Annamalai University

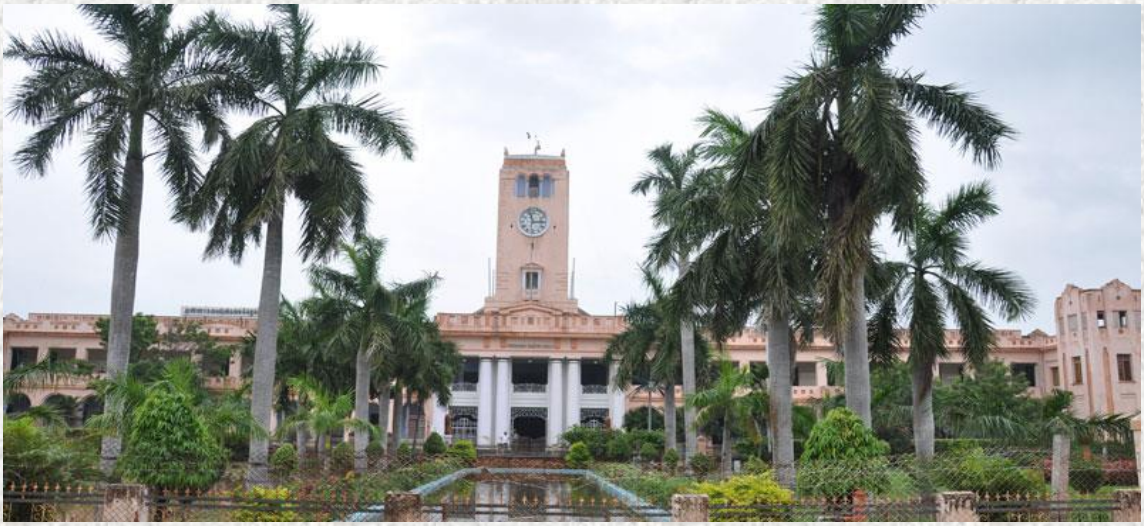
(Accredited with 'A' Grade by NAAC)

Faculty of Science

DEPARTMENT OF CHEMISTRY

M.Sc CHEMISTRY (TWO-YEAR)

Programme Code: SCHE21



Regulations, Curricula and Syllabus
2019-2020

M.Sc. CHEMISTRY (TWO YEAR)

Programme Code: SCHE21

These regulations are common to all the students admitted to the **Two Year Master Programme** in the **Faculty of Science** from the Academic Year 2019 – 2020.

1 Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/ Laboratory /Seminar/Project work/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Core Course** is mandatory and an essential requirement to qualify for the Degree.

1.12 **Elective Course** is a course that a student can choose from a range of alternatives.

1.13 **Value-added Courses** are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.15 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.16 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 **Learning Objectives** are statements that define the expected goal of a course in

Course Objectives in terms of demonstrable skills or knowledge that will be acquired by a student.

1.19 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters to the sum of the total credits of all courses in all the semesters is given in section 11.4.

1.22 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2 Programme Offered and Eligibility Criteria:

Faculty of Science	
M.Sc. Chemistry	**A pass in B.Sc. Chemistry, B.Sc. Applied Chemistry or B.Sc. Industrial Chemistry with not less than 50% of marks in Part–III.**

In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for the above Programme**.**

3 **Reservation Policy:** Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4 Programme Duration

4.1 The Two Year Master's Programme consists of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5 Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), Value Added Course and Project.

5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 Departmental Electives (DEs) are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2 Interdepartmental Electives (IDEs) are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties. IDEs are listed in the Hand Book which is available in the University website.

5.4 Experiential Learning

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2 In-plant training/field trips/internships/industrial visits fall under this category.

5.5 Project

5.5.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value Added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction. Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semester.

5.7 Online Courses

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 Credit Distribution: The credit distribution is organized as follows:

SEMESTER I to IV	Credits
Core Courses	72
Elective Courses	15
Project	06
Constitution of India	02*
Total	93

5.9 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester

1 Practical/Project period of two hours duration per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

8.4.2 The students will be informed in advance about the assessment procedures.

8.4.3 The question paper will be set by the respective course teacher using Bloom Taxonomy.

8.4.4 CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5 CIA Tests will be for one or two hours duration depending on the quantum of syllabus.

8.4.6 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the course teacher in consultation with the Head of the Department.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.

8.5.2 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses and project work, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will carry 40% and the ESE 60% of the marks.

9.2 Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Teacher.

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	15
Test-II	15
Record	10
Total	40

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by Internal examiners.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project work will consist of a Review of literature survey, experimentation/ field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
Review- I: 10	Review- II: 15	Project / Dissertation Evaluation	Viva-voce
		50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than **50% marks** in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 **GPA** is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

11.4 **CGPA** is the Weighted average Grade Point of all the Courses passed starting from the first semester to the current semester,

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;G_i is the Grade Point obtained by the student for the Course i and n is the number of Courses passed in that semester, m is the number of semesters.

11.5 Evaluation:

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	Classification of Final Result
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0 and above but below 5.0	Re-appear

11.6 Classification of Results. The successful candidates are classified as follows:

11.6.1 **For First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25 and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2 **For First Class:** Candidates who have passed all the courses with a CGPA of 6.5 and above.

11.6.3 **For Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain overall highest CGPA in all examinations in the First Appearance Itself are eligible for **University Rank.**

11.7 Course-Wise Letter Grades

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade sheet of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the

student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days' notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. Academic misconduct: Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. Transitory Regulations: Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

M.Sc. Chemistry (Two Year) Programme
Programme Code: SCHE21
Curricula and Scheme of Examination
(For students admitted from the academic year 2019-2020)

Course Code	Course Title	L	P	C	CIA	ESE	Total
FIRST SEMESTER							
19CHEC101	Core 1:Organic Reaction Mechanisms	4		4	25	75	100
19CHEC102	Core 2:Coordination Chemistry and Inorganic Reaction Mechanisms	4		4	25	75	100
19CHEC103	Core 3:Chemical Thermodynamics, Photochemistry and Group Theory	4		4	25	75	100
19CHEP104	Core 4:Organic Chemistry Practical- I		6	3	40	60	100
19CHEP105	Core 5:Physical Chemistry Practical- I		6	3	40	60	100
	Elective 1: Interdepartmental Elective	3		3	25	75	100
				21			
SECOND SEMESTER							
19CHEC201	Core 1:Organic Photochemistry and Molecular Rearrangements	4		4	25	75	100
19CHEC202	Core 2:Solid State and Organometallic Chemistry	4		4	25	75	100
19CHEC203	Core 3:Chemical Kinetics and Quantum Mechanics	4		4	25	75	100
19CHEP204	Core 4:Organic Chemistry Practical–II		6	3	40	60	100
19CHEP205	Core 5:Inorganic Chemistry Practical–I		6	3	40	60	100
	Elective 2: Interdepartmental Elective	3		3	25	75	100
19CHEE20X	Elective 3: Department Elective	3		3	25	75	100
				24			
THIRD SEMESTER							
19CHEC301	Core 1:Synthetic Organic Chemistry	4		4	25	75	100
19CHEC302	Core 2:Green Chemistry, Computational Chemistry, Drug Design and Spectroscopy	4		4	25	75	100
19CHEC303	Core 3:Spectral and Analytical Techniques	4		4	25	75	100
19CHEC304	Core 4:Electrochemistry and Spectroscopy	4		4	25	75	100
19CHEP305	Core 5:Inorganic Chemistry Practical - II		6	3	40	60	100
19CHEP306	Core 6:Physical Chemistry Practical - II		6	3	40	60	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
19CHEE30X	Elective 5: Department Elective	3		3	25	75	100
*19PSCI300	Constitution of India	2		2*	25	75	100
				28			

FOURTH SEMESTER							
19CHEC401	Core 1:Nuclear, Bioinorganic and Materials Chemistry	4		4	25	75	100
19CHEC402	Core 2:Nano Materials, Macromolecular and Surface Chemistry	4		4	25	75	100
19CHEP403	Core 3:Organic Chemistry Practical–III		4	2	40	60	100
19CHEP404	Core 4:Inorganic Chemistry Practical–III		4	2	40	60	100
19CHEP405	Core 5:Physical Chemistry Practical–III		4	2	40	60	100
19CHED406	Project Work		12	6	25	75	100
	TOTAL CREDITS			**93**			
	Value Added Courses						

L- Lectures; P- Practicals; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination.

***19PSCI300 = NON-CREDIT COMPULSORY COURSE**

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available. The details of interdepartmental electives are given in the "**Handbook of Interdepartmental Electives-Two Year Programme**" and listed in the University website.

2. Students may opt for any Value-added Courses listed in the University website. The details of Value Added Courses are given in the "**Handbook of Value Added Courses**" and listed in the University website.

3.Guidance/ Discussion on course specific **Experiential Learning** to students will be provided wherever feasible to apply the knowledge, skills and attitude taught in the course, either within the classroom, within the community, or within the workplace, to learn by experience which would improve their employability skills.

DEPARTMENT ELECTIVE COURSES (DE)

S.No.	Course Code	Course Title	Hours/ week		C	Marks		
			L	P		CIA	ESE	Total
1.	19CHEE206	Selective Materials, Techniques and Environmental Chemistry	3	-	3	25	75	100
2.	19CHEE207	Applied Chemistry	3	-	3	25	75	100
3.	19CHEE307	Scientific Research Methodology	3	-	3	25	75	100
4.	19CHEE308	Organic Chemical Technology	3	-	3	25	75	100

L- Lectures; P- Practicals; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination.

ANNAMALAI UNIVERSITY

Department of Chemistry

Pattern of question paper for END semester examinations

(Based on Revised Bloom's Taxonomy)

Year: I

Programme: M.Sc Two Year PG Programme **Semester: I / II**

Course Code: **Course Name:**

Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) **Marks: (10x2=20)**

(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe……
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4) **Marks: (8x5=40)**

(Answer any EIGHT of the questions)

11. Prepare…..
12. Solve…..
13. Apply……
14. Show…..
15. Categorize…
16. Analyze…
17. Distinguish….
18. Infer….
19. Compare….
20. Compute

Part-C (Level-K5) **Marks: (3x10=30)**

(Answer any THREE of the questions)

21. Discuss…
22. Summarize….
23. Evaluate…..
24. Disprove….

Part-D (Level-K6) **Marks: (1x10=10)**

(Answer any ONE of the questions)

25. Design….
26. Develop…

ANNAMALAI UNIVERSITY

Department of Chemistry

Pattern of question paper for END semester examinations

Year: II

Programme: M.Sc Two Year PG Programme **Semester: III / IV**

Course Code: **Course Name:**

Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) **Marks: (10x2=20)**

(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe…..
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4) **Marks: (6x5=30)**

(Answer any SIX of the questions)

11. Apply……
12. Show…..
13. Prepare
14. Make use of….
15. Categorize…
16. Analyze…
17. Distinguish….
18. Simplify…..

Part-C (Level-K5) **Marks: (3x10=30)**

(Answer any THREE of the questions)

19. Discuss…
20. Recommend with
21. Evaluate…..
22. Justify….
23. Optimize…

Part-D (Level-K6) **Marks: (2x10=20)**

(Answer any TWO of the questions)

24. Design….
25. Formulate …
26. Modify …..

M.Sc Chemistry (TWO YEAR) PROGRAMME

[End Semester Examinations]

Bloom's Taxonomy - Questions Conforming to Levels K1 to K6

I Year (Two year PG)			
Level	Part	Questions & Marks	Total Marks
K1	A	5 x 2	10
K2		5 x 2	10
K3	B	4 x5	20
K4		4 x5	20
K5	C	3 x 10	30
K6	D	1 x 10	10
			100

II Year (Two Year PG)			
Level	Part	Questions & Marks	Total Marks
K1	A	5 x 2	10
K2		5 x 2	10
K3	B	2 x 5	10
K4		4 x 5	20
K5	C	3 x10	30
K6	D	2x 10	20
			100

ANNAMALAI UNIVERSITY

Department of Chemistry

[Question Paper Pattern - INTERNAL TESTS I & II (CIA)]

(Based on Revised Bloom's Taxonomy)

Programme: M.Sc : Two Year PG **Semester: All**

Time: 2 Hrs **Max.Marks:50**

Part-A (Level-K1) **Marks: (6x2=12)**

(Answer ALL of the questions)

1. Define /Choose/ Relate……
2. What / Why / How?
3. Multiple Choices a. b. c. d.
4. Multiple Choices a. b. c. d.
5. Match the following i - a ii - b iii - c iv - d v - …..
6. Match the following i - a ii - b iii - c iv - d v - …..

