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

Regulations 2019
Curriculum and Syllabi

(Amendments updated upto June 2020)

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 2019
CURRICULUM AND SYLLABI
(Amendments updated upto June 2020)

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:

- 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 & TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS - 2019 FOR

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

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires **"Programme"** means Post Graduate Degree Programme (M.Tech. / MCA / M.Sc.)

"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.,

"Institution" means B.S. Abdur Rahman Crescent Institute of Science & Technology.

"Academic Council" means the Academic Council, which is the apex body on all academic matters of B.S. Abdur Rahman Crescent Institute of Science & Technology.

"Dean (Academic Affairs)" means Dean (Academic Affairs) of B.S. Abdur Rahman Crescent Institute of Science & Technology who administers the academic matters.

"Dean (Student Affairs)" means Dean (Student Affairs) of B.S. Abdur Rahman Crescent Institute of Science & Technology, who looks after the welfare and discipline of the students.

"Controller of Examinations" means the Controller of Examinations of B.S. Abdur Rahman Crescent Institute of Science & Technology who is responsible for the conduct of examinations and declaration of results.

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.	

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 of this Institution as specified in the clause 3.2 [Eligible entry qualifications for admission to P.G. programmes] or any other degree examination of any University or authority accepted by this Institution as equivalent thereto.

2.2.2 Eligibility 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 (3 years)	6	12
MCA (Lateral Entry)	4	8
MCA (2 years)	4	8
M.Sc.	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	Qualifications for admission
1.	Aeronautical Engineering	M. Tech. (Avionics)	B.E. / B. Tech. (Aeronautical Engineering)
2.	Civil Engineering	M. Tech. (Structural Engineering)	B.E. / B. Tech. (Civil Engineering) / (Structural Engineering)

		M. Tech. (Construction Engineering and Project Management)	B.E. / B. Tech. (Civil Engineering) / (Structural Engineering) / B. Arch.
3.	Mechanical Engineering	M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace /Aeronautical / Material Science / Marine Engineering)
		M.Tech. (CAD/CAM)	
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engg.)	B.E. / B. Tech. (EEE/ECE/E&I/I&C / Electronics / Instrumentation)
		M.Tech. (Power Electronics and Drives)	
5.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	B.E. / B. Tech. (EEE/ ECE / E&I / CSE IT / I&C / Electronics / Instrumentation)
		M.Tech. (VLSI and Embedded Systems)	B.E. / B. Tech. (ECE / E&I / I&C / EEE / CSE / IT)
6.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation Engineering)	B.E. / B. Tech. (EIE/ICE/Electronics/ECE/EEE)
7.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B. Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics / MCA)
8.	Information Technology	M.Tech. (Information Technology)	B.E. / B. Tech. (IT/CSE/ECE/EEE/EIE/ICE/ Electronics / MCA)

9.	Computer Applications	MCA (3 years)	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		MCA – (Lateral Entry)	B.Sc. Computer Science / B.Sc. Information Technology / BCA
		MCA (2 years)	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level or B.Sc. Computer Science / B.Sc. Information Technology / BCA
10.	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the subjects of study
11.	Physics	M.Sc.(Physics)	B.Sc. (Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
12.	Chemistry	M.Sc.(Chemistry)	B.Sc. (Chemistry / Applied Science)
13.	Life Sciences	M.Sc. Molecular Biology & Biochemistry	B.Sc. in any branch of Life Sciences
		M.Sc. Biotechnology	B.Sc. in any branch of Life Sciences
		M.Sc. Microbiology	B.Sc. in any branch of Life Sciences
		M.Tech. Biotechnology	B.Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences

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 oriented core courses
iv. Project work / thesis / dissertation
v. Laboratory Courses
vi. Seminars
vii. Mini Project
viii. Industrial Internship
ix. Value Added Courses
x. MOOC Courses (NPTEL, SWAYAM, etc.,)

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 total credits specified in the curriculum of the respective specialization of the programme.

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

Programme	Range of credits
M.Tech.	74 - 80
MCA (3 years)	118 - 126
MCA (Lateral Entry)	80 - 85
MCA (2 years)	85 - 90
M.Sc.	77- 82

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

- One credit for one lecture period per week or 15 periods of lecture per semester
- One credit for one tutorial period per week or 15 periods per semester
- One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester
- One credit for four weeks of industrial internship or 160 hours per semester.

