for determination of order of a reaction.	2	
	16	Concept of activation energy and its calculation from Arrhenius equation (qualitative treatment only)	3	
	17	problems	2	
IV		**Photochemistry**	**10**	**22**
	18	Introduction – Difference between thermal and photochemical processes – Characteristics of electromagnetic radiation - Beer Lambert's law.	3	
	19	Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence.	1	
	20	Quantum yield and its explanation with example – Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence.	3	
	21	Photosensitization, Role of photochemical reactions in biochemical processes	2	
	22	Photostationary states – Chemiluminescence	1	
V		**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher	**30**	
	1	● Absorption (and transmittance) measurements of a colourless and a coloured light absorbing substance in a solution by using a spectrophotometer either experimentally or by simulation. For simulation use https://mas-iiith.vlabs.ac.in/exp/uv-visible-spectroscopy/simulation/expt1/mas_expt1.html ● Verify Beer Law using a spectrophotometer either experimentally or by simulation. For simulation use https://mas-iiith.vlabs.ac.in/exp/beer-law/simulation/expt4/mas_expt4.html https://mas-iiith.vlabs.ac.in/exp/lambert-law/simulation/expt3/mas_expt3.html https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html ● Draw structures of organic molecules using any chemistry structure drawing softwares/websites (any five molecules) Samples: https://molview.org/ https://pubchem.ncbi.nlm.nih.gov//edit3/index.html https://www.chemspider.com/StructureSearch.aspx	25	

		http://www.kingdraw.cn/en/ https://www.rcsb.org/chemical-sketch • Measure the bond length and bond angle of organic molecules using softwares Samples: https://molview.org/ • Determination of heat of solution (ΔH) of oxalic acid/benzoic acid from solubility measurement.		
	2	• Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of velocity constant for acid hydrolysis of methyl acetate. Determination of velocity constant for the saponification of ethyl acetate. Preparation of buffers and determination of pH values of fruitjuices using pH meter. Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
5. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013.
6. K. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education, New Delhi, 2004.
7. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Edn., Sultan Chand & Sons, New Delhi, 2011.
8. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
9. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

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

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

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

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

BSc CHEMISTRY

<table>
<tr><td>Programme</td><td colspan="5">B.Sc Chemistry</td></tr>
<tr><td>Course Title</td><td colspan="5">BASIC ORGANIC CHEMISTRY</td></tr>
<tr><td>Type of Course</td><td colspan="5">MINOR</td></tr>
<tr><td>Semester</td><td colspan="5">III</td></tr>
<tr><td>Academic Level</td><td colspan="5">200-299</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>3</td><td>-</td><td>2</td><td>75</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Fundamental Concepts of organic chemistry- Nomenclature, Isomerism, Fuctional groups, Homologous series</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course explores basics of organic chemistry reaction mechanism, Reactions and mechanism of important functional groups and stereochemistry</td></tr>
</table>

Course Outcomes (CO):

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

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

Detailed Syllabus:

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

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

References

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

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

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

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

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

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

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

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

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

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry
Course Title	**BIOORGANIC CHEMISTRY**
Type of Course	**MINOR**
Semester	**III**
Academic Level	**200-299**

<table>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>3</td><td>-</td><td>2</td><td>75</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Fundamental Concepts of organic chemistry- Nomenclature,isomerism, Functional groups,Homologous series
2. Preliminary ideas of carbohydrates and Biomolecules</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course explores basics of organic chemistry reaction mechanism, Reactions and mechanism of important functional groups, Chemistry of Carbohydrates,Biomolecules and natural products</td></tr>
</table>

Course Outcomes (CO):

CO	**CO Statement**	**Cognitive Level***	**Knowledge Category#**	**Evaluation Tools used**
CO 1	To understand the basic concepts of reaction mechanisms	U	C	Instructor-created exams / Assignment
CO 2	To realise types of organic reactions and intermediates	Ap	P	Instructor-created exams Assignment /quizes
CO 3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules	U	C	Assignment/Seminar
CO 4	To appreciate the importance of biomolecules in recognizing their central role in life processes	An	P	Instructor-created exams / Assignment
CO 5	To emphasize how organic chemistry provides a framework for unravelling	U	C	Group work /Assignment/class test

	the complexities of bio molecular structures.			
CO 6	To enable the students to develop analytical skills in organic qualitative analysis	Ap	P	Observation of practical skill/Viva voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Basic concepts of Organic Chemistry.**	**15**	**30**
	1	Introduction- Homolysis and Heterolysis with suitable examples. Curley arrow rules. Reagents – Electrophiles, nucleophiles and free radicals	2	
	2	Electron Displacement Effects: Inductive effect, Definition - Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition – Characteristics - +E effect and -E effect - Addition of H+ to ethene and addition of CN- to acetaldehyde.	1	
	4	. Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene,nitrobenzene, Phenol and Aniline	3	
	5	Hyperconjugation effect: Definition – Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	1	
	6	Steric effect	1	
	7	Reaction intermediate:Type ,shape and stability of Carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions-Defintion and one example	2	
II		**Chemistry of carbonyl compounds and amines**	**10**	**22**
	9	**Aldehydes & Ketones**: Preparation from alcohols –Comparison of reactivity of aldehydes and ketones. Nucleophilic addition reactions-addition of HCN and bisulphite.	3	
	10	**Carboxylic Acids**: Preparation from Grignard reagent – Decarboxylation – Kolbe electrolysis	2	
	11	**Amines**: Preparation from nitro compounds – Hofmann's bromamide reaction – Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline	3	
	12	**Diazonium salts**:Preparation and synthetic application of benzene diazonium chloride	1	

	13	Preparation and uses of methyl orange	1	
III		**Carbohydrates**	**10**	**23**
	14	Classification- Monosaccharides, oligosaccharides, and polysaccharides, Aldose and Ketose, reducing and nonreducing sugars	2	
	15	Cyclic structure of Ribose, Deoxy ribose. glucose and fructose.	2	
	16	D and L forms of glyceraldehyde, Glucose - manufacture of glucose from starch, physical properties, uses, Structure of D and L glucose	2	
	17	Analytical test for glucose - effect of heating, effect of conc sulphuric acid, Fehling's test, Tollens test, Molisches test.	1	
	18	Fructose- preparation from cane sugar, properties. Sucrose - manufacture of sucrose from sugar cane juice. Starch and cellulose - physical properties, structure (Basic ideas only)	3	
IV		**Proteins and Nucleic acids**	**10**	**23**
	19	Amino acids – Classification – Structure of amino acids – Zwitter ion formation – Isoelectric point. Peptide linkage,polypeptides and proteins. Primary ,secondary and tertiary structure of proteins. Denaturation of proteins. Tests for proteins: Xanthoprotein test, Biuret test and Ninhydrin test.	3	
	20	Enzymes,characteristics and examples	1	
	21	Nucleic acids: Introduction, constituents of nucleic acids – nitrogenous bases, nucleosides and nucleotides. Double helical structure of DNA. Difference between DNA & RNA – DNA finger printing and its applications	3	
	22	Lipids:Classification-Fats and oils.Biological functions of lipids. Steroids :classification.Structure and biological functions of cholesterol,testosteroneand progestron.Elementary ideaof HDL and LDL	3	
V		**PRACTICALS RELATED TO THE MODULE II and III**	**30**	
	1	Reactions of Organic Compounds	4	
	2	II. Functional groups test for 1. Phenols -Phenol 2. Amines-Aniline 3. Aldehydes and ketones -benzaldehyde, benzophenone). 4. Carboxylic acid (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea	20	
	3	III.Preparation of organic compounds-	6	

References

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
6. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
7. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

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

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**ORGANIC AND PHYTOCHEMISTRY**				
Type of Course	**MINOR**				
Semester	**III**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic concepts of Organic Chemistry 2. Basic concepts of Biomolecules				
Course Summary	This course ensure students to acquire a profound understanding of Organic Chemistry by emphasizing fundamental reactions and concepts, and to explore the importance of Organic Chemistry in the study of biomolecules.				

Course Outcomes (CO):

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

	recognizing their central role in life processes.			
CO5	To emphasize how organic chemistry provides a framework for unravelling the complexities of bio molecular structures.	Ap	P	Group work /Assignment/class test
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	Ap	P	Observation of practical skill/Viva voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Basic concepts of Organic Chemistry**	**15**	**30**
	1	Homolytic and heterolytic fission with suitable examples. Curly arrow rules. Types of reagents -Electrophiles, Nucleophiles and Free radicals.	1	
	2	Electron Displacement Effects: Inductive effect, definition, Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition, Characteristics - +E effect and -E effect. Addition of H^+ to ethene and addition of CN^- to acetaldehyde.	2	
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene, phenol and aniline.	2	
	5	Hyperconjugation effect: Definition, Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	2	
	6	Steric effect and its importance in reactivity.	1	
	7	Reaction intermediate: Type, shape and stability of carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions-Definition and example.	2	
II		**Chemistry of Alkyl halides, Alcohols and Phenols**	**10**	**23**
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes- Wurtz reaction and Fittig's reaction. SN^1 and SN^2 reactions of alkyl halides-Mechanism and stereochemistry.	3	

	10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only).	2	
	11	Reactions of alcohols-Substitution, dehydration, oxidation and esterification. Haloform reaction - iodoform test -Luca's test-Chemistry of methanol poisoning, harmful effect of ethanol in human body.	3	
	12	Phenols: Preparation from chlorobenzene. Comparison of acidity of phenol, p-nitrophenol and p-methoxyphenol.	1	
	13	Preparation and uses of phenolphthalein.	1	
III		**Chemistry of Carbonyl compounds and Amines**	**10**	**22**
	14	Aldehydes & Ketones: Preparation from alcohols. Comparison of reactivity of aldehydes and ketones.	1	
	15	Nucleophilic addition reactions in aldehydes and ketone. Addition of HCN and bisulphite. Clemmensen reduction and Wolff Kishner reduction.	2	
	16	Carboxylic Acids: Preparation from Grignard reagent-Decarboxylation-Kolbe electrolysis.	2	
	17	Amines: Preparation from nitro compounds-Hofmann's bromamide reaction, Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline.	3	
	18	Diazonium salts: Preparation and synthetic application of benzene diazonium chloride. Preparation and uses of methyl orange.	2	
IV		**Biomolecules**	**10**	**23**
	19	Carbohydrates: Classification with examples-cyclic structures of glucose and fructose - Applications of carbohydrates.	2	
	20	Proteins: Amino acids- Classification, Zwitter ion formation – Peptide linkage – Polypeptides and proteins –Primary, secondary and tertiary structure of proteins – Globular and fibrous proteins – Denaturation of proteins. Enzymes: Characteristics and examples.	4	
	21	Natural products: Alkaloids: Extraction, Classification, Source, structure and physiological functions of nicotine, coniine and piperine.	1	
	22	Terpenes: Classification with examples, Isoprene rule – Isolation of essential oils by steam distillation – Uses of lemongrass oil, eucalyptus oil and sandalwood oil – Source, structure and uses of citral and menthol – Natural rubber – Vulcanization and its advantages.	3	
V		**Organic Chemistry Practicals**	**30**	
	23	General Reactions of Organic Compounds	4	

	24	Study of the reactions of functional groups from the following list. 1. Phenols –(phenol) 2. Amines-(aniline) 3. Aldehydes and Ketones-(benzaldehyde, benzophenone). 4. Carboxylic acids (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea)	20	
	25	Organic Preparations.	6	

References

1. Morrison, R. T. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3. I. L. Finar, *Organic Chemistry*, Vol. I & II, 5th Edn., Pearson Education, New Delhi, 2013.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
6. O.P Agarwal, Chemistry of Organic Natural Products, 30 th Edn. Goel Publications, 2006
7. S.P Bhutani, Chemistry of Biomolecules, Ane Books Pvt Ltd, 2000
8. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
9. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.
10. V.K Ahluwalia, S.Dhingra. Comprehensive Practical Organic Chemistry, Universities Press, Hyderabad, 2004.

Mapping of COs with PSOs and POs :

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

CO 4	2	-	2		2	2	2			2	1		
CO 5	2		-	-	2	-	2			2	1		
CO 6	2	-	2		-	2	2		1		2		1

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**ORGANIC CHEMISTRY IN DAILY LIFE**				
Type of Course	**MINOR**				
Semester	**3**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic concepts of Organic Chemistry 2. Chemistry and its importance in daily life				
Course Summary	This course ensure students to acquire a profound understanding of Organic Chemistry, emphasizing fundamental reactions, concepts and its implication in daily life.				

