B.S. Abdur Rahman® Crescent Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2025

CURRICULUMANDSYLLABI

(As approved by 24th Academic Council)

August - 2025

M.SC. CHEMISTRY

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio- Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF CHEMISTRY

VISION

To evolve as a premier department, achieving excellence in chemical Sciences through academic research programs, interdisciplinary collaboration and fostering innovation for societal impact.

MISSION

- To Impart specialized knowledge and advanced skills in Chemical Sciences through postgraduate and doctoral programs.
- To undertake research in emerging areas of Chemical Sciences and translating findings into tangible societal benefits.
- To establish strategic collaborations with industry and research institutes to drive joint research projects for technological transfer.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M.SC. CHEMISTRY

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs)

- To demonstrate a broad knowledge of descriptive chemistry.
- To impart the basic analytical and technical skills to work effectively in the various fields of chemistry.
- To motivate critical thinking and analytical skills to solve complex chemical problems, e.g., analysis of data, interpretation of spectra, prediction of chemical structure, team-based problem solving, etc.
- To demonstrate an ability to conduct experiments in the above subdisciplines with mastery of appropriate techniques and proficiency using core chemical instrumentation and modeling methods.
- To perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusion
- To develop skills in quantitative modeling of static and dynamic chemical systems.
- To develop laboratory competence in relating chemical structure to spectroscopic phenomena.
- To synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment and modern instrumentation.

PROGRAMME OUTCOMES(POs)

On successful completion of the programme, the graduates will be able to,

- Think critically and analyze chemical problems.
- Present scientific and technical information resulting from laboratory experiments in both written and oral formats.
- Work effectively and safely in a laboratory environment.
- Use technologies/instrumentation to collect and analyze data
- Work in teams as well as independently.
- Apply modern methods of analysis to chemical systems in a laboratory setting

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- **PSO1:** Graduates will demonstrate the ability to synthesize, separate, and characterize complex chemical compounds by integrating knowledge of chemical structure with spectroscopic data.

- **PSO2:** Graduates will be able to perform accurate quantitative measurements and master the use of contemporary chemical instrumentation to analyze data and solve complex chemical problems.

- **PSO3:** Graduates will apply advanced analytical techniques and quantitative methods to solve complex chemical problems, effectively communicating their scientific findings through professional written reports and oral presentations.

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI – 600 048.
REGULATIONS 2025

M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)

ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.

iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare, conduct of co-curricular, extra-curricular events and discipline in the campus.

viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **"Dean of the School"** means the Dean of the School of the department concerned.

x) **"Head of the Department"** means the Head of the Department concerned.

2.0 ADMISSION REQUIREMENTS

2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 BRANCHES OF STUDY

3.1 The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

3.2 Programmes offered

S. No.	Name of the Department	Programmes offered
1.	Aeronautical Engineering	M.Tech. (Avionics)
2.	Civil Engineering	M.Tech. (Structural Engineering)
		M. Tech. (Construction Engineering and Project Management)
3.	Mechanical Engineering	M.Tech. (CAD/CAM)
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)

S. No.	Name of the Department	Programmes offered
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)
		M.Tech. (Artificial Intelligence and Data Science)
7.	Information Technology	M.Tech. (Information Technology)
8.	Computer Applications	MCA
9.	Mathematics	M.Sc. (Actuarial Science)
10.	Physics	M.Sc.(Physics)
11.	Chemistry	M.Sc.(Chemistry)
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology
		M.Sc. Biotechnology
		M.Sc. Microbiology
		M.Sc. Stem Cell Technology
		M.Sc. Clinical Embryology
		M.Tech. Biotechnology
		M.Tech. Food Biotechnology
13.	Commerce	M.Com
14.	Arabic and Islamic Studies	M.A. Islamic Studies

3.3 Eligible entry qualifications for admission to programmes

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
	M. Tech. (Construction Engineering and Project Management)	B.Tech. in Mechanical / Civil / Electrical and Electronics / Geo Informatics / B Plan / B. Des, and B.Arch.
3.	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
	M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
7.	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2level or equivalent degree in relevant field.
9.	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	M.Sc.(Physics)	B.Sc. in Physics / Applied Science /

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Stem Cell Technology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Clinical Embryology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
	M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
13. .	M.Com	B.Com. / BBA
14. .	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with Aalim Sanad / Diploma / Certificate in Arabic or Islamic Studies.

4.0. STRUCTURE OF THE PROGRAMME

4.1. The PG. programmes consist of the following components as prescribed in the respective curriculum:

i. Core courses
ii. Elective courses
iii. Laboratory integrated theory courses
iv. Project work
v. Laboratory courses
vi. Open elective courses
vii. Seminar
viii. Mini Project
ix. Industry Internship
x. MOOC courses (NPTEL- Swayam, Coursera etc.)
xi. Value added courses

4.1.1. The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

4.1.2. For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

4.1.3. The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Range of credits
M.Tech.	80 - 86
MCA	80 - 86
M.Sc.	80 - 85
M.Com.	80 - 88
M.A.	80 - 84

4.1.4. Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester.
- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

4.1.5. The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

4.1.6 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

4.1.7 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

4.1.8 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, alter to

open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

4.1.9. Online courses

Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

Students shall undergo project related online course on their own with the mentoring of the project supervisor.

3.5 Project work

3.5.1 Project work shall be carried out by the student under the supervision of a faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work and shall re-register in the subsequent semester.

5.0 DURATION OF THE PROGRAMME

5.1. The minimum and maximum period for completion of the programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

5.2 Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.

5.3 Medium of instruction, examinations and project report shall be in English.

6.0 REGISTRATION AND ENROLLMENT

6.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

6.2 Change of a Elective Course

A student can change an enrolled elective course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

6.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

6.4 A student can enroll for a maximum of 36 credits during a semester including Redo / Predo courses.

7.0 BREAK OF STUDY FROM PROGRAMME

7.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

7.1.1 Medical or other valid grounds

7.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

7.1.3 Debarred due to any act of indiscipline

7.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

7.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

7.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

8.0 CLASS ADVISOR AND FACULTY ADVISOR

8.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

8.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

9.0 COURSE COMMITTEE

9.1 Each common theory / laboratory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as course

coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

10.0 CLASS COMMITTEE

10.1 A class committee comprising faculty members handling the courses, student representatives and a senior faculty member not handling any courses for that class as chairman will be constituted in every semester:

10.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department
ii) Faculty members of all courses of the semester
iii) All the students of the class
iv) Faculty advisor and class advisor
v) Head of the Department – Ex officio member

10.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

10.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi of courses.

10.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a

common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

11.0 CREDIT REQUIREMENTS TO REGISTER FOR PROJECT WORK

11.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

11.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightage of Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.4 Laboratory Integrated Theory (LIT) Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component (for a 4 credit LIT Course). Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

Component	Maximum Marks	Weightage for Final Grade	Mode of Assessment
Theory Component	100	75%	CAT1 (25%) + CAT2 (25%) + SEE (50%)
Practical Component	100	25%	Continuous assessment only
Final Grade Basis	Consolidated	100%	75% Theory + 25% Practical
Pass Requirement	-	-	Minimum 40% in Semester-End Theory Exam (SEE)

Note:

1. Proportionate weightage shall be assigned to LIT courses based on their credit value, whether 2 or 3 credits.
2. In Lab-Integrated Professional Elective courses, the laboratory component shall be assessed by the course faculty.

12.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.6 Industry Internship

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

Mini project work, shall be carried out individually or as a group activity involving a maximum of three students.

Each group shall identify a suitable topic within their domain, either disciplinary or interdisciplinary, based on the students' abilities and in consultation with the faculty mentor. The topic must lead to the development of a small-scale system or application.

The progress of the mini project shall be evaluated through three periodic reviews: two interim reviews and one final review. A project report shall be submitted by the end of the semester. The reviews shall be conducted by a committee of faculty members constituted by the Head of the Department / Dean of the School.

An oral examination (viva voce) shall be conducted as the semester-end examination by an internal examiner approved by the Controller of Examinations, based on the project report.

The weightage for assessment shall be as follows:

• Periodic Reviews: 50%

- 25% by the Project Guide
- 25% by the Review Committee

• Project Report: 20%

• Viva Voce Examination: 30%

The Project shall be carried out individually or as a group activity, involving a maximum of two or three students.

A committee of faculty members, constituted by the Head of the Department / Dean of the School, shall conduct three periodic reviews during the semester to monitor and assess the progress of the project.

At the end of the semester, students shall submit a project report, based on

which a semester-end oral examination (viva voce) shall be conducted by an external examiner approved by the Controller of Examinations.

The assessment weightage shall be as follows:

• Periodic Reviews – 50%

- 25% by the Project Guide
- 25% by the Review Committee

• Project Report – 20%

• Viva Voce Examination – 30%

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 **For the first attempt of the arrear theory examination**, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. **There shall be no arrear or improvement examination for lab components**.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of

the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

14.1 A student shall earn 100% attendance in the scheduled contact hours (such as lectures, tutorials, labs, etc.) for that course. However, a relaxation of up to 25% in attendance may be granted to account for valid reasons such as medical emergencies, participation in co-curricular or extracurricular activities with prior approval, or other genuine circumstances.

If a student's attendance falls below 75% in a particular course, even after considering the permissible relaxation, they will not be allowed to appear for the semester-end examination in that course. Instead, the student will be awarded an “I” grade (Incomplete) for the course

14.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

14.3 If a student’s attendance in any course falls between 65% and 75% due to medical reasons (e.g., hospitalization, illness) or participation in institution-approved events, they may be granted exemption from the minimum attendance requirement and allowed to appear for the semester-end exam. The student must submit valid documents to the class advisor upon rejoining, with approval from the HoD/Dean. Final approval for **condonation** will be granted by the Vice Chancellor based on the Dean (Academic Affairs)’s recommendation.

14.4 A student who has obtained an “I” grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall **repeat** all the courses of the semester in the subsequent academic year. However, he /

she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

14.5 The student awarded “I” grade, shall enroll and repeat the course when it is offered next. In case of “I” grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

14.6 A student who is awarded “U” grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to **redo** the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains “U” grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

14.7 If a student with “U” grade, who **prefers to redo** any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier “U” grade and continuous assessment marks shall continue.

15.0 REDO / PRE-DO COURSES

15.1 A student can register for a maximum of three redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the concerned department, based on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

15.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is **no provision for any substitute examination and withdrawal from a redo course**.

15.3 A student shall be permitted to pre-do a course offered by the concerned department, provided it does not affect the regular semester class schedule. Such permission shall be granted based on the availability of faculty members, the maximum permissible credit limit of the semester, and the

student's fulfillment of the necessary prerequisites for the course. The proposal shall be recommended by the Dean of the School and the Head of the Department, and shall require final approval from the Dean (Academic Affairs).

16.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

16.1 All assessments of a course shall be made on absolute marks basis. The class committee without the student members shall meet to analyse the performance of students in all assessments of a course and award letter grades following the relative grading system. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-
I	-
PA	-
FA	-

"W"- denotes withdrawal from the course

"I" - denotes "Incomplete" ie. inadequate attendance in the course and prevention from appearance of semester end examination

"U" - denotes unsuccessful performance in the course.

"PA" - denotes the 'Pass' of the zero credit courses.

"FA" - denotes the 'Fail' of the zero credit courses.

16.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be **repeated by the student for improvement of grade**.

16.3 Upon awarding grades, the results shall be endorsed by the chairman of the

class committee and Head of the Department / Dean of the School. The Controller of Examinations shall further approve and declare the results.

16.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee, through proper application to the Controller of Examinations. Subsequently, the Head of the Department / Dean of the School offered the course shall constitute a revaluation committee consisting of chairman of the class committee as convener, the faculty member of the course and a senior faculty member having expertise in that course as members. The committee shall meet within a week to revalue the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

16.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from the first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i}$$

Point in the i^{th} course,

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I”, "W", “PA” and **“FA”** grades are excluded for calculating GPA.

"U", “I”, "W", “PA” and **“FA”** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks shall be as follows:

Percentage equivalent of marks = CGPA X 10

16.6 After successful completion of the programme, the degree shall be awarded to the students with the following classifications based on CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the prescribed period of 8 semesters for all students (except lateral entry students) and 6 semesters for lateral entry students
First Class	6.50 and above and completing the programme within a maximum of 10 semesters for all students (except lateral entry students) and 8 semesters for lateral entry students
Second Class	Others

16.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the UG programme within the minimum prescribed period of study (except clause 7.1.1)

16.6.2 Eligibility for First Class

- A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 7.1.1)

16.6.3 The students who do not satisfy clause 16.6.1 and clause 16.6.2 shall be classified as second class.

16.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

17.0 SUPPLEMENTARY EXAMINATION

Final year students and passed out students can apply for supplementary

examination for a maximum of **three** courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of **three** courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

18.0 DISCIPLINE

18.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

18.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the Head of the Department / Dean of the School concerned shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

19.0 MULTI ENTRY AND MULTI EXIT (MEME) FRAMEWORK *

In accordance with the provisions of the National Education Policy (NEP) 2020, the programme shall support a Multi Entry – Multi Exit (ME-ME) framework to provide flexibility in the academic pathway of students.

*** At present (AY 2025-26), it is applicable only for all M.Tech. Programmes.**

19.1. Exit Option:

19.1.1 Credit Requirement for Award of M.Tech. Degree

To qualify for the award of a M.Tech. degree from the Institute, a student must successfully complete the total credit requirements as prescribed in the approved curriculum of the respective programme. The specific credit requirements are determined by the programme curriculum.

19.1.2 Provision for Multiple Exit

In alignment with NEP 2020 guidelines, the Institute provides students enrolled in postgraduate programmes with the option of multiple exits, subject to the following conditions:

a. Exit at the End of First Year

Students may choose to exit the programme at the end of the first year,

provided they have fulfilled the prescribed academic requirements.

b. Application for Exit

A student intending to exit must submit a formal written application in the prescribed format at least **eight weeks prior to the scheduled end of the academic year.**

c. Departmental Recommendation

1. Upon receipt of the application, the concerned Department shall evaluate the academic record of the student and recommend the award of a **Post Graduate Diploma**, based on the credits earned.

2. In the case of arrear courses, the post graduate diploma will be conferred only after successful clearance of all pending arrears.

d. Notification of Completion

Once a student has fulfilled the requirements for the award of post graduate diploma, the Department shall notify the same to controller of examinations for further processing and issuance.

19.1.3 Award of Qualifications under Multiple Exit Scheme

Post graduate diploma: Awarded after successful completion of the first year, subject to earning the prescribed cumulative credits as per the respective programme curriculum (e.g., 44 credits from the first year) along with 3 credits of Skill Based Courses.

19.1.4 Conditions Governing Exit

1. The multiple exit facility is intended strictly for **genuine and exceptional circumstances,** such as prolonged illness, or securing an employment opportunity necessitating a temporary withdrawal from the programme.

2. Students opting for a temporary exit after the first year must obtain **prior approval from the Registrar through Dean (Academics),** based on the recommendation of the respective Head of the Department.

19.1.5 Expectation of Programme Continuity

While the option for multiple exits exists, it is generally expected that students admitted to a post graduate programme shall pursue their studies continuously until completion of the final degree requirements.

19.2. Entry Option:

Students seeking re-entry into the programme (multi-entry) must submit an application through the proper channel at the beginning of the odd semester.

Admission shall be subject to fulfilment of institutional guidelines, credit mapping, and availability of seats.

19.3. Credits Requirement for the Certifications

Name of the Certificate Programme	Required Credits
Post graduate Diploma (Level 6.5 as per NEP 2020)	40* - 45

* The minimum number of credits that a student must earn (as per the respective curriculum) in order to get the above certification program

20.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

20.1 A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the maximum period of 8 semesters from the date of admission, including break of study.

ii. No disciplinary action is pending against him/her.

iii. Enrolled and completed at least one value added course.

iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

20.2 The award of the degree must have been approved by the Institute.

21.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S.ABDURRAHMANCRESCENTINSTITUTEOFSCIENCEAND TECHNOLOGY

REGULATIONS 2025

CURRICULUM &SYLLABI FOR

M.SC. CHEMISTRY

SEMESTER I

S.No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	CHF6101	Stereochemistry and Reaction Mechanisms	4	0	0	3
2.	PCC	CHF6102	Thermodynamics and Chemical Equilibria	4	0	0	3
3.	PCC	CHF6103	Concepts in Inorganic Chemistry	3	0	0	3
4.	PEC	CHFYXXX	Professional Elective1	3	0	0	3
5.	PEC	CHFYXXX	Professional Elective2	3	0	0	3
6.	PCC - LC	CHF 6104	Organic Chemistry Practical I	0	0	4	2
7.	PCC - LC	CHF 6105	Physical Chemistry Practical I	0	0	4	2
8.	PCC - LC	CHF 6106	Inorganic Chemistry Practical I	0	0	4	2
9.	PROJ	CHF 6107	Scientific Seminar	0	2	0	1
10.	MC	MAF 6188	Mathematics for Chemistry	2	0	0	2[$]
			Credits				**22/ 24**

SEMESTER II

S.No.	Course Group	Course Code	Course Title	L	T	P	C
1.	ES	GEF 6202	Research Methodology and IPR	3	1	0	4
2.	PCC	CHF 6201	Synthetic Organic Chemistry I	3	0	0	3
3.	PCC	CHF 6202	Chemical Kinetics and Electrochemistry	3	0	0	3
4.	PCC	CHF 6203	Coordination Chemistry	3	0	0	3
5.	PEC	CHFY XXX	Professional Elective 3	3	0	0	3
6.	PCC - LC	CHF 6204	Organic Chemistry Practical II	0	0	4	2
7.	PCC - LC	CHF 6205	Physical Chemistry Practical II	0	0	4	2
8.	PCC - LC	CHF 6206	Inorganic Chemistry Practical II	0	0	4	2
9.	PROJ	CHF 6207	Mini Project	0	0	4	2
10.	MC	ENE 6281	Professional Communication	0	0	2	1
			Credits				**25**

SEMESTER III

S.No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	CHF 7101	Synthetic Organic Chemistry II	3	0	0	3
2.	PCC	CHF 7102	Quantum Chemistry and Group Theory	3	0	0	3
3.	PCC	CHF 7103	Organometallics and its Applications	3	0	0	3
4.	PEC	CHFY XXX	Professional Elective 4	3	0	0	3
5.	PEC	CHFY XXX	Professional Elective 5	3	0	0	3
6.	OEC	OEE XXX	Open Elective 1	3	0	0	3
7.	PROJ	CHF 7201	Project Work - Phase I	0	0	8	4*
8.	PROJ	CHF 7105	Industry Internship #	0	0	4	2
9.			MOOC (Course)				
			Credits				**20**

SEMESTER IV

S.No.	Course Code	Course Title	L	T	P	C
1.	CHF 7201	Project Work - Phase II	0	0	34	10
		Credits			**(4 + 10 =14)**	

Overall Total Credits – 81 / 83

* Credit for Project Phase-I is incorporated in phase–II

$ non-Mathematics students of B.Sc. Chemistry

Industrial training will be undertaken during first year summer vacation for 30 days. The credit will be awarded in the 3rd Semester.

LIST OF PROFESSIONAL CORE ELECTIVES

S.No.	Course Code	Course Title	L	T	P	C
		Analytical Chemistry				
1.	CHFY001	Analytical Techniques	3	0	0	3
2.	CHFY002	Principles and Applications of Photophysicsand Photochemistry	3	0	0	3
3.	CHFY003	Computational Chemistry	3	0	0	3
4.	CHFY004	Basics of Forensic Chemistry	3	0	0	3
5.	CHFY005	Molecular Spectroscopy with Structural Interpretation	3	0	0	3
		Medicinal, Pharmaceutical and Biological Chemistry				
6.	CHFY006	Biomolecules	3	0	0	3
7.	CHFY007	Biochemistry	3	0	0	3
8.	CHFY008	Chemistry of Carbohydrates	2	0	2	3
9.	CHFY009	Medicinal and Pharmaceutical chemistry	3	0	0	3
10.	CHFY010	Advanced Concepts in Organic Synthesis	3	0	0	3
		Materials and Technology				
11.	CHFY011	Nanomaterials andApplications	3	0	0	3
12.	CHFY012	Corrosion and its Control	3	0	0	3
13.	CHFY013	Polymer Science and Technology	3	0	0	3
14.	CHFY014	Polymer Structure and Property Relationship	3	0	0	3
15.	CHFY015	Solid State Chemistry and Applications	3	0	0	3
		Energy, Water and Environment for Sustainability				
16.	CHFY016	Green Chemistry	3	0	0	3
17.	CHFY017	Concepts and Techniques in Catalysis	3	0	0	3
18.	CHFY018	Alternative Energy Sources: Conversion and Storage	3	0	0	3
19.	CHFY019	Biomass for Energy Applications	3	0	0	3
20.	CHFY020	Industrial Pollution Control	3	0	0	3

SEMESTER I

		L	T	P	C
CHF6101	**STEREOCHEMISTRY AND REACTION**				
SDG: 9	**MECHANISMS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES: To make the students to understand the

COB1: concepts of absolute and relative configurations in stereochemistry

COB2: various theoretical models that explain stereoselectivity and stereospecificity

COB3: detailed mechanisms of nucleophilic and electrophilic substitution reactions

COB4: principles and mechanisms of addition and elimination reactions

COB5: concepts in aromaticity

MODULE I STEREOCHEMISTRY - I L: 9 T: 0 P: 0

Introduction to molecular symmetry and chirality - optical isomerism - conditions for optical activity - Fischer, Newmann, Sawhorse and flying wedge projection formulae and their interconversions - D and L Notation - Cahn - Ingold - Prelog rules, R and S - notations - optical activity in the absence of chiral carbon: biphenyls, binaphthyls, allenes, spiranes, exo - cyclic alkylidene, cycloalkanes, ansa and cyclophanic compounds - geometrical isomerism: cis, trans and E,Znomenclature - Topicity and prostereoisomerism: prochirality, homotopic, enantiotopic and diastereotopic atoms, groups and faces.

MODULE II STEREOCHEMISTRY - II L: 9 T: 0 P: 0

Conformational analysis: acyclic systems: 1,2 disubstituted ethane derivatives - cyclic systems: cyclobutane, cyclopentane, cyclohexane and cycloheptane - Conformation and reactivity in disubstituted cyclohexanes - asymmetric synthesis: stereoselective, stereospecific reactions - Felkin - Ann model - - Cram’s rule - Prelog’s rule - enantioselective synthesis - optical purity and enantiomeric excess - desymmetrisation and kinetic resolution - methods of determination of absolute configuration - racemic modifications - racemisation: thermal, anion, cation, reversible formation - resolution of racemic modifications - epimerisation - mutarotation.

MODULE III NUCLEOPHILIC AND ELECTROPHILIC SUBSTITUTION REACTIONS L: 9 T: 0 P: 0

Aliphatic nucleophilic substitution (S_N1, S_N2 and S_Ni): mechanism, stereochemistry, effects of substrate, attacking nucleophile, leaving group, solvent and neighbouring group participation - substitutions at carbonyl, bridgehead, vinylic and allylic carbons - ambident nucleophiles - O versus C alkylation - aromatic nucleophilic substitution (ArS_N2, ArS_N1 and Benzynemechanisms) - reactions of aryl diazonium salts - aromatic electrophilic substitution reactions: nitration, sulphonation; chlorination, bromination and Friedel - Crafts reaction.

MODULE IV ADDITION AND ELIMINATION REACTIONS L: 9 T: 0 P: 0

Electrophilic, nucleophilic and free radical additions to carbon - carbon and carbon - hetero multiple bonds - stereochemistry, orientation and reactivity - E1, E2 and E1CB: mechanisms, effects based on substrates, attacking base, leaving group and solvent - stereochemistry of E2 elimination - competition between elimination and substitution reactions - orientation effects in elimination reactions - pyrolytic eliminations - Chugaev and Cope eliminations.

MODULE V AROMATICITY L: 9 T: 0 P: 0

Huckel's rule - aromaticity, anti - aromaticity, non - aromaticity and homo - aromaticity - neutral, charged aromatic systems (3, 4, 5, and 7 - membered ring systems), annulenes, fused rings systems, heterocycles and hetero annulenes.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Eliel E.L. and Wilen S.H., Stereochemistry of Organic Compounds, John Wiley India, 2009.
2. Kalsi P.S., Stereochemistry Conformation and Mechanism, 11th Edition, New Age International Private Limited. 2022.
3. Clayden, J.; Greeves, N.; and Warren, S. Organic Chemistry, 2nd Edition, Oxford University Press, 2014.
4. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.
5. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009.