Part-B (Level-K2) **Marks: (3x5=15)**

(Answer any THREE of the questions)

7. Explain…..
8. Describe…..
9. Select……
10. Compare

Part-C (Level-K3/ Level-K4) **Marks: (2x7=14)**

(Answer any TWO of the questions)

11. Apply….
12. Calculate….
13. Categorize…

Part-D (Level-K5/ Level- K6) **Marks: (1x9=9)**

(Answer any ONE of the questions)

14. Discuss….
15. Summarize….

PROGRAMME OUTCOMES (POs)

After the successful completion of the M.Sc Chemistry (2 year) Degree Programme, the graduates will be able to know about:

PO1	Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.
PO2	Resource Utilisation: Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.
PO3	Analytical and Technical Skills: Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO4	Critical thinking and Problem solving: Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.
PO5	Project Management: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.
PO6	Individual and team work: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7	Effective Communication: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO8	Environment and Society: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO9	Ethics: Commitment to professional ethics and responsibilities.
PO10	Life-long learning: Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the programme, the student will be able to

PSO1	Gain complete knowledge about all fundamental aspects of all branches of chemistry.
PSO2	Understand the basic concepts of organic chemistry like reagents in organic syntheses, stereochemistry, instrumental method of chemical analysis and natural products etc.
PSO3	Identify the importance inorganic chemistry includes coordination chemistry, role of metal ions in biological processes and organometallic chemistry.
PSO4	Gather attention about the physical aspects of molecules like molecular spectroscopy, role of catalysts , polymer chemistry, materials chemistry and bio-physical chemistry.
PSO5	Learn about the potential uses of analytical industrial chemistry, medicinal chemistry, and environment oriented chemistry. Apply the various analytical techniques like IR, mass, NMR, NQR, EPR, XRD to structural characterization of unknown compounds.
PSO6	Carry out experiments in the area of organic analysis, estimation, separation derivative process, inorganic semi micro analysis, preparation, conductometric and potentiometric analysis.
PSO7	Obtain knowledge in Spectral, Analytical, Qualitative & Quantitative techniques and contribute new scientific insights or innovative applications of chemical research to the next generation.

Semester	19CHEC101: Organic Reaction Mechanisms	L	P	C
I		4	0	4

Learning Objective (LO):

LO1	To learn the fundamental mechanisms underlying different chemical reactions, basic aspects of stereochemistry and conformational analysis of six membered ring systems.

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand various types of reaction mechanisms involved in synthetic organic transformation.
CO2	Appreciate various types of reaction mechanisms involved in synthetic organic transformation.
CO3	Analyse basic stereochemistry concepts in a proper perspective.
CO4	Evaluate the principles of Photochemistry.
CO5	Apply the concepts of asymmetric synthesis.

Unit – 1: Organic Reaction Mechanisms – I

Aromaticity - Electronic Effects **-** Types of organic reactions - Reaction intermediates - formation, structure and stability of carbocations, carbanions, radicals, carbenes and nitrenes.

Aliphatic nuceleophilic substitution - S_N1, S_N2 and S_Ni mechanisms with examples. - structure and solvent effect on nucleophilic substitution reactions. Aromatic nucleophilic substitution: Unimolecular, bimolecular and benzyne mechanisms.

Esterification and transesterification - Ester hydrolysis - acid catalysed acyl oxygen and alkyl oxygen fission mechanisms - explanation of the principle of microscopic reversibility.

Unit – 2: Organic Reaction Mechanisms – II

Addition to carbon-carbon and carbon-oxygen multiple bonds - electrophilic and nucleophilic addition - addition to conjugated system. Hydration of olefins - Hydroboration

Elimination reactions: E1, E2, E1cB & E2C mechanisms - Pyrolytic eliminations - cis elimination - orientation of double bond - Bredt's rule, Hofmann and Saytzeff rules.

Aliphatic electrophilic substitution - S_E1, S_E2 and S_Ei mechanisms with examples. Aromatic electrophilic substitution - mechanisms of nitration, halogenation and sulphonation reactions. Friedel-Crafts reaction and its modifications. Influence of substituents on reactivity and orientation. Electrophilic substitution of naphthalene - formation of two isomers - explanation of kinetic and thermodynamic controls by sulphonation of naphthalene.

Unit – 3: Organic Stereochemistry- I

Optical isomerism - chirality - asymmetry and dissymmetry - enantiotopic and diastereotopic hydrogens. Enantiomers and diastereomers and their representation by flywedge and Fischer projections – R and S notation.

Walden inversion, asymmetric transformation and asymmetric induction - enantio and diastereo selective synthesis - enantiomeric excess and diastereomeric excess.

Atropisomerism of biphenyls, allenes and spiranes. Geometrical isomerism about C=C bond - E-Z notation - determination of configuration of geometrical isomers - geometrical isomerism in acyclic oximes.

Unit – 4: Organic Photochemistry – I

Principles of photochemistry - Jablonski diagram - Photochemical reactions of saturated ketones - Norrish type - I and II reactions - photoreductions of ketones - Paterno- Buchi reaction - reaction of α,β-unsaturated ketones- isomerisation and cycloadditions - photo reactions of cyclohexadienones. Photochemical cis-trans isomerisation of simple alkenes - photochemical oxidation, oxidative couplings and Barton reaction. Application of photochemical reactions in organic synthesis.

Unit – 5: Natural Products – I

Amino acids - classification, general methods of preparation and general properties of amino acids. Proteins - classification - peptides synthesis - primary structure of peptides - end terminal analysis - -secondary structure of proteins - tertiary and quaternary structure of proteins. Classification of enzymes and their specificity - Ribonucleosides and ribonucleotides - RNA - types - structures of DNA and RNA.

Introduction - chemical classification of alkaloids and terpenoids - isoperene rule - General methods of structure elucidation of alkaloids and terpenoids. Structure and synthesis of citral and papaverine.

Unit – 6 (Not for Final Examination)

Nomenclature of alicyclic, bicyclic and tricyclic compounds (basic skeletal structure only with or without one substituent). Biogenesis- The building blocks and construction mechanism of 1. Terpeniods – Mono Sesqui, Di and Triterpeniods. 2. Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan.

Text Books:

1. Smith. M. B., (2016), *March's Advanced Organic Chemistry*, John Wiley & Sons, 7th Ed., New York.
2. Carey. F. and Sundberg. R. J., (2007), *Advanced Organic Chemistry*-Part A and B, Springer Science + Business Media, 5th Ed., Berlin.
3. Clayden. J., Greeves. N. and Warren. S., (2012), *Organic Chemistry*, Oxford University Press, 2nd Ed., UK.
4. Norman. R. O. C. and Coxon. J. M., (2003), *Principles of Organic Synthesis*, Chapman & Hall, 3rd Ed., London (UK).
5. Finar. I. L., *Organic Chemistry* ,Vol 1 & 2: Pearson, 7th Ed. (2009) Chennai.

Supplementary reading:

6 Eliel. E. N., (2008), *Stereochemistry of Carbon Compounds*, Tata McGraw Hill Ed, Reprint, Noida (UP).

7 Nasipuri. D., (2005), *Stereochemistry of Organic Compounds*, New Age International (P) Ltd, Reprint New Delhi.

8 Kalsi. P. S, (2007), *Organic Reactions: Stereochemistry and Mechanism through solved problems*, New Age International (P) Ltd, 4th Ed., New Delhi.

9 Eliel. E. L. and Wilen. S. H., (2008), *Stereochemistry of Organic Compounds*, Wiley India Ed. New Delhi.

10 Coxon. J. M. and Halton. B., (2000), *Organic Photochemistry*, Cambridge University Press 2nd Ed. UK.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3						2	3			3	3				1	
CO2		3						3			3	3					
CO3			3					3		3	3	3					
CO4	3						2	3			3	3					3
CO5			3					3		3	3	3					3

*1-Low *2-Medium *3-Strong

Semester I	19CHEC102: Coordination Chemistry and Inorganic Reaction Mechanisms	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To learn the fundamental mechanisms underlying Coordination Chemistry, reaction mechanism and photoinorganic chemistry.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the basics of coordination Chemistry.
CO2	Appreciate various theories of inorganic complexes.
CO3	Evaluate inorganic reaction mechanisms.
CO4	Analyse substitution reaction mechanisms and electron transfers.
CO5	Apply the concepts of energy transfer to photovoltaics.

Unit – 1: Coordination Chemistry of Transition Metal ions

Nomenclature of coordination compounds - Stability constants of complexes and their determination (pH metric and spectrophotometric methods). Factors influencing stability, stabilization of unusual oxidation states by complex formation.

Pearson's HSAB concept, acid-base strength and hardness and softness, symbiosis, theoretical basis of hardness and softness. Electronegativity and hardness and softness.

Stereoisomerism of coordination complexes.

Unit - 2: Theories of Coordination Compounds

VB theory-Crystal field theory- splitting of d-orbitals under various geometries- CFSE-factors affecting the magnitude of 10Dq-Evidences for CFSE- Spectrochemical series-Distortions in octahedral complexes- Jahn-Teller theorem, Jahn-Teller effect, Molecular orbital theory-MO concepts of octahedral and tetrahedral complexes- MO energy level diagrams of sigma and pi bonding in octahedral complexes, nature of metal-ligand pi bonds- Evidences for pi back bonding.

Unit – 3: Reaction Mechanism-I

Substitution reactions of octahedral complexes: Labilities, inertness, stability and instability of coordination compounds- Nature of substitution reactions- Theoretical approach to substitution mechanisms-Mechanism of substitution reactions of complexes of cobalt-acid hydrolysis-base hydrolysis of cobalt(III) complexes.

Racemisation and isomerisation: Twist mechanisms for isomerisation – Intramolecular mechanisms for racemisation.

Unit – 4: Reaction Mechanism-II

Substitution reactions of square planar complexes: Reactions of Pt(II) complexes- Trans effect- Theories of trans effect-Mechanism of substitution- kinetics of Pt(II) complexes.

Electron transfer reactions-Electron tunneling hypothesis-Marcus-Hush theory. Atom transfer reaction-one electron and two electron transfer-inner sphere and outer sphere mechanism.

Unit – 5: Photoinorganic Chemistry

Excited states of metal complexes-Energy transfer under conditions of weak interaction and strong interaction-exciplex formation. Conditions of the excited states to be useful as redox reactants-photosubstitution, photooxidation and photoreduction- Photochemical reactions involving Ruthenium(II) bipyridyl complex. Application to photovoltaics-water photolysis- carbondioxide reduction.

Unit – 6 (Not for Final Examination)

Applications of coordination compounds: Metal complexes in analytical chemistry, medicinal chemistry, industrial process, water suffering process and agriculture.

Photochemistry of Cr(III), Co(III), Pt(II) and Pt(IV) complexes.

Text books:

1. Huheey, J.E., (2013), *Inorganic chemistry*, Pearson, London.
2. Shriver, D.F., Atkins, P.W., (2010), *Inorganic chemistry*, Langford-Oxford University Publications, London.
3. Basalo. F, Pearson. R.G,(2000), *Mechanism of Inorganaic Reactions*, John Wiley & Sons, India.
4. Kettle. S.F.A,(2013), *Physical Inorganic Chemistry*: *A Coordination Chemistry Approach*, Springer, New York.

Supplementary reading:

5. Tobe. M. L. and Burgess. J., (1999), *Inorganic Reaction Mechanism*, Longman, India.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	2				2					3		2		
CO2	3		3										3				
CO3	3		3	3						3			3				
CO4	3		3			1		3					3				3
CO5	3		3	1		3				3			3				3

*1-Low *2-Medium *3-Strong

Semester I	19CHEC103: Chemical Thermodynamics, Photochemistry and Group Theory	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To learn the fundamentals of thermodynamics, photochemistry and group theory.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand basics of Thermodynamics.
CO2	Evaluate basic reaction mechanisms involved in Photochemistry.
CO3	Understand the fundamentals of statistical thermodynamics.
CO4	Appreciate the fundamentals of photochemistry and radiation Chemistry.
CO5	Apply the principles of Group theory.

Unit – 1: Classical Thermodynamics

Calculation of adiabatic flame temperature, Maxwell's relations, thermodynamic equation of state, thermodynamics of open systems, partial molar quantities, chemical potential, Gibbs- Duhem equation, variation of chemical potential with temperature and pressure, third law of thermodynamics-Determination of absolute entropies of solids, liquids and gases –residual entropy. Nernst heat theorem, chemical equilibrium-Van't Hoff isotherm, standard free energy change of reactions, variation of equilibrium constant with temperature and pressure.

Unit – 2: Thermodynamics of Non Ideal and Irreversible Systems

Fugacity of gases – determination of fugacity using graphical method and van der Waals equation – variation of fugacity with temperature and pressure. Concept of activity and activity coefficients – mean ionic activity and mean activity coefficients - determination of activity and activity coefficients using EMF measurements.

Non-equilibrium thermodynamics - conservation of energy and mass, entropy production in chemical reactions – Microscopic reversibility and Onsager reciprocal relation. General application of non-equilibrium thermodynamics.

Unit – 3: Statistical Thermodynamics

Thermodynamic probability and entropy. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

Partition function – translational, rotational, vibrational and electronic partition functions. Calculations of thermodynamic properties and equilibrium constant in terms of partition functions. Theories of heat capacity of solids-Einstein and Debye theories.