Course Outcomes (CO):

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

	happiness index and life expectancy.			
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	Ap	P	Observation of practical skill/Viva voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Basic concepts of Organic Chemistry**		**15**	**30**
	1	Homolytic and heterolytic fission with suitable examples. Curly arrow rules. Types of reagents -Electrophiles, Nucleophiles and Free radicals.	1	
	2	Electron Displacement Effects: Inductive effect, definition, Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition, Characteristics - +E effect and -E effect. Addition of H^+ to ethene and addition of CN^- to acetaldehyde.	2	
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene, phenol and aniline.	2	
	5	Hyperconjugation effect: Definition, Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	2	
	6	Steric effect and its importance in reactivity.	1	
	7	Reaction intermediate: Type, shape and stability of carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions-Definition and example.	2	
II	**Chemistry of Alkyl halides, Alcohols and Phenols**		**10**	**22**
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes-Wurtz reaction and Fittig's reaction. SN^1 and SN^2 reactions of alkyl halides-Mechanism and stereochemistry.	3	
	10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only).	2	
	11	Reactions of alcohols-Substitution, dehydration, oxidation and esterification. Haloform reaction - iodoform test -Luca's test-Chemistry of methanol poisoning, harmful effect of ethanol in human body.	3	

	12	Phenols: Preparation from chlorobenzene. Comparison of acidity of phenol, p-nitrophenol and p-methoxyphenol.	1	
	13	Preparation and uses of phenolphthalein.	1	
III	**Chemistry of Carbonyl compounds and Amines**		**10**	**23**
	14	Aldehydes & Ketones: Preparation from alcohols. Comparison of reactivity of aldehydes and ketones.	1	
	15	Nucleophilic addition reactions in aldehydes and ketone. Addition of HCN and bisulphite. Clemmensen reduction and Wolff Kishner reduction.	2	
	16	Carboxylic Acids: Preparation from Grignard reagent-Decarboxylation-Kolbeelectrolysis.	2	
	17	Amines: Preparation from nitro compounds-Hofmann's bromamide reaction, Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline.	3	
	18	Diazonium salts: Preparation and synthetic application of benzene diazonium chloride. Preparation and uses of methyl orange.	2	
IV	**Chemistry in Daily Life**		**10**	**23**
	19	Petrochemicals: Name, carbon range and uses of fractions of petroleum distillation. Octane number, Cetane number, Flash point. LPG and CNG: Composition and uses.	2	
	20	Pharmaceuticals: Drug - Chemical name, generic name and trade names with examples. Antipyretics, analgesics, antibiotics, antacids, antiseptics (definition and examples, structure not expected).	2	
	21	Dyes: Definition- Requirements of a dye. Theories of colour and chemical constitution. Structure and applications of martius yellow, indigo and alizarin.	3	
	22	Food: Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) Commonly used permitted and non-permitted food colours (structures not required).	3	
V	**Organic Chemistry Practicals**		**30**	
	23	General Reactions of Organic Compounds	4	
	24	Study of the reactions of functional groups from the following list. 1. Phenols –(phenol) 2. Amines-(aniline) 3. Aldehydes and Ketones-(benzaldehyde, benzophenone). 4. Carboxylic acids (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea)	20	
	25	Organic Preparations.	6	

References

1. Morrison, R. T. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
6. Jayashree Ghosh. A textbook of Pharmaceutical Chemistry, 3 rd Edn. S Chand and Company Ltd. New Delhi,1999
7. B. Srilakshmi. Food Science 5th Edn. New Age publishers, New Delhi, 2010.
8. K. Singh. Chemistry in Daily Life. Prentice Hall of India, New Delhi
9. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

Programme	B.Sc Chemistry				
Course Title	**ORGANIC CHEMISTRY AND POLYMERS**				
Type of Course	**MINOR**				
Semester	**III**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic concepts of Organic Chemistry 2. Basic concepts of Polymer Chemistry				
Course Summary	This course ensure students to acquire a profound understanding of Organic Chemistry and Polymer Chemistry by emphasizing fundamental reactions and concepts.				

Course Outcomes (CO):

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

CO5	To understand the applications of different polymers.	Ap	P	Group work /Assignment
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	Ap	P	Observation of practical skill/Viva voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Basic concepts of Organic Chemistry**	**15**	**32**
	1	Homolytic and heterolytic fission with suitable examples. Curly arrow rules. Types of reagents -Electrophiles, Nucleophiles and Free radicals.	1	
	2	Electron Displacement Effects: Inductive effect, definition, Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition, Characteristics - +E effect and -E effect. Addition of H^+ to ethene and addition of CN^- to acetaldehyde.	2	
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene, phenol and aniline.	2	
	5	Hyperconjugation effect: Definition, Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	2	
	6	Steric effect and its importance in reactivity.	1	
	7	Reaction intermediate: Type, shape and stability of carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions-Definition and example.	2	
II		**Chemistry of Alkyl halides, Alcohols and Phenols**	**10**	**22**
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes- Wurtz reaction and Fittig's reaction. SN^1 and SN^2 reactions of alkyl halides-Mechanism and stereochemistry.	3	
	10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit,	2	

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

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

References

1. Morrison, R. T. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
6. V.R Gowarikar. Polymer Chemistry, New Age International Pvt Ltd., New Delhi, 2010.
7. B.K. Sharma, Polymer Chemistry. Goel Publishing House, Meerut, 1989
8. Gowri Sankar Misra. Introductory Polymer Chemistry, New Age International, New Delhi, 1993.
9. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**APPLIED ORGANIC CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**III**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamental Concepts of organic chemistry- Nomenclature, isomerism, Fuctional groups, Homologous series 2. Basic concept of organic reaction mechanism, Chemistry of functional group				
Course Summary	This course explores organic spectroscopy, Chemistry of aromatic hydrocarbons, applications like medicinal chemistry and separation techniques				

Course Outcomes (CO):

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

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

Detailed Syllabus:

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

III	**Medicinal Chemistry**		**10**	**23**
	14	Drug: Chemical name, generic name and trade names with examples	2	
	15	Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	16	Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics(definition and examples).	3	
	17	tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).	2	
	18	Synthesis of aspirin and Paracetamol	1	
IV	**Purification and Characterization Techniques**		**8**	**18**
	19	Distillation- Simple, fractional, steam and vacuum distillations	2	
	20	recrystalisation, sublimation, solvent extraction	2	
	21	Chromatography, stationary phase, mobile phase, Rf values	2	
	22	TLC, Column chromatography, HPLC and GC (basic concepts only).		
V	**PRACTICALS RELATED TO THE MODULE II and III**		**30**	
	1	**Introduction to organic lab**	4	
	2	1.Distillation of Aniline, Limonene (from orange peels) 1. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol 2. Sublimation of a dicarboxylic acid/Naphthalene 3. Chromatographic separations – (any two) a) Separation of a mixture of two amino acids paper chromatography. b) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC) 4. TLC of Spinach	20	
	3	**Open ended** 1. Drawing structures using softwares. 2. Column Chromatography 3. Teacher can select preparation of organic compound related to the topics in the theory like synthesis of aspirin,sanitizer,drugs etc	6	

References

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

2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3.Organic spectroscopy, William Kemp
4.Spectroscopy of organic compounds, P S Kalsi
5. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
7. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, Satyajit D. Sarker and Lutfun Nahar, Wiley
8. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014
9. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edn., Pearson Education, Noida, 2013.
10.An Improved Method for the Extraction and Thin-Layer W Chromatography of Chlorophyll a and b from Spinach Hao T. Quach, Robert L. Steeper, and G. William Griffin, J Chem Edn, 2004, 81, 385
11. Quinone Synthesis and a Visual Introduction to Column Chromatography: An Undergraduate Experiment Danielle L. Pearson* and Russell R. A. Kitson* J. Chem. Educ. 2022, 99, 3731−3734

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

VOCATIONAL MINOR COURSES

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

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**INTRODUCTION TO INDUSTRIAL CHEMISTRY**				
Type of Course	**VOCATIONAL MINOR**				
Semester	**I**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic awareness on types of industries 2. Types of redox reactions and titrations				
Course Summary	The course explores various industries and their scope, industrial processes, IPR, and analytical knowledge acquisition through volumetric analysis.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the elementary ideas of Cosmetics, Soaps, Detergents, Textiles, Food and Petrochemical industries	U	F	Instructor-created exams / Group Tutorial Work
CO2	Acquire knowledge on elementary concepts of Paints and coatings, Polymers, Fine chemicals and Pharmaceuticals	U	F	Instructor-created exams / Assignments
CO3	Remember the early chemical technologies leading to the Industrial Revolution	R	F	Group Tutorial Work/Seminar
CO4	Analyse various unit processes involved in industry	An	P	Instructor-created exams / Viva
CO5	Acquire skills in various titrimetric analysis of industrial importance	Ap	P	Practical Assignment / Observation of Practical Skills
CO6	Understand the basic concepts, and ethics of Intellectual Property Rights	U	C	Instructor-created exams/Group Tutorial Work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Industrial chemistry: An Overview**	**9**	**20**
	1	History of industrial chemistry-Social Background: Industrial Revolution, Early Chemical Technologies.	2	
	2	Types of chemical industries – Glass, Cement, Ceramics, Metals, Steel (Elementary idea only)	1	
	3	Paints and coatings, Polymers, Agrochemicals, Fine chemicals, Pharmaceuticals (Elementary idea only)	1	
	4	Cosmetics, Soaps and Detergents, Textiles, Petrochemicals, Food, Spices, Sugar, Brewery (Elementary idea only)	1	
	5	Management of lab chemicals and equipment, Chemical waste management, fire and health safety management	2	
	6	Methods for procuring chemicals and equipment, record keeping, supply requirements, evaluation of supply trends	2	
II		**Industrial Process**	**12**	**26**
	7	Unit process, unit operations, flow diagrams, Energy balance and materials balance, fuels, calorific value	4	
	8	Fluid flow, streamline flow, turbulence flow, viscosity, Newtonian and non-Newtonian fluids	4	
	9	Heat transfer, types of heat exchangers, refrigeration cycles	4	
III		**Intellectual Property Rights (IPR)**	**9**	**20**
	10	Basic concepts, Purpose and Ethics of IPR	1	
	11	Seven Types including – Copyright & trademarks;	2	
	12	Patents, Geographical indications & Plant varieties	1	
	13	Industrial designs, Layout designs of ICs	2	
	14	Basics of patenting, IP filing methods.	3	

IV	**Scope of Industrial Chemistry**		**15**	**32**
	15	Types of industries – Cottage industries, Small and Large scale industries	2	
	16	Fundamentals of entrepreneurship – Types of entrepreneurs, Entrepreneurship and economic growth	2	
	17	Process of starting a business – Search for business ideas, Sources of business idea, Idea processing, Input requirements	2	
	18	Basics of fund management, fundamentals of finance and budgeting.	2	
	19	Business proposals- Basics of product value assessment, evaluation of product quality testing, evaluation for commercialization.	2	
	20	Basics of overall project management, report preparation and presentation	2	
	21	Start-up and Financial support schemes, MSME	2	
	22	Employment Opportunities – Job positions and eligibility requirement	1	
V	**Volumetric Estimation II**		**30**	
	1	Iodimetry and Iodometry 1. Estimation of copper 2. Estimation of arsenious oxide	5	
	2	Complexometric Titrations Using EDTA 3. Estimation of Zn 4. Estimation of Mg	10	
	3	Industrial applications 1. Estimation of Acetic acid content in commercial vinegar 2. Estimation of Alkali content in Antacid Tablets 3. Determination of hardness of water 4. Estimation of Ascorbic acid in fruit juices	15	
Books and References:				

1. B.K Sharma, Industrial Chemistry, Goel Publications (1983).
2. R.K. Das, Industrial Chemistry, Kalyani Publications, New Delhi (1982).
3. W.L.Badger and J.T.Bachero, Introduction to Chemical Engineering,Tata McGraw Hill, U.S.A
4. W.L.McCabe and J.C.Smith,Unit operations in Chemical Engineering,Tata McGraw Hill N.Y
5. J.H.Perry, Chemical Engineering Hand Book, McGraw Hill, N.Y. 4. D.D.Kale, Unit Operations– 1 and
Pune Vidyarthi GrihaPrakashan, Pune
6. K.A.Gavhane, Unit Operations-II Heat and Mass transfer, Nirali Prakashan.
7. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
8. D.A.Skoog, D.M.West and S.R.crouch, Fundamentals of Analytical Chemistry, 8 thEdn., Brooks/Cole
Nelson

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 2	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 3	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 4	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 5	-	-	2	-	-	2	3	-	2	-	3	-	3
CO 6	-	-	-	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓		✓
CO 4	✓	✓		✓
CO 5		✓	✓	
CO 6	✓			✓

