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

Regulations 2022
Curriculum and Syllabi
(As approved by the 19th Academic Council)
September - 2022

M.Sc. (Chemistry)

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

REGULATIONS 2022

CURRICULUM AND SYLLABI

(As approved by the 19th Academic Council)

SEPTEMBER – 2022

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 AND MISSION

VISION

- To blossom as a department with excellence in the field of Chemical Sciences through academic and research programmes in cutting-edge areas.

MISSION

- To provide knowledge and skill in Chemical Sciences through post graduate and doctoral programmes.
- To undertake research in emerging areas of Chemical Sciences and transform the findings for the benefit of the society.
- To establish collaboration with industry and research institutes and to promote joint research projects

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M.Sc (Chemistry)

PROGRAMME EDUCATIONAL OBJECTIVES:

- 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 sub-disciplines 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 conclusions.
- 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:

On successful completion of this programme, the students 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

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

REGULATIONS 2022

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 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 PROGRAMMES OFFERED AND ADMISSION REQUIREMENTS

2.1 Programmes Offered

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.	

2.2 ADMISSION REQUIREMENTS

2.2.1 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.

2.2.2 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 DURATION, ELIGIBILITY AND STRUCTURE OF THE PROGRAMME

3.1. 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

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

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

3.2 ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO PROGRAMMES

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	Aeronautical Engineering	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.	Civil Engineering	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.
		M. Tech. (Construction Engineering and Project Management)	B.E. / B.Tech. in Civil Engineering / Structural Engineering / B.Arch. or Equivalent degree in relevant field.
3.	Mechanical Engineering	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.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	Computer Science and Engineering	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	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE /

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		Intelligence and Data Science)	ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
7.	Information Technology	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.	Computer Applications	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.	Mathematics	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	Physics	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	Chemistry	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	Life Sciences	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.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.
13.	Commerce	M.Com	B.Com. / BBA
14.	Arabic and Islamic Studies	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 AalimSanad / Diploma / Certificate in Arabic or Islamic Studies.

3.3.STRUCTURE OF THE PROGRAMME

3.3.1 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

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

3.3.3 For the award of the degree, the student has to earn a minimum totalcreditsspecified in the curriculum of the respective specialization of the programme.

3.3.4 The curriculum ofprogrammes 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.	76 -80
MCA	86
M.Sc.	77 - 85
M.Com.	88
M.A.	72

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

- ❖ Onecredit 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.

3.3.6 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

3.3.7 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.

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

3.3.9 Apart from the various elective courses listed in the curriculum for each specialization ofprogramme, the student can choose a maximum of two electives from any other similar programmes across departments, aliter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

3.4. ONLINE COURSES

3.4.1 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.

3.4.2 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 thesupervision 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.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 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.

4.2 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.

5.0 COURSE COMMITTEE

5.1 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.

6.0 CLASS COMMITTEE

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

6.2 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

6.3 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 assessmentshall 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.

6.4 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.

6.5 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.

7.0 REGISTRATION AND ENROLLMENT

7.1 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.

7.2 Change of a Course

A student can change an enrolled 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.

7.3 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.

7.4 A student can enroll for a maximum of 32 credits during asemester including Redo / Predo courses.

8.0 BREAK OF STUDY FROM PROGRAMME

8.1 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:

8.1.1 Medical or other valid grounds

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

8.1.3 Debarred due to any act of indiscipline

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

8.3 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).

8.4 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.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT WORK

9.1 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

9.2 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.

10.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded "I" grade in that course.

10.2 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.

10.3 If a student secures attendance between 65% and less than 75% in any course in a semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the institution approved events, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examination of that course. In all such cases, the students shall submit the required documents immediately after joining the classes to the class advisor, which shall be approved by the Head of the Department / Dean of the School. The Vice Chancellor, based on the recommendation of the Dean (Academic Affairs) may approve the condonation of attendance.

10.4 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.

10.5 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.

10.6 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.

10.7 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.

11.0 REDO COURSES

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

11.2 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.

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 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. 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.

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

In the case of project work, a committee of faculty members constituted by the Head of the Department / Dean of the School will carry out three periodic reviews. Based on the project report submitted by the students, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by the Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.

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 componentsand 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 SUPPLEMENTARY EXAMINATION

14.1 Final Year 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.

15. PASSING, DECLARATION OF RESULTS AND GRADE SHEET

15.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall preferably meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. 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
I	0

"I" denotes inadequate attendance and hence prevented from appearing for semester end examination

"U" denotes unsuccessful performance in the course.

15.2 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.

15.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department/Dean of School and it shall be declared by the Controller of Examinations.

15.4 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 fees tothe Controller of Examinations. Subsequently the Head of the Department/ Dean of 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 knowledgeable in that course as members. The committee shall meet within a week to re-evaluate the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

15.5 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 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 Point in the i^{th} course

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

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" grade is excluded for calculating GPA.

"U" and**"I"** grades are excluded for calculating CGPA.

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

Percentage Equivalent of Marks = CGPA X 10

15.6 After successful completion of the programme, the Degree shall be awarded upon fulfillment of curriculum requirements and classification based on CGPA as follows:

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the minimum prescribed period.
First Class	6.50 and above and completing the programme within a minimum prescribed period plus two semesters.
Second Class	Others

15.6.1 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 PG programme within the minimum prescribed period of study (except clause 8.1.1)

15.6.2 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 8.1.1)

15.6.3 The students who do not satisfy clause 15.6.1 and clause 15.6.2 shall be classified as second class.

15.6.4 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.

16.0 DISCIPLINE

16.1 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.

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

17.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

17.1 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 stipulated time.
ii. No disciplinary action is pending against him/her.
iii. Enrolled and completed at least one value added course.
iv. Enrollmentin at least one MOOC / SWAYAM course (non-credit) before the final semester.

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

18.0 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. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

M.SC CHEMISTRY

CURRICULUM & SYLLABUS, REGULATIONS 2022

SEMESTER I

S.No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	CHE 6101	Stereochemistry and Reaction Mechanisms	3	0	0	3
2.	PCC	CHE 6102	Thermodynamics and Chemical Equilibria	3	0	0	3
3.	PCC	CHE 6103	Fundamentals of Inorganic Chemistry	3	0	0	3
4.	PEC	CHEY XXX	Professional Elective-1	3	0	0	3
5.	PEC	CHEY XXX	Professional Elective-2	3	0	0	3
6.	LC	CHE6104	Laboratory Techniques in Organic Synthesis	0	0	4	2
7.	LC	CHE 6105	Experiments on the Determination of Thermodynamics and Chemical Equilibria Parameters	0	0	4	2
8.	LC	CHE 6106	Inorganic Chemistry Practical	0	0	4	2
9.	MC	ENE 6182	Professional Communication	2	1	0	3
			Credits				**24**

SEMESTER II

S.No.	Course Group	Course Code	Course Title	L	T	P	C
1.	MC	GEE 6202	Research Methodology and IPR	3	0	0	3
2.	PCC	CHE 6201	Synthetic and Spectroscopic Organic Chemistry	3	0	0	3
3.	PCC	CHE 6202	Kinetics and Electrochemistry	3	0	0	3
4.	PEC	CHEY XXX	Professional Elective-3	4	0	0	4
5.	PEC	CHEY XXX	Professional Elective-4	4	0	0	4
6.	LC	CHE 6203	Multistep Synthesis and Characterization of Organic	0	0	4	2

			Compounds				
7.	LC	CHE 6204	Experiments on Kinetics and Electrochemical Parameters	0	0	4	2
8.	LC	CHE 6205	Inorganic Chemistry Practical	0	0	4	2
9.	PROJ	CHE 6206	Seminar	0	2*	0	1
10.	MC		Aptitude* Parallel Session (Value Added Course)	2*	0	0	0
			Credits				**24**

SEMESTER III

S.No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	CHE 7101	Retrosynthetic Analysis and Heterocyclic Compounds	3	0	0	3
2.	PCC	CHE 7102	Quantum Chemistry and Group Theory	3	1	0	4
3.	PCC	CHE 7103	Organometallic Chemistry	3	0	0	3
4.	PCC	CHE 7104	Structural Interpretation of Materials	3	0	0	3
5.	PEC	CHEY XXX	Professional Elective-5	3	0	0	3
6.	PEC	CHEY XXX	Professional Elective-6	3	0	0	3
7.	OEC		Open Elective-1	3	0	0	3
8.	PROJ	CHE 7105	Project Work - Phase I	0	0	12	2**
9.	PROJ	CHE 7106	Industrial Internship #	-	-	-	2
10.			MOOC (Credit Transfer)				
			Credits				**24**

SEMESTER IV

Sl.No.	Course Group	Course Code	Course Title	L	T	P	C
	PROJ	CHE 7201	Project Work - Phase II	0	0	34	10
			Credits			**(2 + 10)**	**12**

Overall Total Credits - 84

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

** Credits for project work phase I in III semester to be accounted along with project work phase II in IV semester

Professional Electives Courses

S.No.	Course Code	Course Title	L	T	P	C
		Basic Chemistry				
1.	CHEY 001	Analytical Techniques	3	0	0	3
2.	CHEY 002	Transition and Inner Transition Elements Chemistry	3	0	0	3
3.	CHEY 003	Molecular Spectroscopy	3	0	0	3
4.	CHEY 004	Photophysics and Photochemistry	3	0	0	3
		Medicinal, Pharmaceutical and Biological Chemistry				
5.	CHEY 005	Bioorganic Chemistry	3	0	0	3
6.	CHEY 006	Chemistry of Heterocyclic Compounds and Natural Products	3	0	0	3
7.	CHEY 007	Biochemistry	2	0	2	3
8.	CHEY 008	Medicinal and Pharmaceutical Chemistry	3	0	0	3
9.	CHEY 009	Chemistry of Carbohydrates	3	0	0	3
10.	CHEY 010	Advanced Concepts in Organic Synthesis	3	0	0	3
11.	CHEY 011	Pharmaceutical Technology	3	0	0	3
12.	CHEY 012	Elemental Forensic Chemistry	3	0	0	3
		Materials and Technology				
13.	CHEY 013	Nanotechnology and Catalysis	3	0	0	3
14.	CHEY 014	Protective Coatings	3	0	0	3
15.	CHEY 015	Corrosion and Corrosion Control	3	0	0	3
16.	CHEY 016	Polymer Technology	3	0	0	3
17.	CHEY 017	Polymer Structure and Property Relationship	3	0	0	3
18.	CHEY 018	Electrochemical Energy Conversion and Storage	3	0	0	3
19.	CHEY 019	Industrial Electrochemistry	3	0	0	3
20.	CHEY 020	Surface Coating Technology	3	0	0	3
		Energy, Water & Environment for Sustainability				
21.	CHEY 021	Green and Sustainable Chemistry	3	0	0	3
22.	CHEY 022	Industrial Pollution Control	3	0	0	3
23.	CHEY 023	Alternative Energy Resources	3	0	0	3

24.	CHEY 024	Solar Energy	3	0	0	3
25.	CHEY 025	Fuel Cells *f*or Sustainable Energy Production	3	0	0	3
26.	CHEY 026	Biomass for Energy Applications	3	0	0	3
27.	CHEY 027	Environmental Chemistry	3	0	0	3

SEMESTER I

CHE 6101	**STEREOCHEMISTRY AND**	**L**	**T**	**P**	**C**
SDG: 9	**REACTION MECHANISMS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

To make the student conversant with

COB1: absolute and relative configurations of organic compounds

COB2: various theories on stereochemical reactions

COB3: mechanism of nucleophilic and electrophilic substitution reactions

COB4: mechanism of addition and elimination reactions

COB5: concepts in aromaticity

MODULE I STEREOCHEMISTRY - CHIRALITY 9

Introduction to molecular symmetry and point groups – optical isomerism – conditions for optical activity – Fischer, Newmann, Sawhorse and flying wedge projection formulae and their interconversions – concept of chirality – R,S-nomenclature - geometrical isomerism – E,Z nomenclature – determination of configuration of geometrical isomers – Atropisomerism - biphenyls, binaphthyls, allenes, spiranes, exo-cyclic alkylidene, cycloalkanes – ansa and cyclophanic compounds.

MODULE II STEREOCHEMISTRY – ASYMMETRIC SYNTHESIS 9

Conformational analysis and reactivity of cyclic and acyclic systems – topicity – prochirality - enantiotopic and diastereotopic atoms, groups and faces – Felkin-Ann model – asymmetric synthesis - Cram's rule – Prelog's rule – stereoselective, stereospecific reactions - enantioselective synthesis - optical purity and enantiomeric excess - desymmetrisation and kinetic resolution – methods of determination of absolute configuration.

MODULE III NUCLEOPHILIC AND ELECTROPHILIC SUBSTITUTION REACTIONS 10

S_N1, S_N2, Neighboring group participation and S_Ni, S_NAr mechanisms – effects of substrate, attacking nucleophile, leaving group and solvent – stereochemistry of nucleophilic substitution reactions – substitutions at carbonyl, bridgehead, vinylic and allylic carbons - ambident nucleophiles - O versus C alkylation – activated aromatic nucleophilic substitution -

Reactions of aryl diazonium salts – aromatic electrophilic substitution reactions and mechanisms.

MODULE IV ADDITION AND ELIMINATION REACTIONS 10

Addition to carbon-carbon and carbon-hetero multiple bonds – electrophilic, nucleophilic and free radical additions – stereochemistry of addition to carbon-carbon multiple bonds – orientation and reactivity, addition to conjugated systems and orientation – addition to α,β-unsaturated carbonyl groups – E1, E2 and E1CB mechanisms – stereochemistry of E2 elimination – competition between elimination and substitution reactions – orientation effects in elimination reactions – effects of substrate structures, attacking base, leaving group and medium on E1 and E2 reactions – pyrolytic eliminations - Chugaev and Cope eliminations.

MODULE V AROMATICITY 7

Aromaticity – concept – Huckel and Craig rules – Aromatic and anti aromatic compounds – benzenoid, non-benzenoid and homo aromatic compounds – anti-aromaticity - Annulenes – Aromaticity in cyclopentadienyl anion, tropolone, fullerenes, azulenes, fulvenes, azirines, heteroaromatic systems and charged ring systems – NMR and aromaticity

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Eliel E.L. and Wilen S.H., Stereochemistry of Organic Compounds, John Wiley India, 2009. (No later editions available)
2. Nasipuri D., Stereochemistry of Organic Compounds, 4nd Edition, Wiley Eastern Ltd., 2020.
3. Kalsi P.S., Stereochemistry Conformation and Mechanism, Wiley Eastern Ltd., New Delhi, 2019.
4. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2000. (No later editions available)
5. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A – Structure and Mechanisms, 5th Edition, Springer, 2007. (No later editions available)
6. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007. (No later editions available)

7. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009. (No later editions available)
8. Peter Sykes, Guidebook to Mechanism in Organic Chemistry, Orient Longman, 2005. (No later editions available)
9. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014. (No later editions available)
10. Ahluwalia, V. K.; Parashar, R. K. Organic Reaction Mechanism, Narosa publications, 4th Edition, 2010. (No later editions available)

COURSE OUTCOMES:

The students 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: recognize the aromaticity and aromatic electrophilic substitution reaction

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M			L										
CO2	H	M			L										
CO3	H	L			L										
CO4	H														
CO5	M				L										

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

SDG 9: Industry and Innovation

Statement: Foundation to work in R&D of pharmaceutical industry and for teaching career.

CHE 6102	THERMODYNAMICS AND CHEMICAL	L	T	P	C
SDG: 9	EQUILIBRIA	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: laws of chemical thermodynamics, types of process and applications and Partial molar quantities. Fugacity, activity and activity

COB2: second law of thermodynamics, Gibbs Helmholtz equation and third law of thermodynamics

COB3: statistical thermodynamics and Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

COB4: phase equilibria and phase rule and two component system, three component systems

COB5: Law of Mass Action, Vant's Hoff Equation, Le Chatelier Principle, Hammett Equation and Taft Equation

MODULE I BASICS OF THERMODYNAMICS 9

Properties, process and functions of thermodynamics – isothermal and adiabatic expansion of ideal gas and changes in thermodynamic properties – Joule Thomson effect – standard enthalpy changes – bond energy, applications of bond energy - First law of thermodynamics, limitations– free energy and work function (workout problems in all topics). Absolute entropy. Partial molar quantities. Fugacity, activity and activity coefficients.