Unit – 4: Photochemistry and Radiation Chemistry

Photophysical process, primary and secondary processes, Quantum yield, Kinetics of collisional quenching – Stern Volmer equations. Photosensitization, Chemiluminescence, Photosynthesis, solar energy conversions, Semiconductor photo catalysis, lasers.

Radiation Chemistry-linear energy transfer, G-value, dosimeters, radiolysis of water, solvated electrons.

Unit – 5: Principles and Applications of Group Theory

Symmetry elements and symmetry operations, point groups, group multiplication table of C_{2v} and $C_{3v,}$ reducible and irreducible representations, properties of irreducible representations orthogonality theorem. Construction of character tables of C_{2v} and C_{3v}. Selection rules for IR and Raman spectra, procedure for determining symmetry of normal modes of vibration of H_2O and NH_3 molecules - hybrid orbitals in BF_3, CH_4 and NH_3.

Unit – 6 (Not For Final Examination)

Application of Bose-Einstein statistics to photon gas and superfluidity of liquid helium Application of Fermi-Dirac statistics to electron gas and thermionic emission.

Applications of Group theory to IR, Raman and Electronic spectra - SALC procedure - evaluation of energies and MO's for systems like ethylene, butadiene

Metal Oxide Semiconductors and Doped Metal Oxide Semiconductors and its applications. Mechanism of photocatlysis and its applications.

Text Books:

1. Gurdeep Raj, (2004), *Thermodynamics*, Goel Publishers, India.
2. Moore W. J., (1998), *Basic Physical Chemistry*, Orient Longman ,India.
3. Peter Atkins, Julio de Paula, (2013), *Physical Chemistry*, Oxford Univ.press, UK.
4. Rohatgi-Mukherjee K. K.,(2005),Fundamentals of Photochemistry, New Age International, Hyderabad.
5. Cotton F. A., (2003), *Chemical Applications of Group Theory*, Wiley Eastern, India.
6. Raman, K. V (2004), *Group Theory and its Application to Chemistry*, Tata McGraw Hill, New Delhi.

Supplementary Reading

7. Glasstone. S, (1966), *Text Book of Physical Chemistry*, Mc Millan, India.
8. Kuriacose.J.C, Rajaram.J, (1986),*Thermodynamics for Chemistry*, Shoban Lal Nagain Chand, New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3					1		3						
CO2	3		2	3							3						
CO3	3		2	3						3	3						3
CO4	3		2	3						3	3				3		
CO5	3		2	3						3	3			3			

*1-Low *2-Medium *3-Strong

Semester I	19CHEP104: Organic Chemistry Practical – I	L	P	C
		0	6	3

Learning Objective (LO):

LO1	To learn different types of organic reactions and its mechanisms and to undertake experiments on organic reactions.

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Acquire basic laboratory skills required to carry out organic reactions.
CO2	Independently perform two step organic preparations.
CO3	Analyse the mechanisms of reactions.
CO4	Gain the expertise to apply it to specific research problems.

Preparation of organic compounds involving two step reactions.

Text books:

1. Vogel. A. I., Tatchell. A. R., Furnis. B. S., Hannaford. A. J., Smith. P.W.G., (2005), *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson, Chennai.

Supplementary reading:

2. Ahluwalia. V. K., Bhagat. P. and Aggarwal. R., (2005), *Laboratory Techniques in Organic Chemistry*, I.K. Int., New Delhi.
3. Gnanaprakasam. N. S. and Ramamurthy. G., (2000), *Organic Chemistry Lab Manual*, S.V. Printers, Chennai**.**

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	3			3			3	3				3	
CO2	3		3	2					3		3	3				3	
CO3	3		3	3						3	3	3				3	
CO4	3	3	3	2	3			3		3	3	3			1	3	1

*1-Low *2-Medium *3-Strong

Semester I	19CHEP105: Physical Chemistry Practical – I	L	P	C
		0	6	3

Learning Objective (LO):

LO1	To learn the principles and verification of electrochemistry and binary solutions and to perform experiments in studying the important concepts electrochemistry and binary systems.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Acquire practical knowledge on important equations in thermodynamics.
CO2	Acquire the practical knowledge of understanding important equations in distribution experiments.
CO3	Perform conductometric experiments.
CO4	Acquire the practical knowledge of understanding important equations in distribution experiments.
CO5	Evaluate their knowledge to analyze the analytical problems.

I. Conductivity Experiments

1) Determination of cell constant
2) Determination of the solubility of sparingly soluble salt
3) Verification of DHO equation – Equivalent conductance of strong electrolyte
4) Dissociation constant of weak electrolyte (verification of Ostwald's dilution law)

II. Conductometric titrations

5) Acid-base titrations
   i) HCl vs NaOH, ii) CH_3COOH vs NaOH,
6) Displacement titrations (NH_4Cl vs NaOH)
7) Precipitation titrations
   i) $CuSO_4$ vs NaOH, ii) $BaCl_2$ vs Na_2CO_3, iii) KCl vs $AgNO_3$
8) Titration of mixtures
   i) HCl + CH_3COOH vs NaOH, ii) HCl + $CuSO_4$ vs NaOH iii) HCl + NH_4Cl vs NaOH

III. Distribution Law Experiments

1) Partition coefficient of iodine between two immiscible solvents
2) Study of the equilibrium constant of the reaction : $KI + I_2 \leftrightarrows KI_3$
3) Estimation of iodide ions using partition experiments
4) Distribution of ammonia between water and chloroform
5) Determination of formula of cuprammonium complex

Text Books:

1. Levitt B.P., (1985), Ed., *Findlay`s Practical Physical Chemistry*, 9th Ed., Longman, London.

2. Gurtu J.N.,. Kapoor R, (1987), *Advanced Experimental Chemistry*, Vol.I, S. Chand & Co.,New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3				1			3		3				3
CO2	3		3								3		3	3	3		
CO3	3		3	3						3	3		3	3			
CO4	3	3	3					1		3	3		3				
CO5	3		3	3						3	3		3				3

*1-Low *2-Medium *3-Strong

Semester II	19CHEC201: Organic Photochemistry and Molecular Rearrangements	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To understand addition, elimination, rearrangement and name reactions along with their mechanism and synthetic utility and to understand various types of oxidation and reduction reactions.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the theoretical basis and mechanisms underlying additions and elimination reactions.
CO2	Appreciate reaction mechanisms involved in rearrangements.
CO3	Evaluate the chemistry of dyes and their synthetic utilities.
CO4	Differentiate the various types of heterocyclic molecules.
CO5	Understand the relationship between the structure and function of various classes of natural compounds.

Unit – 1: Organic Photochemistry – II

Classification of pericyclic reactions - electrocyclic reactions – cycloaddition reaction - sigmatropic shifts - Woodward-Hoffmann selection rule – analysis of pericyclic reactions - Correlation diagram – Frontier Molecular Orbital approach and Perturbation Molecular Orbital approach - Sommlet-Hauser, Cope and Claisen rearrangements.

Molecular Rearrangements.

A detailed study of the following rearrangements: Carbon-carbon migration: Pinacol- Pinacolone, Wagner-Meerwein and Favorskii. Carbon-nitrogen migration: Hoffmann, Schmidt, Lossen, Curtius and Beckmann, Carbon- oxygen migration: Baeyer-Villiger. Nature of migration, migratory aptitude.

Unit – 2: Organic Stereochemistry- II

Conformational analysis of 1,2-disubstituted ethanes - relative stabilities of gauche and anti conformations. Representations of the conformations of diastereomers with two asymmetric carbons using Newmann and Sawhoarse projections - relative stabilities of diastereomers.

Conformational analysis of cyclohexane, mono and disubstituted derivatives - reactivity of cyclohexane derivatives - Conformation and stereochemistry of cis and trans-decalin and 9-methyldecalin.

Unit – 3: Synthetic Dyes and Supramolecular Chemistry

Colour and constitution (Electronic concept). Classification of dyes, Chemistry and Synthesis of methyl orange, congo red, malachite green, crystal violet, fluorescein, alizarin and indigo.

Definition of Supramolecular Chemistry, Nature of binding interactions in supramolecular structure: ion-ion, ion-dipole, dipole-dipole, Hydrogen bonding, cation-π, anion- π, π-π and van der Waals interaction. Synthesis of crown ethers, cryptands, calixarenes, cyclodextrins, cyclophanes, cryptophanes and dendrimers.

Unit – 4: Small Ring and Higher Ring Heterocycles

Three-membered and four-membered heterocycles-synthesis and reactions of azirodines, oxiranes, thiranes, azetidines, oxetanes and thietanes. Benzo-Fused Five-Membered Heterocycles -Synthesis and reactions of benzopyrroles, bezofurans and benzothiophenes.

Six membered Heterocycles with two or more Heteroatoms. Synthesis and reactions of diazones, triazines, tetrazines and thiazines. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Seven-and Large-membered Heterocycles - Synthesis and applications of azepines, oxepines, thiepines, diazepines thiazepines, azocines, diazocines, dioxocines and dithiocines.

Unit – 5: Natural Products – II

Antibiotics: classification, structure and uses of penicillins, fluoroquinolones, chloramphenicol, and streptomycin-Structural elucidation and synthesis of chloroamphenicol. **Vitamins:** classification, structure and uses of vitamins A, B1, B6, C, D, E and K.

Steroids: Occurrence - Diel's hydrocarbon - nomenclature of Steroids - Structure and biological importants of cholesterol, cholic acid, estrone, estradiol, testosterone and androstrone.

Unit – 6 (Not for Final Examination)

Problems in each type of photochemical reactions and molecular rearrangements. Aromatic transition state-general rule for pericyclic reactions. Structural elucidation of tetracyclins, streptomycin, penicillins, Estriol and progesterone.

Text books:

1. Sankararaman. S., (2015), *Pericyclic Reactions* – A Text Book, Narosa, 1st Ed., New Delhi.
2. Smith. M. B., (2016), *March's Advanced Organic Chemistry*, John Wiley & Sons, 7th Ed., New York.
3. Carey. F. and Sundberg. R. J., (2007), *Advanced Organic Chemistry*-Part A and B, Springer Science and Business Media, 5th Ed., Berlin.
4. Clayden. J., Greeves. N. and Warren. S., (2012), *Organic Chemistry*, Oxford University Press, 2nd Ed., UK.
5. Norman. R. O. C. and Coxon. J. M., (2003), *Principles of Organic Synthesis*, Chapman & Hall, 3rd Ed., London.
6. Stuart Warren, (2007), *Organic Synthesis*: *Disconnection Approach*, Wiley India (P) Ltd., New Delhi.

Supplementary Reading:

7. Ahluwalia. V. K., (2012), *Oxidation in Organic Synthesis*, CRC Press, 1st Ed., Florida.
8. Ahluwalia. V. K., (2012), *Reduction in Organic Synthesis*, CRC Press, 1st Ed., Florida.
9. Ingold. C. K., (1994), *Structure and Mechanism in Organic Chemistry*, CBS Pub., 2nd Ed., New Delhi.

10. Mukherji. S. M. and Singh. S. P., (2016), *Reaction Mechanism in Organic Chemistry*, Trinity Press, Revised Ed., New Delhi.
11. Eliel. E. L. and Wilen. S. H., (2008), *Stereochemistry of Organic Compounds*, Wiley India Ed., New Delhi.
12. Finar. I. L., (2009), *Organic Chemistry* , Vol 1 and 2: Pearson, 7th Ed., Chennai.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3			3	3					3
CO2	3		3								3	3					
CO3	3			3						3	3	3					
CO4	3	3						3			3	3			3	3	3
CO5	3			3				2		3	3	3			3	3	

*1-Low *2-Medium *3-Strong

Semester II	19CHEC202: Solid State and Organometallic Chemistry	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To learn the principles of solid state, polymeric inorganics and organometallic Chemistry.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Correlate the structure of solids with their applications.
CO2	Understand the various classes of polymeric inorganic compounds.
CO3	Appreciate the classification and factors influencing phase transitions.
CO4	Evaluate the structure and applications of organometallic compounds.

Unit - 1: Solid State Structures and Structural Defects

Ionic bonding, Lattice energy, Born equation and its derivation, Limiting radius ratio rules, Radius ratio for trigonal, tetrahedral, octahedral and cubic sites.

Structures of some ionic crystals (sodium chloride, caesium chloride, rutile, wurtzite, fluorite).

Crystal defects: Stoichiometric defects-Schottky and Frenkel defects – colour centres in alkali halide crystals – Nonstoichiometric defects- metal excess and metal deficiency defects – extended defects – line and plane defects.

Unit - 2: Polymeric Inorganic Compounds

Structures and classification of higher boranes - carboranes - metallocarboranes- silicates- silicones - Phosphazenes - Linear and cyclic phosphazenes -Sulfur - nitrogen compounds- S_4N_4- one dimensional conductor $[(SN)_x]$–Metal clusters-binuclear metal halide clusters- structure and bonding in octachlorodirhenate(III). Isopoly and heteropolyacids- structure and bonding of isopoly & 6- and 12- heteropoly anions.