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

Programme	B.Sc Chemistry				
Course Title	**INTRODUCTION TO POLYMER CHEMISTRY**				
Type of Course	**VOCATIONAL MINOR**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Fundamental knowledge of chemistry principles and terminology. Understanding of basic organic chemistry concepts. Familiarity with chemical bonding and molecular structure. Proficiency in stoichiometry and reaction mechanisms.				
Course Summary	This course provides a comprehensive overview of polymer chemistry, covering fundamental concepts, properties, synthesis techniques, and industrial applications of polymers. Students explore polymer classification, properties, polymerization techniques, processing methods, and the characteristics of various commercial polymers. By the course's conclusion, students will have gained essential knowledge in polymer chemistry and its practical applications.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand various classification of polymers and types of polymerisation methods	U	C	Instructor-created exams / Quiz
CO2	Understand the important characteristics of polymers such as average molecular weight, glass transition temperature, viscoelasticity and degradation.	U	F	Class test /Assignment / Quiz
CO3	Appreciate the importance of processing techniques	U	F	Class test /Assignment / Quiz

CO4	Characterize different commercial polymers and to understand the significance of recycling	U	C	Class test /Assignment / Quiz
CO5	Develop practical skill in analyzing properties of polymers	Ap	An	viva/ practical skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours	Marks
I	**Introduction to Polymers**		**15**	**32**
	1	Polymers and macromolecules, Monomers, Homo and hetero polymers, Copolymers.	3	
	2	Classification based on origin (natural, semi-synthetic, and synthetic), Synthesis (addition and condensation), Structure (linear, branched chain, and cross-linked) intermolecular forces.	3	
	3	Elastomers, Fibers, Thermoplastics, and Thermosetting polymers, Tacticity.	3	
	4	Types of Polymerization: Chain and step growth polymerizations, Free radical, Ionic, and Coordination polymerizations with mechanism, and its advantages.	4	
	5	Ziegler-Natta polymerization (mechanism expected).	1	
	6	Ring-opening & Group transfer polymerization (Mechanism not needed).	1	
II	**Properties of Polymers**		**10**	**22**
	7	Molecular weights of polymers: Average molecular weights, Number average, Weight average, Sedimentation average (Method of determination not required).	2	
	8	Viscosity average molecular weight, Determination of viscosity average molecular weight.	2	
	9	Polydispersity index and Molecular weight distribution, Molecular weight and Degree of polymerization.	2	
	10	Glass transition temperature, Definition, Factors affecting Tg, Importance of Tg.	2	
	11	Viscoelasticity of polymers (Basic concepts only).	1	
	12	Polymer Degradation: Basic idea of thermal, photo, and oxidative degradation of polymers.	1	
III	**Polymerisation Techniques**		**10**	**22**

	13	Polymerization Techniques: Bulk, Solution, Suspension, Emulsion, Melt, Condensation, and Interfacial polycondensation polymerizations.	5	
	14	Polymer Processing: Calendering, Rotational molding, Compression, Injection molding, Blow molding, and Thermoforming.	5	
IV	**Commercial Ploymers**		**10**	**22**
	15	Commercial Polymers: Preparation, Structure, Properties, and Applications of: Polyolefins (HDPE, LDPE, PP, and PS).	1	
	16	Vinyl polymers (PVC, PVP, and EVA, Saran), Fluoropolymers (Teflon), Acrylic polymers (PAN and PMMA).	1	
	17	Aliphatic polyamides (nylon 66 and nylon 6), Aromatic polyamides (kevlar).	1	
	18	Polyester (terylene), Polycarbonate (lexan), Polyurethanes.	2	
	19	Resins, Glyptal and Formaldehyde resins (UF, MF, and PF).	1	
	20	Rubbers (natural rubber - Vulcanization, EPDM, BR, SBR, Nitrile rubber, Neoprene, Butyl rubber, and Silicone rubber).	2	
	21	Conducting polymers, Doping (conduction mechanism not required).	1	
	22	Pollution due to plastics, Recycling of plastics, Plastic identification code.	1	
V	**Practicals**		30	
	Any Five of the following. 1. Identify everyday plastics by their physical properties 2. Determination of density of polymers 3. Effect of liquid on rubber 4. Determine glass and filler content 5. Determination of total solid content of latex 6. Determination of dry rubber content of latex 7. Determination of alkalinity of latex 8. Determination of KOH number Teacher can suggest determination of other properties of polymers other than mentioned above (Open ended)			

References:

1. Billmeyer Jr., F. W. (2007). *Textbook of Polymer Science.* John Wiley and Sons, New

Delhi.
2. Gowarikar, V. R. (2010). *Polymer Chemistry.* New Age International Pvt. Ltd., New Delhi.
3. Sharma, B. K. (1989). *Polymer Chemistry.* Goel Publishing House, Meerut.
4. Arora, M. G., Singh, M., & Yadav, M. S. (1989). *Polymer Chemistry, 2nd Revised Edn.* Anmolpublications Private Ltd., New Delhi.
5. Saunders, K. J. (1988). *Organic Polymer Chemistry, 2nd Edn.* Chapman and Hall, London.
6. Stevens, M. P. (1998). *Polymer Chemistry: An Introduction, 3rd Edn.* Oxford University Press, USA.
7. Misra, G. S. (1993). *Introductory Polymer Chemistry.* New Age International, New Delhi.
8. Bhatnagar, M. S. (2014). *Polymer Chemistry.* S Chand and Company Pvt. Ltd., New Delhi (Reprint).

Further reading:
1. Seymour, R. B., & Carraher, C. E. (1981). *Polymer Chemistry: An Introduction.* Marcel Dekker, Inc. New York.
2. Odian, G. (2004). *Principles of Polymerization, 4th Edn.* Wiley.
3. Ghosh, P. (1991). *Polymer Science & Technology.* Tata McGraw-Hill Education.
4. Lenz, R. W. (1967). *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York.
5. Stevens, M. P. (1998). *Polymer Chemistry: An Introduction, 3rd Edn.* Oxford University Press.

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

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

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**PERSPECTIVES OF INDUSTRIAL CHEMISTRY**				
Type of Course	**VOCATIONAL MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Elementary ideas of fuel, food, fertilizers, cleansing agents, dyes and cosmetics. 2. Basic understanding of volumetric titrations				
Course Summary	This course details the processes involved in fuel production, manufacturing and chemistry involved in cleansing agents, dyes, cosmetics and various fertilizers and pesticide industries. The course also furnishes practical knowledge about the preparation of the above described products.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Learn the composition and refining processes of crude petroleum and petroleum products	U	F	Instructor-created exams / Group Tutorial Work
CO2	Gain insight into non-petroleum fuels and clean fuels, various lubricants and industrial usage of coal	R	F	Instructor-created exams / Home assignments
CO3	Acquire knowledge in food chemistry which includes an overview on various food additives such as food colours, flavours and artificial sweeteners	U	C	Group Tutorial Work/Seminar
CO4	Analyse the composition and functioning of various cleansing agents, dyes and cosmetics	An	P	Instructor-created exams / Viva
CO5	Analyse the different types of pesticides as insecticides, herbicides, rodenticides and fungicides	An	M	Instructor-created exams / Assignments

CO6	Gain practical skills in some industrially important chemical analyses including test for food adulteration, acid value, ester value and saponification value of oils, TFM of soaps and preparation of some cosmetic products	Ap	P	Practical Assignment / Observation of Practical Skills
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Fuel Chemistry**	**9**	**20**
	1	Review of energy resources (renewable and non-renewable -Clean Energy). Classification of fuels and their calorific value.	2	
	2	Uses of coal (fuel and non fuel) in various industries and its composition	1	
	3	Composition of crude petroleum, Refining and different types of petroleum products and their applications.	1	
	4	Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking)	1	
	5	Elementary ideas on Non-petroleum fuels (CNG, LNG, bio-gas, fuels derived from biomass), clean fuels (wind, solar, tidal)	2	
	6	Lubricants: Solid and semisolid lubricants, synthetic lubricants	2	
II		**Food Chemistry**	**12**	**26**
	7	Food additives: Functional food additives, Food colours-permitted and non permitted – adulteration and Toxicology.	3	
	8	Flavours – natural and synthetic – Soft drinks – formulation. Health drinks.	3	
	9	Artificial sweeteners – Artificial ripening of fruits and its side effects.	1	
	10	Modern Food Habits: Definition and health effects of fast foods, instant foods, dehydrated foods and junk foods. Harmful effects of modern food habits.	3	
	11	Spices: Introduction, (turmeric, chilli, coriander, pepper, cardamom, cloves), general extraction procedure, applications	2	
III		**Cleansing agents, Dyes and Cosmetics**	**18**	**39**
	12	Cleansing Agents: Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) – Cleaning action – Advantages and disadvantages of soaps and detergents	3	
	13	Shaving creams-Ingredients and functions, Shampoos – Different kinds of shampoos (Anti-dandruff, anti-lice, herbal and baby shampoos).	2	

	14	Tooth paste: composition and preparation.	1	
	15	Dyes: Definition – Requirements of a dye – Theories of colour and chemical constitution – Classification based on structure and mode of application to the fabric . Industrial method of dyeing	3	
	16	Cosmetics: Hair dye: Types, chemicals used and its harmful effects.	2	
	17	Face and skin creams: Types, ingredients and functions. Antiperspirants, sun screen, Face and skin powders, nail polishes, lipsticks, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics	3	
	18	Perfumes: Science of smell, history of fragrance, fragrance sources, natural products and aroma chemicals used in fragrances,	2	
	19	Fragrance applications in personal care and household products, safety and regulations of fragrance, emotional and psychological effects of odours.	2	
IV		**Fertilizers and Pesticides**	**6**	**13**
	20	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers	2	
	21	Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers.	2	
	22	Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides	2	
V		**Practical**	**30**	
	1	Test for adulteration in selected food products (5 experiments)	15	
	2	Determination of Acid value, ester value and saponification value of oils, TFM of soaps	7	
	3	Preparation of pain balms, lip balms, soaps, liquid detergent, shampoo, hand sanitizer and disinfectants	8	

Books and References:

1. B.K. Sharma, Industrial Chemistry, Goel Publications (1983).
2. R.K. Das, Industrial Chemistry, Kalyani Publications, New Delhi (1982).
3. G. R. Chatwal, Synthetic Drugs, Himalaya Publishing House, Bombay, 1995.
4. J.Ghosh, A Textbook of Pharmaceutical Chemistry, S. Chand & Co Ltd., 1997
5. B. Sreelakshmi, Food Science, New Age International Pvt. Ltd, New Delhi, 2015
6. D. Swern, Bailey’s Industrial Oil and Fat Products, Vol. I and II, 4th Edn., John Wiley, 1982.
7. A. I. Vogel ‘A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis’: (Third Ed.) (ELBS)

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 2	-	-	-	-	-	2	3	-	2	-	3	2	3
CO 3	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 4	-	-	-	-	-	2	3	-	2	1	3	-	3
CO 5	-	-	-	-	-	2	3	-	2	1	3	-	3
CO 6	-	-	2	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓		✓	

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

BSc CHEMISTRY

<table>
<tr><td>Programme</td><td colspan="5">B.Sc Chemistry</td></tr>
<tr><td>Course Title</td><td colspan="5">COMMERCIAL POLYMERS</td></tr>
<tr><td>Type of Course</td><td colspan="5">VOCATIONAL MINOR</td></tr>
<tr><td>Semester</td><td colspan="5">II</td></tr>
<tr><td>Academic Level</td><td colspan="5">100-199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
<tr><td>4</td><td>3</td><td></td><td>2</td><td>75</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Concept of polymers. Use of polymers. Knowledge on synthetic polymers and their application.</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is intended to provide basic knowledge about commercial polymers. It deals with types, techniques of preparation and characterization of plastics, rubber and fibre materials. The applications of these materials in daily life, engineering and biomedical fields have been emphasized. The students are exposed to the problems of polymer waste management and the strategies developed to minimize plastic pollution.</td></tr>
</table>

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic principles of polymer chemistry, including polymerization mechanisms, molecular structure, and polymer characterization techniques.	U	C	Instructor-created exams / Quiz
CO2	Students should become familiar with the major families of commercial polymers, such as polyethylene, polypropylene, polyvinyl chloride (PVC), polystyrene, polyethylene terephthalate (PET), and others.	R,U	F	Class test /Assignment / Quiz
CO3	Students should gain awareness of the environmental impact of polymers and explore sustainable practices in polymer production, usage, and disposal. They should understand concepts such as biodegradability, recycling, and the development of eco-friendly polymers.	R, U, Ap	F	Class test /Assignment / Quiz