REFERENCES:

1. J Nasipuri D., Stereochemistry of Organic Compounds, 4nd Edition, New Age International Private Limited. 2020.
2. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A - Structure and Mechanisms, 5th Edition, Springer, 2007.
3. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007.
4. Peter Sykes, Guidebook to Mechanism in Organic Chemistry, Orient Longman, 2005.
5. Ahluwalia, V. K.; Parashar, R. K. Organic Reaction Mechanism, Narosa publications, 4th Edition, 2010.

COURSE OUTCOMES: The student will be able to

CO1: assign stereochemical configuration of organic compounds

CO2: apply stereochemical concepts for predicting reaction products

CO3: postulate the mechanism of nucleophilic and electrophilic substitution reactions

CO4: depict the mechanism of various addition and elimination reactions

CO5: **e**valuate compounds for aromaticity based on electronic configuration and structural features

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	-	-	H	-	-	H	H	M
CO2	H	M	-	-	H	-	-	H	H	M
CO3	H	H	-	-	H	-	-	H	H	H
CO4	H	H	-	-	H	-	-	H	H	M
CO5	M	L	-	-	L	-	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation and knowledge dissemination.

CHF6102	THERMODYNAMICS AND CHEMICAL	L	T	P	C
SDG: 4	EQUILIBRIA	3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: the fundamental laws of thermodynamics and partial molar properties to analyze ideal and non - ideal systems in binary and ternary mixtures

COB2: principles of statistical thermodynamics and apply partition functions to evaluate thermodynamic properties and equilibrium constants

COB3: principles of irreversible thermodynamics and their relevance to physical and biological systems

COB4: thermodynamics of chemical equilibria and the influence of molecular structure on reaction rates

COB5: concepts of phase transitions and equilibria in one - , two - and three - component systems

MODULE I CLASSICAL THERMODYNAMICS L: 9 T: 0 P: 0

Review of laws of thermodynamics - partial molar properties: chemical potential - Gibb's - Duhem equation - binary and ternary systems - effect of pressure and temperature - Lewis Rendal rule - determination of partial molar quantities - thermodynamics of real gases: Fugacity - determination of fugacity by graphical and equation of state methods - dependence of temperature, pressure and composition - thermodynamics of ideal and non - ideal binary mixtures - Duhem - Margulus equation - applications of ideal and non - ideal mixtures - activity and activity coefficients - standard states - determination of activity: vapour pressure and freezing point methods.

MODULE II STATISTICAL THERMODYNAMICS L: 9 T: 0 P: 0

Introduction of statistical thermodynamics - concepts of thermodynamic and mathematical probabilities - distribution of distinguishable and non - distinguishable particles - assemblies, ensembles and canonical particles - Maxwell - Boltzmann, Fermi - Dirac and Bose - Einstein statistics - comparison and applications - partition functions - evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases - thermodynamic functions in terms of partition functions - calculation of equilibrium constants - statistical approach to thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function, residual entropy, equilibrium constants and equipartition principle - heat capacity of mono and di atomic gases - ortho and para hydrogen - heat capacity of solids - Einstein and Debye

models.

MODULE III IRREVERSIBLE THERMODYNAMICS L: 9 T: 0 P: 0

Theories of conservation of mass and energy - entropy production in open systems by heat, matter, current flow, force and flux concepts - Onsager theory: validity and verification - Onsager reciprocal relationships - electro kinetic and thermo mechanical effects - Peltier effect and Seebeck effect - Application of irreversible thermodynamics to biological systems.

MODULE IV CHEMICAL EQUILIBRIA L: 9 T: 0 P: 0

Free energy of spontaneous reaction - law of mass action - De Donder's treatment of chemical equilibria - temperature dependence of equilibrium constant Vant's Hoff Equation - Le Chatelier principle - heterogeneous equilibria - - Hammett equation - Taft equation.

MODULE V PHASE EQUILIBRIA L: 9 T: 0 P: 0

Elementary description of phase transitions - phase equilibria and phase rule: one component systems (water, CO_2, S) and two component system - thermal analysis curve - two component system: solid - gas (dehydration and rehydration of $CuSO_4$. $5H_2O$), solid - liquid - three component systems involving liquid - liquid equilibria - fractional distillation - azeotropes and eutectics.

L - 45; T - 0; P - 0; Total Hours: 45

TEXT BOOKS:

1. Rajaram J. and Kuriacose J.C. Chemical Thermodynamics: Classical, Statistical and Irreversible, 1st Edition, Pearson Education India, 2013.
2. Klotz I.M. and Rosenberg R.M. Chemical Thermodynamics: Basic Concepts and Methods, 7th edition, Wiley - Interscience, Newwork, 2010.
3. Puri B.R., Sharma L.R. and Pathania M.S., Principles of Physical Chemistry, 48th Edition, Vishal Publishing Co. India, 2022.

REFERENCES:

1. Atkins P., Paula J.D. and Keeler J. Atkins' Physical Chemistry, 12th Edition, Oxford University Press, London, 2022.
2. Glasstone S. Thermodynamics for Chemists, Eastern Wiley Publication, 2008.
3. Castellan G.W., Physical Chemistry, 3rd Edition, Narosa Publishing House, 2004.
4. Nash L.K. and Addison, Elements of Statistical Thermodynamics, Wiley Publication Co., 1971.
5. Gupta M.C., Statistical Thermodynamics, New Age International Private Limited, 4th

Edition, 2024.

COURSE OUTCOMES: The student will be able to

CO1: understanding of the laws of thermodynamics and partial molar properties to interpret the behavior of ideal and non - ideal binary and ternary systems

CO2: apply the principles of statistical thermodynamics to evaluate thermodynamic properties and equilibrium constants using partition functions

CO3: understand and apply irreversible thermodynamic principles to analyze electrokinetic and thermomechanical effects

CO4: apply free energy concepts and structure - reactivity relationships to evaluate chemical equilibria and predict reaction rates

CO5: analyze phase behavior and interpret phase diagrams of multi - component systems using phase rule and thermal analysis

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	L	-	-	M	-	-	H	H	H
CO2	H	M	-	-	H	-	-	H	H	H
CO3	H	H	-	-	H	-	-	H	H	M
CO4	M	M	-	-	H	-	-	H	H	M
CO5	M	M	-	-	L	-	-	H	H	M

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement

Fundamental understanding of thermodynamics and chemical equilibrium provides a strong foundation for quality teaching and effective learning

CHF6103	CONCEPTS IN INORGANIC CHEMISTRY	L	T	P	C
SDG: 04		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: Periodic properties of elements

COB2: Ionic solids

COB3: Covalent Bonding and Non - valence Forces

COB4: p - Block Elements

COB5: Nuclear Chemistry

MODULE I ATOMIC STRUCTURE AND PERIODICITY L: 9 T: 0 P: 0

Modern views on atomic structure: wave mechanical description of electron and orbitals, radial density functions and orbital energies, angular functions and orbital shapes - Effective nuclear charge - Slater rule and their uses - Periodicity - the trend in the atomic and ionic radii, ionization potential, electron affinity and electronegativity along the period - Electronic configuration and termsymbols.

MODULE II SOLID STATE CHEMISTRY L: 9 T: 0 P: 0

Packing of ions in crystals and crystal structures - ccp, hcp, bcc, and fcc - Radius ratio and structure of ionic lattices: geometrical method of computing radius ratio, radius ratio and coordination number, stoichiometry and crystal structures - Structure of sodium chloride, cesium chloride, flourite, antifluorite, zincblende, wurtzite, rutile, spinels, inverse spinels, and perovskite - Crystal defects. Schottky defects, controlled valency, F - center, and Frenkel defect - Non - stoichiometric, interstitial, and electron deficient compounds - Lattice energy: Born - Lande equation, modified Born - Lande equation, factors affecting lattice energy - Born - Haber cycle: thermochemical calculations, radii of nonspherical ions, solubility and thermal properties of ionic compounds as afunction of U_0 and ΔH_f - Polarization in ionic compounds: covalency and Fajan's rule, effects of polarization.

MODULE III COVALENT BONDING L: 9 T: 0 P: 0

Valence bond theory - hybridization and resonance - diatomic and polyatomic systems - VSEPR theory and shape of molecules - molecular orbital theory - LCAO approximation for diatomic and polyatomic systems. MO energy level diagrams of homodiatomic and heterodinuclear molecules (CO, NO, HCI, CO_2, $BeCl_2$) - Bonding in metals: packing of atoms in metals, band theory of metals and metallic properties, Insulators, and semiconductors - Vander Waals forces - hydrogen bond - clathrates.

MODULE IV COMPOUNDS OF P - BLOCK ELEMENTS L: 9 T: 0 P: 0

Allotropes of carbon: graphite, diamond, fullerenes, carbon nanotubes - hydrides, halides, oxides, oxo acids and oxoanions, boranes, carboranes, metallocarboranes, borazine, silicates, silanes, nitrides of phosphorus and sulphur, selenides, Inter - halogen compounds and polyhalogenions, compounds of xenon, krypton and radon.

MODULE V NUCLEAR CHEMISTRY L: 9 T: 0 P: 0

Nuclear particles, Nuclear forces, nuclear size and density, Packing fraction, Mass defect, Binding energy, nuclear models, nuclear fission, nuclear fusion, nuclear reactor, Radioactivity, Detection and measurement of radioactivity, Artificial radioactivity, Q values of nuclear reactions, Radiolysis. Radio isotopes: Co - precipitation, ion - exchange, solvent extraction - as atracer, Synthesis of labeled compounds, isotopic dilution and radio pharmaceuticals.

L - 45 - Total Hours: 45

TEXTBOOKS:

1. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Vishal Publishing Co, 33rd Edition, Delhi, 2019.
2. F.A. Cotton, G. Wilkinson and P.L. Gaus, Basic Inorganic Chemistry, 3rdEdition, John Wiley, NewYork, 2003.
3. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, Blackwell Science, 2003.

REFERENCES:

1. F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry - 6th ed. - Wiley Interscience, NewYork, 2007.
2. Huheey J.E, Keiter, E.A. and Keiter R.L., Inorganic Chemistry, 4th Edition, Addison Wesley Publication, London, 2006.
3. Atkins P.W., Overton T., Rourke J., Weller M. and Armstrong F., Shriver and Atkins inorganic chemistry, 4th edition, Oxford University Press, 2006.
4. Jolly W.L., Modern Inorganic Chemistry, 2nd Edition, McGraw - Hill, Inc., 1991.

COURSE OUTCOMES: Students will be able to

CO1: Demonstrate an understanding of the basic principles of periodicity.

CO2: Demonstrate the understanding of ionic bonding and draw the crystal structures

CO3: Demonstrate the understanding of covalent bonding non - bonding

interactions

CO4: Demonstrate the structure and applications of compounds of main group elements

CO5: Find the applications of nuclear reactions

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	H	M	M	-	H	M	M
CO2	H	M	M	H	M	M	-	H	M	M
CO3	H	M	M	H	M	M	-	H	M	M
CO4	H	M	M	H	M	M	-	H	M	M
CO5	H	M	M	H	M	M	-	H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement: Fundamental understandings of inorganic chemistry provide a strong footing for the quality teaching and learning process.

CHF6104	ORGANIC CHEMISTRY PRACTICALI	L	T	P	C
SDG: 3, 9		0	0	4	2

COURSE OBJECTIVES: To make the students to understand the

COB1: separation of two component mixtures

COB2: analyze the functional groups present in simple organic compounds

COB3: basic purification techniques for organic solvents, reagents and compounds

COB4: synthesis of one stage simple organic molecules

PRACTICALS	L:	T:	P:
	0	0	60

List of Experiments:

1. Qualitative analysis of organic compounds
2. Separation of organic compounds with two component mixtures and its qualitative analysis.
3. Recrystallisation: purification of solids
4. Simple, fractional and vacuum distillation: purification of liquids
5. Melting points and ranges for organic compounds
6. Separation of three component mixture using extraction techniques
7. Synthesis of aspirin
8. Synthesis of acetaminophen
9. Mono - and di - nitration of aromatic compounds
10. Sulfonation of aromatic compounds
11. Bromination of cinnamic acid
12. Oxidation of cyclohexanol
13. Reduction using $NaBH_4$
14. Synthesis involving Diels - Alder reaction
15. Synthesis involving aldol condensation

P - 60; Total Hours: 60

TEXT BOOKS:

1. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 7th Edition, Prentice Hall, 2018.

REFERENCES:

6. Addison Ault, Techniques and Experiments for Organic Chemistry, 3rd Edition,

2015, University science books, UK
7. A. M. Carlos, Nuno R Candias, Comprehensive Organic Chemistry Experiments for the Laboratory Classroom, 2016, RSC.
8. http: //murov.info/orglab.html

COURSE OUTCOMES: The student will be able to

CO1: separate and analyse the different component mixtures of organic compounds

CO2: purify the organic compounds by using recrystallisation and distillation techniques

CO3: analyze and predict the functional groups present in simple organic compounds

CO4: perform synthesis of organic compounds

Board of Studies (BoS):
14th BoS of Chemistry held on 17.07.2025

Academic Council:
24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	H	H	M	H	M	-	H	H	H
CO2	M	H	H	M	H	M	-	H	H	H
CO3	M	H	H	M	H	M	-	H	H	H
CO4	M	H	H	M	H	M	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well - Being - Ensure healthy lives and promote well - being for all at all ages.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHF6105	PHYSICAL CHEMISTRY PRACTICAL I	L	T	P	C
SDG: 6,7,9		0	0	4	2

COURSE OBJECTIVES:

To make the student conversant with

COB1: Verification of Ostwald dilution law and temperature dependence of solubility of benzoic acid in water and DMSO

COB2: Determination of the thermodynamic solubility product and mean ionic activity and effect of concentration of an electrolyte on the solubility of an organic acid

COB3: Determination of the transition temperature and Partition coefficient of water and organic compounds

COB4: Determination of the equilibrium constant

COB5: Phase diagram for water - ethanol - benzene system and Solubility curve for a ternary system of liquids and the uses of chemistry related computer packages

List of Experiments

1. Temperature dependence of solubility of benzoic acid in water and DMSO.
2. Determination of the transition temperature of sulphur system.
3. Partition coefficient of iodine between carbon tetrachloride and water/ benzoic acid between water and benzene.
4. Solubility curve for ternary system of liquids - water - acetic acid - chloroform system.
5. Determination of CST in phenol - water system
6. Determination of activity coefficients of an electrolyte at different molalities
7. Study the effect of addition of an electrolyte on solubility of an organic acid
8. Effect of ionic strength on the solubility of $CaSO_4$ and determine its thermodynamic solubility product and mean ionic activity.
9. Effect of concentration of an electrolyte such as KCI, NaCI, Na_2SO_4, K_2SO_4 on the solubility of an organic acid (benzoic acid or salicylic acid) at room temperature
10. Phase diagram of ternary system: water - ethanol - benzene system at room temperature/ nitrobenzene - acetic acid - water/ water acetic acid - chloroform
11. Determination of the equilibrium constant of the esterification reaction between acetic acid and ethanol.
12. Determination of the equilibrium constant of the keto - enol tautomerism of ethyl acetoacetate.

13. Verification of Beer - Lambert equation
14. Determination of sucrose content in cane sugar by polarimetry
15. Determination of DEp of a redox system by cyclic voltametry
16. Determination of average molecular weight (Mv) of a polymer by viscometry

P - 60; Total Hours - 60

REFERENCES:

1. V.D. Athawale, Experimental Physical Chemistry, New Age International, 2007.
2. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books Pvt. Ltd.,2005.
3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.
4. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand and Co., New Delhi, 2007.
5. D.R. Satiya, Practical Chemistry, 2nd Edition, Allied Publishers, Madras, 1991.
6. D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, McGraw Hill, London, 1962.

COURSE OUTCOMES:

The students will be able to

CO1: recall the thermodynamic and chemical equilibrium concepts and determine the parameters

CO2: verify Beer Lamberts law for solutions of various concentrations

CO3: determine sucrose content in different sugar molecules

CO4: determine the redox potential and diffusion coefficient for any redox system using CV

CO5: determine the average molecular weight of any polymer

Board of Studies (BoS):

14th BoS of Chemistry held on 17.07.2025

Academic Council:

24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	H	M	H	H	H	-	H	H	H
CO2	H	H	M	H	H	H	-	H	H	H
CO3	H	H	M	H	H	H	-	H	H	H
CO4	H	H	M	H	H	H	-	H	H	H
CO5	H	H	M	H	H	H	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 6: Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all
SDG 7: Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable and modern energy for all
SDG 9: Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement

Experimental principles can be applied to any relevant system for sustanibaleindustrialisation and to ensure clan water and energy.

CHF6106	INORGANIC CHEMISTRY PRACTICAL I	L	T	P	C
SDG: 4		0	0	4	2

COURSE OBJECTIVES: The students will be trained

COB1: the purification process such as distillation, extraction, etc.

COB2: to identify individual common and rare cations present in the given mixture

COB3: to estimate the chloride ions present in water

COB4: to estimate the various ions by titrimetry

COB5: to estimate the ions such as iron, cobalt, nickel, chromium and manganese and spectral techniques

PRACTICALS

List of Experiments:

1. Water distillation and solvent extraction
2. Semi - micro qualitative analysis: Analysis and identification of two common and two rare cations in a mixture including spot test confirmation
3. Estimation of chloride in water by Mohr's method
4. Complexometric titrations: Estimation of Ca^{2+}, Mg^{2+}, Mn^{2+} and Zn^{2+}
5. Spectrophotometric analysis of iron, cobalt, nickel, chromium and manganese.

P - 60 ; TOTAL HOURS - 60

REFERENCES:

1. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, Department of Science and technology, India.
2. Rakesh K. Sharma, Indu Tucker Sidhwani and Mihir K. Chaudhuri, Green Chemistry Experiments: A Monograph, I K International Publishing House; 1st Edition, 2012.
3. J. Mendham, R.C. Denney, M.J.K. Thomas David and J. Barnes, Vogel's Quantitative Chemical Analysis, 6 th Edition, Prentice Hall, 2000.
4. V.V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Edition, The National Publishing Company, Chennai, 1974.
5. Mukhopadhyay R and Chatterjee P, Advanced Practical Chemistry, Books and Allied (P) Ltd., 2007.
6. Dinesh Sharma, A Handbook of Analytical Inorganic Chemistry, International Scientific Publishing Academy, India, 2005.

COURSE OUTCOMES: The students will be able to

CO1: Distill water and other organic solvents

CO2: Analyze the common and rare cations present in the given mixture

CO3: Estimation of chloride in water by titrimetry

CO4: Estimate the ions present in the sample by complexometric titration

CO5: Estimate the ions such as iron, cobalt, nickel, chromium and manganese present in the sample by spectral methods

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	H	L	H	-	H	H	H
CO2	H	M	M	H	L	H	-	H	H	H
CO3	H	M	M	H	L	H	-	H	H	H
CO4	H	M	M	H	L	H	-	H	H	H
CO5	H	M	M	H	L	H	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement: Fundamental understandings of inorganic chemistry lab provide a strong footing for the quality teaching and learning process.

CHF 6107	SCIENTIFIC SEMINAR	L	T	P	C
SDG: 4, 9		0	0	2	1

COURSE OBJECTIVES:

COB1: To enable students in searching and analyzing scientific literature

COB2 To equip students with the skills to present complex chemical concepts effectively

GENERAL GUIDELINES:

- Seminar shall be carried out individually under the guidance of the allotted supervisor.
- Each student shall identify a contemporary and advanced topic within the chemical sciences domain.
- The faculty mentor will provide guidance on topic selection, literature sourcing, and the structure of the presentation.
- The Head of the Department shall constitute a Seminar Review Committee to evaluate the student's performance based on technical depth, presentation skills, and the ability to handle queries.
- Seminar will be evaluated through three periodic internal reviews and one final review, through oral power point presentations. Students should communicate and interact only in English in the review process.
- Final review shall be conducted as the semester end examination.
- The weightage for assessment shall be as follows:
  Periodic Reviews (Internal): 60%; Final Review (External):40%

COURSE OUTCOMES:

At the end of the Project, the students will be able to

CO1: critically evaluate recent research papers

CO2: communicate scientific data confidently to a technical audience

Board of Studies (BoS):
17thBOS of Department of Chemistry held on 17.07.2025.

AcademicCouncil:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	H	H	M	H	M	M	M	M
CO2	H	H	H	H	H	H	M	M	M
CO3	H	H	M	M	H	M	M	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Quality Education - ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

MAF 6188	MATHEMATICS FOR CHEMISTRY	L	T	P	C
SDG: 4		1	1	0	2

COURSE OBJECTIVES:

COB1: To Understand set theory and compute eigenvalues / eigenvectors for chemical matrix applications.

COB2: To apply differentiation techniques to model chemical rates and behaviours.

COB3: To develop the ability to perform integration methods to solve chemistry-related quantitative problems.

COB4: To gain foundational knowledge of statistical concepts and methods for data analysis.

MODULE I ALGEBRA 6+2

Matrix – Special types of matrices – Eigenvalues and eigenvectors – Polynomial, rational fractions, proper and improper fractions, partial fraction – Application of binomial, exponential and logarithmic series to summation – Sets and subsets – Basic set operations – Functions and relations.

MODULE II DIFFERENTIAL CALCULUS 6+2

Function and limits – Differentiation of standard functions – Product and quotient rule – Function of function rule – Inverse functions – Implicit functions – Successive differentiation – Conditions for a function to be a maximum or a minimum at a point – Partial differentiation.

MODULE III INTEGRAL CALCULUS 5+2

Introduction, definition, standard formulae – Rules of integration – Method of substitution – Method of Partial fractions – Integration by parts – Bernoulli's formula – Properties of definite integrals – Application.

MODULE IV STATISTICS 5+2

Introduction – Mean, median, mode – Skewness – Kurtosis – Correlation and linear regression analysis.

L – 22; T – 8; TOTAL HOURS – 30

TEXT BOOKS:

1. Seymour Lipschutz, "Schaum's Outline of Set Theory and Related Topics", Revised Edition, 1998.
2. T.K. Manickavachagam Pillai and S. Narayanan, "Calculus Volumes I & II", S.Viswanathan Printers & Publishers, Revised Editions, 2010.
3. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand, 2014.

REFERENCES:

1. Manickavachagam Pillai, T.K, Natarajan,T. and Ganapathy, K.S.,"Algebra",

Vol I & II, S.Viswanathan Printers & Publishers, 1999, Revised Edition, 2010.
2. S.P. Gupta, “Elements of Statistics”, S. Chand, 2019.
3. Donald A. McQuarrie, “Mathematics for Physical Chemistry”, 3rd Edition, University Science Books, 2008.

COURSE OUTCOMES: At the end of the course students will be able to

CO1: apply the principles of set theory and compute eigenvalues and eigenvectors of matrices to solve linear algebra problems.

CO2: use appropriate differentiation techniques to analyze and solve problems involving rates of change and function behaviour.

CO3: evaluate definite and indefinite integrals to solve problems in applied contexts.

CO4: analyze and solve basic statistical problems using appropriate measures and techniques.

Board of Studies (BOS):	**Academic Council:**
17th BOS of Department of Mathematics and Actuarial Science held on 23.06.2025.	24th AC held on 26.08.2025.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H													H	
CO2	M	L												M	
CO3	M													L	
CO4	H					H								H	

*** Legend: L – Low (1), M – Medium (2), H – High (3).**

SDG 4 - Quality Education: Ensure inclusive and equitable quality education and promote lifelong opportunities for all.
Learning of various mathematical tools will lead to knowledge of applications in the field of chemical sciences.

SEMESTER II

GEF6202	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
SDG: 4, 9, 11 and 15		**3**	**1**	**0**	**4**

COURSE OBJECTIVES: Students will be trained to

COB1: Basic concepts of Research and formulation.

COB2: Safety in research laboratory and research data collection.

COB3: Impart knowledge for enabling students to develop data analytics skills and valid interpretation.

COB4: write Scientific and Technical reports and Thesis

COB5: Familiar the Intellectual Property Rights.

MODULEI INTRODUCTION TO RESEARCH METHODOLOGY AND RESEARCH FORMULATION **L: 9 T: 3 P: 0**

Research: Objectives, Motivation and types - Approaches, Significance of Research, Research process, Criteria of good research,Limitations Encountered by researchers - Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review - primary and secondary sources, reviews, monograph, patents, research databases, web as a source, identifying gap areas from literature and research database. Formulating working hypotheses.