MODULE II ADVANCED THERMODYNAMICS 9

Second law of thermodynamics - entropy changes isothermal expansion of ideal gas ,reversible and irreversible process and phase changes - Maxwell relations – criteria to reversible and irreversible process – Gibbs Helmholtz equation - Clausius-Clapeyron equation – partial molar properties – chemical potential - Gibbs-Duhem equation - third law of thermodynamics – evaluation of absolute entropies of solids, liquids and gases.

MODULE III STATISTICAL THERMODYNAMICS 9

Objectives of statistical thermodynamics – probability – microstates and macrostates for distinguishable and indistinguishable particles – permutation and combinations – Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics - partition functions and their relation to

thermodynamic quantities Derive the expression for translational,rotational, vibrational and electronic partition functions and its simple application tomono atomic gases (ortho-para hydrogen) and solids.

MODULE IV PHASE EQUILIBRIA 9

elementary description of phase transitions; phase equilibria and phase rule; one component systems (water, CO_2, S) and two component system – thermal analysis curve - classification of two component system – solid-gas (dehydration and rehydration of CuSO4. 5H2O), solid liquid systems – three component systems involving liquid-liquid equilibria. Fractional distillation. Azeotropes and eutectics.

MODULE V CHEMICAL EQUILIBRIA 9

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 – Heterogeneous Equilibria – Le Chatelier Principle - Hammett Equation - Taft Equation.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Atkins P., and Paula J.D., Physical Chemistry, 7th Edition, Oxford UniversityPress, London, 2002.
2. Alberty P.A. and Silbey R.U., Physical Chemistry, 1st Edition, John Wiley andSons Inc., 1995.
3. Castellan G.W., Physical Chemistry, 3rd Edition, Narosa Publishing House,2004.
4. Kuriacose J.C. and Rajaram J., Thermodynamics for Students of Chemistry,3rd Edition, S. Chand and Co., New Delhi, 2001.
5. Crow D.R., Principles and Application of Electrochemistry, Chapman and Hall,1988.
6. Nash L.K. and Addison, Elements of Statistical Thermodynamics, WileyPublication Co., 1971.
7. Gupta M.C., Statistical Thermodynamics, Wiley Eastern, New Delhi, 1990.
8. An Introduction to Electrochemistry by Samuel Glasstone,Affiliated East - WestPress Pvt Ltd, New Delhi
9. Principles of colloid and surface chemistry Paul C. Hiemenz, Raj Rajagopalan,3rd edition, Marcel Dekker, 1997.

COURSE OUTCOMES:

The students will be able to

CO1: derive the laws of chemical thermodynamics, types of process and applications and Partial molar quantities. Fugacity, activity and activity

CO2: second law of thermodynamics, Gibbs Helmholtz equation and third law of thermodynamics

CO3: statistical thermodynamics and Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics

CO4: phase equilibrium and phase rule and two component system, three component systems

CO5: Law of Mass Action, Vant's Hoff Equation, Le Chatelier Principle, Hammett Equation and Taft Equation

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M			L										
CO2	H	M			L										
CO3	H	L			L										
CO4	H														
CO5	M				L										

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 thermodynamics and chemical equilibiria provide a strong knowledge for quality teaching and learning process.

CHE 6103	FUNDAMENTALS OF INORGANIC	L	T	P	C
SDG:04	CHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Periodic properties of elements,

COB2: Chemical bonding and non-valence forces,

COB3: Aqueous and non-aqueous chemistry of inorganic compounds,

COB4: Compounds of main group elements.

COB5: Nuclear reactions and radioactivity

MODULE I CHEMICAL PERIODICITY 9

Modern views on atomic structure – Wave equation – hydrogen atom and poly electron atoms, periodic properties of elements – Electronic configuration and term symbols, atomic size, ionization energy, electron affinity, electro negativity, covalent and ionic radii, inert pair effect.

MODULE II CHEMICAL BONDING AND NON-VALENCE FORCES 9

Ionic solids – lattice energy – Born-Haber cycle - thermochemical calculation on ionic compounds, 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. Van der Waals forces – hydrogen bond – clathrates.

MODULE III AQUEOUS AND NON-AQUEOUS CHEMISTRY 8

Acid-base concepts, HSAB theory, super acids, non-aqueous solvents – reactions in liquid ammonia, sulphuric acid, aprotic solvents - molten salts - electrode potentials and applications in inorganic systems.

MODULE IV MAIN GROUP ELEMENTS 11

Allotropy, hydrides, halides, oxides, oxoacids and oxoanions, boranes, carboranes, metallocarboranes, borazine, silicates, nitrides, phosphides, arsenides, phosphazenes, nitrides of sulphur, selenides, Inter-halogen compounds and polyhalogen ions, compounds of xenon, krypton and radon.

MODULE V NUCLEAR CHEMISTRY 8

Nuclear particles, Nuclear forces, Nuclear size and density, Packing fraction, Mass defect, Binding energy, Nuclear models, Nuclear fission, Nuclear fusion, Radioactivity, Detection and measurement of radioactivity, Artificial radioactivity, Q values of nuclear reactions

L – 45; Total Hours –45

TEXT BOOKS:

1. BR Puri, LR Sharma and KC Kalia, Principles Of Inorganic Chemistry, Vishal Publishing Co, 33rd Edition, Delhi, 2019
2. Lee J.D., Concise Inorganic Chemistry, 5th Edition, Blackwell Science, 2003.

REFERENCES:

1. Cotton F.A., Wilkinson G. and Gaus P.L., Basic Inorganic Chemistry, 3rd Edition, John Wiley and New York, 2003.
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. Huheey J.E., Keiter E.A. and Keiter R.L., Inorganic Chemistry, 4th Edition, Addision Wesley Publication, London, 1993.
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 an understanding of chemical bonding and non-valence interactions.

CO3: Compare the aqueous and non-aqueous behavior of inorganic compounds

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

CO5: Find the applications of nuclear reactions.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	M	M	L	H									
CO2	M	M	M	M	L	H									
CO3	M	M	M	M	L	H									
CO4	M	M	M	M	L	H									
CO5	M	M	M	M	L	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.

CHE 6104	LABORATORY TECHNIQUES IN	L	T	P	C
SDG: 3,9	ORGANIC SYNTHESIS	0	0	4	2

COURSE OBJECTIVES:

To make the student conversant with

COB1: Separation of two component mixture

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

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. Reaction using Grignard reagent
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:

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.htm

COURSE OUTCOMES:

The students 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):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H	H	M	H	M									
CO2	M	H	H	M	H	M									
CO3	M	H	H	M	H	M									
CO4	M	H	H	M	H	M									
CO5															

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

SDG 3: Good health

SDG 9 : Industry and Innovation

Statement :

SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

SDG3: R&D labs in API labs in the production new drug candidates

CHE 6105 EXPERIMENTS ON THE DETERMINATION OF THERMODYNAMICS AND CHEMICAL EQUILIBRIA PARAMETERS

L	T	P	C
0	0	4	2

SDG: 3,9

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. Verification of Ostwald dilution law using weak acid and determination of its dissociation constant.
2. Temperature dependence of solubility of benzoic acid in water and DMSO.
3. The effect of ionic strength on the solubility of $CaSO_4$ and so determine its thermodynamic solubility product and mean ionic activity.
4. The 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.
5. Determination of the transition temperature of sulphur system.
6. Partition coefficient of iodine between carbon tetrachloride and water.
7. Partition coefficient of benzoic acid between water and benzene.
8. Determination of the equilibrium constant of the esterification reaction between acetic acid and ethanol.
9. Determination of the equilibrium constant of the keto-enol tautomerism of ethyl acetoacetate.
10. Phase diagram for water-ethanol- benzene system at room temperature.
11. Solubility curve for a ternary system of liquids, say water-acetic acid-

chloroform system.

12. Uses of computer packages: Microsoft (word, excel and power point), origin, chemsketch and chemdraw.

P - 60; Total Hours –60

REFERENCES:

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

COURSE OUTCOMES:

The students will be able to

CO1: Verify the Ostwald dilution law and temperature dependence of solubility of benzoic acid in water and DMSO

CO2: Determine the thermodynamic solubility product and mean ionic activity and effect of concentration of an electrolyte

CO3: Determine the transition temperature and partition coefficient of water and organic compounds

CO4: Determine the equilibrium constant of esterification reaction and keto-enol tautomerism

CO5: Determine the phase diagram solubility curve for a ternary system of liquids and the uses of chemistry related computer packages

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H	H	M	H	M									
CO2	M	H	H	M	H	M									
CO3	M	H	H	M	H	M									
CO4	M	H	H	M	H	M									
CO5															

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

SDG 3: Good health
SDG 9 : Industry and Innovation

Statement :
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.
SDG3: R&D labs in API labs in the production new drug candidates

CHE 6106	INORGANIC CHEMISTRY	L	T	P	C
SDG: 4	PRACTICAL-I	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+}, Mn2+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 & 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):

12th BoS of Chemistry held on 22.07.2022

Academic Council:

19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M	M	H	L	H									
CO2	H	M	M	H	L	H									
CO3	H	M	M	H	L	H									
CO4	H	M	M	H	L	H									
CO5	H	M	M	H	L	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.

ENE 6182	PROFESSIONAL	L	T	P	C
SDG: 4 and 8	COMMUNICATION	2	1	0	3

COURSE OBJECTIVES:

COB1: To enhance the Employability and Career Skills of students

COB2: To orient the students towards grooming as a professional

COB3: To make them Employability Graduates

COB4: To train students making effective presentations and discussion various topics.

MODULE I COMMUNICATION AT WORKPLACE 3+1

Language and communication-Communication at the workplace- Formal and informal communication- Direction of flow of communication- Non-verbal communication- Communication and organizational culture-Communication and inter- personal relations- Importance of the 'U' in communication.

MODULE II PRESENTATION SKILLS 3+5

Importance of presentation skills-Overcoming the fear of public speaking towards making effective presentations- A step-by-step approach to presentations –planning the presentation-Gathering feedback- Making the presentation.

MODULE III CORRESPONDENCE AT WORK 3+3

Importance of workplace correspondence-Types of correspondence-Mechanics of effective business correspondence-Tips for effective correspondence-The seven Cs of communication- Writing effective emails- Email etiquette-Personal touch in business communication.

MODULE IV TEAM WORK 3+5

Importance of team work-Understanding team behavior-Team as an employability skill- Team formation and development-Pooling competencies in a team- Significance of team spirit-How to be an effective team player – Group Discussion.

MODULE V WORKPLACE ETIQUETTE 3+1

Etiquette in modern workplace- Workplace etiquette- global and local Culture sensitivity-Gender sensitivity- importance of grooming-Etiquette in

interaction-Netiquette.

L-30, T-15; TOTAL HOURS - 45

REFERENCES:

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. Interact English Lab Manual for Undergraduate Students,.OrientBalckSwan: Hyderabad, 2016.
3. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
5. S. Hariharan etal. Soft Skills. MJP Publishers: Chennai, 2010.
6.Pillai, Sabina & Fernandez, Agna.Soft skills & Employability Skills,Cambridge University Press India Pvt.Ltd.,New Delhi.

COURSE OUTCOMES:

CO1: Identify the flows of communication
CO2: Make effective presentations
CO3: Write effective business correspondences.
CO4: Participate in group discussions and team work confidently.
CO5: Follow appropriate workplace etiquette

Board of Studies (BoS):	**Academic Council:**
15thBoS of the Department of English held on 14.6.2022	19th AC held on 29.09.2022

SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

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

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

SEMESTER II

GEE 6202	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
SDG: 4, 9, 11 & 15		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

Students will be trained to

COB1: Basic concepts of Research.

COB2: Select and Define a research problem

COB3: Analyze and Interpret the Results

COB4: write Scientific and Technical reports & thesis

COB5: Apply the Copyrights, Patents and Intellectual Property Rights.

MODULE I INTRODUCTION TO RESEARCH METHODOLOGY 9

Research: Objectives, Motivation and types - Approaches, Significance of Research, Research process, Criteria of good research, Problems encountered by researchers - Introduction to ethics, scientific conduct and misconduct, misconduct and why it occurs, fabrication, authorship issues, The investigation and punishment of scientific misconduct (Erratum).

MODULE II RESEARCH FORMULATION AND DESIGN 9

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, development of working hypothesis. Definition and importance of Journal Impact factor, Cite Scores and Citation Indexes.

MODULE III DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA 9

Observation and Collection of data, methods of data collection, sampling methods, data processing, analysis strategies and tools, data analysis with statistical tools (Sigma STAT, SPSS student, ANOVA), hypothesis testing. Importance and scientific methodology in recording results, importance of negative results, conceptions of error of measurement - absolute and relative errors, true score theory and generalisability theory. Measures of central tendency – mean median and mode.

MODULE IV SCIENTIFIC AND TECHNICAL WRITING 9

Different types of scientific and technical publications in the area of research - Technical writing skills for report, synopsis and thesis – organisation of contents and layout of the research reports, oral presentation, mechanics of writing a research report, precautions for writing research reports, conclusions. Preparing papers for international journals - software for paper formatting like LaTeX/MS Office, Grammarly - reference management software – Mendeley and detection of similarity index / plagiarism by Turnitin.

MODULE V INTELLECTUAL PROPERTY RIGHTS 9

The concept, Intellectual Property system in India, development of TRIPS complied regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, Commercialization, Copy Right, Royalty, Trade related aspects of Intellectual Property Rights (TRIPS); Geographical indications, Industrial designs, Enforcement of Intellectual Property Rights, Function of UNSECO in IPR maintenance. Patents, Patentable subject matter, Rights conferred, Exceptions, Term of protection, Conditions on Patent applicants, Process patents.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Cooper Donald R, Schindler Pamela S and Sharma JK., 2012. “Business Research Methods”, Tata McGraw Hill Education, 11e.
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 & Sons Publishers, Inc
6. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976. John Wiley & 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 Communicationof 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 and define appropriate research problem and parameters

CO3: apply packages for data collection, analyze and interpretation of data into reports.

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

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

Board of Studies (BoS) : 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO 1	PSO 2	PSO 3
CO1													M		
CO2			H					M						M	
CO3		H			M										
CO4													H		M
CO5										H			H		

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

CHE 6201	SYNTHETIC AND SPECTROSCOPIC	L	T	P	C
SDG: 3,9	ORGANIC CHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

To make the student

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

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

COB3: study the orbital interactions in concerted reactions

COB4: conversant with light mediated organic transformations

COB5: understand the basics of NMR and IR for structural elucidation of organic compounds.

MODULE I CARBANIONS AND CARBOCATIONS 9

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.

Structure and stability of carbocations – classical and non-classical carbocations – reactions of carbocation – C-C bond formation involving carbocations – oxymercuration.

MODULE II RADICALS, CARBENES, NITRENES AND YLIDES 9

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 – structure of nitrene – generation and reactions of nitrene – chemistry of phosphorous and sulfur ylides – generation and reactions of ylides.

MODULE III PERICYCLIC REACTIONS 9

Classification – electrocyclic, cycloaddition, sigmatropic, chelotropic and ene reactions – Woodward-Hoffmann rules – Frontier orbital and orbital symmetry correlation approaches – examples of pericyclic reactions: Diels-Alder, Clasien, Cope, aza-cope and ene reactions (with stereochemical aspects) – 1,3-dipolar cycloaddition and its utility in organic synthesis.

MODULE IV ORGANIC PHOTOCHEMISTRY 7

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

MODULE V NMR, IR and Mass of organic compounds 11

NMR phenomenon – spin nuclei (^{1}H and ^{13}C) – chemical shift – coupling constant – examples of AB, AX, AA′BB′ and ABX systems, NOE – DEPT – ^{13}C NMR, 2D NMR – Infrared spectroscopy - organic functional group identification through IR spectroscopy - Mass spectrophotometry – deduction of structure through mass spectral fragmentation – Mclafferty - HRMS – case studies.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A – Structure and Mechanisms, 5th Edition, Springer, 2007.
2. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007.
3. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.
4. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009.
5. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, Organic Chemistry, 11th Edition, John Wiley and Sons, New York, 2013.
6. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2014.
7. Sankararaman S., Pericyclic reactions – a Textbook: Reactions, Applications and Theory, Wiley-VCH, 2005.
8. V. Ramamurthy, Kirk S Schanse, Organic Photochemistry, CRC press, Taylor & Francis, 2018.
9. John D. Coyle Introduction to Organic Photochemistry, John Wiley and Sons, 1991.
10. Ian Flemming, Pericyclic Reactions, 2nd Edition, Oxford University Press, 2021.