UNIT – 3: Phase Transitions

Buerger's classification – Thermodynamic classification – Ubbelohde's classification – Kinetics of phase transitions – Nucleation rate – Avrami equation – Factors that affect the kinetics of phase transitions – Crystal chemistry and phase transitions – Martensitic transformations – Order- disorder transitions.

Unit - 4: Organometallic Chemistry-I

Types of ligands- Concept of haptacity-18 electron rule and its limitations- bonding in metal carbonyls- - Polynuclear carbonyls with and without bridging groups-Applications of IR spectra in the study of structure of metal carbonyls-structure and bonding in metal nitrosyls and dinitrogen complexes-Preparation, structure and bonding in metal alkenes (Zeise's salt), alkynes and allyl complexes- Metallocenes: preparation, properties, structure and bonding in ferrrocene.

Unit - 5: Organometallic Chemistry –II (Catalysts and Reaction Mechanisms)

Homogeneous catalysis: Alkene hydrogenation, synthesis gas, hydroformylation, synthetic gasoline and Monsanto acetic acid process, Wacker process, polymerization by Ziegler-Natta Catalysis – Isomerization of alkenes – Fluxional behaviour of organometallic compounds – Isolobal concept in organometalic compounds and metal clusters.

Unit – 6 (Not for Final Examination)

Structure and properties of solid – prototypical oxides, fluorides, sulfides and related compounds. Monoxides of 3d metals, higher oxides and glasses – layered MS_2 compounds and intercalations.

Organosilicon compounds – organometallic compounds of arsenic, antimony and bismuth – catenated and multiply bonded compounds.

Text books:

1. Huheey, J.E,. Keiter. E. L, Keiter. R. L., Medhi. O. K,(2011), I*norganic chemistry,* Pearson press, London.
2. Huheey, J.E.,(2013), *Inorganic chemistry*, Pearson press, London.
3. Lee, J.D., (2012), *Concise inorganic chemistry*, Wiley. New Delhi.
4. Cotton. F.A, Wilkinson. G,(2013), *Advanced Inorganic Chemistry*, Wiley Eastern, New Delhi.
5. Douglas. B.,(2017), *Concept and Models of Inorganic Chemistry*, Wiley, New Delhi.

Supplementary Reading:

6. Anthony R. West,(2016), *Solid-state Chemistry and its applications*, John Wiley,New Delhi.
7. Shriver, D.F., Atkins, P.W., (2011), *Inorganic chemistry*, Langford-Oxford University Publications, 5 th Edition, London.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3		3				3		3	3		3				
CO2	3	3		3							3		3		1		
CO3	3	3		3						3	3		3				
CO4	3	3	1	2				3			3		3	1	1	3	3

*1-Low *2-Medium *3-Strong

Semester II	19CHEC203: Chemical Kinetics and Quantum Mechanics	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To acquire knowledge on the basic concepts in chemical kinetics and to learn quantum theory.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the theoretical basis underlying the kinetics of different chemical reactions.
CO2	Appreciate the theories of molecular dynamics.
CO3	Comprehend the quantum mechanics of simple systems.
CO4	Evaluate the applications of quantum chemistry.

Unit – 1: Chemical Kinetics and Catalysis

Absolute Reaction Rate Theory in thermodynamic terms – Significance of entropy and volume of activation. Ionic reactions – primary and secondary salt effects - Acid-base catalysis – Bronsted relations, catalytic coefficients and their determination. Enzyme catalysis - Michaelis-Menten equation – Heterogeneous catalysis-Langmuir-Hinshelwood and Eley- Rideal mechanisms

General features of fast reactions – Study of fast reactions by flow methods.

Unit – 2: Chemical Dynamics

Potential energy surfaces, Kinetic isotopic effects - Dynamics of unimolecular reactions – Lindemann-Hinshelwood – Rice Ramsperger Kassel (RRK) theory and Rice Ramsperger Kassel – Marcus (RRKM) theory.

Study of fast reactions by laser, relaxation, flash Photolysis and nuclear magnetic resonance methods.

LFERs – Hammett equation, Taft equation, separation of polar, resonance and steric effects.

Unit – 3: Quantum Mechanics of Simple System -I

Planck's quantum theory, wave particle duality, uncertainty principle, operators and commutation relations-Postulates of quantum mechanics – derivation of Schrodinger's time- independent wave equation and its application to particle in a one-dimensional box, particle in a three-dimensional box, harmonic oscillator, rigid rotor and Schrodinger equation for hydrogen atom-separation of variables-energy levels-radial factors of the hydrogen atom wave functions .

Unit – 4: Applications of Quantum Chemistry - II

Covalent bonding – Born-Oppenheimer approximation-Hydrogen molecule ion, LCAO – MO and VB treatments of the hydrogen molecule. Antisymmetry and Pauli's

exclusion principle. Slater determinantal wave function, term symbols and spectroscopic states – Russell- Saunders coupling.

Unit – 5: Applications of Quantum Chemistry - III

The variation Theorem, linear variation principle, perturbation theory (first order and non degenerate). Applications of variation method and perturbation theory to the helium atom. Hybridization-determination of bond angles of sp, sp^2 and sp^3 hybridizations. Huckel pi- electron (HMO) theory and its applications to ethylene, butadiene and benzene. HMO orbital construction, calculation of properties –delocalization energy, electron density and bond order. A brief idea of self consistent field theory.

Unit - 6 (Not For Final Examination)

Computer Applications in Chemistry Introduction to computers and computing - Block diagram of a PC and the functions of the various units of computer - High and low level languages - Introduction to net working - LAN, WAN, Internet and Intranet - WorldWideWeb - ChemWeb - E-journals - search engines for chemistry. Introduction to C language - Structure of C program - Control statements.

Examples of simple chemistry Programmes. 01. Conversion of Celsius temperature to Kelvin temperature 02. Applications of Beer-Lambert Law. 03. Linear least square - Fit log k vs I/T plot to get Arrhenius parameters. 04. Determination of Anharmonicity constant and dissociation energy calculation.

Text books:

1. Atkins P., Paula J. D, (2013),*Physical Chemistry*, Oxford University Press, UK.
2. Laidler K. J., (2014), *Chemical Kinetics*, Tata Mc Graw Hill, New Delhi.
3. Prasad R. K., (2017), *Quantum Chemistry*, New Age International, Hydrabad.
4. Puri, Sharma, Pathania, (2017), *Principle of Physical Chemistry*, Vishal Publishing Ltd. New Delhi.
5. Sen K. B. K.,(1992), *Quantum Chemistry*, Tata McGraw Hill, New Delhi.

Supplementary Reading:

6. Chandra A. K., (1997), *Introduction to Quantum Chemistry*, Tata McGraw Hill,New Delhi.
7. Levine W., (2014), *Quantum Chemistry*, PHI Learning, India.
8. Agrawal G.L, (1990), *Basic Chemical Kinetics,* Tata McGraw Hill, New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3			3		3				3
CO2	3		3								3		2				3
CO3	3			3						3	3		3	3	3		
CO4	3	3						3		3	3		3	3		3	3

*1-Low *2-Medium *3-Strong

Semester II	19CHEP204: Organic Chemistry Practical–II	L	P	C
		0	6	3

Learning Objective (LO):

LO1	To undertake separation and analysis of organic mixtures using two component system.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Acquire the necessary practical skills to independently analyse organic compounds.
CO2	Gain expertise in the separation of two component mixtures of organic compounds.
CO3	Systematically evaluate organic compounds.
CO4	Apply the knowledge in industries.

Qualitative Analysis: Analysis of two component mixture. Separation and systematic analysis of the separated two individual components.

Text books:

1. Mohan. J., (2003), *Organic Analytical Chemistry, Theory and Practice*, Narosa., New Delhi.
2. Ahluwalia. V. K., Bhagat. P., Aggarwal. R., (2005), *Laboratory Techniques in Organic Chemistry*, I. K. International., New Delhi.
3. Vogel. A. I., Tatchell. A. R., Furnis. B. S., Hannaford. A. J., and Smith. P.W.G., (2005), *Vogel's Textbook of Practical Organic Chemistry,* 5th Ed., Prentice Hall., New Delhi., N.S and Ramamurthy, (2000), *Organic Chemistry Lab Manual*, S.V. Printers.

Supplementary reading:

4.Gnanaprakasam. N. S. and Ramamurthy., (2000), G., *Organic Chemistry Lab Manual*, S.V. Printers., Chennai.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3									3					3	
CO2	3		3								3	3				3	3
CO3	3			3							3			3		3	
CO4	3	3				3	3	3			3	3		3	3	3	3

*1-Low *2-Medium *3-Strong

Semester II	19CHEP205: Inorganic Chemistry Practical–I	L	P	C
		0	6	3

Learning Objective (LO):

LO1	To get the skill in the identification of cations including rare earth metals and to develop the skill in the estimation of metal ions by complexometric titrations.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Acquire the necessary practical skills to independently analyze inorganic compounds
CO2	Gain expertise in the systematic analysis of inorganic compounds.
CO3	Apply the knowledge in industries.

Semi Micro Qualitative Analysis

Mixture containing two common cations and two of the following less familiar cations.

Se, Te, W, Mo, Be, Ti, Ce, Th, Zr, U, V, Tl and Li.

Text Books:

1. Ramanujam, V, (1988), *Inorganic Semi Micro Qualitative Analysis,* National Pubs. Chennai.
2. Vogel, A.I. (1989), *Text Book of Quantitative Inorganic Analysis*, 5th Ed., Longman,UK.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		1	1		2			3		3			2	3
CO2	3		3								3		3				3
CO3	3	1	3	1				2		3	3		3			3	3

*1-Low *2-Medium *3-Strong

Semester III	19CHEC301: Synthetic Organic Chemistry	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To learn the new techniques in planning an organic synthesis and to acquire knowledge about polymers and its industrial importance.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the concepts of retrosynthetic analysis.
CO2	Learn about various organic reagents used in synthetic organic chemistry.
CO3	Evaluate the various organic reactions and its mechanisms.
CO4	Understand about selective synthetic methods.
CO5	Gain knowledge about polymers.

Unit – 1: Planning Organic Synthesis

An introduction to retrosynthesis - Synthon, Synthetic equivalent, Target molecule, Functional group interconversion - Disconnection approach - One group disconnection - Disconnection of alcohols, olefins and ketones - Logical and illogical disconnections. Two group disconnection - 1,2-, 1,3-, 1,4-, 1,5- and 1,6-dioxygenated skeletons and dicarbonyls. Retro Diels - Alder reaction - Pericyclic reactions – Retrosynthesis of some heterocycles containing two nitrogen atoms. Retrosynthetic analysis of Camphor, Longifiline and Reserpine.

Unit – 2: Reagents in Organic Chemistry

Uses of the following reagents in organic synthesis and functional group transformations. Sodium borohydride, Lithium aluminium hydride, tri-n-butyltin hydride, Lithium dimethyl cuprate, Lithium diisopropyl amide, Trimethyl silyl iodide, dicyclohexylcarbodiimide, OsO_4, DDQ, SeO_2, PCC. Phase Transfer Catalysts - Benzyltriethylammonium halides - Crown ethers.

Oxidation and reduction:

Oxidation - Swern and Dess-Martin oxidations, Corey-Kim oxidation, PCC and $KMnO_4$ oxidations.

Reduction using hydride reagents, $LiAlH_4$, $NaBH_4$ and other organoboranes: chemo- and stereoselectivity, catalytic hydrogenation (homogenous and heterogeneous catalysts).

Unit – 3: Organic Reactions and Advanced Mechanisms

Formation of C-C single bond: Aldol condensation, Claisen ester reaction, Stobbe condensation, Knoevenagel reaction, Michael addition, Dieckmaan condensation - Stork enamine reaction - Mannich reaction. **Formation of C=C double bond:** Wittig reaction, Claisen-Schmidt condensation and Peterson's synthesis.

Cannizaro and cross Cannizaro reactions, Benzoin condensation, Wolff-Kishner reduction, Clemmenson reduction, Birch reduction and Chichibabin reaction.

General methods of investigation of organic reaction mechanisms - kinetic and non-kinetic methods - Baldwin rules - cross over experiments - isotopic labeling primary and secondary kinetic isotopic effects - solvent kinetic isotopic effects. SN1', SN2' and SNi' mechanisms - Neighbouring group participation - non-classical carbocation and memory effect.

Unit – 4: Selective Synthetic Methods

Need for protection of functional groups during chemical reactions - protection of hydroxyl, mercapto, amino, carbonyl and carboxylic groups.

Asymmetric synthesis with chiral substrate: Nucleophilic addition to α-chiral carbonyl compounds, Electrophilic addition to α-chiral olefins - epoxidation, cyclopropanation, hydroboration. Asymmetric synthesis using chiral reagents and catalysts: Chiral organo boranes - application in hydroboration, reduction and allylation reactions, epoxidation catalyst, semicorin catalyst, Jacobson catalyst - Uses of Champhor derived auxiliaries and menthol derived auxiliaries in asymmetric synthesis.

Unit – 5: Polymers

Chemistry of polymerisation, Kinetics of polymerisation, Chemical and geometrical structure of polymer molecules, Glass transition temperature, Crystallinity in polymers - Copolymerisation. Polymer stereochemistry.