MODULEII GOOD LABORATORY PRACTICES, SAFETY and DATA COLLECTION **L: 10 T: 2 P: 0**

Introduction: History, definition, Principles, Good Laboratory Practices (GLP) and its application GLP training: Stepwise implementation of GLP and compliance monitoring, Safety Symbols, Science Safety Rules - Dress Code, First Aid, Heating and Fire Safety - Observation and Collection of data, methods of data collection; Primary and secondary; data processing, analysis strategies and tools, data analysis with statistical tools (Hypothesis testing, large and small sample test).Importance of negative results.

MODULEIII DATA ANALYSIS and DRAWING **L: 9 T: 3 P: 0**

Analyzing the data and drawing structures / schemes / flow charts using Chemdraw and Chemsketch - Measures of central tendency - mean median and mode - Sampling methods - Data analysis using Excel, Origin and Sigma plot - data analysis with statistical tools (Sigma STAT, SPSS student, ANOVA) - hypothesis testing - Importance and scientific methodology in recording results - Error significance - Conceptions of error of measurement - absolute and relative errors, true score theory and generalisability theory.

MODULEIV RESEARCH ETHICSand TECHNICAL WRITING **L: 08 T: 4 P: 0**

Introduction to ethics, scientific misconduct - causes and effects; fabrication; authorship issues, The investigation and punishment of scientific misconduct (Erratum and Retraction) - Different types of scientific and technical publications - Definition and importance of Journal Impact factor, COPE guidelines,Cite Scores and Citation Indexes. Technical writing skills for report, synopsis, thesis and book chapter - . Preparing manuscripts for international journals - softwares; MS Office/LATEX, Grammarly; Mendeley; detection of similarity index / plagiarism / AI support by Turnitin as per UGC Norms.

MODULE V INTELLECTUAL PROPERTY RIGHTS **L: 09 T: 3 P: 0**

Basics of Intellectual Property - Intellectual Property system in India, IP Research, and Universities - Patents Act, 1970, Patents—From ball pens to biologics - Patentable subject matter, Rights conferred Exceptions, Term of protection and Conditions on Patent applicants and patent process. Trade Mark Act, 1999, Trade secrets, The Designs Act, 2000, Copy Right, Royalty, Geographical indications, Industrial designs, Trade related aspects of Intellectual Property Rights (TRIPS); development of TRIPS complied regime in India. Enforcement of Intellectual Property Rights, Function of UNESCO in IPR maintenance.

L - 45; T - 15; P - 0; Total Hours: 60

TEXT BOOKS:

1. Cooper Donald R, Schindler Pamela S and Sharma JK., 2012. “Business Research Methods”, Tata McGraw Hill Education, 11th Edition.
2. Kothari C.R., “Research Methodology, Methods and Techniques”, Wiley Eastern Ltd., NewDelhi, 1991.

REFERENCES:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
3. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes
5. Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005. John Wiley and Sons Publishers, Inc
6. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976. John Wiley and Sons Publishers, Inc
7. R Arora. Encyclopaedia of Research Methodology in Biological Sciences., Anmol Publishing, 2004.
8. Coghill M. and Gardson L.R., The ACS Style Guide Effective Communication of Scientific Information, 3rd Edn., Oxford University Press, 2006.

COURSE OUTCOMES: The students will be able to

CO1: recognize the basic concepts of research and its methodologies

CO2: select appropriate safety measurements and data collection methods

CO3: Apply various statistical hypothesis testing and interpret the results.

CO4: write scientific report as journal article, thesis and technical proposal for funding.

CO5: propose research findings as patents, copyrights, trademarks and other IPR.

Board of Studies (BoS): 14th BoS of Department of Chemistry held on 17.07.2025

Academic Council: 24thACheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	-	-	-	M	-	H	M	M
CO2	-	H	-	M	M	H	-	H	H	M
CO3	-	H	-	-	M	-	-	M	M	H
CO4	-	-	H	-	-		-	H	H	H
CO5	H	-	-	-	-	H	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4:Quality Education

SDG 9:Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG 11:Sustainable Cities and Communities

SDG 15:Life on Land

Statement:
The understanding of concepts of high quality research, innovative thinking, knowledge on sustainable development and service to the society and mankind through quality research.

CHF6201	SYNTHETIC ORGANIC CHEMISTRY-I	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: structure and reactivity of carbanions and carbocations involved in organic reactions

COB2: structure and reactivity of radicals, carbenes, nitrenes and ylides in organic transformations

COB3: concepts for various named reactions and rearrangements

COB4: study the orbital interactions and reaction mechanism in concerted reactions

COB5: conversant with light mediated organic transformations

MODULE I REACTION INTERMEDIATES - I L: 9 T: 0 P: 0

Structure and stability of carbanion - chemistry of enolates and enamines - kinetic and thermodynamic enolates - alkylation and acylation of enolates and enamines - nucleophilic addition to carbonyls - organolithium, organozinc, organocopper reagents (1,2 vs 1,4-addition) - reaction of carbanions: Aldol, Claisen, Robinson annulation, Dieckmann, Michael, Kolbe-Schmidt, Grignard, Wurtz, Favorskii, Cannizzaro, Perkin, Benzoin - Structure and stability of carbocations - classical and non-classical carbocations - reactions of carbocation: Pinacol-pinacolone, Wolff.

MODULE II REACTION INTERMEDIATES - II L: 9 T: 0 P: 0

Generation of radical intermediates - addition to alkenes, alkynes (inter and intramolecular) for C-C bond formation - Baldwin rules

Structure and generation of carbenes - addition and insertion reactions - Simmon-Smith

Structure of nitrene - generation and reactions of nitrene - Curtius

Chemistry of phosphorous and sulphur ylides - generation and reactions of ylides - Vilsmeier-Haack Formylation, Corey-Chaykovsky, Wittig, Horner-Wadsworth-Emmons.

MODULE III NAMED REACTIONS AND REARRANGEMENTS L: 9 T: 0 P: 0

Name reactions: Sharpless epoxidation, dihydroxylation, Corey-Winter olefination, Shapiro reaction, Bamford-Stevens, Arndt-Eistert, Eschenmoser-Tanabe fragmentation, Stobbe condensation, Peterson olefination, Hofmann-Löffler-Freytag, Birch reduction, Baylis-Hillman, Mitsunobu reaction, Duff reaction, Nef reaction.

Rearrangements: Wagner-Meerwein, Tiffeneau-Demjanov, Beckmann, Hofmann, Curtius, Lossen, Schmidt, Wolff, Brook, Benzilic acid, Baeyer Villiger, Dakin, Ramberg-Bäcklund,

Ferrier, Stevens, Sommelet-Hauser.

MODULE IV PERICYCLIC REACTIONS L: 9 T: 0 P: 0

Classification - Woodward-Hoffmann rules - Frontier orbital and orbital symmetry correlation approaches - electrocyclic reactions - Cycloaddition reactions -Sigmatropic reactions -Chelotropic reactions - 1,3-dipolar cycloaddition and its utility in organic synthesis - examples of pericyclic reactions: Diels-Alder, Clasien, Cope, aza-cope, Nazarov and ene reactions.

MODULE V ORGANIC PHOTOCHEMISTRY L: 9 T: 0 P: 0

Photochemical reaction of ketones: Norrish type I and II, Paterno-Buchi and Barton reactions - photochemical oxidation and reduction, photochemical reactions of olefins: cis-trans isomerization, di-pi-methane and Fries rearrangements.

L – 45; Total Hours: 45

TEXT BOOKS:

1. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009.
2. Clayden, J.; Greeves, N.; and Warren, S. Organic Chemistry, 2nd Edition, Oxford University Press, 2014 *(No later editions available).*
3. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.
4. Sankararaman S., Pericyclic reactions - a Textbook: Reactions, ApplicationsandTheory,Wiley-VCH,2005.
5. Richard O.C. Norman, James M. Coxon, Principles of Organic Synthesis, 3rd Edition, Taylor & Francis.

REFERENCES:

1. George S. Zweifel, Michael H. Nantz, Modern Organic Synthesis, 1st edition
2. Peter Sykes, Guidebook to Mechanism in Organic Chemistry, Orient Longman, 2005.
3. IanFlemming,PericyclicReactions,2ndEdition,OxfordUniversity Press,2021.
4. V. Ramamurthy, Kirk S Schanse, Organic Photochemistry, CRC press, Taylor & Francis, 2018.
5. John D. Coyle Introduction to Organic Photochemistry, John Wiley and Sons, 1991.

COURSE OUTCOMES: The student will be able to

CO1: proposereactionmechanismsoforganicreactionsinvolvingcarbanions and carbocations

CO2: comprehendthestructure-reactivitypatternofradicals,carbenes, nitrenesandylidestowardsorganictransformations

CO3: identify various named reactions and rearrangements

CO4: predict the orbital interactions and orbital symmetry correlations of various organic reaction *via* pericyclic reactions

CO5: analysethephotochemicalreactionmechanisms

Board of Studies (BoS):
14th BoS of Chemistry held on 17.07.2025

Academic Council:
24thACMheld on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	-	-	H	-	-	H	H	H
CO2	H	M	-	-	H	-	-	H	H	H
CO3	H	H	-	-	H	-	-	H	H	H
CO4	H	H	-	-	H	-	-	H	H	H
CO5	M	L	-	-	L	-	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 9: Industry, Innovation & Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical R&D and teaching with goals of sustainable industrial innovation and knowledge dissemination.

CHF6202	**CHEMICAL KINETICS AND**	**L**	**T**	**P**	**C**
SDG: 9	**ELECTROCHEMISTRY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES: To make the students to understand the

COB1: temperature dependence of reaction rates and theoretical models in chemical kinetics.

COB2: kinetics of complex, chain, fast, and polymerization reactions with itsexperimental methods

COB3: principles, mechanisms, and applications of homogeneous, heterogeneous and enzyme catalysis

COB4: behavior of strong electrolytes in solution, ionic interactions, interfacial electrochemistry, and the role of electrodes in pH and ion measurements.

COB5: principles of electrochemical energy conversion and storage, overvoltage phenomena, and the mechanisms and prevention of corrosion

MODULE I KINETICS OF REACTIONS IN GAS PHASE AND IN SOLUTIONS **L: 9 T: 0 P: 0**

Temperature dependence reaction rate: linear and non - linear Arrhenius equation - interpretation of Arrhenius parameters - evaluation of activation and thermodynamic parameters - Erying equation - theories of unimolecular reactions: Lindemann - Hinshelwood, RRK and RRKM theories - potential energy surfaces for bimolecular reactions - adiabatic and non - adiabatic curve crossing processes - collision theory and transition state theory: evaluation of thermodynamic parameters of activation - applications of ARRT to reactions between atoms and molecules - time and true order kinetic parameter evaluation - factors determining reaction rates in solutions - effect of dielectric constant - ionic strength - primary and secondary salt effect.

MODULE II KINETICS OF COMPLEX AND FAST REACTIONS **L: 9 T: 0 P: 0**

Complex Reactions: Kinetics and empirical rate expressions for opposing, parallel and consecutive reactions - chain reactions: chain length - Rice - Herzfeld pyrolysis of acetaldehyde - hydrogen - halogen (thermal and photochemical) reaction - combustion and explosion kinetics: gas phase combustion H_2 - O_2 reaction - hydrocarbon

combustion - explosion limits - fast reactions: relaxation theory and relaxation techniques - temperature, pressure jump methods and electric and magnetic field jump methods - stopped flow flash photolysis methods and pulse radiolysis - kinetics of polymerization: free radical, cationic, anionic polymerization - polycondensation.

MODULE III CATALYSIS AND SURFACE CHEMISTRY L: 9 T: 0 P: 0

Homogeneous catalysis: general mechanism, activation energy for the process - acid base catalysis: catalytic activity, acid - base strength and acidity functions - enzyme catalysis and its mechanism - Michaelis - Menten equation - effect of pH and temperature on enzyme catalysis - mechanism of enzyme inhibition - adsorption: chemisorptions and physisorption - types of surface reaction - adsorption isotherms: Freundlich, Langmuir and Gibbs - determination of surface area, pore volume and pore size - thermodynamics of interfaces - - BET of multilayer adsorption - heterogeneous catalysis: general mechanism - thermodynamic considerations - preparation of catalysts: precipitation and impregnation methods - role and load of supports - heterogeneous catalysts for catalytic cracking and Fischer - Tropsch synthesis.

MODULE IV ELECTROCHEMISTRY - I L: 9 T: 0 P: 0

Theory of strong electrolytes: inter - ionic attraction theory - Debye - Huckel theory of strong electrolytes - Debye - Huckel model of ionic atmosphere - Debye - Huckel limiting law and its extension - Debye - Huckel Onsager equation: derivation, verification and modifications - Huckel - Bronsted equation - determination of activity coefficients using Bronsted equation - Debye - Falkenhagen’s effect and Wien’s effect - electrical double layers formation - structure of electrified interfaces - Stern model of the double layer - electrodes: glass electrode - platinum electrode - glassy carbon electrode - ion selective electrode and measurement of pH.

MODULE V ELECTROCHEMISTRY - II L: 9 T: 0 P: 0

Electrochemical energy conversion and storage: lead acid battery and lithium battery - fuel cells: H_2 - O_2 and Methanol fuel cell - capacitors and supercapacitors - over voltage - theories of over voltage - applications of over voltage - hydrogen and oxygen overvoltage - Butler - Volmer equation - Tafel equation - corrosion - types of corrosion: galvanic, aeration, stress, pitting - factors influencing corrosion - Pourbaix diagram - corrosion control method - cathodic protection - corrosion inhibitors.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Rajaram J. and Kuriacose J.C., Kinetics and Mechanisms of Chemical Transformations, Macmillan India Ltd., New Delhi, 2011.
2. Laidler K.J. Chemical Kinetics, 3rd edition, Pearson, 2003.
3. Crow D. R. Principles and applications of electrochemistry, 4th Edition, Chapman and Hall / CRC, 2014.
4. Puri B.R., Sharma L.R. and Pathania M.S., Principles of Physical Chemistry, 48th Edition, Vishal Publishing Co. India, 2022.
5. Chakrabarthy D.K. and Viswanathan B. Heterogeneous catalysis, New Age International Publishers, 2011.

REFERENCES:

1. Mcqurrie D.A. and Simon J.D., Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
2. Ytsiimiriski K.B. Kinetic Methods of Analysis, Pergamom Press,1996.
3. Glasstone S., Electro chemistry, Affiliated East - West Press, Pvt., Ltd., New Delhi, 2008.
4. Viswanathan B., Sundaram S., Venkataraman R. Rengarajan K. and Raghavan P.S. Electrochemistry - Principles and applications, S. Viswanathan Printers, Chennai, 2007.
5. Wang J., Analytical Electrochemistry, 3rd Edition, Wiley - VCH, 2006.
6. Viswanathan B., Sivasanker S. and Ramaswamy A.V. Catalysis: Principles and Applications, Narosa Publishing House, New Delhi, 2004.
7. McCafferty E. Introduction to corrosion science, 2nd Edition, Springer International Publishing AG, 2017.

COURSE OUTCOMES: The student will be able to

CO1: evaluate the kinetic and thermodynamic parameters and apply theories to chemical reactions

CO2: analyze complex reaction mechanisms and apply appropriate experimental metnods to investigate fast and polymerization reactions

CO3: explain catalytic mechanisms and evaluate surface and catalyst properties

CO4: analyze electrolyte behavior, interfacial structures, and electrode functions

CO5: explain the working of batteries, fuel cells, and supercapacitors, analyze overvoltage behavior and evaluate types of corrosion and

suitable control methods

Board of Studies (BoS):
14th BoS of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	L			M			H	H	H
CO2	H	M			H			H	H	H
CO3	H	H			H			H	H	H
CO4	M	M			H			H	H	H
CO5	M	M			L			H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement

Fundamental understanding of chemical kinetic, catalysis and electrochemistry provides a strong foundation for quality teaching and effective learning

CHF6203	COORDINATION CHEMISTRY	L	T	P	C
SDG: 04		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: Structure, isomerism and stability of coordination compounds

COB2: CFT and MO Bonding approach in coordination compounds

COB3: Magnetic and spectral properties of coordination compounds

COB4: Reactions of coordination compounds

COB5: Chemistry of lanthanides and actinides

MODULE I COORDINATION COMPOUNDS L: T: P: 0

Transition metals and coordination compounds, Nomenclature - coordination number, ligands, coordinate complexes - Isomerism - structural and stereoisomerisms - absolute configuration - ORD and CD spectra - HSAB concept, thermodynamic and kinetic stability, successive and overall stability constants, Irving - William series, chelate and macrocyclic effect.

MODULE II THEORIES OF METAL LIGAND BONDING L: T: P: 0

Theories of bonding: VBT, CFT: Octahedral, tetrahedra, squareplanar, square pyramidal, trigonal bipyramidal Complexes and their limitations, Jahn - Teller Effect, CFSE for d^1 to d^{10} systems pairing energy, low - spin and high - spin complexes and magnetic properties - LFT, and molecular orbital (MO) theory of selected octahedral and tetrahedral complexes.

MODULE III MAGNETIC AND SPECTRAL PROPERTIES OF COORDINATION COMPOUNDS L: T: P: 0

Molecular magnetism: diamagnetic and paramagnetic susceptibilities, temperature dependent paramagnetism, the Curie law, ferromagnetic and antiferromagnetic interactions - Methods of determining magnetic susceptibility: Gouy and Faraday balances - Van Vleck equation and magnetic moments of free metal ions - ESR spectroscopy: isotropic and anisotropic g - values and structure, hyperfine and zero field effects on spectrum, Electronic absorption spectroscopy: derivation of term symbols, electronic states and spectra of Oh and Td complexes of d^n metal ions, Orgel and Tanabe - Sugano diagrams - IR spectra of terminal and bridgingcarbonyls differentiation of linkage isomers: cyano - , isocyano, nitroandnitrito, thiocyanato and isothiocyanato complexes - nuclear quadrupole interaction.

MODULE IV REACTIONS OF COORDINATION COMPOUNDS L: T: P: 0

Reaction mechanisms - Inert and labile complexes, substitution reactions in octahedral and square planar complexes ,trans effect and its influence, water exchange, anation and base hydrolysis, stereochemistry, inner and outer sphere electron transfermechanism - photo chemical reactions of coordination compounds - substitution, red - ox and rearrangement reactions.

MODULE V CHEMISTRY OF f - BLOCK ELEMENTS L: T: P: 0

Lanthanides - occurrence, isolation, lanthanide contraction, oxidationstates, spectral and magnetic properties, co - ordination complexes, actinides, comparative chemistry with transition metals and lanthanides, applications of inner transition elements.

L - 45 - TotalHours: 45

TEXTBOOKS:

1. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Vishal Publishing Co, 33rd Edition, Delhi, 2019.
2. F.A. Cotton, G. Wilkinson and P.L. Gaus, Basic Inorganic Chemistry, 3rd Edition, John Wiley, NewYork, 2003.
3. Huheey J.E., Keiter E.A.and Keiter R.L., Inorganic Chemistry, 4th Edition, Addison Wesley Publication, London, 2006.

REFERENCES:

1. F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry - 6th ed. - Wiley Interscience, NewYork, 2007.
2. Atkins P.W., Overton T., Rourke, J., Weller, M. and Armstrong, F. Shriver and Atkins inorganic chemistry, 4th edition, Oxford University Press, 2006.
3. Jolly W.L., Modern Inorganic Chemistry, 2nd Edition, McGraw - Hill, Inc., 1991.

COURSE OUTCOMES: Students will be able to

CO1: Find the geometry, isomerism and stability of coordination compounds

CO2: Demonstrate CFT and MOT approach for the formation of coordination compounds

CO3: Predict the magnetic and spectral properties of coordination compounds

CO4: Illustrate the reactions of coordination compounds

CO5: Analyze and compare the inner transition metals with transition metals

Board of Studies (BoS):	**Academic Council:**
14th BoS of Chemistry held on 17.07.2025	24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	M	H	M	-	H	H	M
CO2	H	M	M	M	H	M	-	H	H	M
CO3	H	M	M	M	H	M	-	H	H	M
CO4	H	M	M	M	H	M	-	H	H	M
CO5	H	M	M	M	H	M	-	H	H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG4: Quality education Ensure inclusive and equitable quality education and promotelifelong learning opportunities for all

Statement:

Coordination Chemistry concepts helps the students to carryout inorganic complex reactions.

CHF6204	ORGANIC CHEMISTRY PRACTICALII	L	T	P	C
SDG: 3, 9			0	4	2

COURSE OBJECTIVES: To make the students to understand the

COB1: identification of organic compounds by TLC technique.

COB2: purification of organic compounds by column chromatography

COB3: multistep synthesis of organic compounds

COB4: structural identification by FT - IR, NMR and MASS

PRACTICALS **L: 0 T: 0 P: 60**

List of Experiments:

1. Thin layer chromatography: Identification of organic compounds
2. TLC: mixtures of organic compounds and market drugs.
3. Column chromatography: separation of organic compound mixtures
4. Nucleophilic substitution with saccharin (N - versus O - alkylation)
5. Synthesis of cyclohexene from cyclohexanone (2 stage)
6. Ortho and para - nitroacetanilide from acetophenone via Beckmann rearrangement (3 stage)
7. Synthesis of tetraphenylcyclopentadienone (3 stage)
8. Preparation and reduction of benzil (3 stage)
9. Photochemical reaction (Benzophenone to benzopinacol)
10. Click reaction (1 - 3 dipolar cycloaddition)
11. Mass, IR and NMR instrumental techniques - demonstration
12. Analysis of all the synthesized products by mpt., IR, NMR and mass data

P - 60; Total Hours: 60

TEXT BOOKS:

1. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 7th Edition, Prentice Hall, 2018.

REFERENCES:

1. Addison Ault, Techniques and Experiments for Organic Chemistry, 3rd Edition, 2015, University science books, UK
2. A. M. Carlos, Nuno R Candias, Comprehensive Organic Chemistry Experiments for the Laboratory Classroom, 2016, RSC.
3. http: //murov.info/orglab.html

COURSE OUTCOMES: The student will be able to

CO1: analyse the identification of organic compounds by TLC

CO2: separate compounds by using column chromatography

CO3: hypothesize the outcome of an organic reaction

CO4: analyse and assign structures of organic compounds by using NMR, IR and mass spectral data

Board of Studies (BoS):
14th BoS of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	H	H	M	H	M	-	H	H	H
CO2	M	H	H	M	H	M	-	H	H	H
CO3	M	H	H	M	H	M	-	H	H	H
CO4	M	H	H	M	H	M	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well - Being - Ensure healthy lives and promote well - being for all at all ages.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHF6205	PHYSICAL CHEMISTRY PRACTICAL II	L	T	P	C
SDG: 6,7,9		0	0	4	2

COURSE OBJECTIVES:

To make the student conversant with

COB1: Determination of rate constant and order of reaction

COB2: Verification of Freundlich adsorption isotherm and Empirical rate laws

COB3: Determine of the optical properties of the molecules

COB4: Determination of corrosion rate constant and Verification of Kohlrausch's law

COB5: Electroplating of metals

List of Experiments

1. Determination of order of the reaction
2. Determination of rate constant - zero order, first order and second order
3. Saponification of oils/ fats
4. Verification of Freundlich adsorption isotherm - Adsorption of acetic acid/ oxalic acid on activated carbon
5. Empirical rate laws and temperature dependence; complex reactions; steady state approximation
6. Determine the specific rotation of camphor in benzene and carbon tetrachloride by polarimetry
7. Verification of Ostwald dilution law using weak acid and determination of its dissociation constant
8. Verification of Kohlrausch's law and its applications
9. Equivalent conductance of strong electrolytes and verification of Debye Huckel Onsager equation
10. Determination of pKa1/pKa2/ pKa3 of weak dibasic and tribasic acids
11. Conductometric titrations: acid - base and precipitation titrations
12. Determination of activity coefficients of an electrolyte at different molalities
13. Potentiometric titrations: Redox and precipitation titrations
14. Acid base titration by pH metry
15. Determination of corrosion rate constant of iron in acid, neutral and alkali medium
16. Determination of metal to ligand ratio of complexes by Job's method using UV - visible Spectrophotometer.
17. Electroplating of copper, nickel and chromium

P - 60; Total Hours - 60

REFERENCES:

1. V.D. Athawale, Experimental Physical Chemistry, New Age International, 2007.
2. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books Pvt. Ltd.,2005.
3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.
4. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand and Co., New Delhi, 2007.
5. D.R. Satiya, Practical Chemistry, 2nd Edition, Allied Publishers, Madras, 1991.
6. D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, McGraw Hill, London, 1962.