CO4	Students should be able to correlate the molecular structure of thermoplastics with their physical, mechanical, thermal, electrical, and chemical properties. They should understand how these properties influence the selection of thermoplastics for specific applications.	R, U, Ap	C	Class test /Assignment / Quiz
CO5	Students should learn about the synthesis methods and curing mechanisms used for thermosetting polymers, including techniques such as condensation polymerization, addition polymerization, and crosslinking reactions.	R, U	P	Class test /Assignment / Quiz
CO6	Students should be able to classify elastomers based on their chemical structure, polymerization mechanisms, and properties. They should also learn methods for identifying different types of elastomers	R, U	P	Class test /Assignment / Quiz
CO7	Develop practical skill in the preparation of various types of polymers	Ap	P	Viva/ Practical Skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hours	Mark
I		**INTRODUCTION TO COMMERCIAL POLYMERS**	**10**	**22**
	1	Types of polymer (Thermoplastics, Thermosetting polymers, Elastomers, Fibers).	1	
	2	Production Methods, Polymerization, Extrusion, Injection Molding, Blow Molding.	4	
	3	Properties and Applications, Mechanical Properties, Thermal Properties, Chemical Resistance, Electrical Properties, Applications.	3	
	4	Environmental Considerations.	2	
II		**THERMOPLASTICS AND THERMOSETS**	**17 Hrs**	36
	5	Polyolefins and allied polymers, Vinyl polymers, Styrene and its copolymers.	**3**	

	6	Acrylics, Polyamides, Polyesters, PU, Fluoropolymers.	**3**	
	7	Cellulose and its derivatives, Polycarbonates, Polyacetals.	**2**	
	8	PES, PEI, PEEK, Polyacrylic acid, PVA, Polyvinyl Acetals.	**2**	
	9	Thermosetting plastics, Phenol Formaldehyde, Melamine Formaldehyde.	**2**	
	10	Urea Formaldehyde, Epoxy resins, Unsaturated polyester.	**2**	
	11	Vinyl esters, Cyanate esters.	**1**	
	12	Furan resins and Silicone polymers.	**2**	
III	**ELASTOMERS**		**8 Hrs**	**18**
	13	Lignins, Cellulose and its derivatives, Chitin, Chitosan , Source, Properties and Applications.	**2**	
	14	Reclaimed rubber, Reclaiming processes.	**1**	
	15	Elastomers, Natural Rubber, Isoprene rubber, Modified forms of NR- butyl rubber, Nitrile rubber, Chloroprene Rubber.	**2**	
	16	Styrene-Butadiene Rubber, EPDM.	**1**	
	17	Vulcanization, Rubber chemicals, Thermoplastic elastomers.	**2**	
IV	**FIBERS**		**10 Hrs**	**22**
	18	Classification, Sources of fibers, Essential properties of textile fibers.	**1**	
	19	Sources of cellulose, Sources of cellulosic fibers, Sources of synthetic fibers.	**2**	
	20	Fibers formation, Synthesis of monomer, Polymerization and Formation of polymer, Characteristics of fibers formation polymers, Drawing.	**2**	
	21	Fibers structure: Unit cell, Arrangement of chain molecules in the crystallites, Formation and arrangement of crystallites in fibers, Chemical methods.	**3**	
	22	Vegetable fibers, Cellulose, Jute, Flax, Hemp, Ramie, Sisal, Pineapple, Coir.	**2**	
V	**PRACTICAL**		**30**	
		Any Five preparations of the following. 1. Preparation of Glyptal resin 2. Preparation of phenol formaldehyde		

		resin 3. Preparation of urea formaldehyde resin 4. Preparation of aniline formaldehyde resin 5. Preparation of polyaniline 6. Preparation of Nylon 6,6 7. Preparation of PMMA 8. Preparation of linear polystyrene (free radical polymerization) 9. Preparation of crosslinked polystyrene (suspension polymerization) Teacher can suggest preparation of any polymers other than mentioned above (Open ended)		

References

1. Introduction to Polymers" by Robert J. Young and Peter A. Lovell
2. "Handbook of Thermoplastics" edited by Olagoke Olabisi and Kolapo Adewale.
3. "Thermoplastic Materials: Properties, Manufacturing Methods, and Applications" by Christopher C. Ibeh
4. Thermosetting Polymers: Synthesis, Properties, and Applications" edited by Ulf W. Gedde
5. "Thermosets: Structure, Properties, and Applications" edited by Qipeng Guo.
6. Introduction to Thermosetting Plastics" by Syed Qutubuddin and Aftab Ahmed
7. "Elastomers: Types, Properties and Applications" edited by Aubrey Q. Stokes
8. "Rubber Technology Handbook" by Werner Hofmann and Walter Holzwarth
9. "Elastomer Technology Handbook" edited by Jiri George Drobny
10. Textile Fibre Structure" by M.A. Hearle, W.E. Morton, and B.S. Harwood

Mapping of COs with PSOs and POs :

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

CO 5	1	-	-	1	1	1	1	-	1	-	1	-	1
CO 6	2	-	-	2	1	2	2	-	-	-	1	1	1
CO 7	2	-	2	1	1	1	2	-	1	-	-	-	1

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

CO 6	✓	✓		✓
CO 7		✓	✓	

Programme	B. Sc. Chemistry				
Course Title	**INDUSTRIAL POLLUTION AND CONTROL**				
Type of Course	**VOCATIONAL MINOR**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary	The course provides a comprehensive overview of basic concepts of industrial chemistry, Types of chemical industries, various industrial processes, intellectual property right and scope of industrial chemistry.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the adverse effects of emissions from chemical industries and guidelines set by the environmental protection agencies.	U	C	Seminar presentation /Assignment
CO2	Understand the causes and effects of air pollution.	Ap	P	Class test /Quiz /Assignment
CO3	To give an insight to various pollution control measures	An	P	Seminar Presentation / Instructor created exam
CO4	To familiarise waste water treatment methods	U	C	Instructor-created exams / Home Assignments
CO5	Explain different techniques for municipal solid waste and hazardous waste management	Ap	P	Assignment /Seminar presentation /Class test

CO6	Gain practical skills in some industrially important chemical analyses	Ap	P	Lab work /Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**	Marks
I		**Industrial pollution**	**9**	**20**
	1	Types of pollution	**1**	
	2	Types of emissions from chemical industries and effects of environment	**2**	
	3	Environment legislation	**2**	
	4	Effluent guidelines and standards	**2**	
	5	Sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry	**2**	
II		**Air pollution**	**12**	**26**
	6	Definition, Air quality, standards, emission standards, source and classification of air pollutants.	**2**	
	7	Major air pollutants – Oxides of carbon, nitrogen and sulphur	**2**	
	8	Particulates – London smog and photochemical smog	**2**	
	9	Air pollution control measures – Gravitational settling chamber, fabric filter	**2**	
	10	wet scrubber, catalytic converters, stacks and chimneys, cyclone collectors	**2**	
	11	Cottrell electrostatic precipitator, extraction ventilator, zoning and green belt.	**2**	
III		**Water pollution**	**12**	**26**
	12	Water quality parameters: DO, BOD and COD – Determination of BOD and COD	**2**	
	13	Toxic metals in water (Pb, Cd and Hg) – Minamata disaster (a brief study). Control of water pollution – Need for the protection of water bodies.	**2**	
	14	Sewage Treatment: Importance of sewage treatment, broad outline of sewage treatment (preliminary treatment, primary treatment, secondary or biological treatment disinfection	**3**	
	15	Sewage disposal methods of sewage, natural methods (dilution and land treatment)	**3**	

	16	miscellaneous treatments (oxidation ponds, aerated lagoons, oxidation ditch, anaerobic lagoons)	**2**	
IV		**Soil pollution**	**12**	**26**
	17	Soil pollution: Sources by industrial and urban wastes	**2**	
	18	Solid waste management - Sources and generation of solid wastes, their characterization, reduce-reuse-recycle paradigm	**2**	
	19	Chemical composition and classification of solid wastes	**2**	
	20	methods of disposal –sanitary landfill, secured land fill, incineration, pyrolysis, types of composting	**2**	
	21	Hospital waste and hazardous waste, rules regarding solid waste management	**2**	
	22	recycling of waste material, waste minimization technologies.	**2**	
V		1. Water analysis a. Determination of chemical oxygen demand (COD). b. Determination of biological oxygen demand (BOD) c. Estimation of Fluoride, Phosphate, Nitrate, Nitrite and Sulphate 2. Soil analysis a. Determination of TOC. b. Analysis of soil Sulphate. c. Determination of Ca^{2+} and Mg^{2+}	**30**	

References:

1. Rao. C.S., “Environmental Pollution and Control Engineering”, 2nd Edition, Revised, New Age International, 2007
2. Mahajan. S.P., “Pollution Control in Process Industries”, Tata-McGraw Hill, New Delhi, 1985.
3. Narayana Rao, M. and Datta, A.K., “WasteWater Treatment”, 2nd Edition, Oxford and IBH Publications, New Delhi, 2005.
4. Swamy, A.V.N., “Industrial Pollution Control and Engineering”, Galgotia Publications, Hyderabad, 2005.
5. S. K. Banerjee, *Environmental Chemistry*, 2nd Edn., Prentice-Hall of India Pvt. Ltd., New Delhi, 2005.
6. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International
7. N. P Cheremisinoff , *Handbook of Air Pollution Prevention and Control*, 2002.
8. M. Senapati, *Advanced Engineering Chemistry*, 2006.
9. K. C. Schifftner, *Air Pollution Control Equipment Selection Guide*, CRC Press, 2013.

10. K. B. Schnelle, C. A. Brown, *Air Pollution Control Technology Handbook*, CRC Press, 2016.
11. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	-	-	-	1	-	3	-	2	-	3	-	3
CO 2	-	-	-	-	1	-	3	-	2	-	3	-	3
CO 3	-	-	-	-	-	1	3	-	2	-	3	-	3
CO 4	-	-	-	-	-	1	3	-	2	-	3	-	3
CO 5	-	-	-	-	-	1	3	-	2	-	3	-	3
CO 6	-	-	2	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓		✓
CO 4	✓	✓		✓
CO 5		✓	✓	
CO 6	✓			✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**PLASTICS AND FIBER TECHNOLOGY**				
Type of Course	**VOCATIONAL MINOR**				
Semester	**III**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Foundation course in polymer chemistry				
Course Summary	To impart the basic concepts of Mixing and compounding various moulding techniques. Understand about reinforced plastics and fiber technology				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basics of plastic processing and the role of additives in plastics and Describe the principles and techniques involved in mixing and compounding of plastics	U	C	Class test /Assignment / Quiz
CO2	Explain and describe the principles and processes involved in plastic injection molding	R,U	C	Class test /Assignment / Quiz
CO3	Analyze the principles of calendering, laminating, and 3D printing in plastic processing	An	C	Class test /Assignment / Quiz
CO4	Understand the principles, processes involved and equipment used in	U	C	Class test /Assignment / Quiz

	compression molding, transfer molding, blow molding, rotational molding, and reaction injection molding			
CO5	Identify different types of fibers used in industries including cellulose derivatives, polyolefinic, polyester, polyamide, aramid, carbon, and glass fibers.	A	C	Class test /Assignment / Quiz
CO6	Describe fiber spinning operations and the manufacturing process of various types of cords used in the tire industry	U	C	Class test /Assignment / Quiz
CO7	Develop practical skill in different compounding , dipping and molding techniques	Ap	P	viva/ practical skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Mixing and compounding**	**9**	**25**
	1	Introduction to plastic processing, additives for plastics – Fillers, Antioxidants	1	
	2	Stabilisers, Colourants, Flame retardants	2	
	3	Plasticisers. Mixing and compounding of plastics	2	
	4	Mixing and compounding equipments- Compounding by batch mixer	2	
	5	High speed mixer - Two roll mill - Banbury Mixer - Ribbon blender - Planetary mixers	2	
II		**Moulding techniques**	**18**	**25**
	6	Plastic injection moulding, different types of injection moulding machines,	1	
	7	details of injection moulding machine, injection moulding of thermosets.	2	