Industrial polymers - Synthesis, structure and applications of industrially important polymers like PVC, nylon 6,6, buna-S rubber and Polytetrafluoroethylene (*Teflon*). Conducting polymers - Synthesis and applications of polyacetylenes, polyanilines, polypyrroles and polythiophines.

Polymers as aids in organic synthesis - Polymeric reagents, catalysts and substrates. Polymers in Optical lithography - Drug delivery - Drug carriers.

Unit – 6 (Not for Final Examination)

Uses of following reagents in organic synthesis and functional group transformation. Synthesis and uses of drugs- anxiolytics, neuroleptics, hypnotics, sedatives, local anaesthetics, anti-coagulants, hypoglycaemic agents, antihistaminic agents, antimalarials, analgesics, antipyretics and anti-inflammatory.

Text books:

1. Smith. M. B., (2016), *March's Advanced Organic Chemistry*, John Wiley & Sons, 7th Ed., New York.
2. Finar. I. L., (2009), *Organic Chemistry* , Vol 1 and 2, Pearson, 7th Ed., Chennai.
3. Norman. R. O. C. and Coxon. J. M., (2003), *Principles of Organic Synthesis*, Chapman & Hall, 3rd Ed., London.
4. Kalsi. P. S., (2007), *Organic Reactions: Stereochemistry and Mechanism through solved problems*, New Age International (P) Ltd, 4th Ed., New Delhi.
5. Eliel. E. L., (2011), *Stereochemistry of Organic Compounds*, Wiley India 42nd Ed., New Delhi.

Supplementary reading:

6. Michael B. Smith, (2010), *Organic Synthesis*, Elsevier, 4th Ed., New York.
7. Charles. C. K., (2012), *Organic Synthesis*, Narosa, 1st Ed., New Delhi.
8. Ahluwalia. V. K., and Renu Aggarwal, (2006), *Organic Synthesis*, Narosa, 2nd Ed., New Delhi.
9. Gowariker. V. R., Viswanathan. N. V. and Jayadev Sreedhar, (2017), *Polymer Science*, New Age International, 2nd Ed., New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3									3	3					
CO2	3		3								3	3					
CO3	3									3	3	3					
CO4	3	3				3					3	3					3
CO5	3					3				3	3	3			1		2

*1-Low *2-Medium *3-Strong

Semester III	19CHEC302: Green Chemistry, Computational Chemistry, Drug Design and Spectroscopy	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To understand the basic aspects of Green Chemistry and spectroscopy of organic compounds.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Correlate the mass spectra and molecular structure.
CO2	Understand Drug Design and Synthesis.
CO3	Interpret the ^{1}H as well as ^{13}C NMR spectra of organic compounds.
CO4	Learn the principles of multidimensional NMR.
CO5	Analyze the unknown compounds by spectroscopy.

Unit – 1: Green Chemistry

Introduction and principle of green chemistry - Environmental friendly green techniques - solvent supported catalysts and reagents, heterogenous reactions, Examples of organic reactions involving green chemistry techniques.

Techniques in Organic Synthesis - Use of microwave, ultrasound, ionic liquids, super- critical fluid extraction in organic synthesis – Heterogenized reactions

Unit – 2: Computational Chemistry

An introduction to concepts of potential energy surface, Basic principles of molecular mechanics, Ab initio method, Semiemprical calculations (SE) and Density functional theory (DFT) softwares.

Drug Design and Synthesis

Development of new drugs - Procedures followed in drug design. Physico - chemical parameters: Lipophilicity, partition coefficient, electronic ionization constants - Concepts of drug receptors and Drug receptor interactions. Structure Activity Relationship and Quantitative Structure Activity Relationship. Free Wilson and Hansch analysis - Case study using morphines and penicillins.

Synthesis of Benzodiazepene, Sulfonyl urea and Diclofenac drugs.

Unit – 3: Mass Spectrometry

Principles – measurement techniques – (EI, CI, FD, FAB, SIMS) – presentation of spectral data – molecular ions – isotope ions – simple and multicentre fragmentation – fragment ions of odd and even electron types – factors affecting cleavage patterns – rearrangement ions – McLafferty rearrangement – Retro Diels–Alder fragmentation. Mass

spectra of hydrocarbons, alcohols, phenols, aldehydes, ketones, carboxylic acids, amines and their derivatives - MALDI-TOF and its applications.

Unit – 4: NMR Spectroscopy

Nuclear spin and magnetic moment of a nucleus – nuclear energy levels in the presence of magnetic field - basic principles of NMR experiments – CW and FT NMR –^{1}H NMR chemical shift - factors influencing proton chemical shifts - coupling constants – factors influencing coupling constants – ^{1}H NMR spectra of simple organic molecules such as: CH_3CH_2Cl, CH_3CHO, etc., AX, AB and AMX spin system – spin decoupling – nuclear overhauser effect – chemical exchange.

Introduction to ^{13}C NMR - chemical shifts – additivity principle – factors affecting ^{13}C NMR chemical shifts - proton decoupled, off-resonance, INEPT and DEPT ^{13}C NMR spectra –^{13}C NMR spectra of simple organic molecules.

Unit – 5: Multidimensional NMR Spectroscopy

Basic principles of 2D NMR spectroscopy – HOMOCOSY, HSQC, HMBC, TOCSY and NOESY spectra and their applications.

Introduction of 3D NMR experiment, HCCH-TOCSY, HNCA experiment, HNCO experiment, HN(CA)CO experiment, Backbone assignments and Side-chain assignments - Spectroscopic identification of Organic Compounds - Identification of organic compounds using data of UV, IR and NMR spectroscopy and mass spectrometry.

Unit – 6 (Not for Final Examination)

Techniques in organic synthesis – use – Neat reaction, Grinding techniques. Synthesis of Phenothiazines, Piperidinediones, Aminobenzoic acid and its derivatives, 1,3-Indanedione derivatives, Ethylenediamine derivatives, Aminoquinolines, Paracetamol and Phenylbutazone.

Text books:

1. Rashmi Sanghi, Srivastava, (2012), *Green Chemistry*, Narosa Publishing House, 5th Ed., New Delhi.
2. Albert S. Matlack,(2010), *Introduction to Green Chemistry*, CRC Press, 2nd Ed,Florida.
3. Ashutosh Kar, (2015), *Medicinal Chemistry*, New Age International, 6th Ed., New Delhi.
4. Errol Lewars, (2015), *Computational Chemistry*, Springer, 3rd Ed., Berlin.
5. Patrick. G. K., *Medicinal Chemistry*, (2015), Garland Science, 1st Ed., New York.
6. Silverstein. R. M., Webster. F. X., Kiemle. D. J. and Bryce. D. L., (2016), *Spectrometric Identification of Organic compounds*, John Wiley, 8th Ed., New York.
7. Jagmohan, *Organic Spectroscopy*, (2016), Narosa, 2nd Ed., New Delhi.
8. R. S. Macomber, (1998), *A Complete Introduction to NMR Spectroscopy*, Wiley, New York.
9. Jag Mohan, (2016), Organic Spectroscopy, Principles & Applications, Narosa , 2nd Ed., New Delhi.

Supplementary Reading:

10. Sameuel Delvin, *Green Chemistry*, (2006), IVY Publishing House, 1st Ed., London.
11. Srivastava. M. M., and Rashmi Sanghi, (2005), *Chemistry for Green Environment*, Narosa, 1st Ed., New Delhi.
12. Ahluwalia. V. K., (2012), *Medicinal Chemistry*, Ane Books P Ltd. 2nd Edition, New Delhi.

13. William Kemp, (2008), *Organic Spectroscopy*, Macmillan Education UK, 3rd Ed., London.
14. Kalsi. P. S., (2005), *Spectroscopy of Organic Compounds*, New Age International Publishers, 6th Ed, Reprint., New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3			1			3		1	3	3					
CO2	3		3								3	3			3		
CO3	3		2	3						3	3	3			3		
CO4	3	3	3	2	2			3			3	3	3				3
CO5	3		2	3						3	3	3					

*1-Low *2-Medium *3-Strong

Semester III	19CHEC303: Spectral and Analytical Techniques	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To study the electronic and magnetic properties of complexes, applications of diffraction methods and to know the characterization of inorganic compounds using ESR, NQR and Mossbauer spectroscopies.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Evaluate the spectral and magnetic properties of complexes.
CO2	Analyse the spectral techniques like PES and ESR.
CO3	Understand the theory of NQR.
CO4	Appreciate the diffraction methods.
CO5	Gain knowledge on ORD and CD.

Unit - 1: Spectral and Magnetic Properties of Complexes

Ground state Terms for d^1-d^9 ions- Derivation of terms for p^2 and d^1 configurations. Characteristics of d-d transitions. Energy level diagrams – Orgel diagrams of d^1-d^9 - Tanabe-Sugano diagram of d^6. Effect of Jahn Teller distortion, Nephelauxetic effect, Selected examples of d-d spectra – $[Ti(H_2O)_6]^{3+}$, trans – $[Cr(en)_2 F_2]^+$ $[Ni(en)_3]^{2+}$, $[CoF_6]^{3-}$, $[Co(ox)_3]^{3-}$, $[Cu(H_2O)_6]^{2+}$.

Magnetism: dia, para, ferro and antiferro – magnetism – quenching of orbital angular momentum, Temperature independent paramagnetism – Effect of spin orbit coupling on spectral and magnetic properties.

Unit – 2: Photoelectron and ESR Spectroscopies

Valence and core binding energies – Measurement technique – Koopman's theorem – Chemical shifts in X-ray photoelectron spectroscopy – Auger spectroscopy – Applications of ESCA in chemistry.

Electron spin Resonance Spectroscopy – Origin of the spectrum – method of recording - hyperfine splitting – **g** value and hyperfine splitting constant - ESR spectra of simple organic radicals - application of ESR spectra to transition metal complexes

Unit - 3: NQR and Mossbauer Spectroscopies

NQR spectroscopy – Theory of NQR – instrumentation – Nuclear quadrupole coupling constants – Applications.

Mossbauer spectroscopy – principle – source and absorber – isomer shift – quadrupole splitting – magnetic interactions – applications to Fe and Sn compounds.

Unit - 4: Diffraction Methods

Crystal systems and lattice types. Miller indices and Bravais lattices. Unit cells and its identification from systematic absence - the concept of reciprocal lattice – Structure factor and its relation with electron density –Analysis by powder X-ray diffraction and single crystal photography and its applications.

Electron and neutron diffraction – Elementary treatment – Wierl equation – Scattering of neutron by solids and liquids – comparison with X-ray diffraction – Magnetic scattering – measurement techniques – Elucidation of structure of a simple gas phase molecule.

Unit – 5: Chromatography and ORD

Principles of gas – liquid and gas – solid chromatography – Instrumentation – Applications – Principles and Applications of HPLC – super critical fluids chromatography – Properties of super critical fluids – Instrumentation and applications.

Theories of Optical Rotatory Dispersion and Circular Dichroism – correlation between structure and optical rotation – axial haloketone rule – Cotton effect – Octant rule – Deduction of absolute configuration of organic molecules and inorganic complexes.

Unit – 6 (Not for Final Examination)

^{1}H, ^{13}C, ^{19}F, ^{17}O, ^{31}P and ^{119}Sn NMR spectra of coordination compounds – IR and Mass spectra of complexes – Hirshfeld surface analysis.

Text books:

1. Huheey, J.E., (2011), , E. L. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic chemistry* Pearson Press, 5th edition, India.
2. Lee, J.D., (2012), *Concise inorganic chemistry*, 5th edition, Wiley India.
3. Kettle S. F. A, (1998),*Coordination Compounds*, Oxford University Press, London.
4. Day R. A., Underwood A. L. (2019), *Quantitative Analysis*, 6th edition, PHI Learning Pvt., India.
5. Drago R.S.(2015), *Physical Methods in Chemistry*, East West Press, 2nd edition.,India.
6. Ebsworth. E. A. V, Rankine. D.W.H., Craddock. S.,(2000), *Structural Methods in Inorganic Chemistry,* Boca Raton, FL : CRC Press, Florida.
7. Eland J.H.D., Butterworth, (1983), *Photoelectron Spectroscopy*, 2nd Edition, Elsevier.
8. Eliel E.L., (2011), *Stereochemistry of Carbon Compounds*, 42nd Ed. Tata McGraw HillI., India.
9. Eland. J.H.D., Butterworth, (2013), *Photoelectron Spectroscopy*, Butterworth-Heinemann, UK.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3									3		3				
CO2	3		3								3		3				
CO3	3			3						3	3		2	3			
CO4	3	3								3	3		3				3
CO5	3			3						3	3		3	3	1		3

*1-Low *2-Medium *3-Strong

Semester III	19CHEC304: Electrochemistry and Spectroscopy	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To learn the theories electrochemistry and to learn the fundamental concepts of molecular, UV and IR spectroscopy.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the theories of strong electrolytes.
CO2	Acquire the knowledge about various electro analytical techniques.
CO3	Solve the numerical and analytical problems related to electrochemistry and surface chemistry.
CO4	Appreciate the theories of molecular spectroscopies like UV and IR.