COURSE OUTCOMES:

The students will be able to

CO1: determine the rate constant and order of any reaction

CO2: verify the Freundlich adsorption isotherm weak organic acids on activated carbon and verification empirical rate laws

CO3: verify the electrochemistry concepts anddetermine the concentration of ions by conductometry, potentionmetry and pH metry.

CO4: Determine the corrosion rate constant of metals in different medium

CO5: Electroplate any iron article and determine plating rate and determne the metal ligand ratio for any complex formation

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: -24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	H	M	H	H	H	-	H	M	H
CO2	H	H	M	H	H	H	-	H	M	H
CO3	H	H	M	H	H	H	-	H	M	H
CO4	H	H	M	H	H	H	-	H	M	H
CO5	H	H	M	H	H	H	-	H	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 6: Clean Water and Sanitation — Ensure availability and sustainable management of water and sanitation for all

SDG 7: Affordable and Clean Energy — Ensure access to affordable, reliable,

	sustainable and modern energy for all
SDG 9: Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement

Experimental principles can be applied to any relevant system for sustanibaleindustrialisation and to ensure clan water and energy.

CHF6206	INORGANIC CHEMISTRY PRACTICAL II	L	T	P	C
SDG: 04		0	0	4	2

COURSE OBJECTIVES: The students will be trained towards

COB1: titrimetric estimation of the metal components present in alloys

COB2: gravimetric estimation of the metal components present in alloys

COB3: prepare different complexes

COB4: characterize the complexes by spectral techniques

COB5: synthesis of green reagents

PRACTICALS

List of Experiments:

1. Estimation of alloys by gravimetry and titrimetry: brass (Cu and Zn), bronze (Cu and Sn) and ferro nickel (Fe and Ni)
2. Gravimetric Analysis: Estimation of calcium in egg shell, silica in rice husk, iron in steel
3. Complex preparation and characterisation by UV - Visible and FT - IR spectroscopic techniques
   (i) Preparation of 1 - acetyl ferrocene
   (ii) Preparation of bis(acetylacetanato)copper(II)
   (iii) Preparation of tris(acetylacetanato)iron(III)
   (iv) Preparation of tris(acetylacetanato)manganese(III)
   (v) Solvent free and one pot synthesis of phthalocyanine complex of copper(II)
   (vi) Synthesis of tetrabutyl ammonium tribromide (TBATBP) - A green reagent and its application

P - 60 ; TOTAL HOURS - 60

REFERENCES:

1. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, Department of Science and technology, India.
2. Rakesh K. Sharma, Indu Tucker Sidhwani and Mihir K. Chaudhuri, Green Chemistry Experiments: A Monograph, I K International Publishing House; 1st Edition, 2012.
3. J. Mendham, R.C. Denney, M.J.K. Thomas David and J. Barnes, Vogel's Quantitative Chemical Analysis, 6 th Edition, Prentice Hall, 2000.
4. V.V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Edition, The

National Publishing Company, Chennai, 1974.

5. Mukhopadhyay R and Chatterjee P, Advanced Practical Chemistry, Books and Allied (P) Ltd., 2007.
6. Dinesh Sharma, A Handbook of Analytical Inorganic Chemistry, International Scientific Publishing Academy, India, 2005.

COURSE OUTCOMES: The students will be able to

CO1: estimate the various metal ions present in alloys by titrimetry

CO2: estimate the various metal ions present in alloys by gravimetry

CO3: prepare different complexes

CO4: characterize the complexes by spectral techniques

CO5: synthesis green reagents

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	H	M	H	-	H	H	M
CO2	H	M	M	H	M	H	-	H	H	M
CO3	H	M	M	H	M	H	-	H	H	M
CO4	H	M	M	H	M	H	-	H	H	M
CO5	H	M	M	H	M	H	-	H	H	M

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement: Advanced understandings of inorganic chemistry laboratory provide a strong footing for securing challenging positions in industry and academics.

CHF 6207	MINI PROJECT	L	T	P	C
SDG: 3,9		0	0	4	2

COURSE OBJECTIVES:

COB1:	To introduce research work and enable students to perform literature review.
COB2	To execute a synthesis of the research plan.
COB3:	To develop the student's skill to communicate scientific findings effectively.

GENERAL GUIDELINES:

- Students should choose topics focused within the chemical sciences. Project guide shall identify a suitable topic within their domain to conduct the experiments.
- The project guide should ensure that all students working in the projects strictly adhere to safety protocols in handling and disposal of chemicals.
- Project should include a preliminary literature review and a proposed methodology using appropriate analytical, synthetic, or computational techniques.
- The progress of the mini project shall be evaluated through three periodic internal reviews and one final review, through oral power point presentations. Students should communicate and interact only in English in the review process.
- Final review shall be conducted as the semester end examination.
- A project report must be submitted by the end of the semester signed by the student and certified by the project guide & HOD/Dean. It should contain the introduction, literature methods, objectives, methods of characterization, conclusion and references. The report should be submitted by the end of the semester signed by the student and certified by the project guide & HOD/Dean.

COURSE OUTCOMES:

At the end of the Project, the students will be able to

CO1: Analyze existing scientific literature to identify a research gap

CO2: Demonstrate proficiency in executing chemical experiments

CO3: Evaluate chemical substances or processes using appropriate characterization techniques

Board of Studies (BoS):
17th BOS of Department of Chemistry held on 17.07.2025.

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	H	H	M	H	M	H	M	M
CO2	H	H	H	H	H	H	M	H	M
CO3	H	H	M	M	H	M	M	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3: Good Health and Well - Being - Ensure healthy lives and promote well - being for all at all ages.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

ENF 6281	PROFESSIONAL COMMUNICATION	L	T	P	C
SDG: 4 & 8		0	0	2	1

COURSE OBJECTIVES:

COB1: To introduce the fundamentals of professional communication in workplace contexts.

COB2: To develop structured presentation and public speaking skills.

COB3: To develop students' proficiency in written correspondence, including emails, and reports.

COB4: To enhance awareness and use of body language in professional settings

COB5: To instil appropriate workplace etiquette and digital professionalism.

MODULE I COMMUNICATION AT THE WORKPLACE P: 6

Language and communication fundamentals, Types of workplace communication, Formal and informal Communication, Direction and flow of Communication- Organizational communication and interpersonal dynamics, 7 Cs of Communication - Ethical use of AI assisted communication tools

MODULE II PRESENTATION & PUBLIC SPEAKING SKILLS P: 6

Importance of presentation skills, Managing public speaking anxiety, Structured planning and delivery of presentations, Use of visual aids and technology - Interactive tools

MODULE III CORRESPONDENCE AT WORK P: 9

Digital correspondence - Email Writing and Etiquette, Report Writing: Incident Reports, Feasibility Reports, and Executive Summaries

MODULE IV BODY LANGUAGE P: 5

Fundamentals of body language in professional communication, Types of non-verbal cues, posture -Interpreting and responding to non-verbal signals in interpersonal and group contexts, Cultural variations in body language and their implications in global communication

MODULE V WORKPLACE ETIQUETTE P: 4

Workplace etiquette, Cultural sensitivity in globalized work environments, Gender sensitivity and inclusivity, DEI, Netiquette and digital professionalism - video conferencing, Professional networking (Social media, LinkedIn, etc.), Virtual team dynamics

P – 30; Total Hours:30

TEXT BOOKS:

1. Course material by the Department of English

REFERENCES:

1. Bovee, C. L., & Thill, J. V. *Business Communication Today* (14th ed.). Pearson, 2021.
2. Cardon, P. W., & Marshall, B. The hype and reality of social media use for work collaboration and team communication. *International Journal of Business Communication*, 52(3), 2015, 273–293.
3. Guffey, M. E., & Loewy, D. *Essentials of Business Communication* (11th ed.). Cengage Learning, 2020.
4. Jones, D. A., & Pittman, M. The digital professionalism paradox: Workplace norms and expectations in the era of online communication. *Journal of Applied Communication Research*, 49(3), 2021, 283–301.
5. Keyton, J., & Smith, F. L. M. Communication practices of work teams: Task, social, and identity functions. *Journal of Business Communication*, 46(4), 2009, 402–426.
6. Krizan, A. C., Merrier, P., Logan, J., & Williams, K. *Business Communication* (9th ed.). Cengage Learning, 2016.
7. Lesikar, R. V., Flatley, M. E., Rentz, K., & Lentz, P. *Lesikar's Business Communication: Connecting in a Digital World* (13th ed.). McGraw-Hill Education, 2019.
8. Madlock, P. E. The link between leadership style, communicator competence, and employee satisfaction. *Journal of Business Communication*, 45(1), 2008, 61–78.
9. Raman, M., & Sharma, S. Technical communication: Principles and practice (3rd ed.). Oxford University Press, 2015.
10. Robles, M. M. Executive perceptions of the top 10 soft skills needed in today's workplace. *Business Communication Quarterly*, 75(4), 2012, 453–465. https://doi.org/10.1177/1080569912460400

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Demonstrate clarity in professional communication by selecting appropriate modes and formats for workplace interactions.

CO2: Deliver structured presentations with confidence, using relevant verbal and visual communication techniques.

CO3: Produce clear and effective written correspondence, including emails, and formal reports.

CO4: Interpret and apply non-verbal communication cues appropriately in professional contexts.

CO5: Exhibit workplace etiquette, digital conduct, and cultural sensitivity in professional environments.

Board of Studies (BoS):
18th BoS of the Department of English held on 04.06.2025

Academic Council:
24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M	L	L	L	-	M	L	L
CO2	H	H	L	L	L	L	-	M	M	L
CO3	H	M	L	L	L	L	-	H	M	H
CO4	L	L	L	L	L	L	-	M	M	M
CO5	L	L	H	H	H	H	-	H	H	M

Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Statement: This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: This course equips students with the competencies required for employment in a dynamic global workforce.

SEMESTER III

CHF7101	**SYNTHETIC ORGANIC CHEMISTRY-II**	**L**	**T**	**P**	**C**
SDG: 3, 9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES: To make the students to understand the

COB1: oxidation and reduction reactions in organic synthesis

COB2: the knowledge of organic and transition metals reagents for organic transformations

COB3: concepts for rational mechanism-based design of synthetic strategies in organic synthesis.

COB4: knowledge for designing new synthetic strategies for complex target organic molecules.

COB5: various methods for the synthesis of heterocyclic compounds

MODULE I REAGENTS IN ORGANIC SYNTHESIS-1 L: 9 T: 0 P: 0

Oxidation: Mechanism, selectivity, stereochemistry and applications of SeO_2, MnO_2, NBS, HIO_4, PCC, Swern, Dess Martin, Osmium tetroxide, ozonolysis - Reduction: Mechanism, selectivity, stereochemistry and applications of catalytic hydrogenations using Pd, Pt and Ni catalysts, Wolff-Kishner reduction, Dissolving metal reductions, metal hydride reductions using Diborane, $NaBH_4$, LiAlH4, DIBAL-H, $NaBH_3CN$, Bu_3SnH.

MODULE II REAGENTS IN ORGANIC SYNTHESIS-2 L: 9 T: 0 P: 0

Synthesis and applications: Lithiumdiisopropylamide (LDA), Dicyclohexyl carbodiimide (DCC), Trimethylsilyliodide, Gilman's reagent, DDQ, IBX, phase transfer catalysts, Tebbe, Wilkinson's catalysts, Palladium and copper catalysts in coupling (Suzuki, Heck), Low valent titanium (McMurry), Co(Salen) complex (Jacobsen), BINAL(H), BINAP, Grubb and Schrock catalyst (Olefin Metathesis).

MODULE III RETROSYNTHESIS-1 L: 9 T: 0 P: 0

Principles of retrosynthetic analysis - terminologies of retrosynthesis: synthons and synthetic equivalent - linear and convergent synthesis - synthesis of aromatic compounds - types of disconnections - one group and two group C-X disconnections - one group and two group C-C disconnections - amines and alkene synthesis - reactive umpolung - control of stereochemistry.

MODULE IV RETROSYNTHESIS-2 L: 9 T: 0 P: 0

Important strategies of disconnections: functional group interconversions - activating groups - protection and deprotection strategies for hydroxyl, carboxyl, carbonyl, amino and carbon-carbon multiple bonds -chemoselective and regioselective approaches - illustration of all above strategies towards synthesis of few complex target molecules

MODULE V HETEROCYCLES L: 9 T: 0 P: 0

Nomenclature of heterocycles - classification - structure, synthesis and reactivity of pyrole, furan, thiophene, pyridine, pyran, indoles, quinolines, isoquinolines, benzopyran, chromones, coumarins.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Jie Jack Li, Name Reactions- A- Collection of Detailed Mechanisms and Synthetic Applications-5th Edition, Springer, 2014.
2. Christian M. Rojas, “Molecular Rearrangement in Organic Synthesis, “Wiley, Canada, 2015.
3. P.S. Kalsi, “Organic Synthesis through Disconnection Approach”, Medtech, India, 2017.
4. Alan, R Katritzky, Advances in Heterocyclic Chemistry, Elsevier Acad. Press, 2009.
5. S. Warren and P.Wyatt, Organic Synthesis: The Disconnection Approach, Wiley, 2nd Edition, 2008

REFERENCES:

1. Tse-Lok Ho, “Fiesers' Reagents for Organic Synthesis”, Wiley; 1st edition, India, 2013.
2. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, Organic Chemistry, 11th Edition, John Wiley and Sons, New York, 2013.
3. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2014.
4. T. L. Gilchrist, Heterocyclic chemistry, Pearson, 2009.

COURSE OUTCOMES: The student will be able to

CO1: identify the various reagents for oxidation and reduction reactions

CO2: identify the application of various reagents in organic synthesis

CO3: correlate the fundamental and essential concepts towards synthesis of organic molecules

CO4: predict competent synthetic strategies towards the design and synthesis of complex drug or drug like organic molecules

CO5: design synthetic methods to synthesize heterocyclic derivatives.

Board of Studies (BoS):
14th BoS of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	H	L	L		M	M	-	-	H	H	H
CO2	H	L	L		M	M	-	-	H	H	H
CO3	H	L	L		M	M	-	-	H	H	H
CO4	H	L	M	L	M	M	-	-	H	H	H
CO5	H	L	L	L	H	H	-	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well-Being - Ensure healthy lives and promote well-being for all at all ages.

SDG 9: Industry, Innovation & Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical R&D and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHF7102	QUANTUM CHEMISTRY AND GROUP THEORY	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: failure of classical mechanics and the importance of quantum mechanics

COB2: application of Schrodinger wave equation to quantum mechanical systems

COB3: quantum mechanical approach to atomic and molecular electronic structure

COB4: identification of symmetry elements and point groups of molecules

COB5: application of group theory concepts to solve hybridization, IR, Raman and electronic spectra

MODULE I INTRODUCTION TO QUANTUM CHEMISTRY L: 9 T: 0 P: 0

Review of essential mathematical concepts - introduction to classical mechanics - failure of classical mechanics: black body radiation, photo electric effect, hydrogen atomic spectrum and Compton effect - De Broglie wave particle duality - Heisenberg‘s uncertainty principle - postulates of quantum mechanics - operators algebra - eigen functions and eigen values - orthogonality and normalization of wave functions - derivation of Schrodinger’s time dependent and independent wave equation and its significance.

MODULE II QUANTUM MECHANICAL MODELS AND APPROXIMATE METHODS L: 9 T: 0 P: 0

Applications of Schrodinger's equation: free particle moving in a box (1D, 2D and 3D), the rigid rotor, the harmonic oscillators and the hydrogen atom - angular momentum, spin momentum and ladder operator - approximate methods: the variation theorem, linear variation principle - application of variation methods to the helium atom - erturbation theory (introductory concept, degenerate and non - degenerate) - perturbation (first order) method to Helium atom - Slater and secular determinants of wave functions - concept of Hartree Fock / SCF methods.

MODULE III APPLICATIONS OF QUANTUM MECHANICS L: 9 T: 0 P: 0

Born Oppenheimer approximation - VB and MO theory - applications to H_2^+ and H_2 molecules - MO treatment of homo - and hetero nuclear diatomic molecules -

Hukelmolecular orbital theory and its application to ethylene, butadiene, benzene and cyclic systems.

MODULE IV BASICS OF GROUP THEORY L: 9 T: 0 P: 0

Symmetry elements and symmetry operations - concept of Group and its cardinal properties: closure, associative, identity and inverse rule - cyclic group - Abelian group (H_2O only) and non - abelian group (NH_3 only) - Group multiplication table: C_2v and C_3v group - definition and classification of point groups - assignment of point group of simple molecules - matrix representation of the symmetry operations - reducible and irreducible representation - The great orthogonality theorem (GOT) and its consequences - character table definition - construction of character table C_2V, C_3V and D_3h - Mülliken symbols.

MODULE V APPLICATIONS OF GROUP THEORY L: 9 T: 0 P: 0

Prediction of symmetry of atomic orbitals - linear vector and rotation vector - symmetries of tensor like properties (α and g) - prediction of orbitals and hybridization in BF_3 and CH_4 molecules - direct product representation and its applications - identification of IR and Raman active vibration of H_2O, NH_3, BF_3 and CH_4- selection rules to predict allowed and forbidden electronic transition in UV - Visible spectra of formaldehyde (HCHO) - HMO energy calculation for ethylene and butadiene.

L - 45; Total Hours: 45

TEXT BOOKS:

1. McQuarrie D.A., Quantum Chemistry, Viva Books, Reprint - 2011.
2. Prasad R. K., Quantum Chemistry, Fourth Revised Edition, New Age International Publishers, 2020.
3. Engel T. and Philip Reid, Quantum Chemistry and Spectroscopy, 4th edition Pearson, New Delhi, 2018.
4. Vincent A. Molecular Symmetry and Group theory, A programmed introduction to chemical applications, 2nd Edition, Wiley, 2001.
5. Albert Cotton F., Chemical Applications of Group Theory, An Indian Adaptation Edition, Wiley India Pvt Ltd, 2020.

REFERENCES:

1. Levine I.N., Quantum Chemistry, 7th Edition, Pearson Education India, 2016.
2. Chandra A. K., Introductory to Quantum Chemistry, Fourth Edition, Tata McGraw Hill Education Private Ltd, 2017.
3. Bhattacharya P. K., Group theory and its Chemical Applications, 2ndEdn, Himalaya

Publications, India. 2014.
4. R.L. Flurry. Jr. Symmetry Group Theory and Chemical applications, PrenticeHall.Inc. 1980.
5. Hollas J. M. Symmetry in Molecules, Chapman and Hall, London, 1972.
6. Raman K. V. Group Theory and its Applications to Chemistry, Tata McGraw - Hill, NewDelhi, 1990.

COURSE OUTCOMES: The student will be able to

CO1: explain the failure of classical mechanics and basic principles of quantum chemistry to atoms and molecules

CO2: apply Schrodinger wave equation to simple quantum mechanical systems

CO3: use quantum chemical concepts to describe atomic and molecular structures

CO4: identify symmetry elements and assign point groups to molecules, ions, and coordination complexes

CO5: apply group theory to analyze hybridization, IR, Raman and electronic spectra

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	M	-	-	-	M	-	-	-	H	H	H
CO2	H	-	-	-	H	-	-	-	H	H	H
CO3	H	-	-	-	H	-	-	-	H	H	H
CO4	H	-	-	-	H	-	-	-	H	H	H
CO5	H	-	-	-	H	-	-	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement

Fundamental understanding of thermodynamics and chemical equilibrium provides a strong foundation for quality teaching and effective learning

CHF7103	ORGANOMETALLICS AND ITS APPLICATIONS	L	T	P	C
SDG: 04		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: Structure and bonding of organometallic compound

COB2: Structure and electron count of metal clusters

COB3: Reactions of organometallic compounds

COB4: Different types of bio - inorganic molecules

COB5: Application of bio - inorganic molecules

MODULE I BASIC ORGANOMETALLIC CHEMISTRY L:9 T: P: 0

Organometallic chemistry of d - block elements: 18 - electron rule, concept of hapticity - synthesis, structure and bonding of homo and heteroleptic metal - carbonyls, nitrosyls, alkyls, alkenes, allyl, alkynes, andarenes. Synthesis and reactivity of Fischer and Schrock carbenes. Infraredspectra of metal carbonyls and olefins. Neutral spectator ligands: phosphines and N - heterocyclic carbenes - Organometallic compounds of s - block elements: Organo - lithium, beryllium and magnesium compounds.

MODULE II METAL CLUSTERS AND METALLOCENES L: 9 T: P: 0

Metal clusters, Low and high nuclearity clusters, clusters having interstitial atoms, electron counting schemes: polyhedral skeletal electron pair theory / Mingo's rule. Structure and Isolobal analogies. Metallocenes and bent - metallocenes. Fluxionality and dynamics in organometallic chemistry.

MODULE III REACTIONS OF ORGANOMETALLICS L: 9 T: P: 0

Reactions of organometallic complexes: Substitution, oxidative addition, reductive elimination, insertion and deinsertion. Catalysis: Organometallic catalysts, Terminology in catalysis: Turnover, turnover number (TON), turnover frequency (TOF). Hydrogenation, Hydroformylation, Monsanto process, Wacker process, Ziegler - Natta polymerization, C - C coupling reactions, Olefin Metathesis and metathesis polymerization.

MODULE IV BIOINORGANIC CHEMISTRY - I L: 9 T: P: 0

Bioinorganic Chemistry: Transition metals in biology - their occurrence and function, active - site structure and function of metallo proteins and metalloenzymes with varioustransition metal ions and ligand systems - O_2 binding properties of heme (haemoglobin and myoglobin) and non - heme proteins hemocyanin andhemerythrin), their coordination

geometry and electronic structure, co - operativity effect, Hill coefficient and BohrEffect - characterization of O_2 bound species by Raman and infrared spectroscopic methods - representative synthetic models of heme and nonheme systems.

MODULE V BIOINORGANICCHEMISTRY - II L: 9 T: P: 0

Electrontransferproteins - active site structure and functions of ferredoxin, rubredoxin and cytochromes, and their comparisons. Vitamin B12 and cytochrome P450 and their mechanisms of action. Enzymes: superoxide dismutase and catalase, carboxy peptidase A - structure and functions. Metals in medicine - therapeutic applications of cis - platin, transition metal radioisotopes (example: Tc, Co and Cu etc.) and MRI (Mn and Fe) agents. Toxicity of metals - As, Pb, Cd, Hg and Cr toxiceffects with specific examples.

L - 45;Total Hours: 45

TEXT BOOKS:

1. Shriver D.F., Atkins P.W. and Langford C.H., Inorganic Chemistry, 2nd Edition, Oxford University Press (ELBS), Oxford, 1994.
2. Huheey J.E., Keiter E.A. and Keiter R.L., Inorganic Chemistry, 4th Edition, Addison Wesley Publication, London, 1993.
3. Anil Elias, Basic Organometallic Chemistry, 2nd Edition, Universities Press, 2013.

REFERENCES:

1. Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorganic Chemistry, 6th Edition, John Wiley and Sons, NewYork, 2003.
2. Jolly W.L., Modern Inorganic Chemistry, 2nd Edition, McGraw - Hill, Inc., 1991.

COURSE OUTCOMES: Studentswillbeable to

CO1: Analyze and compare variety of metal - carbon bonds involved in organometallic compounds.

CO2: Find the structure and stability of metal clusters and metallocenes.

CO3: Propose the reaction mechanism of organometallic reactions and their applications

CO4: Learn the importance of bioinorganic molecules in life

CO5: Find the application of bioinorganic molecules in biomedical field

BoardofStudies(BoS): 14th BoS of Chemistry held on 17.07.2025

AcademicCouncil: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	M	H	H	-	M	M	H
CO2	H	M	M	M	H	H	-	M	M	H
CO3	H	M	M	M	H	H	-	M	M	H
CO4	H	M	M	M	H	H	-	M	M	H
CO5	H	M	M	M	H	H	-	M	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Industry, Innovation and Infrastructure: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: Holistic understanding of organometallic chemistry promotes sustainable chemical industries.

CHF 7105	INDUSTRY INTERNSHIP	L	T	P	C
SDG: 9		0	0	4	2

COURSE OBJECTIVES

- To enable students to bridge the gap between theoretical chemical concepts and real-world applications.
- To enable students in the meticulous recording of experimental data and the structured reporting of scientific findings.