COURSE OUTCOMES:

The students will be able to

CO1: propose reaction mechanisms of organic reactions involving carbanions and carbocations

CO2: comprehend the structure-reactivity pattern of radicals, carbenes, nitrenes and ylides towards organic transformations

CO3: predict the orbital interactions and orbital symmetry correlations of various organic reaction via pericyclic reactions

CO4: analyse the photochemical reaction mechanisms

CO5: apply the spectroscopic techniques for arriving at the structure of an organic molecule

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H	M			L										
CO 2	H	M			L										
CO 3	H	M													
CO 4	H	M			L										
CO 5	H	M		M	L	M									

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

SDG 3: Good health

SDG 9 : Industry and Innovation

Statement :

SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

SDG3: R&D labs in API labs in the production new drug candidates

CHE 6202	KINETICS AND ELECTROCHEMISTRY	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES

To make the student conversant with

COB1: rate equations for all types of reaction and vant Hoff's rule.

COB2: Lindeman's theory and effect of dielectric constant in ionic rate.

COB3: Freundlich, Langmuir, Gibbs adsorption isotherm and determination of surface area and pore volume and pore size of molecule.

COB4: Debye-Huckel theory, Applications of EMF measurements: Solubility product and Kohlrausch's law and its applications

COB5: types of corrosion, factors influencing corrosion and preventive methods.

MODULE I CHEMICAL KINETICS 9

Empirical rate laws and temperature dependence; complex reactions; steady state approximation; Methods of determining rate laws – unimolecular, reactions; reversible, consecutive and competing reactions – Vant Hoff's rule, Collision theory, Bodenstein's Theory, theory of absolute reaction rates – transmission coefficient – thermodynamic formulation of reaction rates – kinetics – classical treatment – principle of microscopic reversibility - photochemical kinetics – fast reactions – luminescence and energy transformations. enzyme kinetics; salt effects; homogeneous catalysis.

MODULE II KINETICS OF GASEOUS REACTIONS 9

Lindeman's theory – Hinshelwood, Kassel and Slater treatments, reaction rates in solution – effect of dielectric constant and ionic strength – kinetic isotope effect – linear free energy relationships – Hammett equation – Taft equation. Fast reaction kinetics: relaxation and flow methods. Diffusion controlled reactions.

MODULE III SURFACE CHEMISTRY 9

Adsorption, chemisorptions and physisorption- types surface reaction - various adsorption isotherms, Freundlich, Langmuir, Gibbs – determination of surface area – pore volume and pore size – thermodynamics of interfaces– heterogeneous catalysis– BET of multilayer adsorption.

MODULE IV ELECTROCHEMISTRY 9

Derivation of Nernst equation – problems redox systems – Chemical and concentration cells (with and without transference) – Liquid junction potential – derivation of the expression for LJP – its determination and elimination – Debye-Huckel theory, Applications of EMF measurements: Solubility product, determination of transport numbers and equilibrium constant measurements – electrolytic conductance – Kohlrausch's law and its applications – ionic equilibria – conductometric and potentiometric titrations- Butler-Volmer equation – Tafel equation. Fuel cells - Chemistry of fuel cells.

MODULE V CORROSION 9

Different types of corrosion: influence of environment – Nature of metal – over voltage, pH of the environment Pourbaix diagram – areas of anodic/cathodic – purity of metal – physical state of metals, corrosion rate measurements – Evans diagram - Stern Geary equation – mixed potential theory – prevention of corrosion – corrosion inhibitors – Electro and electroless plating.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Laidler K.J., Chemical Kinetics, Harper and Row, New Delhi, 1987.
2. Rajaram J. and Kuriacose J.C., Kinetics and Mechanism of Chemical Transformation, Mcmillan India Ltd., 1993.
3. Kuriacose J.C. and Rajaram J.,Thermodynamics for Students of Chemistry, 3rd Edition, Shoban Lal Nagin Chand and Co., 1999.
4. An Introduction to Electrochemistry by Samuel Glasstone,Affiliated East - WestPress Pvt Ltd, New Delhi.
5. Principles of colloid and surface chemistry Paul C. Hiemenz, Raj Rajagopalan,3rd edition, Marcel Dekker,1997.
6. Sears F.W. and Salinger G.L., Thermodynamics, Kinetic theory and Statistical Thermodynamics, 3rd Edition, Narosa Publishing House, New Delhi, 1998.
7. Billmeyer F.N., Text Book of Polymer Science, 3rd Edition, John Wiley and Sons, New York, 1994.
8. Young R.S., Introduction to Polymers, Chapman and Hall Ltd., London, 1981.
9. E. McCafferty, Introduction to corrosion science, Springer science and business media, 2010.

COURSE OUTCOMES:

The students will be able to

CO1: write rate equations for all types of reaction and vant Hoff's rule.

CO2: explain the concept of Lindeman's theory and effect of dielectric constant in ionic rate.

CO3: Freundlich, Langmuir, Gibbs adsorption isotherm and determination of surface area and pore volume and pore size of molecule.

CO4: Debye-Huckel theory, Applications of EMF measurements: Solubility product and Kohlrausch's law and its applications.

CO5: distinguish types of corrosion, identify factors influencing corrosion and suggest preventive methods.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H	M			L										
CO 2	H	M			L										
CO 3	H	M													
CO 4	H	M			L										
CO 5	H	M		M	L	M									

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 in electrochemistry and chemical kinetics provide a basic knowledge for quality teaching and learning.

CHE 6203	MULTISTEP SYNTHESIS AND	L	T	P	C
SDG: 3,9	CHARACTERIZATION OF	0	0	4	2
	ORGANIC COMPOUNDS				

COURSE OBJECTIVES:

To make the student conversant with

COB1: Identify organic compounds by TLC technique and purify them by column chromatography.

COB2: synthesis of organic transformations

PRACTICALS

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. Mass, IR and NMR instrumental techniques – demonstration
10. 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.

COURSE OUTCOMES:

The students will be able to

CO1: analyse the purity of 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): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	M	H	H	M	H	M									
CO 2	M	H	H	M	H	M									
CO 3	M	H	H	M	H	M									
CO 4	M	H	H	M	H	M									
CO 5															

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

SDG 3: Good health
SDG 9 : Industry and Innovation

Statement :
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.
SDG3: R&D labs in API labs in the production new drug candidates

CHE 6204	EXPERIMENTS ON KINETICS AND ELECTROCHEMICAL PARAMETERS	L	T	P	C
SDG: 3,9		0	0	4	2

COURSE OBJECTIVES:

To make the student conversant with

COB1: Determination of rate constantand 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 and electroless plating

List of Experiments

1. Determination of rate constant - zero order, first order and second order
2. Determination of order of the reaction
3. Verification of freundlich adsorption isotherm- Adsorption of acetic acid and oxalic acid on activated carbon
4. Empirical rate laws and temperature dependence; complex reactions; steady state approximation
5. Determine the specific rotation of camphor in benzene and carbon tetrachloride by polarimetry
6. Study the effect of addition of an electrolyte on solubility of an organic acid
7. Determination of pKa1 and pKa2 of a weak dibasic acid by Potentiometry
8. Determination of corrosion rate constant of iron in acid, neutral and alkali medium
9. Verification of Kohlrausch's law and its applications
10. Electroplating of copper, nickel and chromium
11. Electroless plating copper, nickel and chromium

P - 60; Total Hours –60

REFERENCES:

1. V.D. Athawale, Experimental Physical Chemistry, New Age International, 2007.
2. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand and Co.,

New Delhi, 2007.
3. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books Pvt. Ltd.,2005.
4. D.R. Satiya, Practical Chemistry, 2nd Edition, Allied Publishers, Madras, 1991.
5. 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 reaction
CO2: verify the Freundlich adsorption isotherm weak organic acids on activated carbon and verification empirical rate laws
CO3: determine the optical properties of the organic compounds
CO4: Determine the corrosion rate constant of metals in different medium and verify the Kohlrausch's law
CO5: Electroplating of metals and electroless plating

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022 **Academic Council:** 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	M	H	H	M	H	M									
CO 2	M	H	H	M	H	M									
CO 3	M	H	H	M	H	M									
CO 4	M	H	H	M	H	M									
CO 5															

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

SDG 3: Good health
SDG 9 : Industry and Innovation

Statement :

SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

SDG3: R&D labs in API labs in the production new drug candidates

CHE 6205	INORGANIC CHEMISTRY	L	T	P	C
SDG: 04	PRACTICAL - II	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 & Zn), bronze (Cu & Sn) and ferro nickel (Fe & 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 & 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):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	H	M	M	H	L	H									
CO 2	H	M	M	H	L	H									
CO 3	H	M	M	H	L	H									
CO 4	H	M	M	H	L	H									
CO 5	H	M	M	H	L	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.

SEMESTER III

CHE 7101	RETROSYNTHETIC ANALYSIS AND	L	T	P	C
SDG: 3,9	HETEROCYCLIC COMPOUNDS	3	0	0	3

COURSE OBJECTIVES:

The make the student with

COB1: the knowledge of organic and transition metals reagents for organic transformations

COB2: concepts for rational mechanism-based design of synthetic strategies in organic synthesis.

COB3: knowledge for designing new synthetic strategies for complex target organic molecules.

COB4: various methods to synthesis heterocyclic compounds

COB5: structure and synthesis of alkaloids and steroids

MODULE I REAGENTS IN ORGANIC SYNTHESIS 9

Synthesis and application of - Diborane, $LiAlH_4$, $NaBH_4$, DIBAH, Bu_3SnH, SeO_2, NBS, DCC, PCC, Swern, Dess Martin, DDQ, 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 II RETROSYNTHESIS-1 9

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 III RETROSYNTHESIS-2 9

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

MODULE IV HETEROCYCLES 9

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

MODULE V ALKALOIDS AND TERPENOIDS 9

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

REFERENCES:

1. Tse-Lok Ho, “Fiesers' Reagents for Organic Synthesis”, Wiley; 1st edition, India, **2013**. (ISBN-13 : 978-1118337523)
2. P.S. Kalsi., “Organic Synthesis Through Disconnection Approach”, Medtech, India, **2017**”, (ISBN-13:978-9385998461)
3. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, Organic Chemistry, 11th Edition, John Wiley and Sons, New York, 2013.
4. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2014.
5. Alan, R Katritzky, Advances in Heterocyclic Chemistry, Elsevier Acad. Press, 2009.
6. 6. T. L. Gilchrist, Heterocyclic chemistry, Pearson, 2009

COURSE OUTCOMES:

The students will be able to

CO1: identify various reagents for application in organic synthesis

CO2: correlate the fundamental and essential concepts towards synthesis of organic molecules.

CO3: predict competent synthetic strategies towards the design and synthesis of complex drug or drug like organic molecules

CO4: design synthetic methods to synthesize heterocyclic derivatives

CO5: predict the synthesis of alkaloids and terpenoids

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H	L	L		M	M									
CO 2	H	L	L		M	M									
CO 3	H	L	L		M	M									
CO 4	H	L	M	L	M	M									
CO 5	H	L	L	L	H	H									

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

SDG 3: Good health
SDG 9 : Industry and Innovation

Statement:
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.
SDG3: R&D labs in API labs in the production new drug candidates

CHE 7102	QUANTUM CHEMISTRY AND GROUP THEORY	L	T	P	C
SDG: 4		3	1	0	4

COURSE OBJECTIVES:

To make the student conversant with

COB1: understand the origin of classical mechanics and the background of quantum mechanics

COB2: apply Schrodinger wave equation to quantum mechanical systems

COB3: understand the quantum mechanical approach to atomic and molecular electronic structure

COB4: understand the importance of symmetry and its applications, able to assign the point group of molecules

COB5: apply symmetry elements and point groups concept to solve IR and electronic spectra

MODULE I INTRODUCTION TO QUANTUM CHEMISTRY 9

Review of essential mathematical concepts. General introduction to classical and quantum mechanics. Failure of classical mechanics: black body radiation, photo electric effect, hydrogen atomic spectrum and Compton effect. The need for quantum mechanics: principles and postulates. Operators and their properties. Eigen value – Eigen functions. Time dependent and time independent Schrodinger equation.

MODULE II QUANTUM MECHANICAL MODELS AND APPROXIMATE METHODS 9

Elementary applications of Schrodinger's equation: particle in a box (1D, 2D and 3D), the rigid rotor, the harmonic oscillators and the hydrogen atom. Approximate methods: The variation theorem, linear variation principle. Perturbation theory (introductory concept, degenerate and non-degenerate). Application of variation methods to the helium atom. Concept of Hartree Fock / SCF methods.

MODULE III MOLECULAR QUANTUM MECHANICS AND CHEMICAL BONDING 9

Born Oppenheimer approximation; VB and MO theory; Applications to $H2^+$ and H2 molecules. MO treatment of homo- and hetero nuclear diatomic molecules. Hukel molecular orbital theory and its application to ethylene, butadiene, benzene and cyclic systems.

MODULE IV GROUP THEORY-I 9

Symmetry elements and symmetry operations, types of groups- group postulates - classification of point groups- Schoenflies symbol –matrix representation of symmetry operations and point groups, representation of point group.-Group multiplication table for H_2O and NH_3. Assignments of point groups and geometry of various molecules.

MODULE V GROUP THEORY-II 7

The great orthogonal theorem, reducible and irreducible representations,– character table, construction of character table for C_{2v}, C_{2h} and C_{3v} point groups- Application of character table to molecular symmertry-symmetry adopted linear combinations (SALCs).

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

1. McQuarrie D.A., Quantum Chemistry, First Edition, University Science Books, Mill Valley, California, 2003.
2. Levine I.N., Quantum Chemistry, Fifth Edition, Pearson Education, 2000.
3. Prasad R. K., Quantum Chemistry, Fourth Edition, New Age International Publishers, 2008.
4. Chandra A. K., Introductory to Quantum Chemistry, Fourth Edition, Tata McGraw Hill Education Private Ltd.
5. C.L. Tien., J.H.Lienhard., Statistical thermodynamics, Revised Printing Edition, Hemisphere Publishing Corporation, Oxford.
6. N.M. Laurendeau, Statistical Thermodynamics, fundamentals and applications, 2005, Oxford University Press, Oxford.
7. Albert Cotton F., Chemical Applications of Group Theory, Third Edition, Wiley India Pvt Ltd.
8. P.K.Bhattacharya, Group theory and its Chemical Applications, 2nd Edn, Himalaya Publications, India.2012
9. A. Vincent., Molecular Symmetry and Group theory, A programmed introduction to chemical applications, 2nd Edition, Wiley, 2001.

COURSE OUTCOMES:

The students will be able to

CO1: understand the basic aspects of quantum chemistry of atoms and molecules

CO2: apply Schrodinger wave equation to quantum mechanical systems
CO3: apply quantum knowledge to atomic and molecular structure
CO4: assign the symmetry elements and point group of molecules /ion /complexes
CO5: articulate group theory to molecules and predict IR and electronic spectra

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H														
CO 2	H	M	M												
CO 3	H	H	M	H	M	M									
CO 4	H	H													
CO 5	H	H	H	H	M										

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

SDG 4: Quality Education

Statement: Foundation to work in theoretical chemistry and for teaching career.

CHE 7103	ORGANOMETALLIC CHEMISTRY	L	T	P	C
SDG: 09		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Structure and bonding of organometallic compounds

COB2: Structure and electron count of metal clusters

COB3: Reactions of organometallic compounds

COB4: Different types of bio-inorganic molecules

COB5: Crystal structure and properties of solids

MODULE I BASIC ORGANOMETALLIC CHEMISTRY 9

18-electron rule, concept of hapticity; synthesis, structure and bonding of homo and heteroleptic metal-carbonyls, nitrosyls, alkyls, alkenes, allyl, alkynes, and arenes. Synthesis and reactivity of Fischer and Schrock carbenes.