	8	Extrusion, details of extruders, twin screw extruders, dies, post extrusion processing	2	
	9	Calendaring. Laminating, 3D printing.	4	
	10	Compression moulding: hydraulic presses, press capacity and pressure calculations, moulding process.	1	
	11	Transfer moulding: moulding process and advantages, Blow moulding: extrusion and injection blow moulding.	4	
	12	Rotational moulding: process and equipment.	2	
	13	Reaction injection moulding: introduction, process and advantages.	2	
III		**Reinforced plastics**	**9**	**24**
	14	Reinforced plastics	1	
	15	Processing techniques	2	
	16	Hand lay-up, spray lay up	2	
	17	Filament winding autoclave, Bag moulding	4	
IV		**Fiber technology**	**9**	**24**
	18	Fibers from cellulose and its derivatives	1	
	19	Polyolefinic, polyester, polyamide, aramide	2	
	20	Carbon and glass fibers , Fiber spinning operations	2	
	21	Different types of cords used in tyre industry, definition of denier, tex, tenacity	2	
	22	Different types of twisting, geo textiles	2	
V		**PRACTICALS**	30	
		Any Five experiments from the following can be done 1. Preparation of dispersions of solid latex compounding 2. preparation of emulsions of liquid compounding ingredient 3. preparation of latex compounding for household gloves and finger caps 4. production of finger caps by dipping process 5. production of balloon by dipping process 6. practice production of table mat 7. Hands on training in production of injection moulded plastic articles 8. Hands on training in production of blow moulded plastic articles 9. Hands on training in production of compression moulded plastic articles		

References

1. C. J. Crawford, *Plastic Engineering*, Pergamon Press, London ,1999.

2. D. H. Morton, *Polymer processing*, Chapman and Hall, London, 1989.

3. George Mathews, *Polymer mixing technology*, Applied Science Publishers, London,1982.

4. Joel Frados (Ed) *Plastic Engineering* Hand book, Van Nostrand Reinhold Company, New York, 1976.

5. Polymer Science and Technology,2nd Edn. Joel Fried, Prentice Hall of India Ltd.

6. Text Book of Polymer Science, 3rd Edn. Fred W BillMeyer, JR. Wiley

7. Polymer Science, 3rd Edn. VR Gowariker, NV Viswanathan, Jayadev Sreedhar, New Age International Publishers

8. Polymer Chemistry, Dr BK Sharma, Goel Publishing House.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3		1	2	1	2	3		2	2			3
CO2	3		1	-	-	2	3		2	2			3
CO3	3	-	2	-	-	3	3		3	2			3
CO4	3	-	2		-	2	3		1	2			2
CO5	3		2	-	-	2	2		1	1			3
CO6	3	-	2		-	2	3		1	2			2
CO7	3		3			3	3		3	3		2	3

Correlation Levels:

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

ssessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓
CO7		✓	✓	

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry
Course Title	**INDUSTRIAL QUALITY MANAGEMENT**
Type of Course	**VOCATIONAL MINOR**
Semester	**VIII**
Academic Level	**300 - 399**

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60

Pre-requisites	1. Fundamentals of Quality Management: Familiarity with basic quality management concepts, principles, and methodologies can be beneficial. This includes knowledge of quality standards (e.g., ISO 9001), quality improvement techniques (e.g., Six Sigma, Lean), and quality assurance processes. 2. Problem-Solving Skills: Strong problem-solving and critical thinking skills are crucial for identifying quality issues, analyzing root causes, and developing effective solutions.
Course Summary	To give the students a thorough knowledge about the characteristics, functions and principles of management, administration and management, strategic management process, quality management assistance tools, total quality management tools & techniques, human resource development and management information systems.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Foundational understanding of management principles, functions, theories, and organizational structures, enabling the students to apply this knowledge in practical contexts within various types of organizations.	U	C	Instructor-created exams / Quiz /Assignment
CO2	Students equipped with the knowledge and skills to analyze business environments, formulate effective strategies, evaluate strategic options, and implement strategic plans to achieve organizational success and competitive advantage.	An	C	Class test /Assignment /Quiz

CO3	Able the students to apply quality management principles, tools, and standards to improve processes, enhance product/service quality, meet customer expectations, and ensure organizational excellence.	Ap	P	Assignment/ Class test/Seminar presentation
CO4	Enable the students to apply TQM tools and techniques to improve organizational processes, enhance teamwork, foster customer-centric approaches, and understand the strategic role of HRM in achieving organizational goals and objectives.	Ap	P	Assignments /Seminar presentation
CO5	Have a solid understanding of Management Information Systems, their components, functions, and strategic importance in supporting decision-making, enhancing business processes, and enabling digital transformation in organizations.	U	C	Instructor created exams /Assignment /Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Basic Management**	**11**	**24**
	1	Introduction, Definition and characteristics of management.	1	
	2	Functions of management - Planning, Organising, Staffing, Directing, Coordination, Controlling, Motivating, Communication, Decision Making.	2	
	3	Principles of management – F. W. Taylor, Henry Fayol, Elton Mayo.	2	
	4	Administration and management, Nature of management, levels of management, managerial skills, managerial roles.	3	
	5	Forms of Organization- Line, Line–staff etc. Forms of ownerships – Partnership, Proprietorship, Joint stock, Co-operative society, Govt. Sector etc.	3	
II		**Strategic Management**	**9**	**18**
	6	Concept and Characteristics of strategic management –Defining strategy – Mintzberg’s 5P’s of strategy – Corporate, Business and Functional Levels of strategy.	3	
	7	Strategic Management Process.	1	

	8	Preparing an Environmental Threat and Opportunity Profile (ETOP)	2	
	9	Industry Analysis - Porter's Five Forces Model of competition. BCG Matrix – GE 9 Cell Model -Balanced Scorecard, Generic Competitive Strategies: Low cost, Differentiation, Focus.	3	
III		**Quality Management**	**14**	**28**
	10	Definition of quality, goalpost view of quality, continuous improvement	2	
	11	Types of quality – quality of design, conformance and performance, phases of quality management, Juran and Deming's view of quality	3	
	12	Quality Management Assistance Tools: Ishikawa diagram – Pareto Analysis – Pokka Yoke (Mistake Proofing).	3	
	13	Quality circles, Total Quality Management (TQM), Barriers to TQM, Kaizen, Five S (5S), Six sigma Quality Management Standards – concepts, methodology, principles, applications to manufacturing	3	
	14	The ISO 9001:2000 Quality Management System Standard- The ISO 14001:2004 Environmental Management System Standard- ISO 27001:2005	3	
	15	Information Security Management System	2	
IV		**TQM Tools & Techniques and human resource development**	**14**	**28**
	16	The seven traditional rules of quality, New management rules	2	
	17	Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types	2	
	18	Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal	2	
	19	Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention	4	
	20	Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system.	4	
V		**Management Information Systems**	**12**	
	Open Ended	Concept of data and information, characteristics of information, types of information. Definition of MIS, Need, Purpose and Objectives, Contemporary Approaches to MIS, Components of an information system, need to study information systems, Classification of information systems. Decision-making models, Types of decisions, Decision 3 Support Systems. Introduction to e-		

		commerce, types – B2B, B2C, C2B, C2C etc., Business Process Re-engineering (BPR)		

References:

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6. Kenneth C. Laudon and Jane P. Laudon, "Management Information Systems", 8th Edition, Pearson Education
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8. M.Y. Khan and P. K. Jain, "Financial Management", Tata McGraw Hill, New Delhi
9. Ravi M. Kishore, "Project Management", Tata McGraw Hill, New Delhi
10. Donna C.S., Summers, "Quality Management", 2nd Edition. Prentice Hall, Upper Saddle River, NJ. ISBN-13: 9780135005101.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 2	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 3	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 4	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 5	-	-	-	-	-	2	3	-	2	-	3	-	3
CO 6	-	-	-	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓		✓
CO 4	✓	✓		✓
CO 5		✓	✓	
CO 6	✓			✓

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

Programme	B.Sc Chemistry				
Course Title	**POLYMERS IN INDUSTRY**				
Type of Course	**VOCATIONAL MINOR**				
Semester	**VIII**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4			60
Pre-requisites					
Course Summary	"Polymers in Industry" offers an in-depth exploration of the wide-ranging applications of polymers across various industrial sectors				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students should gain insight into the diverse range of applications and uses of natural fibers across industries such as textiles, apparel, home furnishings, agriculture, packaging, construction, and craft industries	R, U, Ap	C	Class test /Assignment / Quiz
CO2	Students will conduct a comparative environmental analysis between natural and synthetic fibers and they will evaluate the life cycle environmental impacts of both fiber types	Ap,An, E	C,M	Class test /Assignment / Seminar
CO3	Students will become familiar with basic terminology related to adhesives, including terms such as viscosity, cure time, tack, cohesive strength, adhesive failure, and cohesive failure	U	C	Class test /Assignment / Quiz
CO4	Students will explore theories of adhesion, including mechanical interlocking, electrostatic attraction, diffusion, and chemical bonding theories. They will understand how these theories contribute to	U, Ap	C	Class test /Assignment / seminar

	the understanding of adhesive bonding at the molecular level.			
CO5	Students will develop a comprehensive understanding of pigments and paints, including their composition, properties, and applications in various industries such as coatings, plastics, printing, and cosmetics	U, Ap	C	Class test /Assignment / seminar
CO6	Develop a comprehensive understanding of food packaging materials, including conventional materials (e.g., plastics, metals, glass) and emerging edible and biobased materials. They will learn about the properties, functionalities, and applications of different packaging materials in the food industry	R,U	C	Class test /Assignment / Viva
CO7	Develop a thorough understanding of polymers used in biomedical applications, including their chemical structures, properties, and biocompatibility and students will learn about polymer types such as biodegradable polymers, hydrogels, elastomers, and nanocomposites	R,U,Ap	C	Class test /Assignment / seminar
CO8	Students will develop a thorough understanding of the properties of polymers relevant to aerospace applications, including mechanical properties (e.g., strength, stiffness, toughness), thermal properties (e.g., heat resistance, thermal expansion), chemical resistance, and durability in harsh environments (e.g., UV radiation, moisture, space vacuum)	R,U,Ap	C,M	Class test /Assignment / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**Polymers in fiber industry**	**12**	**24**
	1	Harvesting, extraction, processing, and characteristics of natural fibers (cotton, wool, silk, jute, flax).	2	
	2	Application and uses of natural fibers in textiles. Regenerated cellulose fibers-viscose,tencel, cellulose acetate and triacetate (Mention only)	2	
	3	Polyester, nylon, acrylic, polypropylene, polyethylene, acetate, Lycra and their manufacturing processes. Properties and advantages of synthetic 2 fibers.	3	

	4	Comparison with natural fibers in terms of properties and applications. Environmental considerations in synthetic fiber production.	2	
	5	Other fiber forming materials -glass, ceramic, carbon and metal. Innovations in fiber technology. Sustainable practices in textile fibers.	3	
II		**Polymers in adhesives coating**	**15**	**30**
	6	Adhesives-adhesive bonding, advantages-adhesive classification basic terminology, theories of adhesion-wettability	2	
	7	Performance of adhesives - shear, peel and cleavage properties, factors affecting adhesive performance	2	
	8	Design of adhesive joints, selection of adhesives. Structural adhesive, types - epoxy, urethane, acrylic, phenolic and high temperature and PVC plastisol types	2	
	9	Advantages and disadvantages, anaerobic adhesives, cyanoacrylates, hot melt adhesive, pressure sensitive adhesives, silicone adhesives, water based adhesives, inorganic adhesives	2	
	10	Pigments and paints, inorganic pigments & organic pigments, extenders paint preparation factors affecting dispersion, preparation of pigment dispersion	2	
	11	Surface preparation and paint application techniques. Paint properties and their evaluation, mechanism of film formation factors affecting coating properties, methods used for film preparation	3	
	12	Carrier properties, optical properties, ageing properties, rheological properties and adhesion properties of coatings.	2	
III		**PACKAGING APPLICATIONS**	**10**	**22**
	13	Edible and biobased food packaging materials, Edible film and coating,	2	
	14	Polysaccharide based coatings, Lipid based coatings, Protein based coating, First, Second and Third biobased packaging materials.	2	
	15	Permeability of thermoplastic polymers, Multilayer films, Processing, Deteriorative reaction in foods, Enzyme reactions, Chemical reactions,	2	
	16	Physical change, Biological change, shelf life of foods,Factors controlling 2 shelf life.	2	
	17	Packaging of dairy products, Packaging of cereals, snack foods and confectionary,Packaging of beverages, Comparison of polymer packaging with paper, metal and glass materials	2	
IV		**POLYMERS IN BIOMEDICAL APPLICATION**	**11**	**22**

	18	Definition of biomedical Polymers and its classification, Criteria for the Selection of Biomedical Polymers	2	
	19	Properties of biomedical Polymers, : Polymers for biomedical applications– Polymers in dentistry	2	
	20	polymers in Tissue adhesives , Dialysis Membrane	2	
	21	Polymers in Blood oxygenators, Bone cement, Prostheses	2	
	22	polymers in Biodegradable sutures, Control drug delivery systems	3	
V		**POLYMERS IN AEROSPACE APPLICATION**	**12**	
	24	Requirement of polymer characteristics for in space usage, polymers in aerospace applications: thermal blanket, helmet,	4	
	25	polymers in aerospace applications: Adhesive, Space Suits	3	
	26	polymers in aerospace applications: Eelectronic applications, structural applications Important plastics used in Aerospace industry (Thermosetting polyimide, Polyetheretherketone,Polyamide-imide,Polycholrotrifloroethylene,PTFE	2 3	