GENERALGUIDELINES:

- The internship carries two credits with a minimum duration of 30 days.
- Students are encouraged to pursue theirinternship in an Industry / Research Organization / Academic institutions within the chemical sciences domain during the summer vacation after the first year of study.
- Prior to the commencement of the internship, students must obtain permission from the Head of the Department and respective faculty mentor. Students shall submit a detailed internship report at the beginning of the III Semester, describing the nature of work carried out during the internship period.
- The student shall also submit the attendance and internship completion certificate issued by the Industry/ Research Organization / Academic Institution along with confidential feedback provided by them (in a specified format) in a sealed cover to the Class Advisor.
- A committee comprising of faculty members constituted by the Head of the Department/ Dean of School shall evaluate the Internship report, and shall conduct internship midterm reviews in the III semester of study followed by semester end oral examination.
- The weightage of marks for the internship assessment shall be 60% for the internship report and 40% for the viva-voce examination.
- Based on the evaluation of the internship report and the student's performance in the end-semester oral examination, a relative grade shall be warded.

COURSEOUTCOMES:

At the end of the internship, the students will be able to

CO1: Understand key activities in an industry and research organization.

CO2: Apply and provide practical suggestions to real-world problems.

CO3: Demonstrate communication and report-writing skills.

P – 60; TOTAL – 60

Board of Studies (BoS):
17th BOS of Department of Chemistry held on 17.07.2025.

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	H	H	H	H	H	H	H	H
CO2	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG—9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement:The industry internship provides a holistic understanding of chemical concepts in real world and enabling students to apply learnt principles for sustainable development

CHF 7201	PROJECTWORK (PHASE I)	L	T	P	C
SDG:3, 4, 6, 7,9,11, 13, 15		0	0	8	4*

COURSEOBJECTIVES:

The project work aims

- To foster students in independent research capabilities.
- To bridge academic theory with professional practice
- To conduct systematic proper literature survey of recent advancements
- To formulate a precise research problem statement

GENERALGUIDELINES:

- At post-graduate level, project work shall be carried out by the student individually guided by a faculty mentor.
- Students are provided the opportunity to exercise choice-based selection in identifying a faculty mentor whose expertise aligns with their specific area of interest in chemical sciences.
- Students to undertake their Project Work (Phase I & II) either at the parent institution or through collaborative arrangements with industry partners, R&D organizations, or other recognized academic institutions.
- The Project work Phase —I, shall be carried out by the students under the guidance of allotted mentor.
- Incase, the students pursuing their project in the Industry /R &D organization / Eminent academia, a competent person from the project offering organization is assigned as co-guide as per the discretion of the head of the firm, in addition to the Department allotted mentor.
- In the Project work —Phase I, the students are expected to identify the project topic, refer related literatures / data / information to identify the research problem (i.e.,need for the present study). The students shall conduct meticulous literature review to identify the research gap, and frame the objectives to address the same.
- The students are encouraged (i) to frame the methodology to achieve the desired objectives, (ii) toconduct experiments related to the objectives, (iii) to acquire knowledge on various experiments / techniques to conduct experimental experimentation etc, (iv) to acquire knowledge on analysis of their compounds/materials using various characterization techniques,

- The Head of the Department / Dean of School shall constitute a project progress review committee comprising competent faculty as members to continuously monitor the progress made by students during the Project Phase I.
- The project coordinator/Class advisor shall arrange to conduct three progress review meetings to ascertain the progress of the work and award the marks based on the performance on expected metrics.
- At the end of phase –I period, students shall submit a project report covering the various aspects of project work.The typical components of the project report in Phase I shall include Introduction, objectives, need for the present study, scope for investigation, literature review and methodology.
- An oral examination (viva voce) shall be conducted as semester end examination. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 15% shall be for the project report, 10% for project guide and 25% for the viva voce examination.
- The project coordinator/Class Advisor shall arrange for final viva-voce examination to ascertain the overall performance in Project work.

COURSEOUTCOMES:

On completion of the course, students will be able to

CO1: perform systematic literature survey and problem Identification

CO2: perform experimental methodology involving various chemical techniques and characterization tools.

CO3: Demonstrate effective communication and professional report-writing skills.

P – 120; TOTAL – 120

BoardofStudies(BoS):
17th BOS of Department of Chemistry held on 17.07.2025.

AcademicCouncil:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	H	H	H	H	H	H	H	H
CO2	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3:Good Health and Well – Being

SDG 4: SDG 4: Quality Education

SDG 6: Clean Water and Sanitation

SDG 7: Affordable and Clean Energy

SDG 9: Industry and Innovation

SDG 11: Sustainable Cities and Communities

SDG 13: Climate Action and Life on Land

SDG 15: Life on Land

Statement

SDG 3,4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 6,7, 11: Affordable & Clean Energy and Sustainable Cities and communities

SDG-9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

SDG 11,13, 15: The project work provides a holistic development in laboratory and theorticalunderstanding of chemical concepts in real world and enabling students to apply learnt principles for sustainable development

SEMESTER – IV

CHF 7201	**PROJECT WORK (PHASE II)**	**L**	**T**	**P**	**C**
SDG:3, 4, 6, 7,9,11, 13, 14, 15		**0**	**0**	**30**	**10**

COURSEOBJECTIVE:

The project work aims

- To foster students in independent research capabilities.
- To bridge academic theory with professional practice
- To enable research data collection, analysis and interpretation
- To facilitate scientific documentation and report submission
- To defend the research work performed through technical presentation

GENERALGUIDELINES:

- Project work phase II is a continuation of phase I following the same guidelines.
- The project co-coordinator shall arrange to conduct three reviews to ascertain the progress of the work and award the marks based on the performance of students on desired metrices.
- Detailed experimental investigation and in-depth experimental studies shall be performed in line with the objectives of the investigation.
- The students are expected to analyze the obtained results and discuss the same in an elaborate manner by obtaining necessary characterization data.
- The important conclusions need to be drawn and the scope for further research also to be highlighted.
- The outcome of project work shall preferably be published in journals/conference of National or International importance.
- At the end of project phase II, students shall submit a detailed report and it shall include Experimental investigation and analytical study, Results & Discussion of experimental/analytical work, Conclusions, References etc., in addition to work completed in Phase –I viz. Introduction, Literature and methodology.
- The project co-ordinator in consultation with Dean/ Head of the department and Controller of Examination shall arrange for a semester end oral examination by following SOP of the Institution to ascertain the overall performance of the students in Project work.

- The weightage for periodic reviews shall be 50%. Of the remaining 50%, 15% shall be for the project report, 10% for project guide and 25% for the viva voce examination.

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: perform systematic literature survey and problem Identification
CO2: conduct experimental methodology involving various chemical techniques and characterization tools.
CO3: Demonstrate effective communication and professional report-writing skills.

P – 450; TOTAL – 450

Board of Studies (BoS):
17th BOS of Department of Chemistry held on 17.07.2025.

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	H	H	H	H	H	H	H	M
CO2	H	H	H	H	H	H	H	H	M
CO3	H	H	H	H	H	H	M	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3: Good Health and Well – Being
SDG 4: SDG 4: Quality Education
SDG 6: Clean Water and Sanitation
SDG 7: Affordable and Clean Energy
SDG 9: Industry and Innovation
SDG 11: Sustainable Cities and Communities
SDG 13: Climate Action and Life on Land
SDG 15: Life on Land

Statement
SDG 3,4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 6,7, 11: Affordable & Clean Energy and Sustainable Cities and communities
SDG-9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
SDG 11,13, 15: The project work provides a holistic development in laboratory and theorticalunderstanding of chemical concepts in real world and enabling students to apply learnt principles for sustainable development

PROFESSIONAL CORE ELECTIVES

CHFY 001	ANALYTICAL TECHNIQUES	L	T	P	C
SDG: 6, 9		3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: basics in data analysis

COB2: basics and principles in volumetric and gravimetric analysis

COB3: types and principles of electroanalytical methods

COB4: principles and analysis of spectroscopic techniques

COB5: the principle and methods in chromatography and thermal analysis

MODULE I DATA ANALYSIS L: 9 T: 0 P: 0

Precision and accuracy, Classification of errors, methods of minimization and elimination of errors Mean and standard deviation; absolute and relative errors; students t - test, F - test, linear regression for deriving calibration plots, covariance and correlation coefficient - detection limits - Least square method, correlation coefficient and its determination - Fitting of data to hypothesis - AI in analytical chemistry.

MODULE II CHEMICAL METHODS OF ANALYSIS L: 9 T: 0 P: 0

Different methods of expressing concentration terms, Difference between titrimetric and volumetric analysis, Types and roles of indicators - Principle and reactions involved in neutralization, precipitation, complexometric and redox titrations, calculations involving stoichiometry - for all types of systems - Gravimetric analysis (volatilisation and precipitation methods) - Karl Fischer titration.

MODULE III ELECTROANALYTICAL METHODS L: 9 T: 0 P: 0

Types of electrodes - Conductometric Titrations - Potentiometric titrations - pH - metry and ion - selective electrodes - DM Electrode - polarography - electrogravimetry - Amperometric titrations - Coulometric Titrations - cyclic voltammetry, impedance studies - Electrochemical sensors.

MODULE IV SPECTROPHOTOMETRIC TECHNIQUES L: 9 T: 0 P: 0

Quantitative applications of colorimetric analysis - UV - Visible spectrophotometry - Atomic Absorption Spectroscopy (AAS) - Atomic Emission Spectroscopy (AES), Flame photometry, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP - AES) - Turbidimetry and nephlometry.

MODULE V SEPARATION TECHNIQUES AND THERMAL METHODS **L: 9 T: 0 P: 0**

Chromatography: TLC and column Chromatography - Detectors in Chromatography - GC, HPLC, (hyphenated techniques GC/MS, LC/MS) and GPC - ion exchange chromatography - Electrochromatography: Capillary electrophoresis and gel electrophoresis - Thermal analytical techniques: TGA, DTA, DSC, DMA - Chemisorption Techniques - TPD, TPO, TPR, TPS.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., Fundamentals of Analytical Chemistry, 8th Edition, Thomson Brooks/Cole Publication., Singapore, 2004.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., Instrumental Methods of Analysis, 7th Edition, CBS Publication, New Delhi Reprint, 2004.
3. Skoog D.A., Holler F.J. and Nieman T.A., Principles of Instrumental Analysis, 5th Edition, Harcourt College Publication., Singapore, 1998.
4. Christian G.D., Analytical Chemistry, 6th Edition, John Wiley, Singapore, 2003.

REFERENCES:

1. J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education, 1989 (ISBN: 9780470215173).
2. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
3. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004.

COURSE OUTCOMES: The student will be able to

CO1: analyse the numerical data without error

CO2: perform the volumetric and gravimetric analysis of chemical compounds and interpret the result

CO3: perform the electroanalytical titrations and analyse the result

CO4: identify the appropriate spectral technique and do the spectral analysis and interpret the data

CO5: perform the chromatographic techniques and separate the compounds

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	M	H	M	-	H	H	M
CO2	H	M	M	M	H	M	-	H	H	M
CO3	H	M	M	M	H	M	-	H	H	M
CO4	H	M	M	M	H	M	-	H	H	M
CO5	H	M	M	M	H	M	-	H	H	M

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 6: Clean Water and Sanitation

Statement: Ensure availability and sustainable management of water and sanitation for all.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: SDG 9: Innovation in analytical techniques promotes sustainable analysis in industry and ensures sustainable practices in society.

CHFY 002	PRINCIPLES AND APPLICATIONS OF	L	T	P	C
SDG: 9, 11	PHOTOPHYSICS AND PHOTOCHEMISTRY	3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: basic laws of photophysics and photochemistry.

COB2: Basics of fluorescence spectroscopy

COB3: principle and instrumentation of different types of spectrofluorimeter.

COB4: Different types of photochemical reactions

COB5: Applications of Photoscience.

MODULEI PRINCIPLES AND CONCEPTS L: 9 T: 0 P: 0

An overview of: Laws of photochemistry, Beer - Lambert law, electronic energy levels, atomic and molecular term symbols, singlet - triplet state, intensity and strength of electronic transition, selection rules for electronic transition, Jablonski diagram and photophysical processes, Franck - Condon principle. Excited state lifetime, steady state and time resolved emission, factors affecting excited state energy: solvent effect, TICT.

MODULEII PHOTOINDUCED TRANSITIONS L: 9 T: 0 P: 0

Quantum yield expressions, excimer and exciplex, Measurement of quantum yield kinetics of luminescence quenching: static and dynamic, Stern - Volmer analysis, deviation from Stern - Volmer kinetics.Time resolved anisotropy, environmental influence on fluorescence properties and photo - bleaching Resonance energy transfer rates (RET), Rate and efficiency of RET. Electron transfer - rate - excited state oxidation potential, Rehmweller equation, Energy transfer - Dextor and Forster - distance dependance, proton transfer - ESIPT.

MODULEIII INSTRUMENTATION TECHNIQUES L: 9 T: 0 P: 0

Measurement of fluorescence and phosphorescence and lifetimes. Light Sources, detectors - PMT, Diode - array Fluorescence standards - lifetime and decay. Introduction to time - resolved techniques for absorption and emission measurements, detection and kinetics of reactive intermediates. Examples of low temperature matrix isolation of reactive intermediates.

MODULEIV PHOTOCHEMICAL REACTIONS L: 9 T: 4 P: 0

Photochemistry of alkene, cis - trans isomerization, photocycloaddition reactions of

alkene, photochemical electrocyclic and sigmatropic reactions, di - pi - methane rearrangment, electron transfer mediated reactions of alkene. Photochemistry of carbonyl compounds, Norrish type I and type II reactions, enone and dienone cycloadditions. Photochemistry of aromatic systems, electron transfer and nucleophilic substitution reactions. Photochemistry of nitro, azo and diazo compounds. Photochemistry involving molecular oxygen, generation and reactions of singlet oxygen. Photo - fragmentation reactions (Barton, Hofmann - Loffler - Freytag).

MODULE V APPLICATIONS L: 9 T: 4 P: 0

Fluorescence based sensors - examples of molecular and supramolecular systems,biosensors - Limit of detection. Conversion of solar energy to chemical and other forms of energies, solar photovoltaic cell, basic principle and design of the cell.Aggregation induced emission - AIE nanodots - bioimaging. Photocatalysis - LEDs, OLEDs and WLEDs - Forensic Applications: Latent Finger Print Analysis.

L - 45Total Hours: 45

TEXT BOOKS:

1. Fundamental of Photochemistry, K. K. Rohatgi - Mukherjee, New Age International (P) Ltd., New Delhi, 1986.
2. Principles of Fluorescence Spectroscopy, 3rd, J. R. Lakowicz, Springer, New York, 2006.

REFERENCES:

1. Fundamentals of Photoinduced Electron Transfer, G. J. Kavarnos, VCH publishers Inc., New York, 1993.
2. Molecular Fluorescence: Principles and Applications, B. Valeur, Wiley - VCH Verlag GmbH, Weinheim, 2002.
3. Modern Molecular Photochemistry of Organic Molecules, N. J. Turro, V. Ramamurthy, J. C. Scaiano, University Science, Books, CA, 2010.
4. Photochemical Synthesis, I. Ninomiya, T. Naito, Academic Press, New York, 1989.

COURSE OUTCOMES: The students will be able to

CO1: describe and explain common photochemical and photophysical processes and mechanisms with suitable theoretical models, and apply established experimental methods for the investigation of these processes

CO2: describe the interaction of excited states with their surroundings and analyse photoinduced electron transfer and excitation energy transfer with quantitative models

CO3: understand the components of instrumental techniques of photo physical studies and excited state transitions.

CO: describe the structure and function of photosynthetic reaction centres, and explain the function of photosynthetic antenna systems

COB5: apply the knowledge of photochemistry in various fields.

Board of Studies (BoS):
14th BoS of Department of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	-	-	-	-	-	-	-	-	-
CO2	-	H	-	-	-	-	-	-	M	H
CO3	-	-	H	M	-	-	-	H	H	-
CO4	-	H		H	-	H	-	-	-	-
CO5	-	-	-	-	-	-	H	-	-	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 9:Industry and Innovation

SDG 11:Sustainable Cities and Communities

Statement:

SDG9: Foundation to work in RandD of renewable energy and sensors sector and for teaching career.

SDG11: RandD labs in API labs in the production sustainable molecules electrical related works

CHFY 003	COMPUTATIONAL CHEMISTRY	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: Learn the overview of C - programming

COB2: Comprehend the basic ideas of operators, Data input and Output

COB3: Write C - programming in Physical Chemistry

COB4: Apply C - programming in Inorganic Chemistry

COB5: Apply C - programming in Organic Chemistry

MODULE I INTRODUCTION COMPUTER AND C PROGRAMMING L: 9 T:0 P: 0

Importance of Computers - history and development - hardware and software - structure of a computer - operating systems - DOS and UNIX - Low level and High level languages - Interpreter and compiler - Types of Computers - various input and output devices.

Introduction - Importance of C - structure of C - programs - Simple programs - style of the language.

Characters - Keywords, Variables and parameters - Data types - Constants - Declaration of and assignments of values to variables.

Operators - Arithmetic, Relational, Logical, assignment, Increment and Decrement, Conditional and bitwise operators - Special operators.

Expressions - Arithmetic - Evaluation of expression - Procedure of arithmetic operators - Library functions.

MODULE II DATA INPUT AND OUTPUT L: 9 T: 0 P: 0

Character input - The getchar function - Character output - The putchar function - Entering input data - the Scanf function - Writing output data - The printf function - Formatted input and output data - the gets and puts functions - preparing and running a complete program. Decision making and branching: Decision making with IF statement - simple IF statement - the IF…ELSE statement - Nesting of IF…Else statements - The ELSE IF ladder - The Switch statement - The ?: operator - the GOTO statement.

MODULE III STRUCTURE OF C PROGRAM L: 9 T: 0 P: 0

The WHILE statement - The DO statement - The FOR statement - Jumps in loops.

Arrays: One dimensional array - Two dimensional arrays - Initializing two dimensional arrays - Multidimensional arrays. User defined functions: Need for user - defined functions - A multifunction program - The form of C functions - Return values and their types - Calling a function - Category of function - No arguments and no return values - Nesting functions - Recursions - The scope and life time of variables in function.

MODULE IV APPLICATIONS OF C PROGRAM IN CHEMISTRY - I **L: 9 T: 0 P: 0**

Explanation of the formulae, equations and programs to solve the following problems in chemistry:

1. Calculation of Molecular weight of Organic Compounds.
2. Calculation of pH.
3. Determination on First Order rate constant for the given reaction
4. Evaluation of lattice energy using i). Born - Haber Cycle ii). Born - Lande equation
5. Computing ionic radii - Lande‘s method and Paulings method
6. Calculation of Normality, Molarity and Molality of a given solution
7. Converting Kelvin to Celsius temperature and vice versa.
8. Determination of enthalpy of a given solution
9. Evaluation of Cell constant
10. Calculation of energy of Hydrogen atom spectral lines.

MODULE V APPLICATIONS OF C PROGRAM IN CHEMISTRY - II **L: 9 T: 0 P: 0**

Explanation of the formulae, equations and programs to solve the following problems in chemistry:

Organic Chemistry:

1. Use of Recursive functions to calculate the number of π Resonance structures for an organic conjugated system using res - str = n! / ((n/2)! * ((n/2) + 1)!)
2. Empirical formula of Hydrocarbons and other Organic compounds.

Inorganic Chemistry:

1. Array manipulation to balance the chemical equations.
2. Half life and average life periods of radioactive nuclei.
3. Binding energy of nucleus.
4. Program to get output as First ten elements of Periodic Table with their Name, Symbol, Atomic number and Atomic Weight.

Physical chemistry:

1. Calculation of RMS, average and MPV of gases.

2. Solving Quadratic equation to evaluate the Equilibrium constant for the reaction H2 + I2 2HI

3. Illustrate use of Loop to calculate the NMR frequency for a nucleus with Spin ½

4. Mean activity coefficient of an Electrolyte (KCl)

L - 45; Total Hours: 45

TEXT BOOKS:

1. E. Balagurusamy, 2005. Programming in ANSI C, Tata McGraw - Hill Publishing Course contents and lecture schedule Company Ltd., New Delhi, 3rd Edn. 10th reprint.

REFERENCES:

1. Brian W. Kernighan and Dennis M. Ritchie, 2001. The C Programming Language, Prentice Hall of India Private Limited, New Delhi, 2nd Edn.
2. Byron S. Gottfried, 2001. Programming with C, Tata McGraw - Hill Publishing Company Ltd., New Delhi, 2nd Edn.
3. R. Rajaram, 1999. C Programming Made Easy, Scitech Publications, Chennai.
4. Yeshavant Kanitkar, 1999. Let Us C, BPB Publications, New Delhi, 3rd Edn..
5. Yeshavant Kanitkar, C 1998 - Projects, BPB Publications, New Delhi,.
6. K. V. Raman, 1993 Computers in Chemistry, Tata McGraw - Hill Publishing Company Ltd., New Delhi, 3rd Edn.

COURSE OUTCOMES:

CO1: Learn the overview of C - programming

CO2: Comprehend the basic ideas of operators, Data input and Output

CO3: Write C - programming in Physical Chemistry

CO4: Apply C - programming in Inorganic Chemistry

CO5: Apply C - programming in Organic Chemistry

Board of Studies (BoS):

14th BoS of Chemistry held on 17.07.2025

Academic Council:

24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	-	-	-	M	-	-	-	-	-	-	-
CO2	-	-	-	M	-	-	-	-	-	-	-
CO3	M	-	-	M	-	H	-	-	-	-	-

CO4	M	-	-	M	-	H	-				
CO5	M			M		H					

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality education

Statement:Bridging the gap between modern laboratory equipment and the latest software solutions.

CHFY 004	BASICS OF FORENSIC CHEMISTRY	L	T	P	C
SDG: 2, 6, 11, 14		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: Basics of forensic science and structure

COB2: the basic forensic analysis of different materials

COB3: The forensic toxicology and analysis

COB4: the various drugs and analysis

COB5: the fire and explosives and identification

MODULE I INTRODUCTION TO FORENSIC SCIENCE L:9 T:0 P:0

Definition - Locard's exchange principle, principle of individuality, scientific method, evidence analysis - significance of forensic science, history and worldwide developments of forensics and in india - structure of forensic laboratory - code of conduct and code of ethics for forensic science - role of a forensic scientist.

MODULE II FORENSIC ANALYSIS L:9 T:0 P:0

Identification - crime scene support - qualitative and quantitative analysis - preliminary laboratory methods - SWGdrug examination categories - forensic analysis: soil, hair, fibre, polymer and paint, - analyzing DNA samples - examining fingerprints, development of fingermarks using nanoparticles - analyzing gunshot residue - nano trackers

MODULE III FORENSIC TOXICOLOGY L:9 T:0 P:0

Pesticides - herbicides - fungicides - antimicrobials - Samples collected for toxicology studies -Death investigation toxicology - Analytical techniques: immunoassay, chromatographic and mass spectrometric methods - Reinsch Test for heavy metal poison – Breathalyzer

MODULE IV FORENSIC DRUG CHEMISTRY AND ANALYSIS L:9 T:0 P:0

Classes of drugs - synthetic drugs - prescription drugs - stimulants - depressants and antianxiety drugs - hallucinogens - opiates/opioids - doping in sports and work place drug testing -new psychoactive substances - drug investigative analysis - identification of emerging drugs - adulteration of folk medicines and dietary supplements

MODULE V FIRE, ARSON, AND EXPLOSIVES AND ANALYSIS L:9 T:0 P:0

Tpes of fire - flammable substances - combustion and spontaneous combustion - arson and accelerants - explosives and incendiary weapons - identification of explosives - chemical weapons - blood agents - pulmonary/choking agents - blister agents - nerve gases - nettle or urticant agents - incapacitating agents - vomiting agents - riot/tear agents - detection and identification methods - biological weapons:bacteria, fungi, viruses - protein toxins

L: 45; Total Hours:45

REFERENCES:

1. Kelly M. Elkins, Introduction to Forensic Chemistry, CRC Press, 2019.
2. Illustrated Handbook of Forensic Chemistry, E-learning LLC, E-book Edition, 2019.
3. Suzanne Bell, Forensic ChemistryThird Edition, CRC Press, 2022.
4. Mathew E. Johll, Investigating Chemistry: A Forensic Science Perspective, W.H. Freeman Publishers, 2009.
5. J.A. Siegel, Forensic Chemistry: Fundamentals and Applications, Wiley Blackwell, 2000.
6. Yinon Jitrin, Modern Methods & Application in Analysis of Explosives, John Wiley & Sons, England, 1993.