Unit – 1: Electrochemistry - Theories of Strong Electrolytes and Electrochemical Cells

Debye-Huckel-Onsager equation and its verification, conductance at high field and high frequency, Debye-Huckel limiting law.

Electrochemical cell reactions, Nernst equation – electrochemical series. electrode-electrolyte interface, electrical double layer- Helmholtz-Perrin, Gouy-Chapmann and Stern theories – electro kinetic phenomena- Lipmann equation, corrosion and passivity –Pourbaix and Evans diagrams-methods of protection of metals from corrosion

Unit – 2: Electrochemistry- Electrode Reactions, Battery and Fuel Cell

Ion-solvent interactions – Born Model, Enthalpy, free energy and entropy of ion-solvent interactions. Primary and secondary solvations (salting in and salting out). Electrode kinetics – Butler-Volmer equation, Tafel equation, polarization and over voltage – mechanism of hydrogen evolution and oxygen evolution reactions. Batteries-Lead –acid battery, Lithium-Iron and Nickel-Cadmium battery. Fuel cell-hydrogen-oxygen and hydrocarbon-oxygen fuel cell.

Unit – 3: Electroanalytical Methods

Principle and applications of electrogravimetry, coulometry – amperometry – potentiometry – conductometry – polarography – voltammetry – cyclic voltammetry – anodic stripping voltammetry.

Unit – 4: Molecular Spectroscopy

Origin of molecular spectra - Vibrational spectra – harmonic and anharmonic oscillators – fundamental vibrations and overtones – hot bands. Rotational spectra of diatomic molecules- rigid rotor and non-rigid rotor- Effect of isotopic substitution. Vibrational-rotational spectra – P, Q, R branches. Electronic spectra of diatomic molecule – Potential energy curves – Franck-Condon Principle.

Raman spectra – theory – Selection Rules – Rotational Raman Spectra and Vibrational Raman Spectra. Mutual exclusion principle.

Comparison of Raman and IR spectra – structural determination from Raman and IR spectroscopy, rule of mutual exclusion

Unit - 5: UV – Visible and IR -Spectroscopy

Ultraviolet – Visible spectroscopy – types of electronic transitions – chromophores and auxochromes - factors influencing positions and intensity of absorption bands – absorption spectra of dienes, polyenes and α,β - unsaturated carbonyl compounds – Woodward – Fieser rules.

IR Spectroscopy – vibrational frequencies and factors affecting them – identification of functional groups – intra and inter molecular hydrogen bonding – finger print region – Far IR region – metal ligand stretching vibrations.

Unit – 6 (Not For Final Examination)

Advanced Spectral Techniques

Raman Micro spectrometry applied to the Study of Electrode Materials-(Coherent Anti Stokes Raman spectroscopy (CARS), Resonance Raman, Time Resolved Raman Spectroscopy and Surface enhanced Raman spectroscopy and its applications. 2D IR Spectroscopy and Single photon Fluorescence spectroscopy and its applications - Single molecule spectroscopy and its applications

Text Books:

1. Glasstone S., (2008), *Introduction to Electrochemistry*, East West Pvt., Ltd. New Delhi.
2. Bockris O.M and. Reddy A. K. N,(2014), *Modern Electrochemistry*; Vol. 1 and 2, 2nd Ed., Plenum Press, New York.
3. Banwell C.N, (1993), *Fundamentals of Molecular Spectroscopy*, Tata McGraw Hill.
4. William Kemp,(2011), *Organic Spectroscopy*, Mac Millan, UK.
5. Atkins P, Paula J. D,(2013), *Physical Chemistry*, 8th.Ed.Oxford University Press, Great Britain.
6. John R Dyer, (2005), *Application of absorption spectroscopy of organic compounds*, Prentice-Hall of India Pvt. Ltd.

Supplementary Reading:

7. L. Antropov, (2001)*Theoretical Electrochemistry*;University Press of the Pacific, USA.
8. R. G. Compton,(1987), *Electrode Kinetics: Reactions*; Elsevier Science Press, Chennai.
9. Levine. I. N, (1974), *Molecular Spectroscopy*, John Wiley & Sons, New York.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3										3			3			
CO2	3		3								3			2			
CO3	3		3	3						3	3			3			
CO4	3		2	1				3			3			3		3	3

*1-Low *2-Medium *3-Strong

Semester III	19CHEP305: Inorganic Chemistry Practical – II	L	P	C
		0	6	3

Learning Objective (LO):

LO1	To develop skills in the determination of a metal ion in presence of another by appropriate techniques.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Acquire the necessary practical skills to independently determine inorganic ions.
CO2	Gain expertise in the systematic analysis of inorganic compounds.
CO3	Apply the knowledge in industries.

Quantitative analysis

1) Determination of Ba^{2+} and Ca^{2+} ions
2) Determination of Cu^{2+} and Ni^{2+} ions
3) Determination of Cu^{2+} and Zn^{2+} ions
4) Determination of Cu^{2+} and SO_4^{2-} ions
5) Determination of Ca^{2+} and Mg^{2+} ions
6) Analysis of pyrolusite

Text Book:

1. Vogel, A. I., (2015), *Quantitative Inorganic Analysis,* 5th Ed., Prentice Hall.US.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3					3			3						3
CO2	3	3	3					1	3		3						
CO3	3	3	3	1				2		3	3		3				3

*1-Low *2-Medium *3-Strong

Semester III	19CHEP306: Physical Chemistry Practical – II	L	P	C
		0	6	3

Learning Objective (LO):

LO1	To learn the principles and verification of basic electrochemistry and Kinetics

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the necessary practical skills in instrumental analysis.
CO2	Gain expertise in the systematic calculations and graphical representation.
CO3	Apply the knowledge in industries.

I. Potentiometry Experiments

1) Single electrode potentials
2) Solubility of sparingly soluble salt
3) Redox titrations
   a) Ferrous iron (II) **vs.** dichromate (Fe^{2+} vs. $Cr_2O_7^{2-}$)
   b) Iodide ion (I^-) **vs.** $KMnO_4$
   c)Ferrous iron (II) **vs.** Cerium (IV) ion (Fe^{2+} vs. Ce^{4+})
4) Precipitation titrations
   a) Chloride Vs. Silver ion
   b) Iodide Vs. Silver ion
   c) Mixture of chloride and iodide ion Vs. Silver ion
5) Potentiometrtic titrations (by quinhydrone electrode)
   a) Strong acid V**s.** Strong base
   b) Dissociation constant of a weak acid Vs. NaOH
   c) Mixture of acids (HCl + weak acid) Vs. NaOH

II. Chemical Kinetics

1) Acid catalysed hydrolysis of an ester.
2) Comparison of acid strengths.
3) Persulphate – iodide kinetics – clock reaction – Primary salt effects
4) Saponification of an ester
5) Iodination of acetone

Text Books:

1. Levitt, B.P., (1985), *Findlay`s Practical Physical Chemistry*, 9th Ed., Longman,London.
2. Gurtu, J.N. and Kapoor, R., (1987), *Advanced Experimental Chemistry, Vol.I,* S.Chand & Co.New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						1			3			3			
CO2	3		3								3			3			
CO3	3			3						3	3			3		3	3

*1-Low *2-Medium *3-Strong

Semester III	19PSCI300: Constitution of India	L	P	C
		2	0	2

Learning Objective (LO):

LO1	To understand the basic features of Indian Constitution.
LO2	To grasp about the basic Rights and Duties of Indian Citizens.
LO3	To ponder over the form of Indian Political System.
LO4	To have broad understanding about the pivotal provisions related with liberty, equality and fraternity.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Imbibe with the basic features of Indian Political System.
CO2	Enlighten themselves with the rights and duties of Indian Citizens.
CO3	Understand the significance of rule of law.
CO4	Inculcate with basic liberties.

Unit I : Constitution of India – Basic Features and Fundamental Principles

Making of Indian Constitutional Law and Constitutionalism- Historical Perspective of the Constitution of India –Salient features and Characteristics of the Constitution of India.

Unit II : Fundamental Rights and Duties

Scheme of Fundamental Rights-The Scheme of Fundamental Duties and its legal status-The Directive Principles of State Policy – Its Importance and Implementation.

Unit III : Legislative and Financial Powers of States

Federal Structure and Distribution of Legislative and Financial powers between the Union and the States-Parliamentary form of Government of India- The Constitution powers and States of the President of India.

Unit IV : Constitutional Amendments in India

The Historical Perspectives of the Constitutional Amendments in India – Emergency Provisions : National Emergency, President Rule- Financial Emergency.

Unit V : Fundamental Rights

Schemes of the Fundamental Right to Equality – Scheme of the Fundamental Rights to certain Freedom under Article 19 – Scope of the Right to Life and PersonalLiberty under Article 21.

Recent Ammendments in Constitution of India

Faculty member will impart the knowledge on Recent Ammendments in Constitution of India to the students and these components will not cover in the examination.

Text Books

1. Bipan Chandra, Mridula Mukherjee, AdilityMakherjee (2016)., India After Independence 1947- 2000, Penguin Publishers, New Delhi.
2. Durga Das Basu, (2018), Introduction to the Constitution of India, Prentice Hall, New Delhi.
3. JogendraYadav (2000), Transforming India: Dynamics of Democracy, Oxford University Press, New Delhi.

Supplementary Readings

4. The Constitution of India(1950)(Bare Act), Government of India Publications.
5. Busi S.N Ambedkar B.R(2015), Framing of Indian Constitution.
6. Jain M.P(2014), Indian Constitution Law, Lexis Nexis.
7. Paul R.Brass (1999),The Politics of India Since Independence,Cambridge University Press,India.
8. Granvila Austin (2006),The Indian Constitution :Cornerstone of a Nation, Oxford University Press, New Delhi.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1		3	3		2					2					3
CO2		3	2		3	2					3			3	2
CO3	3	2		3	2					2			3	2	2

***1-Low *2-Medium *3-Strong**

Semester IV	19CHEC401: Nuclear, Bioinorganic and Materials Chemistry	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To understand theory of radioactivity and applications of radioisotopes, bioinorganics and materials.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Get a clear understanding about radioactivity and its application for peaceful purposes.
CO2	Get familiar with chemical reactions in physiological systems.
CO3	Understand lanthanides and actinides.
CO4	Appreciate bioinorganic chemistry.
CO5	Learn preparative techniques in inorganic chemistry.

Unit - 1: Nuclear Chemistry

Radioactive decay and equilibrium, Nuclear Q – value and nuclear cross sections, different types of nuclear reactions, fission and fusion. Theories of fission. Fissile and Fertile isotopes.-Nuclear fusion – stellar energy, Theories of α- and β- decay, orbital electron capture, nuclear isomerism, internal conversion. Hot atom chemistry. Radio isotopes and their Applications: Activation analysis, Isotopic dilution technique-radiometric titration- tracer technique. Counting techniques such as G. M. counter and proportional counter. Applications of nuclear science in industry, agriculture and biology.

Unit - 2: Chemistry of Lanthanides and actinides

Correlation of electronic structures, occurrence and isolation, separation - Chemistry of separation of Np, Pu & Am from U & fission products. Oxidation states and general properties – Comparison with 'd' block elements, Lanthanide contraction and its significance, Coordination compounds of lanthanides - Spectral and magnetic characteristics of lanthanides and actinides - Position in the periodic table. Similarities between the actinides and lanthanides.

Unit - 3: Bioinorganic Chemistry-I

Role of alkali and alkaline earth metals in biological systems– Mechanism of ion transport across membranes, Sodium – potassium pump - Ionophores – Metalloporphyrins – cytochromes – iron-sulfur proteins: rubredoxin and ferredoxins. Oxygen carrriers: hemerythrin and hemocyanin- structural features and function of myoglobin and haemoglobin – Photosynthesis - PS-I and PS-II.

Unit - 4: Bioinorganic Chemistry-II

Enzymes-Inhibition and poisoning, Vitamin B_{12} and B_{12} coenzymes, metallothionine. Metalloenzymes-Carbonic anhydrase and Carboxy peptidase. -Nitrogen fixation- in vitro and in vivo. Transition metal-nucleic acid interaction. Anticancer activity of Pt-complexes-

different types of active platinum complexes- Mechanism of anticancer activity of *cis*-platin. Nonactivity of trans-platin - Lithium therapy in psychiatric mind disorder.

Unit - 5: Preparative techniques of inorganic materials

Principle of solid state reactions with reference to MgO and Al_2O_3 - Reaction conditions – Structural considerations – reaction rates – Wagner mechanism – nucleation and diffusion – surface structure and reactivity. Synthesis of $MgAl_2O_4$ (a spinel) – experimental procedure. Synthesis of a Zeolite - $(Na_x(AlO_2)_x(SiO_2)_y)mH_2O$ - Preparation of thin films – cathode sputtering – Preparation of metastable phase by sol-gel technique – Hydrothermal technique – Zone melting – Melts – vapour phase transport methods.