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 28	18 to 26
MCA	12 to 33	12 to 26
M.Sc.	9 to 32	10 to 26

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 of programme, the student can choose a maximum of two electives from any other similar programmes across departments, during the entire period of study, with the approval of the 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 20% of credits of courses in a semester excluding project semester 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 ratified by the respective Board of Studies 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 faculty member.

3.5 PROJECT WORK / DISSERTATION

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

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research Organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly

supervised by a faculty of the Department and an Engineer / Scientist 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 / Dissertation 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 / dissertation 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 whole class. He/she is responsible for maintaining the academic, curricular and co-curricular records of all students throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling on the academic programme, the Head of the Department / Dean of School of the students shall attach a certain number of 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 offer advice to the students on academic and personal matters, and guide the students in taking up courses for registration and enrolment in every semester.

5.0 CLASS COMMITTEE

5.1 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:

5.2 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

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

5.4 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 syllabus.

5.5 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.

6.0 COURSE COMMITTEE

6.1 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.

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.

7.2 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.

7.3 A student can withdraw from an enrolled course at any time before the first 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 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.

8.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

8.1 A student may be permitted by the Dean (Academic Affairs) to avail temporary break of study from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. A student can avail the break of study before the start of first assessment test of the ongoing semester. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1). If any student is debarred for want of attendance or suspended due to any act of indiscipline, it will not be considered as break of study. A student who has availed break of study has to rejoin in the same semester only in the subsequent year. The student availing break of study is permitted to write arrear examinations by paying the prescribed fees.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / DISSERTATION

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 (3 years)	45
MCA (Lateral Entry)	22
MCA (2 years)	22
M.Sc.	18

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

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% (for genuine reasons such as medical grounds, representing for the institution in approved events, etc.) 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. The courses in which the student is awarded "I" grade, shall register and redo the course when it is offered next.

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 that course to the Class Advisor. The Class Advisor will consolidate and furnish the list of students who have earned less that 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of School. Thereupon, the Dean (Academic Affairs) shall announce the names of such students prevented from writing the semester end examination in each course.

10.3 A student who has obtained 'I' grade in all the courses in a semester is not permitted to move to next higher semester. Such student shall redo 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.

10.4 A student shall register to redo a core course wherein "I" or "W" grade is awarded. If the student is awarded, "I" or "W" grade in an elective course either the same elective course may be repeated or a new elective course may be chosen with the approval of Head of the Department / Dean of School.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester in the evening after regular working hours, if such courses are offered by the concerned department. Students may also opt to redo the courses offered during regular semesters, without affecting the regular academic schedule

and not exceeding prescribed maximum credits.

11.2 The Head of the Department with the approval of Dean (Academic Affairs) may arrange for the conduct of a few courses in the evening after regular working hours, depending on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

11.3 The number of contact hours and the assessment procedure for any redo course will be the same as those during regular semesters except that there is no provision for any substitute examination and withdrawal from an evening redo course.

12.0 ASSESSMENTS AND EXAMINATIONS

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

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

12.3 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 component shall have a total of three assessments with two continuous assessments having 25% weightage each and semester end examination having 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination for the award of pass grade. The evaluation of practical component shall be through continuous assessment.

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

12.5 In the case of Industrial training, 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 organisation. The weightage for Industry internship report shall be 60% and 40% for viva voce examination.

12.6 In the case of project work, a committee of faculty members constituted by the Head of the Department will carry out three periodic reviews. Based on the project report submitted by the student, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by 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.

12.7 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be considered for grading along with the marks scored in the semester end arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination to award grades and the internal assessment marks secured during the course of study shall not be considered.

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 arrear examination for theory component. There shall be no arrear or improvement examination for lab component.

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 semester.

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 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
W	0
I	0
AB	0

"W" denotes withdrawal from the course.

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

"U" denotes unsuccessful performance in the course.

"AB" denotes absence for the semester end examination.

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 fee to the 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” and "W" grades are excluded for calculating GPA.