MODULE II METAL CLUSTERS 9

Infrared spectra of metal carbonyls and olefins. Neutral spectator ligands: phosphines and N-heterocyclic carbenes. 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 and Catalysis 9

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 BIO-INORGANIC CHEMISTRY 9

Metals and non-metals in biological systems - metal ion transport - oxygen carriers – haemoglobin, myoglobin - metallo-enzymes – carboxypeptidase-A, carbonic anhydrase, vitamin B_{12}, nitrogenase - electron transfer and redox systems - photosynthesis. 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 - Cd, Hg and Cr toxic effects with specific examples.

MODULE V STRUCTURE AND PROPERTIES OF SOLIDS 9

Crystalline and amorphous solids; crystal systems; types of close packing - hcp and ccp, packing efficiency, Radius ratio, structures of AX, AX_2, A_2X_3, ABX_3 and A_2BX_4 type solids – layer structure: cadmium iodide; covalent solids – diamond, graphite. Defects in solids – origin and types of defects, non-stoichiometry Electrical properties: Band theory of solids – metals, non-metals, semiconductors – Hall effect – insulators; dielectric, ferroelectric, pyroelectric and piezoelectric materials; superconductivity – theory – high TC materials. Magnetic properties: para, ferro and antiferromagnetic properties – magnetic ordered solids – soft and hard materials. Optical and thermal properties of solids.

L – 45; Total Hours –45

TEXT BOOKS:

1. BR Puri, LR Sharma and KC Kalia, Principles Of Inorganic Chemistry, Vishal Publishing Co, 33rd Edition, Delhi, 2019
2. Lee J.D., Concise Inorganic Chemistry, 5th Edition, Blackwell Science, 2003.

REFERENCES:

1. Cotton F.A., Wilkinson G. and Gaus P., Basic Inorganic Chemistry, 3rd Edition, John Wiley and Sons, 2003.
2. Shriver D.F., Atkins P.W. and Langford C.H., Inorganic Chemistry, 2nd Edition, Oxford University Press (ELBS), Oxford, 1994.
3. Huheey J.E., Keiter E.A. and Keiter R.L., Inorganic Chemistry, 4th Edition, Addison Wesley Publication, London, 1993.
4. Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorganic Chemistry, 6th Edition, John Wiley and Sons, New York, 2003.
5. Jolly W.L., Modern Inorganic Chemistry, 2nd Edition, McGraw-Hill, Inc., 1991.
6. Anil Elias, Basic Organometallic Chemistry, 2nd Edition, Universities Press, 2013.

COURSE OUTCOMES:

Students will be able to

CO1: Classify the variety of metal-carbon bonds involved in organometallic compounds.

CO2: Find the structure and stability of metal clusters.

CO3: Illustrate reactivity and stereochemistry of organometallic compounds.

CO4: Learn the importance of bioinorganic molecules in life

CO5: Find the physico chemical properties of crystalline solids

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	M	M	M	M	H	H									
CO 2	M	M	M	M	H	H									
CO 3	M	M	M	M	H	H									
CO 4	M	M	M	M	H	H									
CO 5	M	M	M	M	H	H									

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

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

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

CHE 7104	STRUCTURAL INTERPRETATION	L	T	P	C
SDG: 4, 9	OF MATERIALS	3	0	0	3

COURSE OBJECTIVES:

To use the concepts (basic and advanced level) of analytical methods for structure elucidation of materials and the students will be trained for the

COB1: Interpretation of electronic spectral data of materials

COB2: Interpretation of magnetic spectral data of materials

COB3: Interpretation of structural and morphological data of materials

COB4: Interpretation of thermoanalytical data of materials

COB5: Interpretation of electrochemical and XPS data of materials

MODULE I ELECTRONIC DATA 9

UV-visible, fluorescence and phosphorescence: Characteristic absorption of simple chromophoric groups, conjugated/ aromatic/ ligand systems, metal complexes and materials. FT-IR and Raman: Characteristic group frequencies of organic, inorganic molecules and various materials (polymer, nano, semiconducting) Interpretation of organic and inorganic and hybrid materials using combination of the spectral data.

MODULE II MAGNETIC AND MASS DATA 9

Solid-state nuclear magnetic resonance spectroscopy: Compounds containing ^{1}H, ^{13}C, ^{19}F,^{27}Al, ^{29}Si, and ^{31}P nuclei. Electron spin resonance (ESR): Simulation of ESR spectra of paramagnetic species, spin dynamics in solid and liquid. Mass spectrometry: The production and analysis of positive ions, molecular ions, application of isotopic abundance measurements, fragmentation modes and rearrangement of ions. Interpretation of organic, inorganic compounds and materials using combination of the spectral data.

MODULE III STRUCTURAL AND MORPHOLOGICAL DATA 9

Fundamental theoretical framework for diffraction (XRD) and imaging methods (SEM, TEM and AFM) used in structural and compositional characterization of materials in solid, film state etc.

MODULE IV THERMOANALYTICAL DATA AND SURFACE AREA 9

Interpretation of Differential Thermal Analysis (DTA), Thermo-gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC) data of various

materials including inorganic complex, organic polymeric materials, composite, nano-composites etc; Surface area analysis; isotherms, types, BET surface area, pore dimensions, pore volume, etc.

MODULE V ELECTROCHEMICAL AND XPS DATA 9

Cyclic voltammetry for oxidation and reduction potentials, TAFEL polarization and Impedance spectroscopy for corrosion inhibitor behavior, chronoamperometry for charge or discharge of battery. X-ray photoelectron spectroscopy: Study the chemical composition and oxidation state of elements at the surface and interface. Applications of XPS in various arenas.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. R. S. Drago, Physical Methods for Chemists, W. B. Saunders,1992.
2. R. M. Silverstein, C. G. Bassler and T. C. Morril, Spectrophotometric Identification of Organic Compounds, 5th edition, Wiley, 1991.
3. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 3rd edition, McGraw Hill, 1980.
4. W. Kemp, Organic Spectroscopy, ELBS, 1979.
5. W. L. Jolly, The synthesis and characterization of inorganic compounds, Prentice-Hall, 1970.
6. John Wertz, Electron Spin Resonance: Elementary Theory and Practical Applications, Springer Science & Business Media, 2012.
7. R. F. Speyer, Thermal Analysis of Materials, CRC Press, 1994.
8. P.J. Goodhew, J. Humphreys and R. Beanland, Electron Microscopy and Analysis, Taylor & Francis, 2001.
9. John F Watts, John Woistenhoime, An introduction to surface analysis by XPS and AES, John Wiley and Sons, 2nd edition, 2003.
10. James, B. Condon, Surface Area and Porosity Determinations by Physisorption Measurement and Theory, Elsevier, 1st edition, 2006.

COURSE OUTCOMES:

The students will be able to

CO1: Interpret electronic spectral data of materials

CO2: Interpret magnetic spectral data of materials

CO3: Interpret structural and morphological data of materials

CO4: Interpret thermo analytical data and porous nature of materials

CO5: Interpret electrochemical and XPS data of materials

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M		H	M	H									
CO2	H	M		H	M	L									
CO3	H	L		H	M	M									
CO4	H	L		H	M	H									
CO5	H	L		H	M	L									

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

SDG 4: Quality Education
SDG 9: Industry and Innovation

Statement:
SDG9: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.

PROFESSIONAL ELECTIVES

BASIC CHEMISTRY

CHEY 001	ANALYTICAL TECHNIQUES	L	T	P	C
SDG: 6, 7		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 9

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

Statistics for analytical experimentation: Probability, Regression analysis, Data analysis and signal enhancement.

MODULE II VOLUMETRIC METHODS OF ANALYSIS 9

Different methods of expressing concentration terms, Difference between titrimetic 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)

MODULE III ELECTROANALYTICAL METHODS 9

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

MODULE IV SPECTROPHOTOMETRIC TECHNIQUES 9

Quantitative applications of Colorimetric analysis – UV-Visible spectrophotometry – *Atomic absorption spectroscopy* (*AAS*) - atomic emission spectroscopy (AES), *Flame photometry*, ICP-AES - Fluorescence spectroscopy, Stern Volmer Equation and quantum yield calculation.

MODULE V CHROMATOGRAPHIC TECHNIQUES AND THERMAL METHODS 9

Chromatography**:** Paper, 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.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
6. 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):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M		M											
CO2	H	M		M											
CO3	H	M		M		H									
CO4	H	M		M	M	H									
CO5	H	M		M	M	H									

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

SDG 6: Clean Water & Sanitation
SDG 7: Affordable and Clean Energy

Statement: Through various analytical methods, innovative, cheap and affordable materials can be developed and can be employed in the area of clean water, sanitation and energy

CHEY 002	TRANSITION AND INNER TRANSITION	L	T	P	C
SDG:04	ELEMENTS CHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Geometry and isomerism of coordination compounds

COB2: Bonding and stabilization of coordination compounds

COB3: Spectra and magnetic properties of coordination compounds

COB4: Reactions of coordination compounds

COB5: Chemistry of lanthanides and actinides

MODULE I COORDINATION COMPOUNDS **9**

Transition metals and coordination compounds, Nomenclature; coordination geometry – three, four, five, six, seven and higher coordinate complexes; Isomerism – structural and stereoisomerisms; absolute configuration – ORD and CD spectra; stability of complexes – successive and overall formation constants – thermodynamic aspects. Measurement of successive and overall formation constants of complexes by polarography and potentiometry.

MODULE II THEORIES OF METAL LIGAND BOND **9**

Valence bond theory – hybridization; crystal field theory – crystal field splitting, crystal field stabilization energy – thermodynamic, structural, spectral and magnetic characteristics, John- Teller effect, ligand field theory; molecular orbital theory – pi bonding.

MODULE III SPECTRAL AND MAGNETIC PROPERTIES OF COORDINATION COMPOUNDS **9**

Spectral characteristics - Free ion terms, transformations in crystal field, energy diagrams in weak and strong field cases – Tanabe-Sugano diagrams, selection rules; magnetic properties – Van Vleck equation, magnetic susceptibility - Guoy and Faraday methods; IR and ESR spectra of transition metal compounds

MODULE IV REACTIONS OF COORDINATION COMPOUNDS **9**

Inert and labile complexes; substitution reactions in square-planar and octahedral complexes – factors affecting reactivities; electron transfer reactions- outer sphere and inner sphere mechanisms; photochemical

reactions of coordination compounds – substitution, red-ox and rearrangement reactions.

MODULE V INNER TRANSITION ELEMENTS 9

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

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. BR Puri, LR Sharma and KC Kalia, Principles Of Inorganic Chemistry, Vishal Publishing Co, 33rd Edition, Delhi, 2019
2. Lee J.D., Concise Inorganic Chemistry, 5th Edition, Blackwell Science, 2003.

REFERENCES:

1. Cotton F.A., Wilkinson G. and Gaus P.L., Basic Inorganic Chemistry, 3rd Edition, John Wiley and New York, 2003.
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. Huheey J.E., Keiter E.A. and Keiter R.L., Inorganic Chemistry, 4th Edition, Addision Wesley Publication, London, 1993.
4. Jolly W.L., Modern Inorganic Chemistry, 2nd Edition, McGraw – Hill, Inc., 1991.

COURSE OUTCOMES:

Students will be able to

CO1: Find the geometry and isomerism of coordination compounds

CO2: Demonstrate the valence band and molecular orbital approach for the stability of coordination compounds

CO3: Predict the spectral and magnetic 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): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	M	M	M	M	L	H									
CO 2	M	M	M	M	L	H									
CO 3	M	M	M	M	L	H									
CO 4	M	M	M	M	L	H									
CO 5	M	M	M	M	L	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: Understandings of transition and inner transition metal chemistry provide a strong base for the quality teaching and learning process.

CHEY 003	MOLECULAR SPECTROSCOPY	L	T	P	C
SDG: 6,7		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

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

COB3: basics and principles of spin resonance spectroscopy

COB4: basics and principles of mass spectrometry

COB5: selected spectroscopic techniques in material characterisation

MODULE I ROTATIONAL AND VIBRATIONAL SPECTROSCOPY 9 h

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 – Application in organic and inorganic compounds/complexes - Raman spectroscopy for diatomic molecules – mutual exclusion principle – Application in material science.

MODULE II ELECTRONIC SPECTROSCOPY 9 h

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 - Factors affecting absorbance in Electronic Spectroscopy – Woodward-Fischer rule and Fieser-Kuhn rule - Application in organic and inorganic compounds/complexes.

MODULE III SPIN RESONANCE SPECTROSCOPY 9 h

Nuclear magnetic resonance (NMR) spectroscopy – Principle - relaxation processes – chemical shift – shielding and deshielding - factors affecting chemical shift – anisotropy - hydrogen bond – coupling constant – Region of proton chemical shift in inorganic molecules - Shift reagents in NMR - ^{13}C NMR - chemical shift – Proton coupled and decoupled ^{13}C NMR - DEPT ^{13}C

NMR - Correlation spectroscopy: ^{1}H-^{1}H COSY, ^{1}H- ^{13}C COSY, NOE difference spectroscopy - ^{13}C, ^{19}F and ^{31}P NMR spectra of typical examples - Principle of solid state NMR (magic angle spinning (MAS NMR)).

Electron paramagnetic resonance (EPR) spectroscopy - nuclear hyperfine splitting - EPR spectra of anisotropic systems - anisotropy in g value, hyperfine splitting caused by quadrupole nuclei.

MODULE IV MASS SPECTROMETRY 9 h

Basic principles, ionization techniques, detectors and instrumentation - isotope abundance, molecular ion effect of isotopes – nitrogen rule – determination of molecular formula – fragmentations and rearrangements – metastable ions – fragmentation of organic inorganic/coordination and organometallic compounds.

MODULE V CHARACTERIZATION TECHNIQUES IN MATERIAL SCIENCE 9 h

Principle, instrumentation and applications of - NQR spectroscopy - Mossbauer spectroscopy - X-ray photoelectron spectroscopy - Auger electron spectroscopy - surface plasmon resonance - X-ray fluorescence spectroscopy – SEM – TEM – AFM - STM - X-ray crystallography.

L –45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Banwell C.N. and McCash E.M., Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw Hill, New Delhi, 1995.
2. Kemp W., Organic Spectroscopy, 3rd Edition, ELBS, McMillan, London, 1991.
3. Drago R., Physical Methods for Chemists, Saunders, Philadelphia, 1992.
4. Williams D.H. and Fleming I., Spectroscopic Methods in Organic Chemistry, 4th Edition, McGraw Hill, New York, 1989.
5. Pasto D., Johnson C. and Miller M., Experiments and Techniques in Organic Chemistry Prentice-Hall Inc., New Jersey, 1992.
6. Pavia D.L., Lampman G.M. and Kriz G.S., Introduction to Spectroscopy, 3rd Edition, Brooks/Cole Publication, Singapore, 2001.
7. 7. Robert M. Silverstein, Francis X. Webster, David Kiemle, Spectrometric Identification of Organic Compounds, 7th Edition, Wiley, 2005.

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 spectroscopy

CO3: identify the peaks in simple 1H & 13C NMR and interpret the results

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

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

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H	M		H	M	M									
CO 2	H	M		H	M	M									
CO 3	H	M		H	M	M									
CO 4	H	M		H	M	M									
CO 5	H	M		H	M	M									

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

SDG 6: Clean Water and Sanitation

SDG 7: Affordable & Clean Energy

Statement : Various spectroscopic techniques provides suitable materials to employ in the field of clean water, sanitation and energy and the products can also be analyses

CHEY 004	PHOTOPHYSICS AND	L	T	P	C
SDG: 7,9	PHOTOCHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic laws of photophysics and photochemistry.

COB2: principle and instrumentation of different types of spectrofluorimeter.

COB3: Basics of fluorescence spectroscopy

COB4: Different types of photochemical reactions

COB5: Applications of Photoscience.

MODULE I BASICS OF PHOTOPHYSICS AND PHOTOCHEMISTRY 9

Absorption laws – Basic laws – analysis of spectra – chromophore, auxochrome, blue and red shift, solvent effect and charge transfer spectra. Fundamentals of electronic transitions. Excited state energy relaxations – Jablonski diagram – Radiative and non-radiative transitions, Stokes Shift, Kasha's rule.