Unit – 6 (Not for Final Examination)

Uses of nuclear radiations: Radiation sterilization – Radiation energy for chemical synthesis – Radioisotopes as a source of electricity.

Biological role of some trace non-metals: boron, silicon, sulphur, selenium, arsenic, fluorine, chlorine, bromine, iodine – role of metal complexes in conventional drug resistant to malaria.

Text Books:

1. Keiter, E. L., Keiter R. L,. Medhi O. K, (2011), *Inorganic Chemistry - Principles of Structure and Reactivity,* Pearson Press, 5th edition, India.
2. Arnikar H. J., (2011), *Essential of Nuclear Chemistry*, New Age International,India.
3. Glasstone S., (2014), *Source Book of Atomic Energy*, Krieger Publishing Company, Florida.
4. Huheey, J.E., (2013), *Inorganic chemistry*, Pearson, London.
5. Anthony R. West, (2017), *Solid state chemistry and its applications,* John Wiley, New Delhi.
6. Arumugam. M., (2003), *Material Science*, Anuradha Agencies, India.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3									3	3				2	2
CO2	3		3								3	3				2	
CO3	3			3						3	3	3				2	
CO4	3	3						3			3	3				3	3
CO5	3			3						3	3	3				3	2

***1-Low *2-Medium *3-Strong**

Semester IV	19CHEC402: Nano Materials, Macromolecular and Surface chemistry	L	P	C
		4	0	4

Learning Objective (LO):

LO1	To learn about the synthesis and characterization techniques of nanomaterials and to learn the principle of various adsorption isotherms.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Know various methods of preparations of nanomaterial and its characterization using various microscopic techniques.
CO2	Evaluate the principle and applications of industrially important materials.
CO3	Understand concepts of polymers, mechanism, kinetics and applications.
CO4	Understand about polymer chemistry.
CO5	Understand the basic surface chemistry.

Unit - 1: Synthesis and Applications of Nanomaterials

Preparation of nanomaterials – sol-gel synthesis, Chemical Vapour Deposition (CVD), electrodeposition, ball milling, plasma arcing, uses of natural nanoparticles. Synthesis and applications of carbon nanotubes.

Self assembled monolayers – monolayers on gold – preparation – structure – growth process – patterning monolayers – mixed monolayers.

Core-Shell nanoparticles – introduction – types of systems – characterization – properties. Monolayer–protected metal nanoparticles – characterization – functionalization – Application. Semiconductor quantum dots – synthesis – electronic structure & spectral properties

Sensors – Classification, Types of sensors, properties, chemical sensor, electrochemical sensors, optical sensors, biosensors, nanosensors, nanobiosensors, Applications of Nanosensors.

Unit - 2: Characterization of Nanomaterials

Electron microscopes – scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning Transmission Electron Microscopy (STEM), Scanning Probe Microscopy (SPM) – scanning tunneling microscopy (STM) – Atomic manipulations, Focused Ion beam (FIB) technique – Atomic force microscopy (AFM) – scanning probe Lithography (SPL), Dip pen nanolithography (DPN) - Optical microscopies for nanoscience and Technology – Confocal microscopy – scanning near-field optical microscopy – particle size analysis.

Unit – 3: Material Science

Band theory - insulators, semiconductors and conductors and their applications - superconductors and their applications – A study of conducting polymers, liquid crystals,

NLO, LCD, LED and photochromic materials and their applications. Principle, properties and applications of ferroelectric, piezoelectric and pyroelectric materials.

Unit - 4: Properties of Polymers

Polymer Processing: Plastics elastomers and fibres. Compounding processing techniques: calendaring, die casting, rotational casting, film casting, injection moulding, blow moulding extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

Polymer structure and physical properties –crystalline melting point T_m. Determination of T_g. Relationship between T_m and T_g..

Biopolymers – biomaterials. Polymers in medical field - High temperature and fire – resistant polymers.

Unit – 5: Surface Chemistry

Langmuir and BET isotherms, Adsorption from solutions – Gibbs adsorption isotherm, surface area determination – Applications of adsorption – adsorption indicators. Study of surface film, surface tension, surface free energy: Pressure across an interface – Laplace and Kelvin equations. Surfactant-classification of surfactants, hydrophobic interaction, micellization of surfactant, critical micelle concentration, factors affecting the critical micelle concentration, thermodynamics of micellization.

Unit – 6 (Not For Final Examination)

Nanostructures Carbon clusters: Discovery of C_{60} - alkali doped C_{60} - superconductivity in C_{60} - larger and smaller fullerenes. Carbon nanotubes: Synthesis- single walled carbon nanotubes – structure and characterization - Mechanism of formation - chemically modified carbon nanotubes – doping - Functionalizing nanotubes - Application of carbon nanotubes. Nanowires: Synthetic strategies - Gas phase and solution phase growth - Growth control - Properties.

Text Books:

1. Pradeep T., (2007), *Nano-The Essentials*, Tata McGraw Hill,New Delhi.
2. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, (2005), *Nanotechnology*, Overseas Press, India.
3. Billmeyer .W., (1984), *Text Book of polymer Science*, Johnwiley&Sons ,Newyork.
4. Arumugam M., (2016), *Materials Science*, Anuradha Agencies, 3rd Edition,.India.
5. Peter Atkins, Julio de Paula(2013), *Physical Chemistry*, Oxford press,Great Britain.

Supplementary Reading:

6. Journals like Chemistry of Materials, Journal of Materials Chemistry, Advanced Materials etc.. Web resource: http://chemistry.uohyd.ernet.in/~cy551/
7. Rao C. N. R, Muller A.and Cheetham A. K. (2004) (Eds), *The Chemistry of Nanomaterials:* Vol. 1 and 2; Wiley-VCH; Germany, Weinheim,.
8. Gowrikar V. R., (2015), *Polymer Science*, New Age International. Hyderabad.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3		3	3			3	3		
CO2	3		3						3	3	3			3			
CO3	3									3	3			3			
CO4	3	3				3		3		3	3		3	3			3
CO5	3		3	3		3				3	3		3	3	3		3

*1-Low *2-Medium *3-Strong

Semester IV	19CHEP403: Organic Chemistry Practical – III	L	P	C
		0	4	2

Learning Objective (LO):

LO1	To understand the basic aspects of quantitative experiments in Organic Chemistry and to estimate the organic compounds.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Critically examine quantitative analysis of organic compounds.
CO2	Understand the quantitative methods.
CO3	Perform the estimation of phenol.
CO4	Analyze glucose and ketones.
CO5	Apply the knowledge in industries.

Quantitative analysis and Estimation of phenol, aniline, methyl ketone and glucose by volumetric analysis.

Text Books:

1. Mohan. J., (2003), *Organic Analytical Chemistry*-Theory and Practice, Narosa., New Delhi.
2. Ahluwalia. V. K., Bhagat. P. and Aggarwal. R., (2005), *Laboratory Techniques in Organic Chemistry,* I.K. Int., New Delhi.
3. Gnanaprakasam. N. S., and Ramamurthy. G., (2000), *Organic Chemistry Lab Manual,* S.V. Printers., Chennai.
4. Vogel. A. I., Tatchell. A. R., Furnis. B. S., Hannaford. A. J., Smith. P.W.G., (2005), *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson., Chennai.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3			3	3					
CO2	3		3								3	3					
CO3	3			3						3	3	3					
CO4	3	3						3			3	3					3

*1-Low *2-Medium *3-Strong

Semester IV	19CHEP404: Inorganic Chemistry Practical - III	L	P	C
		0	4	2

Learning Objective (LO):

LO1	To know the colorimetric estimation of metal ions and to understand the complexometric titrations.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the colorimetric estimations of metal ions.
CO2	Gain knowledge on the preparation of complexes.
CO3	Evaluate the water quality that will be useful in environmental aspect.
CO4	Understand the complexometric titrations.
CO5	Calculate the hardness of water sample.

Colorimetric analysis:

Colorimetric estimations of copper, nickel, iron and chromium using photoelectric colorimeter.

Complexometric Titrations:

a) Standardization of EDTA.
b) Determination of Mg^{2+}, Zn^{2+}, Ni^{2+} and Ca^{2+}

Water analysis:

a) Estimation of total alkalinity of water sample
b) Estimation of dissolved oxygen in waste water
c) Estimation of chloride content in water sample
d) Estimation of hardness in water sample by EDTA method
e) Chemical oxygen demand (COD)

Preparation of the followings:

1) Tris(thiourea)copper(I) chloride
2) Potassium trioxalatoferrate
3) Tetraamminecopper(II) sulphate
4) Microcosmic salt
5) Chrome alum
6) Trans-Diaquadioxalatochromate(III)

Text Books:

1. Ramanujam V., (1988),*Inorganic Semi Micro Qualitative Analysis,* National Pubs.,India.
2. Vogel A.I., (1989),*Text Book of Quantitative Inorganic Analysis*, 5th Ed., Longman,UK.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3			3		3				
CO2	3		3						3		3		3				
CO3	3			3						3	3		3				
CO4	3	3						3			3		3			1	3
CO5	3			3						3	3		3				

*1-Low *2-Medium *3-Strong

Semester IV	19CHEP405: Physical Chemistry Practical – III	L	P	C
		0	4	2

Learning Objective (LO):

LO1	To learn the principles and verification of Kinetics, Electrochemistry and Phase diagrams.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Acquire the necessary practical skills to perform physical chemistry practicals.
CO2	Gain expertise in the instrumental analysis.
CO3	Systematically evaluate calculations involving in physical chemistry.
CO4	Apply the gained knowledge in industries.

Electrochemistry:

1. Kinetics of saponification of ester by conductometric method.
2. Determination of activity, activity coefficient of ions
3. Determination of pH of a Buffer solution (potentiometer)

pH Metry:

4.Dissociation constant of monobasic acid

5.Dissociation constant of dibasic acid

6.Dissociation constant of tribasic acid

Chemical Kinetics:

7.Study the influence of cu^{2+} and Fe^{2+} on the reaction between persulfate and iodide ions

8.Determination of energy of activation (E_a) for an acid catalyzed hydrolysis of an ester.

Adsorption :

9.Study of adsorption of acetic acid/oxalic acid on charcoal

Phase Rule:

10.Two component system-simple Eutectic

11.Three component system.

Text Books:

1. Levitt, B.P., Ed., (1985), *Findlay`s practical Physical Chemistry*, 9th Ed., Longman,UK.
2. Gurtu,J.N. and Kapoor, R., (1987), *Advanced Experimental Chemistry*, *Vol.I*, S.Chand & Co.,India.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3									3			3			
CO2	3		3								3			3			
CO3	3			3						3	3			3			
CO4	3	3						3		3	3			3		3	3

*1-Low *2-Medium *3-Strong

Semester IV	19CHED406: Project Work	L	T	C
		0	12	6

Learning Objective (LO):

LO1	To learn the basics of research work by carrying out selective academic and applied projects.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Acquire the practical knowledge of understanding research problems.
CO2	Gain knowledge about basic principles of various components of research.
CO3	Apply the principles of chemistry in various fields.

Project Work: Selective academic and applied projects.

1. The students will be allotted under the guidance of On-Campus Teachers as **PROJECT GUIDES** by the Head of the Department.
2. The Project Students have to discuss with the respective project guide about their area of interest for selection of the Project Topic and submit the written **PROJECT TOPICS** to the Head of the Department which is certified by the research guide.
3. The students have to prepare the **Project Report/Dissertation** (not less than 50 pages) and Submission of the same at least one month before the last working day of the IV Semester through their Research Guide.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3		3	3		3	3	3	3	3	3	3
CO2	3	3	3	3	3	3		2	3		3	3	3	3	3	3	2
CO3	3	3	3	3	3	2		3	3	3	3	3	3	3	3	3	3

*1-Low *2-Medium *3-Strong

DEPARTMENTAL ELECTIVE COURSES

Semester II	19CHEE206: Selective materials, Techniques and Environmental Chemistry	L	P	C
		3	0	3

Learning Objective (LO):

LO1	To learn the advanced materials, basics of important instruments and study the aspects of pollution

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Demonstrate knowledge of materials and chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
CO2	Develop an understanding of chemicals and their effects on the environment.
CO3	Develop an understanding of some basic principles of chemistry and apply these principles to current environmental issues.
CO4	Acquire broad knowledge of the field of environmental toxicology and chemistry including basic principles, target organ toxicity and the toxicity of a select group of chemical compounds.

Unit - 1: Chemistry of Selective Materials

Glasses – Oxide glasses – bond type – Viscosity - Zachariasen's rules – Sun-Rawson criterion – Chalcogenide glass – the photocopying process – glass ceramics – applications – refractories – applications - Solid electrolytes: AgI, $RhAg_4I_5$, β-Alumina – NASICON – Principles and Applications of solid electrolytes - Ferroelectric, piezoelectric and pyroelectric materials – principle, properties and applications. LED – principle – types –– properties – twisted nematic field display —- Shape Memory alloys (SMA) – classification – working principles.– second harmonic generators

Unit - 2: Spectral and thermal techniques

Instrumentation of AAS, AES, Spectrofluorimetry, types of optical instruments components, sample preparation application in quantitative analysis - IR spectroscopy-instrumentation- detectors- various types of sources- monochromators- sample cell considerations - sample preparations - Principle of TGA,DTA and DSC – applications.