References

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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	-	1	1	2	3	3		2	1	2	2	3
CO 2	2		2	2	1	1	3	1	2	1	2	3	2
CO 3	3	-	2	-	-	-	3					2	2
CO 4	3	-	2	1	-	-	3					1	1
CO 5	3		1	2	-	-	3		1		1	2	2
CO 6	3	-	1	2	1	1	3		1		2	2	2
CO 7	3			2	2	3	3		2		2	3	3
CO 8	3			3	2	3	3		2		2	3	3

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓
CO7	✓	✓		✓
CO8	✓	✓		

SKILL ENHANCEMENT COURSES

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**CHEMISTRY IN EVERYDAY LIFE**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Fundamental Chemistry 1. Polymers- Natural and synthetic				
Course Summary	This course opens the the vast domain of applied Chemistry for all				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the composition of products used in everyday life	U	F	Instructed created exams, quiz
CO2	To create awareness on the safety regulations of food products	An	C	Seminars
CO3	To gain knowledge on beverages	U	C	Assignment
CO4	To develop environmentally friendly polymers	An	P	Observation of practical skill
CO5	To apply eco-friendly plastic disposal methods	E	P	Exams
CO6	To demonstrate efficient energy storage systems	U	F	Assignment/ppt presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Diary Products and Beverages**		**10**	**20**
	1	Composition of milk and milk products.	2	
	2	Analysis of fat content, minerals in milk and butter.	2	
	3	Estimation of added water in milk.	1	
	4	Beverages: Analysis of caffeine in coffee and tea,	2	
	5	Detection of chicory in coffee	1	
	6	Chloral hydrate in toddy,	1	
	7	Determination of methyl alcohol in alcoholic beverages	1	
II	**Food additives**		**10**	**20**
	8	Food additives – definitions, classification, and function	1	
	9	Antioxidants, Preservatives, Emulsifiers, Stabilizers, sweeteners, thickening agents, chelating agents, curing agents, leavening agents, anti-caking agents, colouring agents	2	
	10	Flavouring agents, stimulants. Functional rule of food additives	2	
	11	Safety and regulations of food additives.	2	
	12	Food allergy and intolerance	2	
	13	Benefits of additives- Side effects of food additives	1	
III	**Polymers**		**10**	**20**
	14	Basic concept of polymer- classification and characteristics of polymers	2	
	15	Applications of polymers as plastics in electronics, automobile components, medical fields and aerospace materials.	3	
	16	Problems of plastic waste management.	2	
	17	Strategies for the development of environment-friendly polymers	3	
IV	**Chemical and Renewable Energy Sources**:		**6**	**10**
	18	Principles and applications of primary & secondary batteries and fuel Cells	3	

	19	Basics of solar energy	3	
V		**Open Ended: (Practical experience may be offered)**	**9**	
		Analysis of milk, beverages Synthesis of a polymer A project on Food labels and the actual contents Review project on solar cells and batteries		

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**CHEMISTRY OF COSMETICS**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Nomenclature of organic compounds 2. Properties of emulsifiers, surfactants etc				
Course Summary	This course explores application of Chemistry in the synthesis of cosmetic products				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the importance of Chemistry in the preparation of cosmetics	U	C	Instructor-exams
CO2	Familiarise the chemical ingredients in cosmetics.	U	C	Assignment /Presentation/Quiz
CO3	Recognise the essential oils and its extraction	Ap	C	Seminar Presentation / Group Tutorial Work
CO4	Evaluate the synthesis methods of cosmetic products	Ap	P	Practical-Synthesis
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Introduction to Cosmetic Chemistry**		**10**	**20**
	1	Overview of Cosmetic Chemistry- Role of Chemistry in Cosmetics-	2	

	2	Cosmetic ingredients-Classification and properties of cosmetic ingredients	2	
	3	Natural and synthetic ingredients-	2	
	4	Active and inactive ingredients is cosmetics	2	
	5	Nomenclature of cosmetic ingredients	4	
II		**Cosemetic Ingrediants**	**10**	**20**
	6	Colours in Cosmetics	2	
	7	Perfumes and fragrance	2	
	8	Surfactants	2	
	10	Polymers and thickners	2	
	11	Cosmetic emulsions	1	
	12	Microbilogical control and preservation of cosmetics	1	
III		**Perfumes and fragrance in Cosmetics**	**8**	**15**
	13	Essential oils and their importance in cosmetic industries with reference to Eugenol, Geranial, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmine, Civet one, Mascon	3	
	14	Essential oils -Peppermint oil, Spearmint oil, Lavender oil, Rosemary oil, Lemon oil, Clove oil	3	
	15	Extraction of essential oils- Distillation, Solvent extraction, enfleurage Method	2	
IV		**Preparation of Cosmetic products**	**8**	**15**
	16	Preparation and uses of – lipsticks and lipbalm	2	
	17	Preparation and uses of shampoo and talcum powder	2	
	18	Preparation and uses of creams-shaving cream, Cold creams, creams for dry skin	2	
	19	Safety Assessment of Ingredients- Regulatory guidelines- Ethics and sustainability in cosmetic Chemistry	2	
V		**Open Ended Module: Mastering Hashing for Efficient Data Handling**	**9**	
	1	1. Data Collection- of ingredients from labels, different brands 2.Preparation of Cosmetic Products- shampoo, lipstick- Evaluating the quality of the synthesised product 3.Visiting a cosmetic Industry- Group Activity		

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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2		✓		✓
CO 3	✓			✓
CO 4			✓	✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ANALYTICAL TECHNIQUES IN WATER QUALITY ASSESSMENT**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	2	-	1	45
Pre-requisites	1. Basic idea on volumetric Analysis 2. Knowledge on Water distribution and water resources				
Course Summary	1. To enable the students to become aware of the water quality standards and to familiarize the methods for analysing water qualities. 2. To make them aware of the impact of water pollution and hence reduce water pollution.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the analytical techniques used in chemistry for water quality monitoring	U	C	Instructor-created exams / problem solving
CO2	Demonstrate the instrumental methods used in water quality monitoring	U	P	Instructor- Created exams/assignment
CO3	Enhancing the knowledge on water purification methods	U	C	Presentation- Peer Teaching
CO4	Demonstrate the procedures for the determination of water quality	Ap	P	Problem solving- Home Assignments
CO5	Acquire skill on the analytical techniques used in water Analysis	Ap	P	Doing practicals
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Analytical techniques in Chemistry**	**8**	**15**
	1	An introduction to analytical methods in chemistry-concentration terms- Molarity, Molality, Normality, v/v, w/v, ppm and ppb, Dilution of solutions, standard solutions	4	
	2	Principles of Volumetric methods in water Analysis- Acid-base titrations, Redox titrations,	2	
	3	complexometric titration and precipitation titrations	2	
II		**Instrumental Methods of Water Analysis**	**9**	18
	4	pH meter, Conductivity meter, Turbibity meter, Flame photometer, Colourimeter,	2	
	5	Atomic absorption spectrophotometer (AAS), GCMS	2	
	6	Ion-selective electrodes, Isotopic analysis	1	
III		**Water Purification**	**9**	**18**
	7	Water resources: ground water and surface water, Importance of water, Water quality- water cycle,	1	
	8	Distribution of water -Water scarcity, Common water quality problems	1	
	9	Potable Water: Pre-treatment, coagulation, filtration, disinfection,	2	
	10	Water storage supply, Demineralization & desalination		
	11	Water softening methods-Lime soda process- Zeolite process, Ion exchange method	2	
	12	Sewage waste water treatment-Primary, Secondary and tertiary treatment & sewage water treatment plants in Kerala	2	
	13	Desalination of brackish water-Electrodialysis-Reverse Osmosis	1	
IV		**Determination of Water quality parameters**	**10**	**19**
	14	Water quality monitoring	1	
	15	Water Quality parameters- Odour, Temperature, Colour, Turbidity, pH, Total Dissolved Solids (TDS), Conductivity-	2	
	16	Experimental methods for the estimation of Alakalinity, Hardness of water	2	
	17	Estimation of anions and cations from dissolved minerals	1	
	18	Experimental methods for the estimation of Biological parameters- DO, BOD, COD, Microbiological parameters,	2	
	19	Water quality standards: drinking water- WHO guidelines- Water quality standards by BIS, IS-10500-2012 on drinking water specification,17482-2020-on drinking water supply management system	2	
IV	**Water Quality Assessment (Open Ended)**		**9**	
	The following water quality assessment may be through hands on training			

	1	Determination of -temperature, pH, conductivity-Instrumental Methods		
	2	Determination of turbidity using Turbidity meter		
	3	Determination of total dissolved solids (TDS)-Gravimetric/Instrumental method		
	4	Determination of carbonate and bicarbonate using titration method (Acidimetry & Alkalimetry),		
	5	Determination of Ca, Mg, Total hardness -Complexometry		
	6	Determination of Ammonia and iron-Colorimetry		
	7	Determination of Dissolved Oxygen (DO)- Winkler's Method-Iodometry		
	8	Determination of Chloride- Argentometry		

References:

1. R. Ramesh & M. Anbu, Chemical methods for Environmental Analysis: Water and Sediment, Madras Macmillan.
2. B.K. Sharma, Instrumental methods of chemical analysis, Krishna Publication Media (P) Ltd. Meerut.
3. S.S. Dara, A Textbook of Environmental Chemistry and Pollution Control, 8th Edition, S. Chand and Sons, New Delhi
4. B.K. Sharma and H. Kaur, Environmental Chemistry, Goel Publishing House, Meerut
5. Water Pollution- causes, effects and control- P K Goel, New age International

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-						
CO 2	2	3	-	-	-	-						
CO 3	-	-	1	-	-	-						
CO 4	-	-	2	3	-	-						
CO 5	-	1	-	-	-	-						

CO 6	-	-	-	3	-	-						

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1		✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5			✓	✓

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**SCIENTIFIC COMMUNICATION, PUBLIC OUTREACH AND ENTREPRENEURIAL SKILLS**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	2	-	1	45
Pre-requisites	1. Foundational knowledge in chemistry: Fundamental of chemical bonding and geometry of molecules, Concept of isomerism, Elements of symmetry of molecules 2. Proficiency in English to comprehend and engage in scientific writing and communication.				
Course Summary	This course equips participants with advanced technical writing skills, effective science communication strategies, and entrepreneurial insights, preparing them for diverse career pathways in the field of chemistry.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Recognize the importance of effective scientific communication in academia and in the society.	U	F	Instructor-created exams / Quiz
CO2	Acquire practical skills for the data presentation using 2D and 3D chemical structures and animations.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Create scientific illustrations, diagrams, and video stories for science communication to the public audience.	C	M	Seminar Presentation
CO4	Comprehend the basics of entrepreneurship in science and identify opportunities in chemistry	Ap	C	Instructor-created exams / Assignments / Presentation
CO5	Apply entrepreneurial thinking in the development of research proposals	An	P	Writing assignments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Science Communication to Public**	**8**	**15**
	1	Importance of effective communication in academia and beyond and different forms of scientific communication	2	
	2	Tailoring Science for Public Audiences and adapting scientific language for non-experts,	2	
	3	Social media strategies for scientists, Science Journalism, Content Writing.	2	
	4	Interactive Public Presentations	1	
	5	Techniques for effective public speaking	1	
II		**Technical skills for Academic Writing**	**9**	**18**
	6	Structure and organization of scientific articles,	2	
	7	Paper formatting using MS Office, writing chemical equations and formulas, Understanding citation styles, reference management software	3	
	8	AI tools for literature review, content development, editing and data analysis.	2	
	9	Issues in scientific writing (plagiarism, authorship, ghostwriting, reproducible research).	2	
III		**Entrepreneurial Skills for Scientists**	**9**	**18**
	10	Introduction to Entrepreneurship in Science, identifying opportunities for entrepreneurship in chemistry	2	
	11	Basics of intellectual property rights, Understanding the patenting process	4	
	12	Overview of funding sources for entrepreneurial ventures, strategies for successful grant applications	3	
IV		**Practical: Technical skills for Academic Writing**	**10**	**19**
	13	Presentation of data in tables, figures and plots using excel / google sheet and using equations and functions in excel	1	
	14	Drawing 2D chemical structures using ChemSketch or Chemdraw	1	
	15	Creating 3D models of chemical structures for presentations and publications using Avogadro and JMOL; designing 3D molecular structures, measurement of bond length, bond angles and dihedral angles,	2	
	16	Visualizing atomic and molecular orbitals and analyse geometric and conformational isomers using JMOL	2	
	17	Exploring crystal structures, unit cell and symmetry operations in molecules using JMOL	1	
	18	Exploring the structure of protein and nucleic acid using JMOL	1	

	19	Creating scientific illustrations and diagrams (Inkscape, canva), video stories to communicate scientific information (Openshot, Kdenlive),	2	
V		**Open Ended: Practical Application and Project Work**	**9**	
	1	Case studies of successful scientific entrepreneurs	3	
	2	Public Communication Simulation: Role-playing scenarios for engaging with the public and media	2	
	3	Entrepreneurial Pitch Practice: Crafting and presenting a pitch for a scientific entrepreneurial idea	2	
	4	Writing and Presenting a Mock Research Proposal: Students develop a proposal integrating academic writing and entrepreneurial concepts	2	

Reference

1. Communication: A Practical Guide for Scientists, Laura Bowater, Kay Yeoman, Wiley-Blackwell, 2012

2. Robinson, M. S.; Stoller, F. L.; Costanza-Robinson, M. S.; Jones, J. K. Write Like a Chemist; Oxford University Press: New York, 2008.