"U", “I”, "AB" and **"W"** 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

However, to be eligible for First Class with Distinction, a student should not have obtained ‘U’ or ‘I’ grade in any course during his/her period of study and should have completed the P.G. programme within a minimum period (except break of study). To be eligible for First Class, a student should have passed the examination in all the courses within the specified minimum number of semesters reckoned from his/her commencement of study plus two semesters. For this purpose, the authorized break of study is not considered. The students who do not satisfy the above two conditions shall be classified as second class. For the purpose of classification, the CGPA shall be rounded to two decimal places. For the purpose of comparison of performance of students and ranking, CGPA will be considered up to three decimal places.

16.0 DISCIPLINE

16.1 Every student is expected to observe disciplined and decorous behaviour 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 MASTERS DEGREE

17.1 A student shall be declared to be eligible for the award of the Masters 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. Enrollment in 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

Not withstanding 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)
(Four Semesters/ Full Time)
CURRICULUM

SEMESTER I

S. No.	Course Code	Course Title	L	T	P	C
1.	CHD 6101	Stereochemistry and reaction mechanisms	3	0	0	3
2.	CHD 6102	Thermodynamics and Electrochemistry	3	0	0	3
3.	CHD 6103	Fundamentals of representative elements	3	0	0	3
4.	CHD 6104	Analytical Techniques #	3	1	0	4
5.		Elective				3*
6.	CHD 6105	Organic Chemistry Practical	0	0	4	2
7.	CHD 6106	Inorganic Chemistry Practical -I	0	0	4	2
8.	CHD 6107	Physical Chemistry Practical - I	0	0	4	2
9.	CHD 6108	Seminar			2	1
		Total credits				**23**

SEMESTER II

S. No.	Course Code	Course Title	L	T	P	C
1.	GED 6202	Research Methodology #	4	0	0	4
2.	CHD 6201	Reactive intermediates and concerted reaction	3	0	0	3
3.	CHD 6202	Kinetics and catalysis	3	0	0	3
4.	CHD 6203	Transition and inner transition elements	3	0	0	3
5	CHD 6204	Molecular spectroscopy #	3	0	0	3
6.		Elective	3	0	0	3
7.	CHD6205	Synthetic Organic Chemistry Practical	0	0	4	2
8.	CHD6206	Inorganic Chemistry Practical-II	0	0	4	2
9.	CHD6207	Physical Chemistry Practical -II	0	0	4	2
		Total Credits				**25**

SEMESTER III

S. No.	Course Code	Course Title	L	T	P	C
1	CHD 7101	Synthetic and spectroscopic Organic Chemistry	3	0	0	3
2	CHD 7102	Quantum Chemistry and group theory #	3	1	0	4
3	CHD 7103	Organometallic and bioinorganic Chemistry	3	0	0	3
4		Elective				11**
5	CHD 7104	Internship (during summer vacation)				1
6	CHD 7201	Project Phase -1				2***
		Total Credits				**22**

SEMESTER IV

S. No.	Course Code	Course Title	L	T	P	C
1.	CHD 7201	Project Phase -II	0	0		10
		Total Credits				**12*** **

Total credits = 81

- Interdisciplinary courses

*Elective should be chosen with credit not less than 3

**Elective should be chosen with total credit not less than 11

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

- For **Project (phase 1)**, evaluation pattern and minimum requirement is defined.
- **Project (phase 2)**, carried out in the IV semester, is split into two courses as "**Project dissertation**" and "**Comprehensive viva**", which adds value when students go abroad for higher studies.
- The following audited courses (without credit) is offered to M.Sc (Chemistry) students in the third semester which may be handled by CSE/IT/English departments of the university
    - Aptitute/ Soft skills
    - Communication skills
    - Competitive exam training
- Environmental chemistry can be given as a value added course.