Unit - 3: Air and water pollution

Air Pollution: Sources of pollutants - SO_2,NO_2,CO_2, hydrocarbons and lead-pollutant particle size – aerosols and particulates – photochemical and industrial smogs - Air pollution - upper atmosphere – greenhouse effect - biochemical effect of heavy metals, PAN and cyanide.

Water Pollution: Dissolved oxygen – BOD, COD – heavy metal as pollutants – thermal pollution – chemical pollution.

Unit – 4: Soil and radioactive pollutions

Soil pollution: Introduction – indicators of soil pollution - plants as indicators of soil pollution - sources of soil pollutions – fertilizers and pesticides - radioactive pollutants - solid wastes - treatments radioactive pollution.

Unit - 5: Environmental Toxicology

Chemical solution to environmental problems, biodegradability, principles of decomposition, better industrial processes. Bhopal gas tragedy, Chernobyl, Threemileisland, Sewazo and Minamata disasters. Industrial Pollution: Cement, sugar, distillery, drug paper and pulp, thermal power plants, nuclear power plants, metallurgy pol ymers drugs etc., radionuclide analysis, disposal of wastes and their management.

Current Streams of Thought: The Faculty will impart the current developments in the subject during the semester to the students and this component will not be a part of Examinations.

Text Books:

1. West, A. R, (2007), *Solid State Chemistry and its applications*, John Wiley, New Delhi.
2. Khopkar, S. M, (2008), *Basic concepts of Analytical Chemistry*, New Age International Publishers, New Delhi.
3. De, A.K., *Environmental Chemistry*, Wiley Eastern.India.
4. Khopkar, S.M. (2008), , *Environmental Chemistry*, Wiley Eastern.India.
5. Baird, C (2008), *Environmental Chemistry* 4th Ed, W.H Freeman Company, New York.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3			3						
CO2	3		3					3	3		3						
CO3	3			3				3		3	3			1			
CO4	3	3				3		3			3	1	1		3		3

*1-Low *2-Medium *3-Strong

DEPARTMENTAL ELECTIVE COURSES

Semester II	19CHEE207: Applied Chemistry	L	P	C
		3	0	3

Learning Objective (LO):

LO1	To learn the basics of applied chemistry

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Demonstrate knowledge of polymers.
CO2	Develop an understanding of chemicals and their effects on the environment.
CO3	Develop an understanding of some basic principles of photochemistry and apply these principles to current environmental issues.
CO4	Acquire broad knowledge of the field of fuel analysis.

Unit - 1: High Polymers

Naturally occurring Polymers -– Silk, Wool and collagen Synthesis, Properties and uses of the following polymers. PE, PP, PVC, PTFE, PMMA, PS, Bakelite, nylons, polyesters, polyamides, polyureas, Synthetic rubbers - Catenanes – 34 Carbon acyloin. Ion Exchange Resins.

Unit - 2: Analysis of Water Pollution

Origin of waste water, types, water pollutants and their effects. Sources of water pollution – domestic, industrial, agricultural soil and radioactive wastes as source of pollution, objectives of analysis – parameter for analysis – colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen, Heavy metal pollution. Public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Pesticides as water pollutants and analysis. Water pollution laws and standard.

Unit - 3: Applied Photochemistry

Photographic sensitizers – cyanins – pinacyanine, Kryptocyanine – ultraviolet screening agents – Uvinol, Tinuvin – Fluorescent whitening agent – Blankophor– β calcofluor – SD color photography. Additive and subtractive processes. Chemistry of color

Developers Flash photolysis. Chemistry of vision – organic transistors - Introduction examples, organic light emitting diodes – Applications

Unit - 4: Fuel Analysis and Agricultural Chemistry

Solid, liquid and gaseous fuels – ultimate and proximate analysis – calorific values – grading of coal – Liquid fuels – flash point, aniline point, octane number and carbon residues. Gaseous fuels - producer gas and water gas.

Analysis of soil: moisture, pH, total nitrogen, phosphorous, silica, lime, magnesia, manganese, sulphur and alkali salts.

Fertilizers: Fertilizer industries in India, manufacture of ammonia, ammonium salts, urea, nitrates, phosphates and superphosphates – mixed fertilizers – nitrogen fixation.

Unit - 5: Organic Nanomaterials

Fullerenes – synthesis and purification – magnetic and optical properties. Carbon nanotubes – synthesis purification and functionalaization.

Nanoscale organisation for organic sensors – Self-assembly-template method-biological assembling – Lithographic techniques – molecular nanomachines – introduction – single molecular devices.

Current Streams of Thought: The Faculty will impart the current developments in the subject during the semester to the students and this component will not be a part of Examinations.

Text Books:

1. Warren, S (1979) *Designing Organic Synthesis*, John Wiley & Sons, India.
2. Roberts,J. D. And Caserio,M.C.(1982) *Basic Principles of Organic Chemistry*, 2nd Edition,W. A. Benjamin Inc.US.
3. Depuy,C.H and Chapman,D (1985) *Molecular Reactions and Photochemistry*, Prentice Hall. New Delhi.
4. Carrauthers, W (1971) *Some Modern Methods in Organic Synthesis*, Cambridge University Press.UK.
5. Abraham,D.J Edr.(2003) *Burger's Medicinal Chemistry and Drug Discovery, Vol. I.* 2nd edition, John Wiley & Sons., India.
6. Pradeep,T (2007) *Nano: The Essentials*, Tata McGraw Hill, New Delhi.
7. Jackson, M. L (1973) *Soil Chemical Analysis*, Prentice Hall of India, New Delhi.
8. Khopkar,S. M (2011) *Environmental Pollution Analysis*, 2nd edition, New Age International, New Delhi.
9. Dara,S. S. (1993) *A Text Book of Environmental Chemistry and Pollution Control,* S.Chand & Company Ltd. New Delhi.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3						3			3						
CO2	3		3								3	2					
CO3	3			3						3	3			3			
CO4	3	3						3		2	3	3	3			3	3

*1-Low *2-Medium *3-Strong

DEPARTMENTAL ELECTIVE COURSES

Semester III	19CHEE307: Scientific Research Methodology	L	P	C
		3	0	3

Learning Objective (LO):

LO1	To introduce the purpose and importance of research for future development.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the basics of research.
CO2	Appreciate the tools of research.
CO3	Get exposure to research problems.

UNIT - 1 : Meaning of Research

The search for knowledge, purpose of research, scientific method, role of theory, characteristics of research - Types of research: fundamental or pure research, applied research, action research, historical research, experimental research.

UNIT - 2 : Chemical Literature

Sources of chemical information: primary, secondary and tertiary sources - Indexes and abstracts in science and technology: applied science and technology index,biological abstracts, chemical abstracts, chemical titles, current chemical reactions, current contents, engineering index, index chemicus, index medicus, physics abstracts, science citation index - Classical and comprehensive reference works in chemistry. Beilstein, compilations of data, synthetic methods and techniques, treatises, reviews .

UNIT - 3 : Chemical Abstracts

Current awareness searching: CA weekly issues, CA issue indexes - Retrospective searching: CA volumeindexes – general subject index, chemical substance index, formula index, index of ring systems, author index, patent index - 3CA Collective indexes: Collective index (CI), decennial index (DI) - Access points for searching CA indexes: index guide, general subject terms, chemical substance names, molecular formulas, ring systems, author names, patent numbers - Locating the reference: finding the abstract, finding the original document, chemical abstract service source index.

UNIT - 4 : Scientific Writing

Scientific writings: research reports, theses, journal articles, and books - requirement of technical communications: eliminating wordiness and jargon- tautology, redundancy, imprecise words, superfluous phrases - Steps to publishing a scientific article in a journal: types of publications-communications, articles, reviews; when to publish, where to publish,

specific format required for submission, organization of the material - Documenting: abstracts-indicative or descriptive abstract, informative abstract, footnotes, end notes, referencing styles, bibliography-journal abbreviations (CASSI), abbreviations used in scientific writing.

UNIT - 5: Computer Searches of Literature

ASAP Alerts, CA Alerts, SciFinder, ChemPort, ScienceDirect, STN International Journal home pages.

Current Streams of Thought: The Faculty will impart the current developments in the subject during the semester to the students and this component will not be a part of Examinations.

Text books:

1. Dominoswki,R.L (1981) *Research Methods*, Prentice Hall. New Delhi.
2. Best,J.W.(1981) *Research in Education*, 4th ed. Prentice Hall of India, New Delhi.
3. Ebel, H.F., Bliefert, C and Russey,W.E, (1988) *The Art of Scientific Writing*, VCH, Weinheim., New York.
4. Cain, B.E, (1988) *The Basis of Technical Communicating*, ACS., Washington, D.C.
5. Kanare,H.M.,(1985) *Writing the Laboratory Notebook*; American Chemical Society: Washington, DC.
6. Dodd, J.S Ed.,(1985) *The ACS Style Guide: A Manual for Authors and Editors;* American Chemical Society: Washington, DC.
7. Gibaldi, J and Achtert, W. S.(1987) *Handbook for writers of Research Papers,* 2nd ed, Wiley Eastern.,India.
8. Joseph, A.(1986) *Methodology for Research*, Theological Publications: Bangalore.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3		3	3		3	3			3		3				
CO2	3		3	3		3			3		3	2		2		2	2
CO3	3			3					3	3	3				1		

*1-Low *2-Medium *3-Strong

DEPARTMENTAL ELECTIVE COURSES

Semester III	19CHEE308: Organic Chemical Technology	L	P	C
		3	0	3

Learning Objective (LO):

LO1	To understand the elements of chemical engineering in organic synthesis and to know the unit processes in organic chemical technology.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the basics of chemical technology.
CO2	Appreciate principle of chemical engineering.
CO3	Get idea about applications of chemistry in industries.

UNIT - 1 : Elements of Chemical Engineering

Unit operations in chemical engineering: Fluid flow: Reynold's number, Laminar and turbulent flow. Bernoullis' equation, head loss in piping. Calculation of head as an aid in selecting pumps. Turbulent flow and its relevance in heat transfer. Agitation and mixing of liquids - Heat transfer: Heat transfer coefficient, Importance of heat transfer in chemical process. Special provisions for heat transfer in highly exothermic reactions. Corrosion and scale formation in heat exchangers and condensers. Preliminary data to aid design of heat transfer equipment - Mass transfer: Distillation - two and three component systems. Ideal and non-ideal systems, various types of fractioning columns.

UNIT - 2: Applications of Thermodynamics in Organic Unit Processes

Energy balance over a flow system, heat of reaction, effect of temperature upon heat of reaction - Chemical equilibrium, calculation of equilibrium conversion, entropy changes, simultaneous reactions.

UNIT - 3 : Organic Chemical Process Kinetics

Factors vapour phase and liquid phase catalytic reactions affecting chemical processes - Type and shape of reactors used, the method of operation, temperature control - Batch or flow process, batch mixing, fixed or fluidized bed.

UNIT - 4 : Unit Process in Industrial Organic Synthesis

Study of Organic reactions as they apply to industrial processes. Process parameters of importance in scaling up of these reactions from laboratory to pilot plant to main plant - Selection of suitable plant equipment, especially the shape and size of the

reactor stirrer, condenser etc. choice of material of construction - Study of industrial scale nitration, sulphonation, homogeneous and heterogeneous hydrogenation, oxidation and halogenations reactions.

UNIT-5: Study of Detailed Technologies of Manufacture – a dye, a drug and a pigment

Three specific chemicals, one each from the above category will be discussed, illustrating the chemical engineering principles used in proper selection of equipment - The logic involved in the layout of the plant, the control tests for the process itself and isolation methods of the product and its standardization - Importance of quality control and technical service to customers will be pointed out.

Current Streams of Thought: The Faculty will impart the current developments in the subject during the semester to the students and this component will not be a part of Examinations.

Text books:

1. McCabe, W. L and Smith, J.C(1976) *Unit Operations of Chemical Engineering,* 3rd Edition, McGraw-Hill Kogakusha Ltd.,Tokyo.
2. Groggins,P.H (1958) *Unit Processes in Organic Synthesis,*5th Edition McGraw-Hill Kogakusha Ltd., Tokyo.

Supplementary reading:

3. Dridens,(2001), *Outlines of Chemical Technology*, Affiliated East-West Press Pvt. Ltd. India.
4. BIOS, CIOS and FIAT technical reports on the German chemical industry.
5. Clausen,C.A and Matson,G (1978) *Principles of Industrial Chemistry*, John Willey & Sons, New York.

Outcome Mapping:

	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO1	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3				2		3			3	3					
CO2	3		3				2		3		3	3				3	
CO3	3			3						3	3	3			3		3

*1-Low *2-Medium *3-Strong