3. Kovac, J. Write Like a Chemist: A Guide and Resource (Marin S. Robinson, Fredericka L. Stoller, Molly S. Costanza-Robinson, and James K. Jones). J. Chem. Educ. 2009, 86, 170.

4. Kelly, Kristine. “Translating Science: From Academia to Mass Media to the Public.” In Taking Science to the People: A Communication Primer for Scientists and Engineers." University of Nebraska Press, 2010. ISBN: 9780803220522.

5. Avogadro software tutorial: https://avogadro.cc/docs/

6. Jmol Tutorial: https://wiki.jmol.org/index.php/Jmol_Tutorials

7. Communicating Science with social media: https://medium.com/communicating-science-with-social-media

8. Janet R. Morrow, Should You Become a Chemist Entrepreneur? Inorg. Chem. 2021, 60, 23, 17415–17418

9. Law Relating to Intellectual Property Rights, V K Ahuja, Lexis Nexis, 2017

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1				2				3				3	3
CO 2				2				3				3	3
CO 3				1				3				2	3
CO 4				2				3				3	3
CO 5				2				3				3	3
CO 6				1				3				3	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Assignment (20%)
- Presentation (20%)
- Final Exam (40%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Presentation	End Semester Examinations
CO 1	✓			✓
CO 2		✓	✓	
CO 3		✓	✓	
CO 4	✓			✓
CO 5		✓	✓	

VALUE ADDED COURSES

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

BSc CHEMISTRY

Programme	B.Sc Chemistry
Course Title	**CHEMISTRY OF CONSUMER PRODUCTS**
Type of Course	**VALUE ADDED COURSE (VAC)**
Semester	**III**
Academic Level	**100-199**

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45

Pre-requisites	Fundamentals of organic chemistry Foundations of analytical chemistry
Course Summary	This course delves into the scientific principles behind everyday items such as soaps, detergents, shampoos, and cosmetics. Students learn about the chemistry of manufacturing, formulation techniques, and quality control procedures. Topics include how ingredients like linear alkyl benzene and sodium lauryl sulfate are synthesized, as well as the creation of specialized products like anti-dandruff shampoos and herbal soaps. Environmental impact and regulatory compliance are also covered. Through theory and practical lab work, students gain a solid understanding of the chemistry driving these commonly used consumer goods.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the process of making soaps from oils and fats, including the formulation of different types like herbal and medicated soaps.	U	C	Instructor-created exams / Quiz
CO2	Identify the ingredients and functions used in detergent production, comparing their effectiveness with traditional soap.	U	F	Class test /Assignment / Quiz
CO3	Understand the components in anti-dandruff and herbal shampoo, and their safety standards.	U	F	Class test /Assignment / Quiz

CO4	Analyze cosmetic preparation ingredients and functions to ensure the production of safe and effective products like face creams and nail polishes.	An	C	Class test /Assignment / Quiz
CO5	Evaluate the environmental impact of consumer products, proposing sustainable practices to minimize harm.	E	C	Class test /Assignment / Quiz
CO6	Analyze the need for innovative solutions to challenges in consumer product chemistry, fostering creativity and improvement in the industry.	An	F	Class test /Assignment / Quiz
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs (45)	Marks
I		**Soaps**	**9**	**18**
	1	Saponification of oils and fats. Manufacture of soaps.	1	
	2	Formulation of toilet soaps. Different ingredients used and their functions.	2	
	3	Medicated soaps. Herbal soaps. Mechanism of action of soap.	2	
	4	Soft soaps. Shaving soaps and creams.	2	
	5	ISI specifications of soaps and creams. Testing procedures/limits.	2	
II		**Detergents**	**9**	**18**
	6	Types of Detergents. Anionic detergents: Manufacture of LAB (linear alkyl benzene). Sulphonation of LAB – preparation of acid slurry.	**1**	
	7	Different ingredients in the formulation of detergent powders and soaps. Liquid detergents. Foam boosters. AOS (Alpha Olefin Sulphonates)	**2**	
	8	Cationic detergents: examples. Manufacture and application. Non-ionic detergents: examples. Manufacture of ethylene oxide condensater.	**2**	
	9	Mechanism of action of detergents. Comparison of soaps and detergents.	**2**	
	10	Biodegradation – environmental effects. ISI specifications / limits for detergents.	**2**	
III		**Shampoos**	**8**	**15**
	11	Manufacture of SLS and SLES. Ingredients. Functions.	**2**	
	12	Different kinds of shampoos – anti-dandruff, anti-lice, herbal and baby shampoos.	**2**	

	13	Hair dye. Manufacture of conditioners. Coco betaines or coco diethanolamides	**2**	
	14	ISI specifications for shampoos. Testing procedures and limits.	**2**	
IV		**Cosmetic Preparations**	**10**	**19**
	15	Face and skin powders. Ingredients, functions. Different types.	**2**	
	16	Snows and face creams. Chemical ingredients used. Anti perspirants. Sun screen preparations.	**2**	
	17	UV absorbers. Skin bleaching agents. Depilatories. Turmeric and Neem preparations. Vitamin oil.	**2**	
	18	Nail polishes: nail polish preparation, nail polish removers. Article removers.	**2**	
	19	Lipsticks, roughes, eyebrow pencils. Ingredients and functions. Hazards of cosmetic preparations. ISI specifications.	**2**	
IV	UNIT- V	**Open Ended:** Leading firms, brand names, choosing the right product. Packing regulations. Marketing. Licensing – drug license – legal aspects. GMP – ISO 9000/12000 – consumer education. Evaluation of the product – advertisements. Visit to a cosmetic production facility	**9**	

References

1. Gobala Rao.S , Outlines of chemical technology, Affiliated East West press,1998
2. Kafaro, Wasteless chemical processing, Mir publishers, 1995.
3. Sawyer.W, Experimental cosmetics,Dover publishers, New york, 2000.
4. Ayaz Mahmood Dar, Cosmetic Chemistry: An Instant Approach. Educreation Publishing, 2011.
5. P. K. Chattopadhyay, Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, NIIR Board publication.

Mapping of COs with PSOs and Pos

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

5													
CO 6	1		2	1		2	1					2	2

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

	Internal Theory	Assignment / Viva	End Semester Examination
CO1	✓	✓	✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓
CO6	✓	✓	✓

Programme	B.Sc Chemistry				
Course Title	**SOLID WASTE MANAGEMENT**				
Type of Course	**VALUE ADDED COURSE (VAC)**				
Semester	**IV**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Fundamental knowledge of chemistry Chemical processes that occur in the environment, including those related to pollution Basic understanding of environmental chemistry and the impact of solid waste on ecosystems and human health				
Course Summary	This course provides an overview of solid waste management principles, practices, and policies. It covers the generation, collection, transportation, and disposal of solid waste, with a focus on sustainable waste management strategies. The course includes a discussion of waste management strategies for promoting waste reduction, reuse, and recycling. Through this course, the students can explore best practices for sustainable waste management, including waste minimization, source separation, and the global standards for waste management.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To describe the concept of solid waste and its various components.	U	C	Instructor-created exams / Quiz
CO2	To Explore Solid Waste Collection Systems and to compare different methods of solid waste collection	U	F	Class test /Assignment / Quiz

CO3	To Comprehend waste reduction principles and waste management standards	U	F	Class test /Assignment / Quiz
CO4	To Master the different processing techniques of solid waste	U	C	Class test /Assignment / Quiz
CO5	To understand the basic principles involved in the Land disposal of Solid waste, and its merits and drawbacks.	U	C	Class test /Assignment / Quiz
CO6	To familiarize common solid waste treatment technologies like composting, recycling, and incineration	U	F	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs	Mark
I		**Solid waste**	**9**	**18**
	1	Solid waste: Definition, overview of solid waste management, types of solid wastes	2	
	2	sources of solid wastes, properties of solid wastes, Factors affecting the type and quality of waste	2	
	3	causes of solid waste generation, associated risks of solid wastes	2	
	4	Physical and chemical composition of municipal solid waste,	2	
	5	hierarchy of waste management options.	1	
II		**Collection, Transportation, and Processing of Solid waste**	**12**	**23**
	6	Key components of solid waste management: Generation, storage (containers), collection	1	
	7	Specialized collection programs (hazardous waste, bulky waste) and transportation (human powered, animal powered and motorized)	2	
	8	Recycling and resource recovery, layout of routes	1	
	9	Methods of handling and processing of solid wastes: separation, screening,	**1**	
	10	size reduction, densification, baling, cubing, compaction, and pelleting	**3**	
	11	Waste reduction hierarchy (3R Principle - reduce, reuse, recycle).	**2**	

	12	Compliance assessment and certification processes, Overview of waste management standards - ISO 14001, OHSAS 18001	**2**	
III		**Unit-3: Land disposal of Solid waste**	**7**	**14**
	13	Landfilling: Site selection criteria, landfill layout, landfill sections,	**2**	
	14	Occurrence of gases and leachate in landfills: composition and characteristics,	**2**	
	15	generation factors, initial adjustment phase, transition phase, acid formation phase, methane formation phase, maturation phase of gases and leachate,	**2**	
	16	advantages and disadvantages of Land disposal of Solid waste	**1**	
IV	**Unit-4**	**Composting and Thermal treatment**	**8**	**15**
	17	Composting: definition, types, process description, design and operational consideration of aerobic composting;	**2**	
	18	process. Description, design and operational consideration of anaerobic composting; Vermicomposting;	**3**	
	19	Thermal conversion methods: incineration/combustion, pyrolysis and gasification, energy recovery system	**3**	
V	Open Ended	**Open-ended experiments - Suggestions** Biomedical and E-waste management, Case study etc.	**9**	

References

1. Gupta O.P, Elements of Solid Hazardous Waste Management, Khanna Book Publishing Co., Delhi Ed. 2018
2. Bhide, A. D., Solid Waste Management, Indian National Scientific Documentation Centre, New Delhi.
3. George Techobanoglous, Kreith, Frank., Solid Waste, McGraw Hill Publication, New Delhi.
4. Sasikumar, K., Solid Waste Management, PHI learning, Delhi.
5. Hosetti, B.B., Prospect and Perspectives of Solid Waste Management, New Age International Publisher.