MODULE II INSTRUMENTATION TECHNIQUES AND PHOTOINDUCED TRANSITIONS 9

Spectrophotometer, light Sources, detectors-PMT, Diode-array. Spectrofluorimeter – Steady state and Time-resolved fluorimeter. Measurement of quantum yield – Triplet quantum yield and Time resolved absorption spectrum – Laser flash photolysis. Fluorescence standards – lifetime and decay. Pump probe and femtosecond measurements-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.

MODULE III FLUORESCENCE SPECTROSCOPY 9

Quenching of fluorescence, fluorescence lifetime, fluorescence quantum yield- method of determination, Rotation diffusion, Time resolved anisotropy, environmental influence on fluorescence properties and photo-bleaching. Solvent effect-Lippert equation, excited state acidity constants, Fluorescence analysis of excited state reactions. Ultrafast solvation dynamics.

MODULE IV PHOTOCHEMICAL REACTIONS 9

addition reactions - Paterno-Büchi Reaction, elimination reactions - Norrish type I and II reactions. Photoisomerisation, ene reaction. Pericyclic Reactions and Photochemistry: Electrocyclic, cycloaddition and sigmatropic reactions. Photochemistry of alkenes, arenes and carbonyl compounds. Photooxidation and photoreduction. Photochemistry involving molecular oxygen, generation and reactions of singlet oxygen. Photo-fragmentation reactions (Barton, Hofmann-Loffler-Freytag).

MODULE V APPLICATIONS – ENERGY, SENSORS AND BIOLOGY 9

Artificial Photosynthesis –Photovoltaic effect – Silicon solar cells - Organic Solar Cells – DSSC– Inorganic solar cell, QDSSCs, advanced Perovskite solar cells. Sensors – chemosensors – fluorimetric sensors – biosensors - Limit of detection. Aggregation induced emission – AIE nanodots – bioimaging. Photocatalysis – LEDs, OLEDs and WLEDs.

L – 45; TOTAL HOURS – 45

REFERENCES:

1.Fundamental of Photochemistry, K. K. Rohatgi-Mukherjee, New AgeInternational (P) Ltd., New Delhi, 1986.

2.Principles of Fluorescence Spectroscopy, 3rdEd., J. R. Lakowicz, Springer, NewYork, 2006.

3.Fundamentals of Photoinduced Electron Transfer, G. J. Kavarnos, VCHpublishers Inc., New York, 1993.

4.Molecular Fluorescence: Principles and Applications, B. Valeur, Wiley-VCHVerlag GmbH, Weinheim, 2002.

5.Modern Molecular Photochemistry of Organic Molecules, N. J. Turro, V.Ramamurthy, J. C. Scaiano, University Science, Books, CA, 2010.

6.Photochemical Synthesis, I. Ninomiya, T. Naito, Academic Press, New York,1989.

7.Journal of Molecular Liquids 181 (2013) 97–104.

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

CO3: describe the interaction of excited states with their surroundings and analyse photoinduced electron transfer and excitation energy transfer with quantitative models

CO4: describe the structure and function of photosynthetic reaction centres, and explain the function of photosynthetic antenna systems

CO5: apply the knowledge of photochemistry in various fields.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1		M													
CO 2	H			H	M	L									
CO 3			M		H										
CO 4	M														
CO 5				L	H	M									

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

SDG 7: Affordable & Clean Energy

SDG 9 : Industry and Innovation

Statement:

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

SDG3: R&D labs in API labs in the production new molecules for various applications

MEDICINAL, PHARMACEUTICAL & BIOLOGICAL CHEMISTRY

CHEY 005	BIO-ORGANIC CHEMISTRY	L	T	P	C
SDG: 3,9		3	0	0	3

COURSE OBJECTIVES:

The students will be conversant with

COB1: the carbohydrate based chemical reactions and functions in the body.

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

COB3: the different types enzyme and its properties

COB4: structures and functions of DNA and RNA

COB5: the working principles of separation techniques of biomolecules

MODULE I CARBOHYDRATES 9

Monosaccharides: configuration of tetrose, pentose and hexose – Fischer proof for glucose – ring structures and conformation, mutarotation, anomers – conformational analysis of aldohexopyranoses – amino sugars – disaccharides: structural elucidation of sucrose, cellobiose and melibiose – polysaccharides: methods for determining 1,2-, 1,4-, and 1,6- linkages in polysaccharides (Smith degradation) - end group analysis - structural elucidation of starch and cellulose

MODULE II PROTEINS 9

Amino acid: classification – synthesis of amino acid - peptides: synthesis of peptides – solid phase peptide synthesis – protecting group in peptide synthesis - proteins: classification – structure-factors influencing the stability of protein structure.

MODULE III ENZYMES 9

Enzymes: specificity of enzymes – general properties of enzymes – allosteric enzyme, zymogen, holoenzyme, apoenzyme, metalloenzyme – industrial applications of enzyme - competitive and non competitive inhibitors – suicide enzyme inactivators – modified enzymes: enzymes soluble in organic solvent, semisynthetic enzyme – co-enzyme chemistry: structure and biological activities of NAD+, FAD, ADP, and ATP.

MODULE IV NUCLEIC ACID 9

Structural elucidation of RNA and DNA - conformation of sugar-phosphate

backbone - hydrogen bonding by bases - the double helix; A, B, and Z double helices - stability of double Helix - DNA intercalators - chemical synthesis of DNA.

MODULE V SEPARATION OF BIOMOLECULES 9

Chromatography – column, affinity, ion-exchange - Centrifugation – Electrophoresis –paper, gel-agarose, SDSPAGE, Iso-Electric Focusing, 2D gel electrophoresis,

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 students will be able to

CO1: recognize and identify the different types of carbohydrate in nature.

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

CO3: correlate the properties and functions of enzymes with its structure

CO4: be skilled in structural elucidation and synthesis of DNA and RNA

CO5: apply the suitable techniques for the separation of biomolecules

Board of Studies (BoS):	**Academic Council:**
12th BoS of Chemistry held on 22.07.2022	19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	L		L	M	L									
CO2	H	L		L	M	L									
CO3	H	M			M	L									
CO4	M	L			M	L									
CO5	H	L			M	L									

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

SDG 3: Good health
SDG 9 : Industry and Innovation

Statement :
SDG3: R&D labs in API labs in the production new drug candidates
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

CHEY 006	CHEMISTRY OF HETEROCYCLIC	L	T	P	C
SDG: 3,9	COMPOUNDS AND NATURAL PRODUCTS	3	0	0	3

COURSE OBJECTIVES:

To make the conversant with

COB1: the structure and synthesis of various heterocyclic compounds

COB2: structural elucidation of alkaloids

COB3: different types of steroids and its structures

COB4: types and synthesis of terpenoids

COB5: structure and synthesis of vitamins

MODULE I HETEROCYCLES 9

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

MODULE II ALKALOIDS 9

Classification – General methods to determine the structure of alkaloids – structural elucidation of quinine, morphine, narcotine and reserpine.

MODULE III STEROIDS 9

Classification – structural elucidation of cholesterol and ergosterol – biosynthesis of cholesterol - structural elucidation of androsterone, testosterone, progesterone, oestrone - conversion of cholesterol into androsterone, progesterone, testosterone, 5α- and 5β-cholanic acid - conversion of oestrone to oestriol, oestradiol and *vice-versa* - structural elucidation of equilenin (synthesis not expected) - bile acids (general study) – conformational structure of cholestane and coprostane.

MODULE IV TERPENOIDS 9

Nomenclature – classification – isoprene rule - Structure and synthesis of terpenes –α-pinene, zingiberene, cadinene, α-santonin, abietic acid and squalene

MODULE V VITAMINS 9

Classification – Structure and chemical synthesis of vitamins – A, B_1, B_2, B_6, B_{12}, C, E and K

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. John A. Joule, Keith Mills, Heterocyclic Chemistry, 5th Edition, Wiley-blackwell, 2010

REFERENCES:

1. Alan, R Katritzky, Advances in Heterocyclic Chemistry, Elsevier Acad. Press, 2009.
2. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2012.
3. Khan, M.A., "Chemistry of Natural products", First Edition, Omega Publcations, New Delhi, 2011.
4. T. L. Gilchrist, Heterocyclic chemistry, Pearson, 2009
5. Purvesh Shah, Structure and synthesis of Vitamins, Grin Verlag, 2016.

COURSE OUTCOMES:

The students will be able to

CO1: design the synthesis of heterocyclic compounds

CO2: arrive at the structure of alkaloids by characterization techniques

CO3: elucidate the structure of steroids by chemical synthetic conversions

CO4: predict the synthesis of various terpenoids

CO5: analyse the structure of vitamins and its activities

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H			L	M										
CO2	M			L	M										
CO3	MM			L	M										
CO4	M			M											
CO5				L	M										

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

SDG 3: Good health and Well Being

SDG 9 : Industry and Innovation

Statement :

SDG3: R&D labs in API labs in the production new drug candidates

SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

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

COURSE OBJECTIVES:

The students are trained to

COB1: understand the mechanism of enzymes and coenzymes.

COB2: acquire knowledge on carbohydrate metabolism

COB3: understand the lipid metabolism and biological oxidation

COB4: understand the biosynthesis of amino acids and proteins

MODULE I ENZYMES AND COENZYMES 8

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 7

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 8

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 7

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.

PRACTICALS

1. Separation of amino acids by chromatography.

2. The separation of lipids by TLC.
3. Quantitative estimation of amino acids.
4. The determination of glucose by means of the enzyme glucose oxidase.
5. Enzymatic hydrolysis of glycogen by α and β-amylase.
6. Effects of temperature on the activity of α- amylase.
7. Estimation of cholesterol in Blood.
8. Estimation of Glucose in blood and urine.
9. Estimation of Urea in blood.
10. Estimation of ketone bodies in blood.
11. Qualitative analysis of inorganic as well as organic constituents of Urine.

L – 30 ; P – 30 ; TOTAL HOURS – 60

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. Stryer L., Biochemistry, W.H., Ninth edition, Freeman and Company, San Francisco, 2019.
4. Harpers Review of Biochemistry, Lange Medical Publication.
5. Plummer David J., An Introduction to Practical Biochemistry, McGraw Hill, New Delhi, 2017.
6. Singh S.P., Practical Manual to Biochemistry, CBS Publisher, New Delhi, 2005.

COURSE OUTCOMES:

The students 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

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	L	M	M									
CO 2	H	H	H	L	M	M									
CO 3	H	H	H			M									
CO 4	H	H	H	L	M	M									
CO 5															

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

SDG 3: Good health and Well Being
SDG 9 : Industry and Innovation

Statement :
SDG3: R&D labs in API labs in the production new drug candidates
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

CHEY 008	MEDICINAL AND PHARMACEUTICAL	L	T	P	C
SDG: 3,9	CHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

COB1: Understanding of the basic factors governing drug design

COB2: To learn the mode of drug action and synthesis of few analgesics, antihistamines and antimalarials.

COB3: To learn the role, synthesis and drug action of antibiotics.

COB4: To understand the synthesis and mode of action of anti-infectives and anti-viral drugs.

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

MODULE I INTRODUCTION TO DRUG DESIGN 9

Drug discovery and development - lead compounds - factors governing drug design – types of drugs – literature survey for preparation of drugs – spectral characterization of drugs

MODULE II ANALGESICS, ANTIHISTAMINES AND ANTIMALARIALS 9

Synthesis and drug action of: Analgesics – narcotic analgesics – morphine analogues – codeine – antipyretic analgesics –salicyclic acid analogues – and para-amino phenol derivatives – Antihistamines - promethazine, chlorpheneraminemaleate - Antimalarials - 8-amino quinolines and – chloroquine.

MODULE III ANTIBIOTICS 9

Synthesis and mode of action - pencillins, semisynthetic pencillin – chloramphenicol, streptomycin, tetracyclines, cephalosporins - norfloxacin, ciprofloxacin, clotrimazole,

MODULE IV ANTIHYPERTENSIVE, ANTI-INFECTIVES AND ANTIVIRALS 9

Synthesis and drug action - Antihypertensive drugs - methyldopa - antiseptics and disinfectants: benzalkonium chloride - anthelmintics: mebendazole - antivirals: amantadine, acyclovir.

MODULE V STEROIDAL AND NON-STEROIDAL ANTI- 9

INFLAMMATORY DRUGS

Introduction – classification – structure, partial synthesis and mechanism of action: Betamethasone, Cortisone, Hydrocortisone, Prednisolone, Progesterone, Testosterone, Oestradiol - NSAID - Indomethacin, Diclofenac, Phenylbutazone, Oxyphenbutazone, Ibuprofen.

L – 45 ; TOTAL HOURS – 45

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 students 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): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H				M	L									
CO2	M				L	L									
CO3	L				M	L									
CO4	M				L	L									
CO5	H				M	L									

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

SDG 3: Good health and Well Being
SDG 9 : Industry and Innovation

Statement :
SDG3: R&D labs in API labs in the production new drug candidates
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

CHEY 009	CHEMISTRY OF CARBOHYDRATES	L	T	P	C
SDG: 3,9		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: the basic concepts in carbohydrates

COB2: structural and spectroscopic analysis of sugars

COB3: various synthetic methodologies of carbohydrates

COB4: carbohydrates as chiral synthons

COB5: basics on glycans and glycoconjugates

MODULE I CLASSIFICATION OF SUGARS 9

Definition and classification of sugars, nomenclature, aldoses and ketoses, configuration of (+)- glucose: the Fischer proof, ring structures and conformation, mutarotation, anomeric effect - monosaccharides, oligosaccharides and polysaccharides - three-dimensional structure of macromolecular carbohydrates.

MODULE II STRUCTURAL AND SPECTROSCOPIC ANALYSIS OF CARBOHYDRATES 8

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

MODULE III CHEMICAL REACTIONS OF CARBOHYDRATES 9

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 rearrangement.

MODULE IV CARBOHYDRATES AS SYNTHONS 9

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

MODULE V GLYCANS AND GLYCOCONJUGATES 9

Carbohydrate biopolymers, animal glycoproteins, blood-group substances, plant and algal glycoproteins, proteoglycans and glycosaminoglycans,

glycolipids, biological functions of glycan chains in glycoconjugates, carbohydrates and carbohydrate components of nucleic acids and antibiotics.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Momcilo Miljkovic, Carbohydrates, springer, 2010.

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 students will be able to

CO1: describe the concepts in monosaccharides

CO2: identify various methods to elucidate the structure of monosaccharides

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): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M				L	L									
CO2	H				L	L									
CO3	M				L	L									
CO4	H				L	L									
CO5	H				L	H	M								

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

SDG 3: Good health and Well Being
SDG 9 : Industry and Innovation
Statement :
SDG3: R&D labs in API labs in the production new drug candidates
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

CHEY 010	ADVANCED CONCEPTS IN ORGANIC	L	T	P	C
SDG: 3,9	SYNTHESIS	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: different organometallic reactions in organic synthesis

COB2: various types of coupling reactions involving organometallic reagents

COB3: transition metal based chemical reactions

COB4: oxidation and reduction reactions in organic synthesis

COB5: few named uncommon organic reactions

MODULE I ORGANOMETALLIC REACTIONS 9

Organometallic reagents of Al, Cu, Ti, Zr, Cr, Zn, Cd, Hg and Ce metals. Nucleophilic addition to imines, imine derivatives and carboxylic acid derivates; Carbanions stabilized by N, B, S, Si and Se, containing groups; epoxidation; transition metal enolates, metalloenamines, asymmetric synthesis with enol ethers; Eschenmoser coupling reactions; Passserini and Ugi reaction

MODULE II COUPLING REACTIONS 9

Alkylation of enols, enolates; stabilized and non-stabilized carbanions; cyclization reactions; coupling reactions and rearrangements; additions to and substitution at carbon-carbon bonds; organocuprates and conjugate reactions; nucleophiles with cationic pentadienyl- metal complexes; organopalladium reagents; carbometallation

MODULE III TRANSITION METAL MEDIATED REACTIONS 9

Synthesis of sulphides, sulphoxides, phosphonium ylides and related compounds,; protecting groups; reductive elimination; vicinal deoxygenation and vicinal desilylation, Ene reactions; photoisomerisation, transition metal mediated cycloadditions; charge-transfer accelerated cyclization

MODULE IV OXIDATION AND REDUCTION REACTIONS 9

Oxidation by remote functionalisation, epoxidation and asymmetric epoxidation; glycol formation; electrochemical oxidation; oxidative rearrangements; solid-support oxidants and electron transfer reactions.