LIST OF ELECTIVES

Course Code	Course Title	L	T	P	C
	Basic Chemistry				
CHDY 001	Green chemistry #	3	0	2	4
CHDY 002	Photophysics and photochemistry	3	0	0	3
	Medicinal ,Pharmaceutical and Biological Chemistry				
CHDY 003	Bioorganic chemistry #	3	0	0	3
CHDY 004	Chemistry of heterocyclic and natural products	3	0	0	3
CHDY 005	Biochemistry #	3	0	2	4
CHDY 006	Pharmaceutical Technology #	3	0	0	3
CHDY 007	GMP, Quality Assurance and Validation #	3	0	0	3
CHDY 008	Medicinal and Pharmaceutical Chemistry #	3	0	0	3
	Materials and Technology				
CHDY 009	Polymer Chemistry #	3	0	0	3
CHDY 010	Nanotechnology #	3	0	2	4
CHDY 011	Concepts and Techniques in Catalysis	3	0	0	3
CHDY 012	Polymer Technology #	3	0	0	3
CHDY 013	Inorganic Chemical Technology	3	0	0	3
CHDY 014	Organic Chemical Technology	3	0	0	3
	Energy ,Water and Environment				
CHDY 015	Water And Solid Waste Management #	3	0	0	3
CHDY 016	Industrial Electrochemistry	3	0	0	3
CHDY 017	Electrochemical Protection Systems	3	0	0	3
CHDY 018	Protective Coatings	3	0	0	3
	Advanced/Special Electives				
CHDY 019	Chemistry of Carbohydrates	3	0	0	3
CHDY 020	Advanced Concepts in Organic Synthesis	3	0	0	3
CHDY 021	Polymer Structure and Property Relationship	3	0	0	3
CHDY 022	Electrical Properties of Polymeric Materials	3	0	0	3
CHDY 023	Corrosion and Corrosion Control #	3	0	0	3
CHDY 024	Metal Coating Technology #	3	0	0	3

Course Code	Course Title	L	T	P	C
CHDY 025	Advanced Batteries and Systems	3	0	0	3
CHDY 026	Electrochemical Material Science	3	0	0	3
CHDY 027	Electrochemical Energy Conversion and Storage	3	0	0	3
CHDY 028	Fuel Cells and Applications #	3	0	0	3
CHDY 029	Photochemistry	3	0	0	3
CHDY 030	Solar energy	3	0	0	3
CHDY 031	Chemical and Electrochemical Energy Systems	3	0	0	3
CHDY 032	Electrochemical approaches to functional supramolecular systems	3	0	0	3
CHDY 033	Organic Electronic Devices	2	0	2	3
CHDY 034	Carbon and ceramic nanomaterials	2	0	2	3
CHDY 035	Biomass to Energy Conversion	3	0	0	3
CHDY 036	Industrial Pollution Control	3	0	0	3

- Interdisciplinary courses

SEMESTER I

CHD 6101	**STEREOCHEMISTRY AND REACTION MECHANISMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

To make the student conversant with

- Basic concepts in organic chemistry
- Mechanism of nucleophilic and electrophilic substitution reactions
- Mechanism of addition and elimination reactions
- Concepts in aromaticity

MODULE I ST EREOCHEMISTRY I 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 using physical and chemical methods - optical activity of biphenyls, binaphthyls, allenes, spiranes, exo-cyclic alkylidene cycloalkanes – ansa and cyclophanic compounds.

MODULE II STEREOCHEMISTRY II 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 - Sharpless epoxidation.

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 $E1_{CB}$ 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

REFERENCES:

1. Eliel E.L. and Wilen S.H., Stereochemistry of Organic Compounds, John Wiley India, 2009.
2. Nasipuri D., Stereochemistry of Organic Compounds, 2nd Edition, Wiley Eastern Ltd., 1991.
3. Kalsi P.S., Stereochemistry of Organic Compounds, Wiley Eastern Ltd., New Delhi, 1992.
4. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2000.
5. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A – Structure and Mechanisms, 5th Edition, Springer, 2007.
6. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007.
7. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009.
8. Peter Sykes, Guidebook to Mechanism in Organic Chemistry, Orient Longman, 2005.

9. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.
10. Ahluwalia, V. K.; Parashar, R. K. Organic Reaction Mechanism, Narosa publications, 4th Edition, 2010.