COURSE OUTCOMES: The students will be able to

CO1: Recall the basics of forensic science and structure

CO2: To employ the basic forensic analysis for various materials

CO3: Identify the toxicological substances and analyse it

CO4: Classify the various drugs and analysis

CO5: Identify the arson and explosives and identify it

Board of Studies (BoS): 14th BoS of Department of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L	-	-	-	-	-	-	-	-	-
CO2	L	M	L	M	M	M	-	M	L	M
CO3	L	M	L	M	M	M	-	M	L	M
CO4	L	M	L	M	M	M	-	M	L	M
CO5	L	M	L	M	M	M	-	M	L	M

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 2: Zero Hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
SDG 6: Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all
SDG 11: Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG 14: Life Below Water	Conserve and sustainably use the oceans, seas and marine resources

Statement: Prove secured and sustainable management food and water, safe human settlement to have a peaceful society with sustainable devekopment.

CHFY005	MOLECULAR SPECTROSCOPY AND	L	T	P	C
SDG: 6, 9	STRUCTURAL INTERPRETATION	3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: basics of spectroscopy and the principle and techniques in rotational vibrational spectroscopy with interpretation

COB2: basics and principles of UV - Visible spectroscopy and the technique with interpretation

COB3: basics and principles of spin resonance spectroscopy with interpretation

COB4: basics and principles of mass spectrometry with interpretation

COB5: selected spectroscopic techniques in material characterisation

MODULE I ROTATIONAL AND VIBRATIONAL SPECTROSCOPY **L: 9 T: 0 P: 0**

Electromagnetic radiation - regions of the spectrum - enhancement of spectra - Microwave spectroscopy - rotational spectra of diatomic molecules - Infra - red spectroscopy - Vibration in diatomic and polyatomic molecule - selection rules - PQR branches in IR spectra - Fermi resonance - Interpretation of organic and inorganic compounds/complexes - Raman spectroscopy for diatomic molecules - mutual exclusion principle - Rotational fine structure - Interpretation of spectral data.

MODULE II ELECTRONIC SPECTROSCOPY **L: 9 T: 0 P: 0**

Electronic spectra of diatomic molecules: Born Oppenheimer approximation, Franck - Condon principle, intensity of electronic transition, selection rules - Relaxation of the selection rules - Charge Transfer Transitions - types of electronic transition - Chromophore and auxochromes and related shifts - Jablonski Diagram, Process involved during excitation and emission - Woodward - Fischer rule and Fieser - Kuhn rule - Factors affecting absorbance in Electronic Spectroscopy - Interpretation of organic and inorganic compounds/complexes

MODULE III SPIN RESONANCE SPECTROSCOPY **L: 9 T: 0 P: 0**

Nuclear Magnetic Resonance (NMR) spectroscopy - Principle - relaxation processes - chemical shift - shielding and deshielding - factors affecting chemical shift - anisotropy - hydrogen bond - coupling constant - Shift reagents in NMR - ^{13}C NMR - chemical shift -

Proton coupled and decoupled ^{13}CNMR - DEPT^{13}CNMR - Principle of solid state NMR (magic angle spinning (MAS NMR)) - ^{15}N, ^{19}F, ^{27}Al, ^{29}Si, and ^{31}P, ^{11}B, ^{77}Se nuclei spectra of typical examples - Interpretation of organic and inorganic molecules by NMR - Electron Paramagnetic Resonance (EPR) Spectroscopy - Nuclear Hyperfine Splitting - EPR spectra of anisotropic systems - anisotropy in g value, hyperfine splitting caused by quadrupole nuclei, g value calculation.

MODULE IV MASS SPECTROMETRY **L: 9 T: 0 P: 0**

Basic principles, ionisation techniques: hard and soft ionisation techniques, detectors and instrumentation - isotope abundance, molecular ion effect of isotopes - nitrogen rule - HRMS - determination of molecular formula - fragmentations and rearrangements - metastable ions - fragmentation of organic inorganic/ coordination and organometallic compounds - Interpretation of organic, inorganic compounds and materials using combination of the spectral data.

MODULE V CHARACTERIZATION TECHNIQUES IN MATERIAL SCIENCE **L: 9 T: 0 P: 0**

Principle, instrumentation and applications of - NQR Spectroscopy - Mossbauer Spectroscopy - X - Ray Photoelectron Spectroscopy (XPS) - SEM - EDX - TEM - AFM - X - Ray Crystallography, Surface area analysis: isotherms, types, BET surface area, pore size, pore volume and interpretation.

L - 45; P - 0; Total Hours: 75

TEXT BOOKS:

1. Banwell C.N. and McCash E.M., Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw Hill, New Delhi, 1995.
2. Pavia D.L., Lampman G.M. and Kriz G.S., Introduction to Spectroscopy, 3rd Edition, Brooks/Cole Publication, Singapore, 2001.
3. Drago R., Physical Methods for Chemists, Saunders, Philadelphia, 1992.
4. Pasto D., Johnson C. and Miller M., Experiments and Techniques in Organic Chemistry Prentice - Hall Inc., New Jersey, 1992.

REFERENCES:

1. J. Michael Hollas, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, 2002.
2. Ira N. Levine, Molecular Spectroscopy, Wiley, 1975.

3. Robert M. Silverstein, Francis X. Webster, David Kiemle, Spectrometric Identification of Organic Compounds, 7th Edition, Wiley, 2005.
4. Kemp W., Organic Spectroscopy, 3rd Edition, ELBS, McMillan, London, 1991.
5. Williams D.H. and Fleming I., Spectroscopic Methods in Organic Chemistry, 4th Edition, McGraw Hill, New York, 1989.

COURSE OUTCOMES: The students will be able to

CO1: identify the microwave, rotational and vibrational spectra and analyse the data

CO2: choose the type of solvent and wavelength and process the electronic spectra.

CO3: identify the peaks in simple ^{1}H and ^{13}CNMR and interpret the results

CO4: choose the ionization technique, analyser and detector for chemical compounds and interpret the mass spectra

CO5: identify the selected techniques molecules and interpret the simple spectra

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M	H	H	M	H	H	H	M
CO2	H	H	M	H	H	M	H	H	H	M
CO3	H	H	M	H	H	M	H	H	H	M
CO4	H	H	M	H	H	M	H	H	H	M
CO5	H	H	M	H	H	M	H	H	H	M

Note: L - Low CorrelationM - Medium Correlation H - High Correlation

SDG 6: Clean Water and Sanitation - Ensure availability and sustainable management of water and sanitation for all

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement

Spectral techniques provide the pavement for the production of various materials in Research and Industry and ensures sustainable lifestyle in society.

CHFY 006	BIOMOLECULES	L	T	P	C
SDG: 3, 9		3	0	0	3

COURSE OBJECTIVES:

To make the students to understand the

COB1: structure, stereochemistry and synthesis of monosaccharide derivatives

COB2: structure, synthesis and properties of amino acids and proteins

COB3: importance, structure and synthesis of steroid molecules

COB4: importance, structure and synthesis of vitamins

COB5: structure, synthesis and drug application of alkaloid and terpenoids

MODULE I CARBOHYDRATES L: 9 T: 0 P: 0

Classification and nomenclature of carbohydrates - D/L configuration, anomers, epimers - structure and stereochemistry of monosaccharides - Fischer and Haworth projections - chair and boat conformation- mutarotation, tautomerism, and ring - chain equilibrium - reactions of monosaccharides - oxidation, reduction, glycoside formation - Kiliani - Fischer - disaccharides: sucrose, maltose, cellobiose - polysaccharides - glycoproteins and glycolipids - carbohydrates in drug design.

MODULE II AMINO ACIDS AND PROTEINS L: 9 T: 0 P: 0

Amino acids: classification, structure and properties - peptides and peptide bond formation - protecting group in peptide synthesis - synthesis (solid - phase and solution - phase) - Proteins: primary, secondary (α - helix, β - sheet), tertiary, and quaternary structures - Forces stabilizing protein structure (H - bonding, hydrophobic interactions, disulfide bridges) - protein purification - insulin - oxytocin - intro on proteomics.

MODULE III STEROIDS L: 9 T: 0 P: 0

Classification - chemical synthesis and biological importance of: androsterone, testosterone, progesterone, oestrone, oestriol, oestradiol, 5α - and 5β - cholanic acid - chemical structure and physiological roles of: equilenin, bile acids, cholestane and coprostane.

MODULE IV VITAMINS L: 9 T: 0 P: 0

Classification- Structure, biological importance and chemical synthesis of vitamins: A, B_1, B_2, B_6, B_{12}, C, E and K - Vitamin toxicity.

MODULE V ALKALOIDS AND TERPENOIDS L: 9 T: 0 P: 0

Alkaloids - Classification - synthesis of: quinine, morphine, narcotine and reserpine.

Terpenoids - Nomenclature - classification - isoprene rule - synthesis of: α - pinene, zingiberene, cadinene, α - santonin, abietic acid.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.
2. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2000.
3. Stryer, L., "Biochemistry", 5th Edition, W.H. Freeman and Company, San Francisco, 2002.
4. Faber, K., "Biotransformations in Organic Chemistry", Fifth Edition, Springer, New York, 2008.

REFERENCES:

1. Singh, J. and Yadav, L.D.S., "Advanced Organic Chemistry", Ninteenth Edition, A pragati Edition, Meerut, 2016.
2. Khan, M.A., "Chemistry of Natural products", First Edition, Omega Publcations, New Delhi, 2014.
3. Ahluvalia, V.K., "Chemistry of Natural Products", 2nd Edition, Vishal Publishing Co, Jalandhar, 2018.

COURSE OUTCOMES: The student will be able to

CO1: recognize and identify the different types of carbohydrate molecules

CO2: identify the different types of amino acids and propose a reaction methodology for protein synthesis

CO3: analyse the routes of synthesis and biological importance of steroids

CO4: correlate the structure and functions of vitamins

CO5: suggest routes for the synthesis of biologically active alkaloids and terpenoids

Board of Studies (BoS):	**Academic Council:**
14th BoS of Chemistry held on 17.07.2025	24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	H	L	-	L	M	L	-	-	H	H	H
CO2	H	L	-	L	M	L	-	-	H	H	H
CO3	H	M	-	-	M	L	-	-	H	H	H
CO4	M	L	-	-	M	L	-	-	H	H	H
CO5	H	L	-	-	M	L	-	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well - Being - Ensure healthy lives and promote well - being for all at all ages.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHFY 007	BIOCHEMISTRY	L	T	P	C
SDG: 3, 9		2	0	2	3

COURSE OBJECTIVES: To make the students to understand the

COB1: mechanism of enzymes and coenzymes

COB2: knowledge on carbohydrate metabolism

COB3: lipid metabolism and biological oxidation

COB4: biosynthesis of amino acids and proteins

COB5: structure and function of biological membranes and the mechanisms of molecular and ionic transport

MODULE I ENZYMES AND COENZYMES L: 9 T: 0 P: 0

Enzymes: Nomenclature, enzymes-kinetics and mechanism of action, mechanism of inhibition of enzymes and isoenzymes in chemical diagnosis. Co-enzymes: Vitamins as co-enzymes and their significance - Metals as co-enzymes and their significance.

MODULE II CARBOHYDRATE METABOLISM L: 9 T: 0 P: 0

Glycolysis, gluconeogenesis and glycogenolysis - metabolism of galactose and galactosemia - role of sugar nucleotides in biosynthesis and pentose phosphate pathway - citric acid cycle, significance, reactions and energetics of the cycle.

MODULE III LIPID METABOLISM AND BIOLOGICAL OXIDATION L: 9 T: 0 P: 0

Oxidation of fatty acids-oxidation and energetics, biosynthesis of ketone bodies and their utilization, biosynthesis of saturated and unsaturated fatty acids, regulation of lipid metabolism, essential fatty acids. The respiratory chain, its role in energy capture and control, energetics of oxidative phosphorylation, mechanism of oxidative phosphorylation.

MODULE IV BIOCHEMISTRY OF AMINOACIDS AND PROTEINS L: 9 T: 0 P: 0

Biosynthesis of amino acids, catabolism of amino acids and conversion of amino acids to specialized products, biosynthesis of purine and pyrimidine - formation of deoxyribonucleotides.

Genetic code and protein synthesis, components of protein synthesis, inhibition of protein synthesis.

MODULE V BIOMEMBRANES, TRANSPORT, AND ELECTRICAL CONDUCTIVITY **L: 9 T: 0 P: 0**

Micelles - Lipid bilayer structure of membranes - Membrane proteins - Passive, carrier-mediated, and active transport - Ion-selective channels - Transmembrane potential-coupled ATP generation - Receptors - Acetylcholine receptor as a ligand-gated ion channel - Neuronal sodium channel as a voltage-gated ion channel - Neurotransmitters and their mechanisms of action - Action potential - Depolarization and nerve conduction - Ion-channel agonists and antagonists as drugs - Ion channel defects (e.g., Cystic Fibrosis).

L - 45;; Total Hours: 45

TEXT BOOKS:

1. Conn E.E. and Stumph P.K., Outline of Biochemistry, Fifth edition, John Wiley and Sons, New York, 2005.
2. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, Eighth edition, Macmillan Worth Publishers, 2021.
3. Plummer David J., An Introduction to Practical Biochemistry, McGraw Hill, New Delhi, 2017.
4. Singh S.P., Practical Manual to Biochemistry, CBS Publisher, New Delhi, 2005.

REFERENCES:

1. Stryer L., Biochemistry, W.H., Ninth edition, Freeman and Company, San Francisco, 2019.
2. Harpers Review of Biochemistry, Lange Medical Publication.

COURSE OUTCOMES: The student will be able to

CO1: comprehend the importance of enzymes as a regulatory molecule in metabolism

CO2: realise the role of sugar nucleotides in biosynthesis

CO3: recognize the process of oxidation of fatty acids and energetics of oxidative phosphorylation

CO4: diagnose the chemical reactions involved in the biosynthesis of amino acids ad proteins

CO5: explain membrane structure, transport mechanisms, ion channels, and their roles in bioelectric phenomena

Board of Studies (BoS):	**Academic Council:**
14th BoS of Chemistry held on 17.07.2025	24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	H	L	M	M	M	H	H	M
CO2	H	H	H	L	M	M	M	H	H	M
CO3	H	H	H			M	M	H	H	M
CO4	H	H	H	L	M	M	M	H	H	M

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well-Being - Ensure healthy lives and promote well-being for all at all ages.

SDG 9: Industry, Innovation & Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical R&D and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHFY 008	CHEMISTRY OF CARBOHYDRATES	L	T	P	C
SDG: 3, 9		3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: basic concepts in carbohydrates structures and properties

COB2: chromatographic and spectroscopic analysis of carbohydrates

COB3: various synthetic methodologies of carbohydrates

COB4: carbohydrates as chiral synthons.

COB5: basics on glycans and glycoconjugates

MODULE I CLASSIFICATION AND PROPERTIES L: 9 T: 0 P: 0

Definition, classification, nomenclature and configuration of monosaccharides - Fischer ring structures and conformation of monosaccharides - mutarotation - anomeric effect - structure of oligosaccharides and polysaccharides.

MODULE II CHROMATOGRAPHY AND SPECTROSCOPY L: 9 T: 0 P: 0

Methods for isolation and purification - structural analysis: complete and partial hydrolysis - methylation analysis and Smith degradation - chromatographic and electrophoretic techniques - spectroscopic techniques.

MODULE III CHEMICAL REACTIONS OF CARBOHYDRATES L: 9 T: 0 P: 0

Chemical reactions of carbohydrates: oxidation, reduction, formation of derivatives, glycosides, ethers, esters and cyclic acetals, modern chemical transformations - methods for the formation and cleavage of O - glycosidic bond - Ferrier rearrangements.

MODULE IV CARBOHYDRATES AS SYNTHONS L: 9 T: 0 P: 0

Use of protecting groups, chemical and enzymatic synthesis of oligosaccharides - carbohydrates as chiral synthons for natural products synthesis.

MODULE V GLYCANS AND GLYCOCONJUGATES L: 9 T: 0 P: 0

Carbohydrate biopolymers - animal glycoproteins - blood - group substances - plant and algal glycoproteins - proteoglycans and glycosaminoglycans - glycolipids - biological functions of glycan chains in glycoconjugates - carbohydrate components of nucleic acids and antibiotics.

L - 45; T - 0; P - 0; Total Hours: 45

TEXT BOOKS:

1. Momcilo Miljkovic, Carbohydrates, springer, 2010.
2. Clayden, J.; Greeves, N.; and Warren, S. Organic Chemistry, 2nd Edition, Oxford University Press, 2014 *(No later editions available).*
3. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.

REFERENCES:

1. J.F. Kennedy and C.A. White, Bioactive Carbohydrates, Ellis Horwood, New York, 2009.
2. J.F. Kennedy (Ed.) Carbohydrate Chemistry, Oxford University Press, Oxford, 2010.
3. A. F. Bochkov and G. E. Zaikov, Chemistry of the *O* - Glycosidic Bond Formation and Cleavage, Pergamon, Oxford, 1979.
4. S. Hanessian, Total Synthesis of Natural Products: The Chiron Approach, Pergamon, Oxford. 1983.

COURSE OUTCOMES: The student will be able to

CO1: describe the concepts in monosaccharides, oligosaccharides and polysaccharides

CO2: identify various methods to elucidate the structure of carbohydrates

CO3: comprehend the reactivity of monosaccharide derivatives

CO4: employ carbohydrates as chiral synthons for the synthesis of complex organic molecules

CO5: analyse the application and synthesis of glycoconjugates in natural product synthesis

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	-	-	H	-	-	H	H	H
CO2	H	M	-	-	H	-	-	H	H	H
CO3	H	H	-	-	H	-	-	H	H	H
CO4	H	H	-	-	H	-	-	H	H	H
CO5	M	L	-	-	L	-	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well - Being–

Statement: Ensure healthy lives and promote well - being for all at all ages.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHFY009	MEDICINAL AND PHARMACEUTICAL CHEMISTRY	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: basic factors governing drug design

COB2: mode of drug action and synthesis of few analgesics, antihistamines and antimalarials

COB3: synthesis and drug action of antibiotics

COB4: synthesis and mode of action of anti - infectives and anti - viral drugs

COB5: knowledge on the structure and partial synthesis of the steroidal and non - steroidal drugs

MODULE I DRUG DESIGN AND THERAPEUTICS L: 9 T: 0 P: 0

Drug design and drug discovery - Introduction - analogue synthesis - pharmacophore and lead compound identification - molecular modelling - factors affecting drug design - classification of drugs based on therapeutics.

MODULE II ANALGESICS, ANTIHISTAMINES AND ANTIMALARIALS L: 9 T: 0 P: 0

Structure, Synthesis, structure activity relationship, uses and side effects of - Analgesics: Morphine, Aspirin, Acetaminophen, Tramadol - Antihistamines: Cetirizine, Promethazine, Chlorpheniramine - Antimalarials: Quinine, Chloroquine.

MODULE III ANTIBIOTICS L: 9 T: 0 P: 0

Introduction on antibiotic action and drug resistance - structure and synthesis of: pencillins, semisynthetic pencillin, chloramphenicol, streptomycin, tetracyclines, cephalosporins, norfloxacin, ciprofloxacin, clotrimazole.

MODULE IV ANTIHYPERTENSIVE, ANTI - INFECTIVES AND ANTIVIRALS L: 9 T: 0 P: 0

Structure and synthesis of: antihypertensive drugs: methyldopa, diazepam - antiseptics and disinfectants: benzalkonium chloride - anthelmintics: mebendazole - antivirals: amantadine, acyclovir, Indinavir, ritonavir.

MODULE V STEROIDAL AND NON - STEROIDAL ANTI - INFLAMMATORY DRUGS **L: 9 T: 0 P: 0**

Introduction - classification - structure, partial synthesis and application of: betamethasone, cortisone, prednisolone, progesterone, testosterone, oestradiol - NSAID: Indomethacin, diclofenac, phenylbutazone, ibuprofen.

L - 45; T - 0; P - 0; Total Hours: 45

TEXT BOOKS:

1. Gareth Thomas, Medicinal Chemistry. An Introduction. (ISBN: 978 - 0 - 470 - 02597 - 0)
2. Giulia P Colombo, Sofia Ricci. Medicinal Chemistry Research Progress. Nova Science Publishers Inc (24 March 2009).

REFERENCES:

1. Suleyman Kaplan “A Comprehensive Guide to Non - Steroidal Anti - Inflammatory Drugs”, Nova Science Publishers Inc., USA, 2021 (ISBN - 13: 978 - 1536191288).
2. Nayanapalli Pramod, G M Basha, “Structural Classification of Drugs”, BSP BOOKS, India, 2020 (ASIN: B08CTHQ9LX)
3. Alka L. Gupta, “Medicinal Chemistry”, Pragati Prakashan Meerut, India, 2017 ASIN): (B07KP5S46N
4. Dr. V. Kukkarni, “Drug Design”, Nirali Prakashan, Educational Publishers; 4th edition, India, 2014. (ISBN - 13: 978 - 8185790114)

COURSE OUTCOMES: The student will be able to

CO1: accomplish the drug design and its methodologies.

CO2: recognize the synthesis and mode of action of analgesics, antihistamines and antimalarials

CO3: understand the synthesis and mode of action of antibiotics

CO4: be familiar the uses and mode of action of drugs anti - infectives and anti - viral drugs

CO5: comprehend the partial synthesis of steroidal and non - steroidal drug

Board of Studies (BoS):
14th BoS of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	-	-	H	-	-	H	H	M
CO2	H	M	-	-	H	-	-	H	H	M
CO3	H	H	-	-	H	-	-	H	H	M
CO4	H	H	-	-	H	-	-	H	H	M
CO5	M	L	-	-	L			H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation and knowledge dissemination.

CHFY 010	ADVANCED CONCEPTS IN ORGANIC	L	T	P	C
SDG: 3, 9	SYNTHESIS	3	0	0	3

COURSE OBJECTIVES: To make the students to understand the

COB1: oxidation and reduction reactions in organic synthesis

COB2: various types of reactions involving organometallic reagents

COB3: concepts for various named reactions and rearrangements

COB4: asymmetric synthesis and catalysis in organic chemistry

COB5: various methods for the synthesis of alkaloids and terpenoids

MODULE I OXIDATION AND REDUCTION L: 9 T: 0 P: 0

Oxidation: Oxidation involving organo - sulfur and organo - selenium compounds, Swern, Dess - Martin, Prevost, dimethyl dioxirane, transition metal catalyzed oxidations, oxidations at unfunctionalized carbons, electrochemical oxidation, photo sensitized oxidation, Fleming Tamao oxidation, and microbial oxidations, asymmetric Sharpless epoxidation and dihydroxylation, Jacobsen's epoxidation: Mechanism, stereochemistry and applications in organic synthesis.

Reduction: Reduction of carbonyl compounds and C - C multiple bonds: Using Al and B based reagents (e.g. DIBAL, Red - Al, $NaBH_4$ - $CeCl_3.7H_2O$ etc.), low valent Ti species, microbial reductions (NADH models), microbial reductions (NADH model etc.), asymmetric synthesis: Coreys oxazaborolidine catalyzed reduction, Noyoris BINAP, BINAL based reductions.

MODULE II ORGANO METALLIC REACTIONS L: 9 T: 0 P: 0

Metal atom functionality in organometallic reactions, organometallics as protecting and stabilizing groups, palladium catalyzed reactions, Heck reaction, cross coupling reactions (Suzuki, Stille, Negishi, Kumada, Hiyama, Sonogashira, Buchwald - Hartwig), Fischer carbenes, Schrock carbenes, Olefin metathesis, various types of metatheses and application to organic synthesis.

MODULE III NAMED REACTIONS AND REARRANGEMENTS L: 9 T: 0 P: 0

Corey - Winter olefination, Shapiro reaction, Bamford - Stevens, Arndt - Eistert, Eschenmoser - Tanabe fragmentation, Stobbe condensation, Peterson olefination, Hofmann - Löffler - Freytag, Birch reduction, Baylis - Hillman, Mitsunobu reaction,

Duff reaction, Nef reaction Passserini and Ugi reaction, Dotzbenzoannulation, Pauson - Khand reaction.

Rearrangements: Wagner - Meerwein, Tiffeneau - Demjanov, Beckmann, Hofmann, Curtius, Lossen, Schmidt, Wolff, Brook, Benzilic acid, Baeyer Villiger, Dakin, Ramberg - Bäcklund, Ferrier, Stevens, Sommelet - Hauser.

MODULE IV ASYMMETRIC SYNTHESIS AND CATALYSIS L: 9 T: 0 P: 0

Concise introduction to asymmetric synthesis, detailed discussion on resolution, chiral auxiliaries, chiral ligands, chiral catalysts, organocatalysts and photocatalysis with specific examples. Introduction to domino/tandem/cascade reaction concepts with selected examples.