Mapping of COs with PSOs and POs

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

Correlation Levels :

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics

	Internal Theory	Assignment / Viva	End Semester Examination
CO1	✓	✓	✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓
CO6	✓	✓	✓

MULTI-DISCIPLINARY COURSES

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ENVIRONMENTAL CHEMISTRY**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	What is Environment. Basic idea of environmental pollution.				
Course Summary	This course ensures that the students acquire a profound knowledge and understanding on environmental pollution and the necessity of controlling environmental pollution.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Acquire the knowledge on ecosystem.	**U**	**C**	Instructor-created exams / Quiz
CO2	Recall the technical/scientific terms involved in pollution.	U	C	Instructor-created exams / Quiz
CO3	Recognize different types of toxic substances that cause environmental pollution.	U	C	Instructor-created exams / Assignment
CO4	Understand the effects of environmental pollution.	U	C	Seminar Presentation / Viva
CO5	Understand various pollution control measures.	U	C	Instructor-created exams / Quiz
CO6	Discuss and report local and global environmental issues based on the knowledge gained throughout the course.	Ap	P	Group discussion and Seminar presentation/Viva

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

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**Introduction to Environmental Chemistry**	**9**	**18**
	1	Environmental segments-Atmosphere, Hydrosphere, Lithosphere, Biosphere	2	
	2	Interaction between different environmental spheres Concept of ecosystem, abiotic and biotic components	2	
	3	Composition of Air, Water and Soil	2	
	4	Environmental pollution – Concepts and definition – Pollutant, contaminant, receptor and sink	1	
	5	Classification of pollutants – Global, regional, local, persistent and non-persistent pollutants.	1	
	6	Types of pollution	1	
II		**Air Pollution**	**9**	**18**
	7	Tropospheric pollution – Gaseous air pollutants – Hydrocarbons, oxides of sulphur, nitrogen and carbon (Elementary idea only)	2	
	8	Global warming, green house effect, acid rain	1	
	9	Particulates – Smog: London smog and photochemical smog –	2	
	10	stratospheric pollution - depletion of ozone layer, chlorofluorocarbons - Automobile pollution.	2	
	11	Control of air pollution	2	
III		**Water Pollution**	**10**	**20**
	12	Impurities in water – cause of pollution – natural and anthropogenic – Marine water pollution – Underground water pollution.	1	
	13	Source of water pollution – Industrial waste, Municipal waste, Agricultural waste, Radioactive waste, Petroleum, Pharmaceutical, heavy metal, pesticides, soaps and detergents.	2	
	14	Types of water pollutants: Biological agents, physical agents and chemical agents – Eutrophication- biomagnification and bioaccumulation.	2	
	15	Water quality parameters: DO, BOD, COD, alkalianity, hardness, chloride, fluoride and nitrate. Toxic metals in water and their effects: Cadmium, lead and oil pollution in water.	3	
	16	Water pollution control methods	2	

IV	**Soil, Thermal, and Radioactive Pollutions**		**8**	**14**
	18	Soil pollution: Sources by industrial and urban wastes. Non-degradable, degradable and biodegradable wastes. Hazardous waste.	2	
	19	Pollution due to plastics, pesticides, biomedical waste and *e-waste* (source, effects and control measures) – Control of soil pollution - Solid waste Management – Open dumping, Landfilling, Incineration, Re-use, reclamation, recycle, composting.	3	
	20	Thermal pollution – definition,sources, harmful effects and prevention.	1	
	21	Radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study).	2	
V	**Open Ended Module: Environmental issues**		**9**	
	1	Environment and society Pollution case studies: Chernobyl disaster, Bhopal tragedy, Endosulfan disaster in Kerala (brief study) etc.		

References

1. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International.
2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
3. Balram Pani,*Textbook of Environmental Chemistry*, I. K. International Pvt Ltd, 2010.
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5. V.N. Bashkin, *Environmental Chemistry: Asian Lessons*, Springer Science & Business Media, 2003.
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9. P. K. Goel,*Water Pollution: Causes, Effects and Control*,New Age International, 2006.
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Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/viva	Quiz/seminar/ Goupdiscussion	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓
CO 3	✓	✓		✓
CO 4		✓	✓	✓
CO 5	✓		✓	✓
CO 6		✓	✓	

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

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**CHEMISTRY IN DAILY LIFE**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Role of chemicals in or life. Basic idea of environmental pollution.				
Course Summary	This course ensures that the students acquire a profound knowledge and understanding on chemicals that are used in daily life.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	*Know the different chemicals that sustain our life*	**U**	**C**	Instructor-created exams / Quiz
CO2	*Understand the role of chemistry in forensic analysis.*	U	C	Instructor-created exams / Seminar
CO3	*Understand the application of chemistry in agriculture and need of green methods*	U	C	Instructor-created exams /Assignment
CO4	*Understand the chemistry of soaps, synthetic detergents and their environmental effects.*	U	C	Instructor-created exams / Seminar
CO5	*Understand the chemistry of cosmetics and the effect on health.*	U	C	Instructor-created exams / Quiz

CO6	*Understand the chemistry of drugs,food additives their action and possible side effects*	U	C	Seminar/Viva
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Chemistry in Biological Systems & Forensic Chemistry**	**12**	**22**
	1	Vitamins and Minerals: Name, source, function and deficiency diseases.	2	
	2	Enzymes - Classifications, characteristics, examples.	1	
	3	Hormones - Sex hormones - example, function. Pheromones.	2	
	4	Brain chemicals and human mood variations	1	
	5	General discussion of poisons with special reference to mode of action of cyanide, organophosphates and snake venom.	2	
	6	Detection of finger print, blood stain, semen, Breath analyzer	2	
	7	Sport doping-Steroids-Anabolic agents, Stimulants, Diuretics	2	
II		**Chemistry and Agriculture**	**6**	**12**
	8	Essential nutrients for plants – NPK value Chemical composition of soil, Soil enrichment	1	
	9	Fertilizers- natural, synthetic, mixed, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers.	2	
	10	Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides	2	
	11	Pesticide pollution and its impact on environment – Endosulfan disaster in Kerala (brief study).	1	
III		**Cleansing agents and cosmetics**	**9**	**18**
	12	Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) – Cleaning action – Advantages and disadvantages of soaps and detergents –	3	
	13	Shampoos: Ingredients and functions – Different kinds of shampoos (Antidandruff, anti-lice, herbal and baby shampoos).	1	
	14	Tooth paste: Composition and health effects. Hair dye: Chemicals used and its harmful effects.	1	
	15	Face and skin powders: Types, ingredients and functions. Cleansing creams: Cold creams, vanishing creams and bleach creams.	2	

	16	Perfumes, antiperspirants, sun screen preparations, nail polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics.	2	
IV		**Pharmaceuticals and Dyes**	**9**	**18**
	17	Drug: Chemical name, generic name and trade names with examples.	1	
	18	Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	19	Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).	2	
	20	Dyes: classification based on constitution, application, examples, uses.	2	
	21	Dyes: Requirements of a dye – Classification based on mode of application to the fabric –	1	
	22	Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin.	1	
V		**Food Chemistry (OPEN ENDED)**	**9**	
	23	Common adulterants Food Additives: Artificial sweeteners – Taste enhancers Artificial ripening of fruits and its side effects. Modern Food Habits:		

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CO 6		✓	✓	

UNIVERSITY OF CALICUT FIRST SEMESTER EXAMINATION INORGANIC CHEMISTRY I CHE1CJ101	
Maximum Marks: 70	**Duration : 2 hours**

SECTION A (Short Answer)
Overall Ceiling 24
Answer all. Each question carry 3 marks

1.	Explain the involvement of chemistry in daily life with examples?
2.	What do the terms absolute error and relative error mean with regard to analytical determinations?
3.	Distinguish between the terms electronegativity and electron affinity? Explain their variation along a period and down a group?
4.	Discuss the characteristics of ionic compounds and explain the factors affecting the formation of ionic bond?
5.	AgCl is sparingly soluble in water while NaCl is soluble. Comment on this from lattice energy considerations?
6.	Differentiate top-down and bottom-up approaches for the synthesis of nanomaterials?
7.	Explain the significance of surface area to volume ratio in nanomaterial. Provide examples of how this ratio impacts the properties of nanomaterials?
8.	Discuss the application of nanomaterials in electronics?
9.	Discuss the importance of primary and secondary standards in volumetric analysis, providing examples of each?
10.	Critically evaluate the advantages and limitations of the Double burette method of titration compared to other titration techniques?

8x3= 24 Marks

SECTION B (Paragraph)
Overall Ceiling 36
Answer all. Each question carry 6 marks

11.	Explain the difference between accuracy and precision in analytical chemistry? Provide examples to illustrate each concept?
12.	Describe the term standard deviation with respect to analytical determination?

13.	Discuss the concept of isoelectronic species in the context of atomic and ionic radii. How does the nuclear charge affect the size of isoelectronic species?
14.	Discuss the conditions which favour covalent character in ionic compounds?
15.	Compare the bond length, bond energy and magnetic behavior of O_2, O_2^{+}, O_2^{2+}, $O_2^{-}$and O_2^{2-} with the help of Molecular Orbital Theory?
16.	Explain the classification of nanomaterials based on electron confinement?
17.	Explain the significance and applications of nanoparticles such as gold and silver nanoparticles in nanomaterials. How do size-dependent properties play a crucial role in their applications?
18.	Describe the safety measures and precautions that should be followed in a chemical laboratory. Discuss the importance of using Personal Protective Equipment (PPE) and handling hazardous chemicals safely?
	6x6= 36 Marks
	SECTION C (Essay) **Answer any one**
19.	Discuss Born-Haber cycle for NaCl? What are the applications of Born-Haber cycle?
20.	Briefly explain theory of adsorption and complexometric indicators?
	1x10= 10 Marks

UNIVERSITY OF CALICUT

FYUGP CHEMISTRY

FIRST SEMESTER EXAMINATION

CHE1MN101

BASIC INORGANIC AND NANOCHEMISTRY

Maximum Marks: 70	**Duration : 2 hours**

SECTION A (Short Answer)

Overall Ceiling 24

Answer all. Each question carry 3 marks

1.	Discuss the concept of orbit and orbital, highlighting the two major differences between them
2.	Explain the significance of quantum numbers in atomic structure
3.	Differentiate between ionic bond and covalent providing an example for each type
4.	Discuss the Law of Triads and its significance in early attempts to classify elements
5.	Elaborate on the Pauli's Exclusion Principle and how it influences the electron configuration of atoms
6.	Explain the basic principles involved in complexometric titration.
7.	Differentiate between Accuracy & Precision
8.	Discuss Top-down processes and Bottom-up processes for the Synthesis of nanomaterials
9.	Compare Fullerenes and graphene
10.	Summarise the merits of Bohr Atom model

8x3= 24 Marks

SECTION B (Paragraph)

Overall Ceiling 36

Answer all. Each question carry 6 marks

11.	Explain the shape of $BeCl_2$, IF_7, and XeF_2 using VSEPR theory
12.	Explain bond order. How is it calculated? Give the significance of the bond order to explain the bond strength and bond length of a molecule
13.	Illustrate with suitable equation – a) Molarity b) Mole fraction c) Normality
14.	Explain solubility product and its applications in qualitative analysis
15.	Discuss the significance of periodic properties in the modern periodic table and how Ionic radii, Electron affinity, and Oxidation number vary across periods and groups.
16.	Demonstrate the classification of nanomaterials based on dimension with one example for each.

17.	Describe any two methods to synthesis Carbon nanotubes
18.	Discuss the important properties of carbon nanotubes
	6x6= 36 Marks
	SECTION C (Essay) **Answer any one**
19.	Compare VB theory and MO theory
20.	Describe the principles involved in the separation of cations in qualitative analysis
	1x10= 10 Marks

UNIVERSITY OF CALICUT

FIRST SEMESTER EXAMINATION

ENVIRONMENTAL CHEMISTRY
CHE1FM105

Maximum Marks: 50	**Duration : 1 Hour 30 Min**

SECTION A (Short Answer)
Overall Ceiling 16
Answer all. Each question carry 2 marks

1.	Explain the concept of ecosystem and discuss the abiotic and biotic components involved in an ecosystem?
2.	Describe the different types of pollutants based on their persistence and scale of impact on the environment?
3.	Illustrate the concept of global warming and its relationship with the greenhouse effect?
4.	Critically evaluate the role of chlorofluorocarbons (CFCs) in the depletion of the Ozone layer and propose solutions to address this environment issue?
5.	Discuss the different types of water pollutants based on their classification as biological, physical, or chemical agents. Provide examples for each type?
6.	Explain the consequences of water pollution caused by soaps and detergents?
7.	Explain the role of DO (dissolved oxygen) in determining water quality ?
8.	Explain the term soil pollution and detail the sources and effects of hazardous waste on soil?
9.	Evaluate the impact of thermal pollution on the environment and suggest preventive measures to control it?
10.	Discuss hazards associated with radioactive pollution?

8x2= 16 Marks

SECTION B (Paragraph)
Overall Ceiling 24
Answer all. Each question carry 6 marks

11.	Discuss different regions of atmosphere?
12.	Explain the terms pollutant, contaminant, receptor and sink with suitable examples?
13.	Discuss the detrimental effects of pollution caused by oxides of Nitrogen and Sulphur?
14.	Explain acid rain and its impacts on the environment?
15.	Evaluate two methods for soil waste management?

4x6= 24 Marks

SECTION C (Essay) Answer any one	
16.	(a) Explain the difference between primary and secondary pollutants in the context of air pollution. provides specific examples of each type of pollutant? (b) How can we control air Pollution?
17.	(a)Differentiate between biomagnification and bioaccumulation in water ecosystems. Provide examples to illustrate each concept. (b) Discuss the concept of Eutrophication
	1x10= 10 Marks