Reduction by metal hydrides; asymmetric hydrogenation; enzymatic reduction; hydrozirconation, hydroboration, hydroalumination and hydrosilylation reaction

MODULE V NAMED REACTIONS **9**

Birch-Pearson, Dotz, Heck-Stille, Buchwald, Jacobsens, Hegedus, Mcmurray, Noyori, Pauson-Khand, Sharpless, Tebbe-Grubbs, Ritter type reaction, Nef reaction, Vollhardt reactions; Diels-Alder reactions and Nazarov cationic cyclization.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Ghosh and Balakrishna, “Introduction to Organometallic Chemistry”, 2022, ebook: can be obtained from: https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book%3A_Introduction_to_Organometallic_Chemistry_(Ghosh_and_Balakrishna).

REFERENCES:

1. B.M. Trost (ed.) Comprehensive Organic Synthesis: Selectivity, Strategy and Efficiency in Modern Organic Chemistry, Pergamon Press, Oxford, Vols 1-9, 1991.
2. E.J. Corey and X..-M.Cheng, The Logic of Chemical Synthesis, Wiley, New York, 1989.
3. J.D. Morrison (Series Ed.) Asymmetric Synthesis Academic Press, New York.
4. J.P. Collman, L.S. Hegedus, J.R. Norton and R.G. Finke, Principles and Applications of Organotransition Metal Chemistry. University Science Books, Mill Valley, California, 1987.

COURSE OUTCOMES:

The students will be able to

CO1: gain understanding on the various metals in organic reactions

CO2: depict the mechanism of organometallic reactions.

CO3: illustrate organic chemical reactions using transition metals.

CO4: understand the metal mediated oxidation and reduction of organic compounds

CO5: recognise the organometallic based named reactions.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H		L		M	L									
CO2	H				M										
CO3	H			L	M	L									
CO4	H		L		M										
CO5	H				M	L									

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

SDG 3: Good health and Well Being
SDG 9 : Industry and Innovation

Statement:
SDG3: R&D labs in API labs in the production new drug candidates
SDG9: Foundation to work in R&D of pharmaceutical industry and for teaching career.

CHEY 011	PHARMACEUTICAL TECHNOLOGY	L	T	P	C
SDG: 4, 9		3	0	0	3

COURSE OBJECTIVES:

To gather the knowledge on fundamental concept, preparation and evaluation of conventional pharmaceutical dosage forms

COB1: Explain the pre formulation studies.

COB2: Describe the additives used in formulations.

COB3: Outline the formulation strategies of dosage forms.

COB4: Identify the quality checks and packaging materials of dosage forms.

COB5: Summarize the aseptic condition and sterile manufacturing.

MODULE I **9**

PRE-FORMULATION STUDIES

Study of physical properties of drug like physical form, particle size, shape, density, wetting, dielectric constant, solubility, dissolution and organoleptic properties and their effect on formulation, stability and bioavailability – Drug delivery types and methods including nano-delivery system.

MODULE II **9**

LIQUID DOSAGE FORMS: Introduction, types of additives used in formulations, vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavours and others, manufacturing packaging and evaluation of clear liquids, suspensions and emulsions.

SEMISOLID DOSAGE FORMS: Definitions, types, mechanisms of drug penetration, factors influencing penetration, semisolid bases and their selection, general formulation of semisolids, clear gels and manufacturing procedure, evaluation and packaging.

MODULE III **9**

SUPPOSITORIES: Ideal requirements, suppository bases, manufacturing procedure, packaging and evaluation, Pharmaceutical applications.

Aerosols: Definition, propellants, general formulation, manufacturing and packaging methods, quality control of aerosols, pharmaceutical applications.

MODULE IV **9**

Parenteral Products:

a. Definition, types, advantages and limitations. Essential requirements,

vehicles, additives, importance of isotonicity

b. Production facilities and controls, aseptic processing
c. Formulation of injections, sterile powders, large volume parenterals and lyophilized products.
d. Containers and closures selection, filling and sealing of ampoules, vials and infusion fluids. Quality control tests of parenteral products.

Ophthalmic Preparations: Introduction, formulation considerations; formulation of eye drops, eye ointments and eye lotions; methods of preparation; labeling, containers; evaluation of ophthalmic preparations

MODULE V Laboratory Analysis/Exercises 9

1) Preformulation studies: Solubility, dissolution and stability studies.
2) Prepararion and evaluation of liquids: Syrup, suspension and emulsion.
3) Prepararion and evaluation of semisolids: Ointments, creams, pastes, gels.
4) Preparation and evaluation of sterile products: Small and large volume parenterals.

Prepararion and evaluation of ophthalmic products: Eye drops, eye lotion.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Remington's Pharmaceutical Sciences, Volume I and Volume II, Mack Publishing Co., USA.
2. Cooper J.W., and Gunn G., Tutorial Pharmacy, Petman Books Ltd., London.
3. Lachman L., Lieberman H.A, Kanig J.L, Theory and Practice of Industrial Pharmacy, Lea and Febiger, Philadelphia, USA.
4. Ansel H.C., Introduction to Pharmaceutical Dosage Forms, Lea and Febiger, Philadelphia, USA.
5. R.L. Juliano, Drug Delivery Systems, Oxford University Press, Oxford.
6. Pharmaceutical dosage form - Parenteral medication vol- 1&2 by Liberman & Lachman
7. Drug stability - Principles and practice by Cartensen & C.J. Rhodes, 3rd Edition, Marcel Dekker Series, Vol 107.

COURSE OUTCOMES:

Upon the completion of the course the students can able to

CO1: Explain the pre formulation studies.
CO2: Describe the additives used in formulations.
CO3: Outline the formulation strategies of dosage forms.
CO4: Identify the quality checks and packaging materials of dosage forms.
CO5: Summarize the aseptic condition and sterile manufacturing.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	H	M	L	H	M	H									
CO 2	H	M	M	H	M	M									
CO 3	H	L	L	H	M	M									
CO 4	H	L	M	H	M	H									
CO 5	H	L	M	H	M	H									

Note: L- Low Correlation M - Medium Correlation H - 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 R&D laboratory, chemical industry, independent researcher and for teaching career.

CHEY 012 ELEMENTAL FORENSIC CHEMISTRY L T P C
SDG: 4, 9 3 0 0 3

COURSE OBJECTIVES:

To gather the knowledge on sample collection, preparation and analysis of forensic evidences

COB1: Describe the history of forensic science and structure of forensic laboratory in India.

COB2: Interpret the principles of chemistry into analytical methods to solve the forensic problems.

COB3: State about elements of forensic science and Pharmacology principles.

COB4: Explain the analytical methodologies of various physical evidences.

COB5: Summarize the evidence analysis of drugs and explosives.

MODULE I INTRODUCTION TO FORENSIC SCIENCE 9

Definition, Principles and Significance of Forensic science, History and worldwide developments of forensics and in India, Structure of a forensic laboratory – divisions and units of forensic laboratories in India; Introducing Ethics in forensics - professional ethics to science practitioners, code of conduct and code of ethics for Forensic Science, Application of codes and ethics.

MODULE II INCLUSION OF CHEMISTRY INTO FORENSICS 9

Principle, Methods and Instrumentation of chemistry into forensic problems, prevalent chemical methods and analytics involved in evidence analysis, Setting up the stage – Statistics, Qualitative and Quantitative analysis of sample and data, Calibration of data and Quality Assurance.

MODULE III ELEMENTS OF FORENSIC CHEMISTRY 9

Sample preparation, sample separation (centrifugation), chromatography methods for analysis, Instrumentation and microscopic methods.

Drug analysis and Toxicology: - Drugs – acidic and basic and drugs – analysis and Pharmacology.

MODULE IV CHEMICAL ANALYSIS OF PHYSICAL EVIDENCE 9

Chemistry of combustion – residue and sample with explosives, arson and gunshot leftovers – sample collection and analysis.

Chemistry of colour in inks and paints – in crime scene sample – analysis. Chemistry of polymers – fibres, plastics, adhesives, paper and rubber – sample preparation and analysis.

MODULE V LABORATORY ANALYSIS/EXERCISES 9

Essentials of forensic chemistry:

1. Thin layer and column chromatography
2. Spectroscopic techniques (UV-Spectroscopy, FTIR)
3. Drug analysis and Toxicology:
4. Qualitative spot tests for drug analysis, narcotics.
5. Acid/base separation from a drug mixture.
6. Elemental analysis and confirmatory tests for identification of drug sample.
7. Detection of explosives and others:
8. Arson detection by GC analysis.
9. Identifying explosives and metals in residues.
10. Examination of textile fibres and other polymers in sample.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Saferstien: Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA
2. Yinon Jitrin (1993) Modern Methods & Application in Analysis of Explosives, John Wiley & Sons ,England.
3. Mathew E. Johll (2009) Investigating Chemistry: A Forensic Science Perspective.
4. J A Siegel, P.J Saukko (2000) Encyclopedia of Forensic Sciences Vol. I, II and III, Acad. Press.
5. Curry (1986) Analytical Methods in Human Toxicology, Part II.
6. Valerio Causin (2015). Polymers on the Crime Scene: Forensic Analysis of Polymeric Trace Evidence. Springer Cham, Switzerland.

COURSE OUTCOMES:

Upon the completion of the course the students can able to

CO1: Recall about various divisions of forensic laboratory and their functions.

CO2: Classify the prevalent methods involved in the evidence analysis.

CO3: Apply the sample preparation and analytical technique to investigate the toxic samples.

CO4: Demonstrate the appropriate methods to study various crime scene evidences.
CO5: Reproduce the examination of various evidences related to drugs and explosives.

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	H	M	L	H	M	H									
CO 2	H	M	M	H	M	M									
CO 3	H	L	L	H	M	M									
CO 4	H	L	M	H	M	H									
CO 5	H	L	M	H	M	H									

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

SDG 4: Quality Education
SDG 9: Industry and Innovation

Statement:
SDG9: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.

MATERIALS AND TECHNOLOGY

CHEY 013	NANOTECHNOLOGY AND CATALYSIS	L	T	P	C
SDG: 6,7,9,15		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 including various techniques for the processing of nanomaterials

COB2: various techniques available for the characterization of nanostructured materials

COB3: applications in selected fields and impacts of nanotechnology in ecosystem

COB4: Impart the basic concepts involved in catalytic processes.

COB5: Understand the importance of heterogeneous catalysis.

MODULE I INTRODUCTION AND PREPARATION OF NANOMATERIALS **9**

Introduction to nanomaterials, Properties of nanomaterials, Nanostructures: Zero-, One-, Two- and Three-dimensional structures, Surface Plasmon Resonance, Change of bandgap; Methods of preparation of nanomaterials, top-down approach and bottom-up: Chemical precipitation and coprecipitation; Sol-gel synthesis; Ball milling synthesis; lithography, Plasma Laser deposition (PLD) techniques, Thermolysis routes (Solvothermal, Hydrothermal and pyrolysis), Microwave assisted synthesis; Sonochemical synthesis; Electrochemical synthesis.

MODULE II CHARACTERIZATION TECHNIQUES **9**

Structural Characterization: X-ray diffraction, Scanning Electron Microscopy (SEM/HR-SEM/FE-SEM) with EDS, TEM (HR-TEM) and SAED analysis, Atomic force Microscopy (AFM). X-ray Photoelectron spectroscopy (XPS), Raman analysis. Introduction to advanced Scanning Probe Microscopy Techniques Scanning Tunnelling Mode (STM), Piezoelectric force microscopy (PFM). DLS and zeta potential analysis. BET surface area analysis, CHNSO micro analysis.

MODULE III APPLICATIONS AND ENVIRONMENTAL IMPACTS 9

Current applications - Short-term Applications - Long - term Applications – Energy filed - solar cells, military battle suits. Biomedical applications – Photodynamic therapy in targeted drugs - quantum dot technology in cancer treatment, MRI applications. Nanosensors: pH, heat, humidity, gas, toxic chemicals sensors and sensors for aerospace and defence – biosensors – water remediation - Environmental Impacts: toxicological health effects, relevant parameters in nanoparticles toxicology, integrated concept of risk assessment of nanoparticles.

MODULE IV CONCEPTS OF CATALYSIS 9

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 - Catalyst deactivation and regeneration, TOF, TON.

MODULE V HETEROGENEOUS CATALYSTS 9

Metals, metal oxides, mixed metal oxides, supported metals, spinels, perovskites, super acids, hydrotalcites, zeolites and zeotypes (small, medium, large), shape selective catalysts, mesoporous materials (SBA, MCM, KIT, AlPOs, MOFs, COFs) Hydrothermal synthesis, sol-gel process, impregnation method, ion-exchange method - Operations in catalyst manufacture - drying, calcination, spray drying, Reactors- fixed bed and flow reactors.

L – 45; TOTAL HOURS – 45

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 & 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

COURSE OUTCOMES:

The students will be able to

CO1: differentiate the nanomaterials based on their dimensions and acquire knowledge of various synthetic methods

CO2: understand the components of instrumental techniques of and characterization techniques for structural and properties of nanomaterials

CO3: select the appropriate nanomaterials for specific applications in the interested arena

CO4: Find the fundamentals of catalysis

CO5: Evaluate significance of heterogeneous catalysts.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1		L		M	H	H									
CO 2	M			H	M	H									
CO 3					H	M									
CO 4															
CO 5															

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

SDG 6: Clean Water and Sanitation

SDG 7: Affordable & Clean Energy

SDG 9 : Industry and Innovation

SDG 15 : Life on Land

Statement:

SDG 6, 7 & 9: Foundation to work in R&D of renewable energy and sensors sector and for teaching career.

SDG 15: R&D labs in API labs in the production novel materials for various applications

CHEY 014	PROTECTIVE COATINGS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

This course will enable students to learn about:

COB1: organic and inorganic coatings to protect the surface.

COB2: Electroplating

COB3: Evaluation of paints

COB4: Special paints

COB5: Inorganic coating materials

MODULE I PIGMENTS AND RESINS 9

Pigments and additives used in paints - properties and functions - Inorganic, organic and metallic pigments - effect of pigment volume concentration on paint properties-Extenders - Driers. Natural resins - chemistry and properties - shellac Rosin, rubber oils used for surface coatings - preparation and properties of synthetic resins - alkyds - phenolic - vinyls - amino resins - acrylics - epoxies - urethanes - silicones. Formulation of paints and rheological characteristics - Importance of pigment volume concentration, volume solids etc., water based paints, composition and properties - factors affecting water solubility.

MODULE II ELECTROPLATING 9

Surface preparation for paint applications, methods of surface preparation - methods of application of paints brushing - roller coating - compressed air spraying - airless spraying - electrostatic spraying - Electrodeposition of Paints and Electropolymerization Electrokinetic phenomena involved in electrodeposition fundamental principle, formulation of bath - anodic and cathodic deposition - advantages over conventional methods.

MODULE III TESTING AND EVALUATION OF PAINTS 9

Testing and evaluation of liquid paints and coatings - specific gravity - viscosity - time of grind - thickness - hardness, abrasion - flexibility - electrochemical and accelerated tests - field exposure tests - paint film defects - identification and remedial measures.

MODULE IV PAINTS FOR FUNCTIONAL APPLICATIONS 9

Paints for automobiles - aircrafts - marine paints (ships) chemical resistant

coatings - Paints for pipe line, paints for various substrates other than metals - paints for concrete - wood - plastic - powder coatings - basic and application principle.

MODULE V INORGANIC COATINGS 9

Conversion coatings – Oxide, phosphate and chromate coating of ferrous and non-ferrous metals – anodizing-Cementation: Sherardizing, calorizing and chromizing-Metal cladding-ceramic coatings- Electrodeposition coatings, UV curable coatings, Coatings for high temperature.

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. John Williams, Organic Coating Technology Payne, Volume I and II, Henry Fleming Sons Inc., New York London, 1961.
2. Gosta Wranglen, An Introduction to Corrosion and Protection Of Metals, Institute for Metals Kgdd, Stockholm, 1972.
3. Charles G. Munger, Corrosion Prevention by Organic Coating, NACE 1984.
4. H.W. Chatfield, (Editor)s, The Science of Surface Coating, Published: Ernest Benn Limited London, 1962.
5. Willibald Machu, Hand Book of Electropainting Technology, Electrochemical Publication Limited 1978.