MODULE V ALKALOIDS AND TERPENOIDS L: 9 T: 0 P: 0

Structural elucidation and Synthesis of alkaloids - Atropine, Papaverine and Quinine. Structural elucidation and Synthesis of the - α - Terpinenol, Farnesol and Zingiberene.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Jie Jack Li, Name Reactions - A - Collection of Detailed Mechanisms and Synthetic Applications - 5th Edition, Springer, 2014.
2. Christian M. Rojas, “Molecular Rearrangement in Organic Synthesis, “Wiley, Canada, 2015,
3. P.S. Kalsi, “Organic Synthesis Through Disconnection Approach”, Medtech, India, 2017.
4. Alan, R Katritzky, Advances in Heterocyclic Chemistry, Elsevier Acad. Press, 2009.

REFERENCES:

1. Tse - Lok Ho, “Fiesers' Reagents for Organic Synthesis”, Wiley; 1st edition, India, 2013.
2. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, Organic Chemistry, 11th Edition, John Wiley and Sons, New York, 2013.
3. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2014.
4. T. L. Gilchrist, Heterocyclic chemistry, Pearson, 2009.

COURSE OUTCOMES: The student will be able to

CO1: identify the various reagents for oxidation and reduction reactions

CO2: correlate the fundamental and essential concepts towards synthesis of organic molecules using organometallic reagents

CO3: identify various named reactions and rearrangements

CO4: predict asymmetric synthetic strategies towards the synthesis of chiral organic molecules

CO5: design the synthetic methods for the synthesis of alkaloids and terpenoids derivatives

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	-	L	-	M	L	-	H	H	M
CO2	H	-	-	-	M	-	-	H	H	M
CO3	H	-	-	L	M	L	-	H	H	M
CO4	H	-	L	-	M	-	-	H	H	M
CO5	H	-	-	-	M	L	-	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well - Being - Ensure healthy lives and promote well - being for all at all ages.

SDG 9: Industry, Innovation and Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement

Provides a foundation for careers in pharmaceutical RandD and teaching with goals of sustainable industrial innovation, production of new drug candidates and knowledge dissemination.

CHFY 011	NANOMATERIALS AND APPLICATIONS	L	T	P	C
SDG: 3, 6, 7, 9,11		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: basic knowledge on nanoscience and nanotechnology which includes the exotic properties of materials at nanoscale.

COB2: various techniques for the synthesis and processing of nanomaterials

COB3: various techniques available for the characterization of nanostructured materials

COB4: applications in different sectors and impacts of nanotechnology in environment

COB5: Advanced Nanomaterials with high potential Applications

MODULE I INTRODUCTION TO NANOMATERIALS L: 9 T: 0 P: 0

History and Scope - Density of States - Classification of Nanostructures: Zero - , One - , Two - and Three - dimensional - Nature: The Best Nanotechnologist - Unique properties: Surface Plasmon Resonance - quantum confinement effect - Properties of nanomaterials: Atom like behaviour, physicochemical, optical, electrical and electronic, redox, mechanical, magnetic and catalytic activity - Microstructure and defects in nanocrystalline materials - formation of Dangling bonds.

MODULE II METHODS OF SYNTHESIS L: 9 T: 0 P: 0

Synthesis of Nanomaterials, top - down and bottom - upapproaches definition: Physical Methods - Mechanical Milling; Sputter Deposition; Chemical Vapour Deposition (CVD); Molecular Beam Epitaxy (MBE) - Chemical Methods - metal and semiconductor nanoparticles by Colloidal Route; Microemulsions; Sol - Gel Method; Hydro/Solvothermal synthesis; Sonochemical and Microwave synthesis - Biological Methods - Synthesis using microorganisms and Plant Extracts; Use of proteins, Templates like DNA, S - layers - Self Assembly.

MODULE III TOOLS TO CHARACTERIZE NANOMATERIALS L: 9 T: 0 P: 0

Microscopes - Scanning Electron Microscopy (SEM/HR - SEM/FE - SEM) with EDS, TEM (HR - TEM) and SAED analysis, Atomic force Microscopy (AFM). Diffraction

Techniques; X - ray diffraction, DLS and zeta potential analysis - Spectroscopies: UV - Vis - IR absorption - FT - IR - Raman Spectroscopy - Luminescence spectroscopy - X - ray Photoelectron spectroscopy (XPS) - BET surface area analysis, CHNSO micro analysis - Magnetic and Mechanical measurements; Magneto - optical Measurements; Hardness; strength (Elastic moduli) and Nanoindentation.

MODULE IV APPLICATIONS and ENVIRONMENTAL IMPACT L: 9 T: 4 P: 0

Energy; Nanomaterials in energy conversion and storage - solar cells, H2 production - fuel cells - Batteries and supercapacitors. Environment; Pollution Abatement - Sensors - Green Manufacturing. Health; - Diagnosis - Therapeutic Agents - Antimicrobial and Wound Healing - Artificial Implants - Agriculture and food. Communication sector; Nano/Micro Electro Mechanical systems - Lasers - LEDs - Photonic Crystals and Photonic Integrated Circuits. Domestic Applications Cosmetics -- Safety - Security and Defence fields. Nanotechnology and Environment; Environmental Pollution and role of nanotechnology - Effect of Nanotechnology on Human Health.

MODULE V ADVANCED NANOMATERIALS L: 9 T: 4 P: 0

Silicon substitutes - Carbon nanostructures: Introduction. Fullerenes, carbon nanotubes, graphene oxide/rGO. Quantum Dots; Chalcogenides - carbon - perovskites quantum dots.Porous Materials; MOFs - COFs - Zeolites - Aerogels and Xerogels. Core - Shell Particles - Metamaterials - Plasmonic nanomaterials - Multilayered films - MXenes - Polymer based nanocomposites - Biocomposites - Bioinspired Materials.

L - 45; Total Hours: 45

TEXT BOOKS

1. B. Viswanathan, Nano Materials, Narosa Publishing House Pvt. Ltd. 5th Edition 2014.
2. B. S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Murday, Textbook of Nanoscience and Nanotechnology, Universities Press - IIM Series in Metallurgy and Materials Science, 2016

REFERENCES:

1. T. Pradeep, Nano: The Essentials, Tata McGraw - Hill, New Delhi, 2007.
2. G. Cao, Nanostructures and Nanomaterials - Synthesis, Properties and Applications, Imperial College Press, London, 2004.
3. C. N. R. Rao, A. Muller and A. K. Cheetham, The Chemistry of Nanomaterials, Volume 1, Wiley - VCH Verlag GmbH and Co. KgaA, Weinheim, 2004.
4. G. A. Ozin, A. C. Aresnault, L. Cadematriri, Nanochemistry: A chemical approach to

nanomaterials, RSC Publishing, 2008

5. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan Publishers India Limited, 2000.

6. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis, 2003.

COURSE OUTCOMES: The students will be able to

CO1: differentiate the nanomaterials based on their dimensions and identification of nanomaterials with respect to their specific properties

CO2: Adopt a suitable methodology for the large scale synthesis of nanomaterials with desired characteristics

CO3: understand the components of instrumental techniques of and characterization techniques for structural and properties of nanomaterials

CO4: select the appropriate nanomaterials for specific applications in the interested arena

CO5: apply the knowledge of advanced high potential nanomaterials for selective utilization.

Board of Studies (BoS):
14th BoS of Department of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	-	L	-	-	-	H	H	H
CO2	-	H	-	M	M	H	-	H	H	H
CO3	-	H	-	-	-	-	-	H	H	H
CO4	M	-	-	-	M	H	H	H	H	H
CO5	M	-	-	-	-	M	H	H	H	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 3: Good Health and Well - Being

SDG 6: Clean Water and Sanitation

SDG 7: Affordable and Clean Energy

SDG 9: Industry and Innovation

SDG 11: Sustainable Cities and Communities

Statement:

SDG3: RandD labs in API labs in the production new molecules for various applications

SDG6: Ensure healthy lives and promote well - being for all at all ages

SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all

SDG9: Foundation to work in RandD of renewable energy and sensors sector and for teaching career.

SDG11: Make cities and human settlements inclusive, safe, resilient and sustainable

CHFY 012	CORROSION AND ITS CONTROL	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with the:

COB1: Causes, theories of corrosion and different types of corrosion.

COB2: Factors influencing corrosion.

COB3: Control of corrosion using various methods.

COB4: testingofcorrosionbyvarious diagrams.

COB5: Testing of corrosion failures in the real situation.

MODULE I BASICS OF CORROSION 9

Types of Corrosion: dry (O_2, H_2 and other gases) and wet corrosion - Galvanic bimetallic corrosion - differential aeration corrosion - concentration cellcorrosion - erosion corrosion - pitting corrosion - underground soil corrosion - intergranular corrosion - stress corrosion: Types - seasonal cracking of alloys and caustic embrittlement - corrosion fatigue.

MODULEII FACTORS INFLUENCING CORROSION 9

Nature of metal: over voltage, areas of anodic/cathodic, purity of metal, physical state of metals, passive nature of metal, solubility, volatility of corrosion products, corroding environment: influence of pH, Pourbaix diagrams of various Metals: Fe, Al, Ni, Ti, etc, - Anions, formations of cells - Polarization and Overvoltage of electrodes: Activation Polarization - Concentration Polarization - Anodic and Cathodic Polarization.

MODULEIII CORROSION CONTROL 9

Design - selection of materials - pure metals and alloys - annealing - elimination of galvanic action - cathodic protection - sacrificial anodic protection and impressed current cathodic protection - modification of environment: deaeration and dehumidification - corrosion inhibitors - protective coatings: preparation of surface before applying coatings - Classification: Inorganic coatings - metallic and non - metallic - organic coatings - special paints - varnish, enamel and lacquers.

MODULEIV CORROSION TESTING 9

Corrosion Testing, Monitoring and Inspection: Laboratory Tests - Pilot - plant tests - Field Test - Corrosion Potential and Corrosion Rate: calculation of ΔG and other related

thermodynamic parameters - potential measurement - electrochemical series and Galvanic Series - redox reactions - EMF measurement and corrosion current - anodic and cathodic behavior of metals - passivity and Passivators - testing of virgin metals - Pourbaix and Evans diagrams for Alloys.

MODULEV ANALYSIS OF CORROSION FAILURES 9

Failure Analysis and Techniques for Diagnosis of Corrosion Failures: Techniques for Diagnosing Corrosion Failures - Analysis of Corrosion Failures - Case Studies of Corrosion Failures - Corrosion Issues in Specific Industries: Construction, Power Generation, Chemical Processing Industries, Oil and Gas Industries, Pulp and Paper plants - Learning from past corrosion failures and implementing preventative measures.

L - 45 ; TOTAL HOURS - 45

TEXT BOOKS:

1. C.G. Munger and Louis D. Vincent, “Corrosion Prevention by Protective Coatings”, Third Edition (e - Book), 2014.

REFERENCES:

1. M.G. Fontana and, N.G. Green, Corrosion Engineering, McGrawHill Book Company, New York,1984.
2. J.H. Brophy, R.M. Roseand, J. Walf, The Structure and Properties of Materials, Wiley Inter ScienceInc., NewYork,1984.
3. B.T. Kelly, Irradiation Damage to Solids, Pergamon Press, New York,1992.
4. D.R. Cross, Principles and Applications of Electrochemistry, Chapman and Hall, UK,1988.
5. K. Elayaperumal and V. S. Raja, “Corrosion Failures - Theory, Case Studies, and Solutions”, John Wiley and Sons, Inc., 2015.

COURSE OUTCOMES: Studentswillbecome familiar with the

CO1: Different types of corrosion and their mechanismofcorrosion

CO2: Different factors whichinfluence corrosion

CO3: Control of corrosion in real situation.

CO4: Testing and evaluation of corrosion

CO5: Testing the corrosionfailure in the real situation

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	-	-	-	-	-	-	H	-	-
CO2	-	-	-	-	-	-	-	H	-	-
CO3	-	-	-	M	-	L	-	H	-	-
CO4	-	H	H	-	H	H	-	H	-	M
CO5	-	H	-	-	H	H	-	H	-	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of corrosion and its prevention leads to construction of resilient infrastructure and sustainable industrialization.

CHFY 013	POLYMER SCIENCE AND	L	T	P	C
SDG: 4,7,9	TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic concepts of polymers, classification of polymeric materials, molecular weight and its distribution and various polymerization techniques

COB2: mechanism of addition, coordination polymerization and kinetics of polycondensation reaction

COB3: preparation, properties and uses of various polymers based on applications

COB4: different types of moulding techniques of polymeric materials

COB5: testing methods for mechanical, thermal and electrical properties.

MODULEI POLYMERISATION TECHNIQUES L: 9 T: 0 P: 0

Classification of polymers - copolymer: types - tacticity - crystalline and amorphous polymers - factors affecting crystallinity - thermal transitions - Factors influencing glass transition temperature - Molecular weight of polymer - number, weight and viscosity average molecular weights - molecular weight distribution - determination of molecular weight by GPC and viscometry - **Polymerisation techniques**: bulk, solution, suspension and emulsion polymerization, interfacial polymerization

MODULEII KINETICS AND MECHANISM OF POLYMERISATION REACTIONS L: 9 T: 0 P: 0

Mechanism of addition polymerization: free radical, cationic and anionic polymerizations - Trommsdroff effect - living polymers - Ziegler - Natta catalysts - coordination polymerization - Kinetics of polycondensation reactions - copolymer equation - Reactivity ratio and copolymerization behavior

MODULEIII POLYMERIC MATERIALS L: 9 T: 0 P: 0

Commodity polymers: Polyethylene, PVC, PET, Nylons - **Engineering plastics:** PTFE, PMMA, polycarbonate, ABS, Kevlar - **Elastomers:** SBR, neoprene - **High performance polymers**: polysulphones, polyimides - **Conducting polymers**: polyaniline - **Light - emitting polymers:** polypyrrole - **Biopolymers**: PLA - **Foams**: polyurethane.

MODULEIV POLYMER PROCESSING L: 9 T: 0 P: 0

Plastics technology - compounding - Moulding techniques**:** compression - injection - extrusion - blow moulding - thermoforming - pultrusion - **Fibre Technology**- Spinning - Fiber after treatments scouring, lubrication, sizing, dyeing, finishing- **Elastomers technology**- Vulcanization of natural rubber

MODULEV CHARACTERIZATION AND TESTING OF POLYMERS L: 9 T: 0 P: 0

Characterisation of polymers using FTIR, NMR- **Mechanical properties**: Tensile strength, Flexural strength, Izod impact, Compressive strength, Rockwell hardness - **Thermal properties**: TGA and DSC - **Electrical properties:** dielectric constant, dissipation factor, dielectric strength

L - 45; TOTAL HOURS - 45

TEXT BOOKS:

1. Fred W. Bill Meyer ‘Textbook of Polymer Science’ John Wiley and Sons, 2008.
2. Joel R. Fried, “Polymer Science and Technology”, Prentice Hall, 2014.
3. Charles E. Carraher Jr. Introduction to Polymer Chemistry, Fourth Edition, CRC Press, 2017.
4. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
5. Maurice Morton, Rubber Technology, van Nostrand, Reinhold, New York,1987.
6. Andrew J. Peacock and Allison Calhoun, Polymer Chemistry: Properties and Application, Carl Hanser Verlag GmbH and Company, 2012.
7. Iyson R.W., Specialty Polymers, Blackie Academic and Professional, London,1992.
8. Vishu shah., Handbook of plastics testing and failure analysis, John Wiley and Sons, New Jersey, 2007.
9. I.M. Ward and D.W. Hadley, An Introduction to the Mechanical Properties of Solid Polymers, John Wiley and Sons, Chichester, England, 1993.
10. C.C. Ku and R. Liepins, Electrical Properties of Polymers, Hanser Publications, Munich, 1987.

REFERENCES:

1. Herman F. Mark, Encyclopedia of Polymer Science and Technology, Wiley Interscience; 3rd Edition, 2004.
2. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science and

Engineering, John Wiley and Sons, New York, 1998.

COURSE OUTCOMES:

The student will be able to

CO1: classify various polymers, calculate molecular weight of polymers, predict the crystallinity and glass transition temperature based on structure and various polymerization techniques

CO2: explain the mechanism of polymerization reactions and kinetics of polycondensation reaction

CO3: summarize the preparation, properties and uses of various polymers based on applications

CO4: identify a suitablemoulding technique based on the polymeric material and application.

CO5: test the polymers for the mechanical, thermal and electrical properties

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: **24**th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	H	L	L	H	M	H	-	-	-	-	-
CO2	H	M	M	H	M	H	-	-	H	L	H
CO3	H	L	L	H	H	M	-	-	-	-	-
CO4	H	L	L	H	M	H	-	-	H	-	--
CO5	H	L	L	H	H	H	-	-	H	H	

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education

SDG 9: Industry and Innovation

Statement:

SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities

SDG9: Foundation to work in RandD laboratory, chemical industry, independent researcher and for teaching career.

CHFY014 POLYMER STRUCTURE AND PROPERTY L T P C
SDG: 9 RELATIONSHIP 3 0 0 3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Structure of polymers and blend morphology

COB2: Stress - strain properties of polymers

COB3: Thermal and calorimetric properties

COB4: Dielectric and optical properties of polymers

COB5: Chemical properties like solubility parameters, dipolar polymers etc.

MODULEI STRUCTURE OF POLYMERS AND BLENDS L: 9 T: 0 P: 0

Linear, branched, cross linked, and network polymers - homochain and hetero atomic chain polymers - Copolymers - Linear and cyclic arrangement -
equilibrium phase - polymer behaviour - effect of polymer structure, polymer - polymer interaction - special structural effects - blend morphology - chemical reactions - properties - miscible blends - immiscible blends - toughened polymers - Commercial blends - applications.

MODULEII MECHANICAL PROPERTIES L: 9 T: 0 P: 0

Stress - strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness - Crazing in glassy polymers - Ductile brittle transition - Effect of additives on mechanical properties of polymers - Creep, stress relaxation and fatigue - Breakdown test methods.

MODULEIII THERMODYNAMIC AND TRANSITION PROPERTIES L: 9 T: 0 P: 0

Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm - other transitions like □ - transitions, upper and lower glass transition temperatures - Prediction of Tg and Tm of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy -
Specification of thermal evaluation and classification of electrical insulation - artificial pollution tests of HV insulator - AC, DC.

MODULEIV ELECTRICAL AND OPTICAL PROPERTIES L: 9 T: 0 P: 0

Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment - Effect of additives on electrical properties of polymers - Optical properties - Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, reflectance, and gloss - Prediction of refractive indices of polymers by group contributions.

MODULEV CHEMICAL PROPERTIES AND DIELECTRIC BEHAVIOUR L: 9 T: 0 P: 0

Cohesive energy, cohesive energy density - Prediction of solubility parameter - Effect of polymer structure on solubility in solvents and oils - Influence of structure in prediction of flame retardancy, water repellency - Chemical resistance of polymers - Polymer toxicity. non - polar polymers - amorphous dipolar polymers - crystalline dipolar polymers - effects of structures, additives and impurities - testing of degradation in polymers.

L - 45; TOTAL HOURS - 45

REFERENCES:

1. D.W. vanKrevelen and P.J. Hoftyzen, Properties of Polymer, 3rd Edition, Elsevier Scientific Publishing Company Amsterdam, Oxford New York, 1990.
2. J.E. Mark (Editor), AIP, Physical Properties of Polymers Hand Book, Williston, 1996.
3. D.A. Seanor, (Editor), Electrical Properties of Polymers, Academic press, New York, 1982.
4. Jozef Bicerano, Prediction of Polymer Properties, 2nd Edition, Marcel Dekker Inc. New York, 1995.
5. J.M. Margolis(Editor), Engineering Thermoplastics Properties and Applications, Marcel Dekker, New York 1985.
6. R.J. Samuels, Structured Polymer Properties, John Wiley and Sons, New York, 1974.
7. I.M. Ward and D.W. Hadley, An Introduction to the Mechanical Properties of Solid Polymers, John Wiley and Sons, Chichester, England, 1993.

COURSE OUTCOMES:

The students will be familiar with

CO1: Structures of polymers and blends, and their interactions

CO2: effect of polymer structure on mechanical properties

CO3: predict glass transition, melt transition temperatures and also thermal evaluation of polymers

CO4: effect of additives and polymeric structure on diectric constant, dipole moment, transmittance, reflectance etc.

CO5: solubility parameter, flame retardancy and polymer toxicity.

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	-	L	H		H	-	-	-	-
CO2	H	-	M	H	M	H	-	H	L	H
CO3	H	-	L	H	H	M	-	-	-	-
CO4	H	-	L	H	M	H	-	H	-	--
CO5	H	-	L	H	H	H	-	H	H	

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 9:Industry, Innovation and Infrastructure

Statement:

SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

CHFY 015	**SOLID STATE CHEMISTRY AND**	**L**	**T**	**P**	**C**
SDG: 4, 9, 11 and 15	**APPLICATIONS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES: To make the student conversant with

COB1: various aspects of known structures in solid state

COB2: different methods of preparation of solid - state materials

COB3: magnetic properties and its applications

COB4: electrical properties and its applications

COB5: different application of magnetic and electrical materials

MODULEI STRUCTURE OF SOLID L: 9 T: 0 P: 0

Introduction to solid state, Atomic planes, Weiss and miller indices, Distance between atomic planes, Laws of crystallography, Point group, Space group, Structural description with examples: spinel, olivine, garnet, Ilmenite, perovskite, etc. Close - packed structures (ccp and hcp), Colourcentre, Quasi crystal, Liquid crystal, Time crystal.

MODULEII PREPARATIVE METHODS L: 9 T: 0 P: 0

Solid state reactions: General principle, Experimental procedure, Coprecipitation methods, Precursor method, Kinetics of solid - state reaction. Ion exchange reactions, Intercalation reactions (Graphite, Transition metal dichalcogenides, etc.), Preparation of thin films: Chemical method and physical method, Hydrothermal methods, Dry high - pressure methods.

Methods of single crystal growth: Czochralski method, Bridgman method, Flux method, Vapour phase transport method, Comparative study.

MODULEIII MAGNETIC PROPERTY L: 9 T: 0 P: 0

Basics, Types (Paramagnet, Diamagnet, Ferromagnet, Antiferromagnet, Ferrimagnet, Super paramagnet), Soft and Hard magnet, Geomagnetism (Source and effect), Effect of temperature (Curie law and Curie - Weiss law), Details of exchange mechanism (Superexchange and Double exchange), Goodenough - Kanamori - Anderson (GKA) rules, Exchange integral, Magnetism in metals - alloys - transition metal oxides - spinels - garnets.

MODULEIV ELECTRICAL PROPERTY L: 9 T: 4 P: 0

Introduction (Metals, Insulators and Semiconductors), Electronic structure of solids - Band Theory, Intrinsic and extrinsic semiconductors, Hall effect, Thermoelectric effects (Thomson, Peltier, Seebeck, Thermocouple), Dielectric materials, Ferroelectricity, Pyroelectricity, Piezoelectricity, Relationship and applications of Ferro - , Piezo - and Pyroelectricity. Multiferroics.

MODULE V APPLICATION OF MAGNETIC AND ELECTRICAL MATERIALS **L: 9 T: 4 P: 0**

Transformer cores, Information storage, Magnetic bubble memory device, Permanent magnets, Magnetic resonance imaging (MRI), Magnetic levitation (Maglev) trains, Magnetocaloric effect and its applications (Magnetic refrigeration, Cancer treatment etc.). Superconductivity: Basics, Discovery, Meissner effect, Type I and Type II superconductors, BCS theory, Quantum levitation, High Tc materials with examples, Room temperature superconductivity, Applications of superconductivity.

L - 45; Total Hours: 45

TEXT BOOKS:

1. Anthony R. West, Solid state chemistry and its applications, John Wiley and Sons, 1984.
1. E. Smart and E. A. Moore, Solid state chemistry - An introduction, 4th Edition, CRC Press, 2012.

2. **REFERENCES:**

1. V. Keer, Principles of the solid state, 2nd Edition, New Age International, 2017.
2. Solid state chemistry - A modern approach, Ashok Kumar Jha, 1st Edition, CRC Press, 2023.
3. Weller, T. Overtone, J. Rourke and F. Armstrong, Inorganic Chemistry, 6th Edition, Oxford University Press, 2014.
4. Cathrine E. Housecroft and Alan G. Sharpe, Inorganic Chemistry, 5th Edition, Pearson, 2018.
5. B. R. Puri, L. R. Sharma and Madam S. Pathania, Principles of Physical Chemistry, 49th Edition, Vishal Publishing Company, 2020.

COURSE OUTCOMES: The students will be able to

CO1: demonstrate understanding of different structures of solid - state materials with proper examples.

CO2: demonstrate understanding of various methods of preparation for solid -

state materials.

CO3: analyze different categories of magnetic materials and understand their applications.

CO4: analyze diverse categories of electronic materials and understand their applications.

CO5: demonstrate understanding of various application of magnetic and electrical materials.

Board of Studies (BoS):
14th BoS of Department of Chemistry held on 17.07.2025

Academic Council:
24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1		M	-	-	-	-	-		M	L	-
CO2	H	-		H	M	L	-		M	L	-
CO3		-	M	-	H		-		M	L	-
CO4	M	-	-	-	-		-		M	L	--
CO5		-		L	H	M	-		M	L	-

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4: Quality Education
SDG 9: Industry, Innovation and Infrastructure
SDG 11: Sustainable Cities and Communities
SDG 15: Life on Land
Statement:
SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG 11: Make cities and human settlement inclusive, safe, resilient and sustainable
SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainable manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

CHFY 016	GREEN CHEMISTRY	L	T	P	C
SDG: 4,7,9		3	0	0	3

COURSE OBJECTIVES: To make the students conversant with

COB1: the principle and concepts of green chemistry

COB2: various alternative (non - traditional) reagents and chemicals for green synthesis.

COB3: the non - conventional energy sources for green synthesis

COB4: the uses of eco - benign solvents - alternative to organic solvents

COB5: the synthesis of nanomaterials using green chemistry approaches

MODULE I BASICS OF GREEN CHEMISTRY L: 9 T: 0 P: 0

Need for green chemistry; Inception and evolution of green chemistry; twelve principles of green chemistry with their explanations and examples; Designing a green synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy. Prevention/ minimization of hazardous/ toxic products reducing toxicity risk Green chemistry in day to day life. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

MODULE II GREEN REAGENTS AND CATALYSTS L: 9 T: 0 P: 0

Different approaches to green synthesis: (a) Uses of green reagents in organic synthesis - Dimethyl carbonate, polymer supported reagents - peracids and chromic acid; (b) Green catalysts, role of catalysis in sustainable development, homogeneous and heterogeneous catalysts; lntroduction, advantages and applications of (i) Nanocatalysts, (ii) Phase transfer catalysts, (iii) Biocatalysts, (iv) Organocatalysts, in organic synthesis.

MODULE III ALTERNATIVE ENERGY SOURCES L: 9 T: 0 P: 0

Energy requirements for reactions - alternative sources of energy: use of microwaves, principle, instrumentation, benefits and limitation, reactions using microwaves - Fries rearrangement, Diels - Alderreaction, decarboxylation, saponification of ester, alkylation of reactive methylene compounds; Heterocyclic synthesis - pyrrole, quinoline. Use of ultrasonication, concept, instrumentations, advantages , application of ultrasound in the synthesis and oraganic transformations.

MODULE IV GREEN SOLVENTS AND REACTIONS L: 9 T: 0 P: 0

Green solvents - super critical fluids, SC - CO2, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents. Ethyl lactate as a renewable green solvent: Properties and applications.

MODULE V GREENER SYNTHESIS OF NANOMATERIALS L: 9 T: 0 P: 0

Biomimetic, multifunctional reagents; combinatorial green chemistry; Proliferation of solventless reactions; Green chemistry in sustainable development. Green Synthesis of important compounds. Greener synthesis of Nanomaterials— Microwave assisted synthesis of Quantum Dots (QD) and nano catalysts in aqueous medium, Magnetic Nanoparticles. Synthesis of Nanoparticles using Bacteria, Yeast, Algae and Fungus.

L - 45Total Hours: 45

TEXT BOOKS:

1. Green Chemistry - Environmentally benign reactions - V. K. Ahluwalia. Ane Books India (Publisher). (2006).
2. Green Chemistry - Designing Chemistry for the Environment - edited by Paul T. Anastas and Tracy C. Williamson. Second Edition, (1998).
3. Green Chemistry - Frontiers in benign chemical synthesis and processes - edited by Paul T. Anastas and Tracy C. Williamson. Oxford University Press, (1998).
4. Green Chemistry - Environment friendly alternatives - edited by Rashmi Sanghi and M. M. Srivastava, Narora Publishing House, (2003).
5. Sheldon, R.A., Arends, I., and Hannefed, U., Green Chemistry and Catalysis, Wiley - VCH Verlag GmbH and Co. (2007).
6. Anastas, P., and Williamson, T. C., Green Chemistry Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press (1999).
7. Ahluwalia, V. K., and Kidwai, M., New Trends in Green Chemistry, Anamaya Publishers (2004)

COURSE OUTCOMES: The student will be able to

CO1: understanding of the 12 principles of green chemistry to improve the sustainability performance of the products/ materials

CO2: use various alternative reagents and chemicals for green synthesis.

CO3: apply non - conventional energy sources for the synthesis of organic compounds and materials.

CO4: use eco - begin solvents for the synthesis of organic compounds and materials

CO5: understand the synthesis of nanomaterials using greener methods

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	-	H	L	-	-	L	H	H
CO2	H	-	M	-	-	H	-	M	H	-
CO3	H	H	-	M	H	M	-	M	M	M
CO4	H	H	L	-	-	H	-	L	-	L
CO5	H	L	-	L	M		-	L	L	-

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 4 andEnsure inclusive and equitable quality education and promote lifelong learning opportunities for all.

SDG 7 andEnsure access to affordable, reliable, sustainable and modern energy for all.

SDG 9:Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement:The holistic understanding of green chemistry principles and concepts to sustainable development in the field of synthetic and materials chemistry.

CHFY017	CONCEPTS AND TECHNIQUES IN CATALYSIS	L	T	P	C
SDG: 6, 7, 9, 12		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: impart the basic concepts involved in catalytic processes.

COB2: learn the different catalysys and preparation methods

COB3: develop a knowledge in the physic - chemical and spectral characterization

COB4: evaluate the catalysts using different catalytic reactors

COB5: use different types catalysts for various organic reactions

MODULEI CONCEPTS OF CATALYSIS L: 9; T: 0; P: 0

acid - base catalysis - catalysis by transition metal ions and their complexes - supported transition metal complexes as catalysts - catalysis by enzymes - phase transfer catalysis - photocatalysis - adsorption - chemisorption on metals, metal oxides and semiconductors - kinetics of unimolecular and bimolecular surface reactions - Contact time - WHSV - time on stream - turnover number - turnover frequency - Mass and heat transfer in catalytic reactions - Catalyst deactivation and regeneration - Phase Transfer catalysis

MODULEII HETEROGENEOUS CATALYSTS AND THEIR SYNTHESIS L: 9; T: 0; P: 0

Metals, metal oxides, mixed metal oxides, supported metals, spinels, perovskites, super acids, hydrotalcites, zeolites and zeotypes (small, medium, large), shape selective catalysts, microporous and mesoporous materials (MOFs, COFs, SBA, MCM, KIT, AlPOs), graphene and graphene oxides - Electrocatalysts - Green hydrogen catalysts

Hydrothermal synthesis, sol - gel process, impregnation method, ion - exchange method - unit operations in catalyst manufacture - drying, calcination, spray drying

MODULEIII CATALYSTS CHARACTERIZATION L: 9; T: 0; P: 0

Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFT), Diffuse Reflectance UV - Visible Spectroscopy (DRSUV), X - ray Powder Diffraction (XRD),

Brunauer - Emmett - Teller (BET) Surface Area Analysis, Barrett - Joyner - Halenda (BJH) Pore Size and Volume AnalysisMagic Angle Spinning Nuclear Magnetic Resonance (MAS NMR) (29Si, 27Al, 31P), Auger Electron Spectroscopy (AES), Scanning Electron Microscopy and Energy Dispersive Spectroscopy (SEM/EDAX), Electron Probe Micro - Analyzer (EPMA), Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP - AES), X - ray Photoelectron Spectroscopy (XPS), Extended X - ray Absorption Fine Structure Spectroscopy (EXAFS), Transmission Electron Microscopy (TEM), Electron Spin Resonance Spectroscopy (ESR).

MODULEIV CATALYTIC REACTORS L: 9; T: 0; P: 0

Reactor types: Integral and fixed bed reactors - differential reactors - stirred flow reactors - microcatalytic reactors of pulse type - static reactors - high pressure reactors - photoreactor - reaction monitoring by GC and GC - MS.

MODULEV CATALYTIC REACTIONS L: 9; T: 0; P: 0

Catalytic asymmetric synthesis - C - C, C - H bond formation, oxidation - acid catalysedisomerisation - heterogeneous hydrogenation, dehydrogenation, cyclo dehydrogenation, oxidation - Homogeneous catalysis by transition metal complexes - metathesis of olefins - synthetic fuels - Phase transfer catalysed reactions - Photocatalytic reactions and artificial photosynthesis.

L - 45; TOTAL HOURS - 45

TEXT BOOKS:

1. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan Publishers India Limited, 2000.
2. John Meurig Thomas and W. John Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley, 1997.
3. Herman Pines, The Chemistry of Catalytic Hydrocarbon Conversions, Academic Press, 1981.
4. J.W. Niemantsverdriet, Spectroscopy in Catalysis, 2nd Edition, John Wiley and Sons, 2008.
5. Gadi Rothenberg, Catalysis: Concepts and Green Applications, WILEY - VCH Verlag GmbH and Co. KGaA, Weinheim, 2008.
6. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis: Principles and Applications, Narosa Publishing House, 2002.
7. Julian R.H. Ross, Heterogeneous Catalysis: Fundamentals and Applications, Elsevier, 2011.
8. Gerhard Ertl, Handbook of Heterogeneous Catalysis, 2nd Edition, Volume 6,

Wiley - VCH - Verlag, 2008.

9. Charles N. Satterfield, Heterogeneous Catalysis in Practice, McGraw - Hill, 1980.
10. Jens Hagen, Industrial Catalysis: A Practical Approach, 2nd Edition, Wiley, 2006.
11. Jens Weitkamp, Lothar Puppe (Editors), Catalysis and Zeolites: Fundamentals and Applications, Springer, 1999.
12. R.A. Sheldon and Herman van Bekkum (Editors), Fine Chemicals through Heterogeneous Catalysis, John Wiley and Sons, 2008.
13. Michel Che and Jacques C. Védrine (Editors), Characterization of Solid Materials and Heterogeneous Catalysts: From Structure to Surface Reactivity, John Wiley and Sons, 2012.

COURSE OUTCOMES:

The students will be able to

CO1: use the key terms in catalytic process

CO2: synthesise heterogeneous mesoans microporous catalysts by different methods of synthesis

CO3: characterize the synthesized materials by various physico chemical methods

CO4: employ the synthesized materials for catalytic reactions in different types of reactors

CO5: carryout different catalytic reactions of industrially important

Board of Studies (BoS): 14th BoS of Chemistry held on 17.07.2025

Academic Council: 24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	-	-	-	L	-	-	H	M	L
CO2	-	-	M	-	-	-	-	H	M	L
CO3	-	H	-	-	-	-	-	H	M	L
CO4	-	H	-	-	-	-	-	H	M	L
CO5	-	-	-	L	-	-	-	H	M	L

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG 6: Clean Water and Sanitation — Ensure availability and sustainable management of water and sanitation for all

SDG 7: Affordable and Clean Energy — Ensure access to affordable, reliable,

	sustainable and modern energy for all
SDG 9: Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG 12: Responsible Consumption and Production	Ensure sustainable consumption and production patterns

Statement: The catalytic materials and processes brings sustainable development in in the Industries and society.

CHFY018	ALTERNATE ENERGY RESOURSES:	L	T	P	C
SDG: 07	CONVERSION AND STORAGE	3	0	0	3

COURSEOBJECTIVES: The students will be trained about the

COB1: Different types of batteries

COB2: Factors effecting battery performance

COB3: Mechanism in photovoltaics

COB4: Various materials used in solar cells and PEC cells

COB5: Application of photovoltaic cells

MODULE I BATTERIES L: 9 T: P: 0

Lithium - ion battery, The Principle carbonaceous anode materials, cathode material - The intercalative reactions, relationships between performance requirements and materials characteristics - Electrolyte, separator - Advanced Ni - MH Batteries - Improvement in hydrogen storage alloys, improvement in Cathode materials, improvement in separator and cell design.

MODULE II FACTORS AFFECTING BATTERY PERFORMANCE AND SELECTION OF BATTERIES L: 9 T: P: 0

Factors affecting battery capacity, voltage level current drain of discharge - types of discharge continuous, intermittent, constant current, constant load, constant power, temperature of battery during discharge, service life, voltage regulation, changing voltage, effect of all design, battery age and storage condition, effect of battery design - Major consideration in selecting abattery, battery applications, comparative features and performance characteristics, characteristics of batteries for portable equipment.

MODULE III PHOTOVOLTAICS L: 9 T: P: 0

Basic of photovoltaics, homo and heterojunctions, preparation of single crystals and polycrystalline silicon solar cells - Metal - insulator - Metal and semiconductors - Insulator - semiconductors solarcells, photovoltaic measurements - I - V characteristics, spectral response and capacitance measurements.

MODULE IV SOLAR CELLS AND PEC CELLS L: 9 T: P: 0

Preparation of CdS/Cu_2S solar cells by screen printing technique and their characteristics - amorphous Si solar cells - GaAs solar cells - Semiconductors electrolyte

interface - Photoelectrochemical (PEC) cells for conversion of lightenergy to electrical energy, PEC cells based on CdSe Si and GaAs and their output characteristics- Estimation of flatband potential fromMott - Schottkyplots.

MODULEV FUEL CELLS AND SUPERCAPACITORS L: 9 T: P: 0

Introduction - Types of fuelcells - figure of merit, electrocatalysts for hydrogen oxidation and oxygen reduction - electrochemical double layer capacitors - ruthenium oxide as capacitor electrode, manual capacitors with proton conducting solid polymer electrolytes - Ultracapacitors: Doublelayer, Metal Oxide, conducting polymers energy and power densities, voltage limitation and self - discharge.

L - 45 - Total Hours: 45

TEXTBOOKS:

1. Energy Storage Systems for Electronics, Edited by Tetsuya Osaka, and Madhav Dutta, 2000.
2. Handbook of Batteries, David Linden and Thomas B.Reddy, 3rd Edition, McGraw - Hill Handbooks, 2001, USA.

REFERENCES:

1. Photoelectrochemical Solar Cell, Edited by K.S.V. Santhanam and M. Sharon, Elsevier Science Publishers, BV NewYork, 1995.
2. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London 1983.
3. Lindar D., Handbook on Batteries and Fuel Cells, McGraw Book Co., New York, 2 011.

COURSEOUTCOMES: The students will have

CO1: A thorough understanding about batteries and their components

CO2: Influence of various factors on performance of batteries and based on which selection of suitable batteries depending on application

CO3: Understanding the working mechanism of photovoltaics

CO4: Applications in solar cells and PEC cells

CO5: Testing in fuel cells and supercapacitors.

Board of Studies (BoS):	**AcademicCouncil:**
14th BoS of Chemistry held on 17.07.2025	24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	M	M	M	M	H	H	M	M	H
CO2	M	M	M	M	M	H	H	M	M	H
CO3	M	M	M	M	M	H	H	M	M	H
CO4	M	M	M	M	M	H	H	M	M	H
CO5	M	M	M	M	M	H	H	M	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG7: Affordable and Clean Energy

Statement:

Ensure access to affordable, reliable, sustainable and modern energy for all

CHFY 019	BIOMASS FOR ENERGY APPLICATIONS	L	T	P	C
SDG: 07		3	-	-	3

COURSEOBJECTIVES: To make the student conversant with

COB1: Structure, properties and applications of cellulose, hemicelluloses and lignin.

COB2: Types of biomass used as feedstock for energy applications

COB3: Variousbiomass pretreatment techniques.

COB4: Understand the chemistry and economics of biodiesel

COB5: Understand the conversion of lignocelluloses into alcohol and fuel.

MODULE I CELLULOSE, HEMI - CELLULOSE AND LIGNIN L: T: P: 0 9

Chemistry of polysaccharides, Structure and properties of cellulose, Addition and substitution reactions, Structure and properties of hemicelluloses, Hydrolysis of cellulose by acid and enzyme, Chemistry of lignin, Biosynthesis of lignin, Structure and properties of lignin, Isolation and application of lignin, Chemistry of extractives.

MODULE II FEEDSTOCKS FOR BIOENERGY AND BIOFUEL L: T: P: 0 9

Availability and abundance, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, biomassas energy resources: dedicated energy crops, annual crops (maize, sorghum sugarbeet, hemp), perennial herbaceous crops (sugar cane, switch grass, miscanthus), short rotation woody crops (poplar, willow), oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, enhancing biomass properties for biofuels, challenges in conversion.

MODULE III PRETREATMENT TECHNIQUES L: T: P: 0 9

Biomass pretreatment - Physical pretreatment methods - milling, microwave, mechanical extrusion, pulse electric field - Chemical pretreatment methods - acid pretreatment, alkali pretreatment, Organosolv pretreatment, Ionic liquids pretreatment - Physico - chemical pretreatment - Steam explosion pretreatment, Ammonia fiber explosion (AFEX) pretreatment - CO_2 explosion, wet oxidation, sulphite pretreatment - Biological pretreatment

MODULE IV BIODIESEL PRODUCTION L: T: P: 0 9

Chemistry and Production Processes - Vegetable oils and chemically processed biofuels - Biodiesel composition and production processes - Biodiesel economics - standards for biodiesel quality - Energetics of biodiesel production and effects on greenhouse gas emissions - Issues of ecotoxicity and sustainability with expanding biodiesel production.

MODULEV BIOETHANOL PRODUCTION L: T: P: 0 9

Biochemical conversion of lignocellulose to alcohol: Separate hydrolysis and fermentation process (SHF), Simultaneous saccharification and fermentation process (SSF), Consolidated Bioprocess (CBP), Pentose fermentation by yeast and bacteria. Thermochemical conversion of biomass to liquid fuels: Combustion, Pyrolysis process oflignocellulose to liquid fuels, Gasification process, Cogeneration and polygeneration. Innovative cycles (such as biomass integrated gasification combined cycles, biomass air turbines, humid air turbines etc.) for biomass resources, Bioethanol production.

L - 45;TotalHours: 45

TEXTBOOKS:

1. Rogoff, M.J. and Screve, F., Waste - to - Energy: Technologies and Project Implementation, Elsevier Store.
2. Young G.C., Municipal Solid Waste to Energy Conversion processes, John Wiley and Sons.
3. Harker, J.H. and Backhusrt, J.R., Fuel and Energy, Academic Press Inc.
4. EL - Halwagi, M.M., Biogas Technology - Transfer and Diffusion, Elsevier Applied Science.
5. Hall, D.O. and Overeed, R.P., Biomass - Renewable Energy, John Willy and Sons.
6. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press.

REFERENCES:

1. 1.Krzysztof J. Ptasinski, Efficiency of Biomass Energy: An Exergy Approach to Biofuels, Power, and Biorefineries ,John Wiley and Sons, 2015.
2. 2.Kalt schmitt, Martin, Energy from Organic Materials (Biomass), A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition, 2019.

3. 3.George W. Huber, SaraIborra, Avelino Corma, Synthesis of Transportation Fuels from Biomass: Chemistry, Catalysts, and Engineering, Chemical Review 2006, 106, 9, 4044 - 4098.

COURSE OUTCOMES: Students will be able to

CO1: Identify the structure and properties of cellulose, hemicelluloses and lignin.

CO2: Find the significance of different biomass resources.

CO3: Illustrate biomass pretreatment techniques.

CO4: Synthesize the biodiesel at economical price.

CO5: Produce the bioethanol at economical price.

BoardofStudies(BoS): 14th BoS of Chemistry held on 17.07.2025

AcademicCouncil: 24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	M	M	M	M	H	H	M	M	H
CO2	M	M	M	M	M	H	H	M	M	H
CO3	M	M	M	M	M	H	H	M	M	H
CO4	M	M	M	M	M	H	H	M	M	H
CO5	M	M	M	M	M	H	H	M	M	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG7: Affordable and Clean Energy

Statement:

Ensure access to affordable, reliable, sustainable and modern energy for all

CHFY 020	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
SDG: 3,6,7,9,11,12,13		3	0	0	3

COURSE OBJECTIVES: To make the student conversant with

COB1: Understand the environmental pollution, environmental emission standards and the laws and rules.

COB2: Understand the concept of pollution prevention.

COB3: Understand various air pollution control methods.

COB4: Understand various water pollution control methods of primary and secondary treatment.

COB5: Understand the biological treatment, tertiary treatment and solid wastes disposal

MODULE I **EMISSION STANDARDS AND ENVIRONMENTAL LAWS** **L: 9 T: 0 P: 0**

Environment and environmental pollution from chemical process industries - Air pollutants and pollution and its effects - characterization of emissions, water pollutants and pollution - and its effects - characterization of effluents - standards for ambient air, noise emission and effluents - Environmental Laws and rules: Airact 1981 and 1987, Water act 1974, 1977, 1987, Environmental Protection Act 1986, The hazardous wastes (management and handling) rules 1989 and 2000, The manufacture, storage and import of hazardous chemical rules 1989 and 2000, Public liability insurance act 1991, The national environment tribunal act 1995, The chemical accidents, emergency planning,preparedness and response rules 1996, The recycled plastic manufacture and usage rules 1999, The batteries (management and handling (draft) rules 2000 - Ewaste management rule.

MODULE II **POLLUTION PREVENTION** **L: 9 T: 0 P: 0**

Process modification: process change, technology change, better process control and product modification - alternative raw material - recovery of by - product from industrial emission effluents - waste reduction techniques: recycle and reuse of waste and volume reduction - energy recovery and waste utilization - Material and energy balance for pollution minimization - Water use minimization - Fugitive emission/effluents and leakages and their control - LDAR Programme - house keeping and maintenance.

MODULE III AIR POLLUTION CONTROL L: T: P: 9 0 0

Introduction to airpollution control - Particulate emission control by mechanical separation: gravitational settling chambers, cyclone separators, fabric filters and electrostatic precipitator and wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers.

MODULE IV WATER POLLUTION CONTROL L: T: P: 9 0 0

Introduction to Water Pollution and Control - Physical treatment, pre - treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation Secondary treatment: Biological treatment - Anaerobic and aerobic treatment - Trickling filter, activated sludge and lagoons, aeration systems.

MODULE V TERTIARY TREATMENT AND SOLID DISPOSAL L: T: P: 9 0 0

Tertiary treatment: colour and odour removal - Solids Disposal: Sludge separation and drying - Solids waste disposal - composting, landfill, briquetting/gasification and incineration - Standards for treatment and disposal of Bio - medicalwaste by incineration.

L - 45;TotalHours: 45

TEXTBOOKS:

1. Paul N Cheremisinoff, Air pollution control and design for industry, 2018.
2. Rao C.S, Environmental Pollution control Engineering, 2007.

REFERENCES:

1. Thomas T. Shen, Industrial Pollution Prevention, Springer, 1999.
2. Nancy J. Sell, Industrial Pollution Control: Issues and Techniques, 2nd Edition, Wiley, 1992.
3. Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest, Government of India,2006.
4. www.moef.nic.in

COURSEOUTCOMES: Students will be able to describe

CO1: Environmental pollution and the environmental standards.

CO2: The concept of pollution prevention.

CO3: Various air pollution control methods.

CO4: The pre and secondary treatment of water pollution control methods.

CO5: Various tertiary treatment and solid wastes disposalmethods.

BoardofStudies(BoS):
14th BoS of Chemistry held on 17.07.2025

AcademicCouncil:
24th ACM held on26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	M	M	M	M	H	H	M	M	H
CO2	M	M	M	M	M	H	H	M	M	H
CO3	M	M	M	M	M	H	H	M	M	H
CO4	M	M	M	M	M	H	H	M	M	H
CO5	M	M	M	M	M	H	H	M	M	H

Note: L - Low CorrelationM - Medium CorrelationH - High Correlation

SDG3: Good health and well - being

SDG6: Clean water and sanitation

SDG7: Affordable and clean energy

SDG9: Industry, Innovation, and Infrastructure

SDG11: Sustainable cities and communities

SDG12: Responsible consumption and production

SDG13: Climate Action

Statement:

Ensure healthy lives and promote well - being for all at all ages

Ensure availability and sustainable management of water and sanitation for all

Ensure access to affordable, reliable, sustainable and modern energy for all

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Make cities and human settlements inclusive, safe, resilient and sustainable

Ensure sustainable consumption and production patterns

Take urgent action to combat climate change and its impacts