COURSE OUTCOMES:

The students will be familiar with the

CO1: Surface preparation methods

CO2: Different types of paints, their constituents and fictions

CO3: Testing and evaluation of paints

CO4: Constituents and functions of paints

CO5: Inorganic coating methods

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO2	PSO3
CO1					L										
CO2															
CO3		H						M							
CO4															
CO5										H					

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

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

The holistic understanding of coating materials and components leads to construction of resilient infrastructure and sustainable industrialization.

CHEY 015	CORROSION AND CORROSION	L	T	P	C
SDG: 9	CONTROL	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with the:

COB1: Causes and theories of corrosion.

COB2: Different types of corrosion.

COB3: Basic concepts to prevent corrosion and testing of corrosion by variousdiagrams.

COB4: Factors influencing corrosion.

COB5: Control of corrosion using various methods.

MODULE I CORROSION 9

Causes and effects of corrosion — theories of corrosion — Dry corrosion - oxidation — direct atmospheric effect – Hydrogen corrosion, liquid metal corrosion and corrosion by other gases-electrochemical corrosion – hydrogen evolution – presence and absence of oxygen – corrosion by gaseous reduction.

MODULE II FORMS OF CORROSION 9

Eight forms of corrosion- Galvanic bimetallic corrosion – differential aeration corrosion – concentration cell corrosion – erosion corrosion – pitting corrosion – underground soil corrosion – intergranular corrosion – stress corrosion: Types - seasonal cracking of alloys and caustic embrittlement – corrosion fatigue.

MODULE III CORROSION TESTING 9

Rate of corrosion – calculation of ΔG and other related thermodynamic parameters — potential measurement — electrochemical series — redox reactions — EMF measurement and corrosion current – anodic and cathodic behaviour of metals –passivity – testing of virgin metals – alloy – Pourbaix and Evans diagrams.

MODULE IV 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- ions – formations of cells – polarization of

electrodes.

MODULE V 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.

L – ; 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, McGraw Hill BookCompany, New York, 1984.
2. J.H. Brophy, R.M. Rose and J. Walf, The Structure and Properties of Materials, Wiley Inter Science Inc., New York, 1984.
3. B.T. Kelly, Irradiation Diamagneto Solids, Pergamon Press, New York, 1992.
4. D.R. Cross, Principles and Applications of Electrochemistry, Chapman andHall, UK, 1988.

COURSE OUTCOMES:

Students will become familiar with the

CO1: basic concepts of corrosion

CO2: Different types of corrosion and their mechanism of corrosion

CO3: Testing and evaluation of corrosion

CO4: Factors which influence the corrosion

CO5: Control of corrosion in real situation.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					L										
CO2															
CO3		H						M							
CO4															
CO5										H					

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

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

The holistic understanding of corrosion and its prevention leads to construction of resilient infrastructure and sustainable industrialization.

CHEY 016	POLYMER TECHNOLOGY	L	T	P	C
SDG: 4, 9		3	0	0	3

COURSE OBJECTIVES:

The students will be trained on the

COB1: Classification of polymeric materials

COB2: process of elastomers

COB3: different types of moulding

COB4: characterization of polymers

COB5: effect of structure on polymer properties

MODULE I POLYMERIC MATERIALS 9

Introduction – classification – thermoplastics – cellulose derivatives – LDPE, HDPE,PVC, PMMA, PTFE, PET and Nylons – thermosetting resins – phenolic resins, epoxy resins, silicones and polyurethanes – polymer blends and alloys – reinforcedplastics. Fluoropolymers, telomere

MODULE II ELASTOMERS 9

Natural rubber – processing – vulcanization – synthetic rubber – SBR, neoprene, butyl and thiocol rubbers – thermoplastic elastomers – high performance polymers – polythers – PEEK, polysulphones and polyimides.

MODULE III MOULDING TECHNIQUES 9

Moulding constituents – functions – moulding techniques – compression – injection – extrusion – blow moulding – thermoforming – Vacuum forming – pultrusion –casting – calendaring – RIM – lamination.

MODULE IV CHARACTERIZATION AND TESTING 9

Characterisation of polymers by IR and NMR — Thermal properties by TGA and DSC — Testing tensile strength, Izod impact, Compressive strength, Rockwell hardness, Vicot softening point — Test for electrical resistance, dielectric constant, dissipation factor, arc resistance and dielectric strength – water absorption.

MODULE V POLYMER PROPERTIES 9

Effect of structure on mechanical- comparison of PE, PVC , PVA and PS chemical – solubility in polar and non polar solvents, thermal-oxidation and

hydrolysis, electrical –electrical stress, dielectric behavior and optical properties-dielectric constant, refractive index.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapmanand Hall, New York, 1991.
2. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science andEngineering, John Wiley and Sons, New York, 1998.
3. Iyson R.W., Specialty Polymers, Blackie Academic and Professional, London,1992.
4. Maurice Morton, Rubber Technology, van Nostrand, Reinhold, New York,1987.

COURSE OUTCOMES:

The students will be able to

CO1: classify the polymeric materials.

CO2: the processing the natural and synthetic elastomers

CO3: infer the different types of moulding

CO4: characterize the polymers by thermal techniques

CO5: assess the effect of structure on polymer properties

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	H	L	L	H	M	H									
CO 2	H	M	M	H	M	H									
CO 3	H	L	L	H	H	M									
CO 4	H	L	L	H	M	H									
CO 5	H	L	L	H	H	H									

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

SDG No. & Short Description
SDG 4: Quality Education
SDG 9: Industry and Innovation

Statement:
SDG9: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.

CHEY 017	POLYMER STRUCTURE AND	L	T	P	C
SDG: 9	PROPERTY 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.

MODULE I STRUCTURE OF POLYMERS AND BLENDS 9

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.

MODULE II MECHANICAL PROPERTIES 9

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.

MODULE III THERMODYNAMIC AND TRANSITION PROPERTIES 9

Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between -transitions, upper and lower glass□Tg and Tm - other transitions like 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.

MODULE IV ELECTRICAL AND OPTICAL PROPERTIES 9

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.

MODULE V CHEMICAL PROPERTIES AND DIELECTRIC BEHAVIOUR 9

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): **Academic Council:**

12th BoS of Chemistry held on 22.07.2022 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1				H	L	M									
CO 2	H				M										
CO 3	H	M		M											
CO 4	H				M										
CO 5	H			M		H									

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

SDG 9 : Industry, Innovation and Infrastructure

Statement:

SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

CHEY 018	ELECTROCHEMICAL ENERGY	L	T	P	C
SDG: 9	CONVERSION AND STORAGE	3	0	0	3

COURSE OBJECTIVES:

This course will enable students to:

COB1: Fundamentals of electrochemistry

COB2: Factor affecting of battery performances

COB3: Selection of battery and battery applications

COB4: Tests and evaluations of batteries

COB5: Fuel cells and supercapacitors

MODULE I FUNDAMENTALS 9

EMF, Reversible cells, Reversible electrodes, relationship between electrical energy and energy content of a cell, force energy changes and EMF in cells, effect of sulphuric acid concentration on EMF in the lead acid battery, effect of cell temperature in lead acid battery, derivation of number of electrons involved in a cell reactions, calculation of the capacity of a battery, calculations of energy density of cells, heating effects in batteries, spontaneous reaction in electrochemical cells, pressure development
in sealed batteries.

MODULE II FACTORS AFFECTING BATTERY PERFORMANCE 9

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 ageand storage condition, effect of battery design.

MODULE III SELECTION AND APPLICATION OF BATTERIES 9

Major consideration in selecting a battery, battery applications, comparative features and performance characteristics, characteristics of batteries for portable equipment, cost effectiveness, other comparison of performance criteria for battery selection D probable equipment. Types of lead acid battery, double layer theory.

MODULE IV TESTING AND EVALUATION 9

Evaluation of active masses, Porosity - mercury porosity meter, liquid absorption method, Surface area measurement - BET method (nitrogen absorption), internal resistance of cells - D.C. methods, polarization elimination method, A.C. impedance method, testing of storage batteries - capacity test for retention of charge, vibration test, life test, efficiency test, leakage test for sealed cells, testing of separators,

HRD at normal and low temperature.

MODULE V FUEL CELLS AND SUPER CAPACITOR 9

Introduction, Types of Fuel cells, figure of merit, electro catalysts for hydrogen oxidation and oxygen reduction, electrochemical double layer capacitors, ruthenium oxide as capacitor electrode, manual capacitors with proton conducting solid polymer electrolytes.

L – ; TOTAL HOURS –45

REFERENCES:

1. Barak, Electrochemical Power sources, IEEE Series, Peter Peregrinus Ltd., Steverage, UK1980, 1997.
2. N. Corey Cahoon and George W. Heise, Primary Battery (Volume I and II), John Wiley NewYork, 1971 and 1976 London.
3. Linden D. Hand Book on Batteries and Fuel Cell, McGraw Hill Book Co., New York 1955.
4. J.P. Gabano, Lithium Batteries, Academic Press, London, 1983
5. T.R. Crompton, Batteries Reference Book, Batterworths, London.
6. G.W. Vinal, Storage Batteries, John Wiley, New York 1955.

COURSE OUTCOMES:

Students will be able to describe

CO1: Basics of electrochemistry and battery

CO2: Factor affecting the battery capacity and other parameters

CO3: battery applications and selection of batteries

CO4: Evaluation of battery active masses, porosities etc.,

CO5: Fuel cells and super capacitors basics and applications

Board of Studies (BoS):	**Academic Council:**
12th BoS of Chemistry held on 22.07.2022	19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					L										
CO2															
CO3		H						M							
CO4															
CO5										H					

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

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

The holistic understanding of coating materials and components leads to construction of resilient infrastructure and sustainable industrialization.

CHEY 019	INDUSTRIAL ELECTROCHEMISTRY	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

This course will enable students to:

COB1: General concepts of brine eletrolysis

COB2: electrometallurgy

COB3: metal coatings

COB4: electrosynthesis

COB5: industrial electrochemical process

MODULE I CHLORALKALI INDUSTRY 9

General concepts of brine electrolysis – modern technological developments – chlorine cell technologies – mercury and diaphragm cell – membrane – cell.

MODULE II ELECTROMETALLURGY 9

Metal extraction and refining – electrowinning – aluminium extraction – manufacture of sodium, lithium and magnesium – hydrometallurgical processes – electrorefining – aqueous and moltensalt electrorefining.

MODULE III METAL FINISHING 9

Pretreatment – conversion coatings – phosphating – types, methods, properties and influencing factors – evaluation and testing – applications – anodizing – principle and applications - electroplating – objectives, theory and method – electroplating of nickel – electroless plating – galvanizing – tinning.

MODULE IV ELECTROSYNTHESIS 9

Electrolytic preparation of inorganic compounds – fluorine – peracids and their salts – $KMnO_4$ – $K_2Cr_2O_7$ - Organic electrosynthesis – hydromerisation of acrylonitrile – Monsanto process – manufacture of ethylene glycol – electrolysis of organic compounds with the use of ion – exchange membranes.

MODULE V INDUSTRIAL ELECTROCHEMICAL PROCESSES 9

Water treatment and environmental protection – metal ion removal and metal recovery – electro-filtration of particulates from gases – electrodialysis

– desalination – electroflotation.

L –45 ; TOTAL HOURS –45

REFERENCES:

1. P.H. Rieger, Electrochemistry, Prentice Hall, Inc., New York, 1987.
2. D. Fletcher, Industrial Electrochemistry, Chapman and Hall, London, 1982.
3. J. Bockris and A.K.M. Reddy, Modern Electrochemistry, Volume II, Mac Donold, London,1970.
4. C. Rajagopal and K. Vasu, Conversion Coatings, 1st Edition, Tata McGraw Hill, New Delhi,2000.

COURSE OUTCOMES:

Students will be able to describe

CO1: chloralkali industry and basic concepts of brine electrolysis

CO2: metal extraction and refining

CO3: electrochemical metal finishing,

CO4: electrosynthesis of inorganic compounds

CO5: water treatment and electrochemical process

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					L										
CO2															
CO3		H						M							
CO4															
CO5										H					

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

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

The holistic understanding of coating materials and components leads to construction of resilient infrastructure and sustainable industrialization.

CHEY 020	SURFACE COATING	L	T	P	C
SDG: 9	TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic principles of surface chemistry

COB2: various coating techniques including CVD

COB3: industrial coatings and sputtering techniques

COB4: surface coating resins and emulsions

COB5: techniques like laser alloying and electron beam coating

MODULE I SURFACE CHEMISTRY OF ALLOYS 9

Basic physical chemistry, surface chemistry, pretreatment principle - technology and control of electro deposition systems such as alloy plating, electrolysis, composites.

MODULE II METHODS OF COATING I 9

Hot dip coatings - principle, surface preparation, methods, applications, Diffusion coatings - Principle - Cementation - Cladding - case hardening - structures.

Chemical vapor deposition - classification-techniques, metal organic type, plasma assisted, layer assisted, applications.

MODULE III METHODS OF COATING II 9

Industrial coatings like Enamels, Primers, Putties, Lacquers, Water based paints, Inks, HDPCs, Conversion coatings.

Sputtering techniques, methods, applications, plasma treatments, nitriding, carbonizing, boriding, titanizing methods and applications.

MODULE IV SURFACE COATING RESINS 9

Synthesis & characterization of various surface coating resins like Hard resins, Alkyds, Varnishes, Polyesters, Epoxies, Polyamides, Acrylics, Amino resins, CNSL resin, emulsions & water reducible resins.

MODULE V LASER ALLOY AND ELECTRON BEAM COATING 9

Laser alloying - sources, variables, methods, applications, Electron beam coating- evaporation materials, methods, applications.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. G. Braco, Surface Science Techniques, Springer-Verlag Berlin and Heidelberg GmbH & Co. K, 2000.
2. T.S. Sudarsan, Surface Modification Technologies, Marcel Dekker Inc., 1989
3. D.R. Gabe, Principles of Metal Surfaces Treatment and Protection, Pergmon Press 1972.
4. Tracton, Coatings Technology, CRC press, 2006.

COURSE OUTCOMES:

The students will be familiar with

CO1: the pretreatment methods of electrodeposition

CO2: coating methods like, hot dipping, cementation, cladding. Advanced techniques like CVD, plasma assisted, layer assisted methods are also learnt by the students.

CO3: composition and characteristics of industrial coatings including enamels, primers etc.

CO4: synthesis and characterization of resins, emulsions etc

CO5: in detail knowledge about laser alloying, and electron beam coating and their applications in various fields.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		H				M									
CO2		H			M										
CO3			L			H									
CO4	M				L										
CO5				M		H									

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

SDG 9 : Industry, Innovation and Infrastructure

Statement:

SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

ENERGY, WATER ENVIRONMENT FOR SUSTAINABILITY

CHEY 021	**GREEN AND SUSTAINABLE**	**L**	**T**	**P**	**C**
SDG: 4, 7, 9	**CHEMISTRY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

To make the student conversant with

COB1: understand the principle and concepts of green chemistry

COB2: various alternative (non-traditional) reagents and chemicals for green synthesis.

COB3: understand the non-conventional energy sources for green synthesis

COB4: understand the uses of eco-benign solvents - alternative to organic solvents

COB5: synthesis of nanomaterials using green chemistry approaches

MODULE I INTRODUCTION, PRINCIPLE AND CONCEPTS OF GREEN CHEMISTRY **9**

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; Green chemistry in day to day life.

MODULE II NON-TRADITIONAL GREENER ALTERNATIVE APPROACHES **9**

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; Introduction, advantages and applications of (i) Nanocatalysts, (ii) Phase transfer catalysts, (iii) Biocatalysts, (iv) Organocatalysts, in organic synthesis.

MODULE III APPLICATIONS OF NON-CONVENTIONAL ENERGY SOURCES **9**

Introduction of microwave induced synthesis: Microwave activation, equipment, time and energy benefits, and limitations. Organic transformations under microwaves - Fries rearrangement, Diels-Alder

reaction, decarboxylation, saponification of ester, alkylation of reactive methylene compounds; Heterocyclic synthesis - pyrrole, quinoline.
Introduction of ultrasound assisted green synthesis: Instrumentation, physical aspects, applications in organic transformations.

MODULE IV ENVIRONMENTALLY BENIGN SOLUTIONS TO ORGANIC SOLVENTS **9**

Ionic liquids as green solvents: Introduction, properties and types of ionic liquids. Synthetic applications Diels-Alder reaction, epoxidation and Heck reaction.
Aqueous phase reactions: Enhancement of selectivity, efficiency. Synthetic applications - 1,3-Dipolar Cycloadditions, Carbon-Carbon bond-forming processes and bromination reactions.
Fluorous solvents in green chemistry: Scope, definition and their synthetic applicability. Role of supercritical carbon dioxide in green chemistry.
Ethyl lactate as a renewable green solvent: Properties and applications.

MODULE V GREENER SYNTHESIS OF NANOMATERIALS **9**

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 – 45; TOTAL 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 & Tracy C. Williamson. Second Edition, (1998).
3. Green Chemistry – Frontiers in benign chemical synthesis and processes- edited by Paul T. Anastas & Tracy C. Williamson. Oxford University Press, (1998).
4. Green Chemistry – Environment friendly alternatives- edited by Rashmi Sanghi & 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 students 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): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H				L										
CO2			M												
CO3		H						M							
CO4		H													
CO5				L						H					

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

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

SDG 7 & Ensure 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.

CHEY 022	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
SDG: 6,7,9,11, 12,13 and 15		3	0	0	3

COURSE OBJECTIVES:

This course will enable students to:

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 **8**

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 : Air act 1981 and 1987, water act 1974,1977,1987, environmental protection act 1986, The hazardous wastes (management and handling) rules, 1989 & 2000, The manufacture, storage and import of hazardous chemical rules, 1989 & 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.

MODULE II POLLUTION PREVENTION **10**

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 programmes- housekeeping and maintenance.

MODULE III AIR POLLUTION CONTROL 9

Introduction to air pollution 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 10

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 8

Tertiary treatment: colour and odour removal - **Solids Disposal:** Sludge separation and drying- Solids waste disposal – composting, landfill, briquetting / gasificationand incineration.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

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.

COURSE OUTCOMES:

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 disposal methods.

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			H												
CO2			H			M									
CO3					M										
CO4					M										
CO5					M										

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

SDG 7 : Ensure access to affordable, reliable, sustainable and modern energy for all

Statement: The holistic understanding of recycling materials and technology leads to provide modern renewable energy and sustainable industrialization.

CHEY 023	ALTERNATIVE ENERGY	L	T	P	C
SDG: 7,9	RESOURCES	3	0	0	3

COURSE OBJECTIVES:

The students will be trained about the

COB1: Different types of batteries

COB2: Factors affecting battery performance

COB3: Selection and application of batteries

COB4: Application in photovoltaic cells

COB5: Various materials used in solar cells and PEC cells

MODULE I BATTERIES 9

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 9

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 a battery, battery applications, comparative features and performance characteristics, characteristics of batteries for portable equipment.

MODULE III PHOTOVOLTAICS 9

Basic of photovoltaics, homo and heterojunctions, preparation of single crystals and polycrystalline silicon solar cells, Metal-Insulator-Metal and semiconductors - Insulator-semiconductors solar cells, photovoltaic measurements - I-V characteristics, spectral response and capacitance measurements.

MODULE IV FUEL CELLS AND SUPER CAPACITORS 9

Introduction, Types of Fuel cells, figure of merit, electro catalysts for hydrogen oxidation and oxygen reduction, electrochemical double layer capacitors, ruthenium oxide as capacitor electrode, manual capacitors with proton conducting solid polymer electrolytes.

Ultra capacitors: Double layer, Metal Oxide, conducting polymers energy and power densities, voltage limitation and self discharge.

MODULE V SOLAR CELLS AND PEC CELLS 9

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 light energy to electrical energy, PEC cells based on CdSe Si and GaAs and their output characteristics, Estimation of flat band potential from Mott-Schottky plots.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Energy Storage Systems for Electronics Edited by Tetsuya Osaka, Department of Applied Chemistry, Wasuda University, Tokyo, Japan and Madhav Dutta, Intel Corporation, Hillsboro, USA, 2000.
2. Photoelectrochemical Solar Cell, Edited By K.S.V. Santhanam and M. Sharon, Elsevier Science Publishers, BV New York, 1995.
3. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London 1983.
4. W.E. Hatified and J.H. Miller (Editors), High Temperature Superconducting Materials, Marcel Dekker, New York 1988.
5. Lindar D., Handbook on Batteries and Fuel Cells, McGraw Book Co., New York, 2011.

COURSE OUTCOMES:

The students will have

CO1: A thorough understanding about batteries and their components

CO2: Understand the working mechanism of batteries.

CO3: Influence of various factors on performance of batteries and based on which selection of suitable batteries depending on application.

CO4: Testing in fuel cells.

CO5: Applications in solar cells and PEC cells.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		M			H										
CO2	H			H	M										
CO3		H				L									
CO4	M			H		L									
CO5	H				M										

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

SDG 7: Affordable & Clean Energy

SDG 9 : Industry, Innovation and Infrastructure

Statement:

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

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

CHEY 024	SOLAR ENERGY	L	T	P	C
SDG: 4,11,15		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Sustainable energy conversion processes

COB2: Fundamentals of solar cells

COB3: Solar electrical energy conversion

COB4 : Nanomaterials as photovoltaics

COB5: Different types of solar cells

MODULE I INTRODUCTIONS TO SUSTAINABLE ENERGY CONVERSION PROCESSES 8

Photovoltaic, Photothermal, Photoelectrochemical, Biofuel, Wind Power, and Geothermal Systems. Insolation vs. world energy demand, Current energy consumption from different sources, Renewable Energy Resources; Utilization, Storage, and Economic limitations Solar energy: Thermonuclear energy source, Planck's Law, Thermal radiation fundamentals, Solar Radiation Table: extraterrestrial and terrestrial radiations; Solar constant, Air Mass, Spectral Irradiance, Mean annual irradiance on horizontal surface across the world, Radiation on an inclined surface: direct, reflected, and diffused radiations, Global solar radiation data.

MODULE II SOLAR CELL FUNDAMENTALS 9

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell. Semiconductor properties, energy levels, basic equations. Solar cell, p-n junction, structure.

MODULE III SOLAR ELECTRICAL ENERGY CONVERSION 9

Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, IV characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.

MODULE IV NANOMATERIALS FOR PHOTOVOLTAICS 9

Photochemical solar cells, PV panels with nanostructures. Phase compositions on nanoscale microstructures – role of nanostructures and materials – nanomaterials in solar photovoltaic technology- band gap

engineering and optical engineering - tandem structures - quantum well and quantum dot solar cells - photo-thermal cells – organic solar cells. Performance and reliability of nanomaterials based solar cells.

MODULE V SOLAR CELLS 9

Formation of a pn – junction - Space charge and internal field - Quasi – Fermi levels - The Shockley diode equation - Structure of a solar cell - The solar cell equation - Fill factor and maximum power - Various electron - hole-pair recombination mechanisms - Crystalline silicon solar cells - Thin film solar cells: CIGS, Cite and a – silicon - Tandem solar cells - Dye - sensitized solar cells -Organic solar cells. Thin film solar cells, Amorphous silicon (a-Si) solar cells, Cadmium Telluride (Cd-Te) Solar cells, Cu(InGa)Se_2 solar cells, Dye-sensitized solar cells, Organic and polymer solar cells. Photoelectrochemical hydrogen production, photoelectrochemical cells, solar-to-hydrogen efficiency; Hydrogen storage, hydrogen economy, Electrochemical Storage of energy, Current developments in energy storage.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Photoelectrochemical Solar Cell, Edited By K.S.V. Santhanam and M. Sharon, Elsevier Science Publishers, BV New York 1988.
2. C. Hu and R.M. White, Solar Cells, McGraw Hill Book Company, New Delhi, 1983
3. R.K. Kotnala and N.P. Singh, Essentials of Solar Cells, Allied Publishers Pvt. Ltd., Chennai, 1992
4. 4. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London 1983.

COURSE OUTCOMES:

The students will be able to

CO1: Current scenario of energy crisis and need of energy conversion and storage

CO2: Understanding of the design, principle and working of a solar cell

CO3: Identification of specific type of solar cell for the chosen study and analysis

CO4: Comparison of various types of nanomaterials significant in solar energy field and effective utilization of the one which shows better performance.

CO5: Manufacture of a new solar cell device using the available resources and effective utilization of the concepts and design discussed.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		M													
CO2	H	M		L		M									
CO3															
CO4	L		H		H										
CO5															

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

SDG 4 : Quality Education
SDG 11 : Sustainable Cities and Communities
SDG 15 : Life on Land

Statement:
SDG 4 & 11: Foundation to work in R&D laboratories and understanding the research ethics with sustainable development and for teaching career.
SDG 15: R&D labs in API labs in the production novel materials for various applications

CHEY 025	FUEL CELLS F*OR SUSTAINABLE*	L	T	P	C
SDG: 7,11	*ENERGY PRODUCTION*	3	0	0	3

COURSE OBJECTIVES:

The student will

COB1: familiar with the types of fuel cell

COB2: familiar with the components of fuel cells

COB3: understand the performance for fuel cells

COB4: learn the methods **of** production storage of hydrogen

COB5: learn the sustainability **and** applications of fuel cells

MODULE I INTRODUCTION AND TYPES OF FUEL CELLS 9

Introduction - definition - history - difference between batteries and fuel cells - chemistry of fuel cells - classification of fuel cell (based on temperature and electrolyte) - types of fuel cell: polymer electrolyte membrane or proton exchange membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), alkaline fuel cell (AFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC) and solid oxide fuel cells (SOFC)

MODULE II FUEL CELL COMPONENTS 9

Membrane electrode assembly components: membranes and ionomers, fuel cell electrodes and gas diffusion layer, fuel cell electrocatalysts (type and synthesis) - bi-polar plates, humidifiers and cooling plates - *phase-change materials* (PCMs) for thermal packaging - fuel cell stack - Balance of plant - Seals and insulation – Safety.

MODULE III FUEL CELLS PERFORMANCE AND APPLICATIONS 9

Thermodynamics of fuel cells - electrochemical kinetics of fuel cells - Fuel cell efficiency - performance characteristics: voltage efficiency - effect of voltage with current density for low and high temperature fuel cells - causes for voltage losses – introduction to fuel cycle analysis - Mass balance

MODULE IV ProDUCTION AND STORAGE OF HYDROGEN FUEL 9

Hydrogen as energy source - its merit as a fuel - hydrogen production: steam reforming, partial oxidation, coal gasification/thermal reforming, fuel cell technology based on bio-mass - hydrogen storage: compressed hydrogen, liquid hydrogen, metal hydrides, carbon fibers - safety and management of hydrogen

MODULE V FUEL CELL APPLICATIONS AND SUSTAINABILITY 9

Fuel cell material recycle, durability, lifetime issues - Critical issues, adoption, future technologies - distributed power generation - grid-connect applications - non-grid connect applications - combined heat and power (CHP) - economic and environmental analysis - Control of contaminants: CO and sulphur - future trends of fuel cells - Sustainability of Hydrogen Fuel Cell Electric Vehicles.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. R.H. Thring (Editor), Fuel Cells for Automotive Applications, Professional Engineering Publishing UK, 2004.
2. Gregor Hoogers (Editor), Fuel Cell Technology Handbook, SAE International, CRC Press, 2003.
3. Vladimir S. Bagotsky, Fuel Cells: Problems and Solutions, 2nd Edition, John Wiley and Sons, 2012.
4. B. Viswanathan and M. Aulice Scibioh, Fuel Cells: Principles and Applications, Taylor and Francis Group, 2007.
5. Supramaniam Srinivasan, Fuel cells: From Fundamentals to Applications, Springer, 2006.
6. Prospects for Hydrogen and Fuel Cells, International Energy Agency, OECD Publishing, 2005.

COURSE OUTCOMES:

The student will be able to

CO1: classify fuel cells and elaborate the different types of fuel cells.

CO2: explain the components of the fuel cells and can synthesise electrocatalysts for the system

CO3: calculate the open circuit voltage, efficiency and voltage losses, explain fuel cycle analysis and mass balance

CO4: suggest the suitable methods of production and storage of hydrogen for fuel cells.

CO5: find application of fuel cells for variety of application and practice on sustainable environment

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	M													
CO2		M			M										
CO3		M		L											
CO4	M		L			M									
CO5			M												

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

SDG 7: ensure access to affordable, reliable, sustainable and modern energy for all.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

CHEY 026	BIOMASS FOR ENERGY APPLICATIONS	L	T	P	C
SDG: 7		3	0	0	3

COURSE OBJECTIVES:

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: Various biomass pretreatment techniques.

COB4: Understand the chemistry and economics of biodiesel

COB5: Understand the conversion of lignocelluloses into alcohol and fuel.

MODULE I STRUCTURE AND PROPERTIES OF BIOMASS 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 BIOMASS FEEDSTOCKS 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, biomass as energy resources: dedicated energy crops, annual crops (maize, sorghum sugar beet, hemp), perennial herbaceous crops (sugarcane, switchgrass, 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 BIOMASS PRETREATMENT 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 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

MODULE V BIOETHANOL 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 of lignocellulose 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; Total Hours –45

REFERENCES:

1. Krzysztof J Ptasinski, Efficiency of Biomass Energy: An Exergy Approach to Biofuels, Power, and Biorefineries, John Wiley and Sons, 2015.
2. Kaltschmitt, Martin, Energy from Organic Materials (Biomass), A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition, 2019.
3. George W. Huber, Sara Iborra, AvelinoCorma, 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.

Board of Studies (BoS): **Academic Council:**

12th BoS of Chemistry held on 22.07.2022 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H	M	M	M	H									
CO2	M	H	M	M	M	H									
CO3	M	H	M	M	M	H									
CO4	M	H	M	M	M	H									
CO5	M	H	M	M	M	H									

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

SDG 7: Affordable & Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all.

Statement: Utilization of biomass for the energy need provide solution for affordable and sustainable energy for all.

CHEY 027	ENVIRONMENTAL CHEMISTRY	L	T	P	C
SDG: 13		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Understand the issue of chemicals based pollution.

COB2: Understand the chemicals mobility in aquatic systems.

COB3: Understand contaminating chemicals in air and their fate.

COB4: Understand the type of soil contaminants and provide remediation.

COB5: Identify emerging environmental contaminants including speciation

MODULE I FUNDAMENTALS 9

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product (Ksp) ,heavy metal precipitation, amphoteric hydroxides, CO_2 solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order- 12 Principles of green chemistry.

MODULE II AQUATIC CHEMISTRY 9

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction , pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation

MODULE III ATMOSPHERIC CHEMISTRY 9

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO2 capture and sequestration – acid rain- origin and composition of particulates. black carbon, air quality parameters determination.

MODULE IV SOIL CHEMISTRY 9

Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

MODULE V EMERGING POLLUTANTS 9

Heavy metals-chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals- Pesticides, Dioxins & Furan, PCBs ,PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites ,environmental applications.

L – 45; Total Hours –45

REFERENCES:

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird„ Environmental Chemistry, Freeman and company, New York, 5th Edition,2012.
3. Manahan, S.E., "Environmental Chemistry", Ninth Edition, CRC press, 2009.
4. Ronald A. Hites ,"Elements of Environmental Chemistry", Wiley, 2nd Edition,2012.

COURSE OUTCOMES:

Students will be able to

CO1: In solving environmental issues of chemicals based pollution.

CO2: To determine chemicals mobility in aquatic systems.

CO3: To identify contaminating chemicals in air and their fate.

CO4: Understand the type of soil contaminants and provide remediation.

CO5: Identify emerging environmental contaminants including speciation

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	M	M	H									
CO 2	M	H	M	M	M	H									
CO 3	M	H	M	M	M	H									
CO 4	M	H	M	M	M	H									
CO 5	M	H	M	M	M	H									

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

SDG 13: Climate Action: Take urgent action to combat climate change and its impacts

Statement: Understanding of environmental chemistry will lead to take necessary changes for maintaining a healthy environment.