OUTCOMES:

The students will be able to

- assign stereochemical configuration of organic compounds
- apply stereochemical concepts for predicting reaction products
- postulate the mechanism of nucleophilic and electrophilic substitution reactions
- depict the mechanism of various addition and elimination reactions
- recognize the aromaticity and aromatic electrophilic substitution reaction

CHD 6102 THERMODYNAMICS AND ELECTROCHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student conversant with

- laws of chemical thermodynamics and applications of Vant-Hoff's and Clausius-Clapeyron equations in chemical thermodynamics
- application of partition function
- applications of emf measurements and Butler-Volmer equation and Tafel equations
- Types and prevention of corrosion
- Types of adsorption and determination of surface area

MODULE I CHEMICAL THERMODYNAMICS 9

State and Path functions – First law of thermodynamics – Joule-Thomson effect – thermochemistry – standard enthalpy changes – standard enthalpies of formation – second law of thermodynamics – free energy and work function – Maxwell relations – third law of thermodynamics – evaluation of absolute entropies of solids, liquids and gases. Clausius-Clapeyron equation– partial molar properties – chemical potential – Vant Hoff's equation – Gibbs-Duhem equation.

MODULE II 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 to mono atomic gases (ortho-para hydrogen) and solids.

MODULE III ELECTROCHEMISTRY 9

Derivation of Nernst equation – problems – Chemical and concentration cells (with and without transference) – Liquid junction potential – derivation of the expression for LJP – its determination and elimination – Applications of EMF measurements: Solubility product, determination of transport numbers and equilibrium constant measurements – Debye-Huckel theory – 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 -

classification of fuel cell (based on temperature and electrolyte) – types of fuel cell:

MODULE IV CORROSION 9

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

MODULE V COLLOIDS AND SURFACES 9

Stability and properties of colloids – Diffusion – adsorption – surface reaction : various adsorption isotherms – determination of surface area – pore volume and pore size – thermodynamics of interfaces– heterogeneous catalysis– BET of multilayer adsorption – colloidal electrolytes – reactions on surfaces.

L – 45; Total Hours –45

REFERENCES:

1. Atkins P., and Paula J.D., Physical Chemistry, 7th Edition, Oxford University Press, London, 2002.
2. Alberty P.A. and Silbey R.U., Physical Chemistry, 1st Edition, John Wiley and Sons 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. An Introduction to Electrochemistry by Samuel Glasstone,Affiliated East - West Press Pvt Ltd, New Delhi
7. Principles of colloid and surface chemistry Paul C. Hiemenz, Raj Rajagopalan, 3rd edition, Marcel Dekker,1997

OUTCOMES:

The students will be able to comprehend the

- laws of chemical thermodynamics and applications vant-Hoff's and Clausius-Clapeyron equations in chemical thermodynamics
- application of partition function
- applications of emf measurements and Butler-Volmer equation and Tafel equations
- types and prevention of corrosion
- types of adsorption and determination of surface area

CHD 6103	FUNDAMENTALS OF REPRESENTATIVE ELEMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- Periodic properties of elements ,
- Bonding in inorganic molecules,
- Nuclear reactions and radioactivity,
- Properties of s- and p- block elements ,
- Compounds of p- block elements.

MODULE I ATOMIC STRUCTURE 9

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

MODULE II CHEMICAL BONDING 9

Valence bond theory – hybridization and resonance – diatomic and polyatomic systems - VSEPR theory - molecular orbital theory – LCAO approximation for diatomic and polyatomic systems. vander waals' forces – hydrogen bond – clathrates

MODULE III NUCLEAR CHEMISTRY 6

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

MODULE IV CHEMISTRY OF s- AND p- BLOCK ELEMENTS 9

Alkali and alkaline earth metals: The metals and their halides, oxides and hydroxides, 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 V p-BLOCK ELEMENTS 12

Halides, oxides, oxoacids and oxoanions, boranes, carboranes, metallocarboranes, borazine, silicates, nitrides, phosphides, arsenides, phosphazenes, nitrides of sulphur, selenides, Interhalogen compounds and polyhalogen ions, compounds of xenon, krypton and radon

L – 45; Total Hours –45

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.
5. Lee J.D., Concise Inorganic Chemistry, 5th Edition, Blackwell Science, 2003.

OUTCOMES:

Students will be able to

- Demonstrate an understanding of the basic principles of periodicity.
- Demonstrate an understanding of valence bond and molecular orbital theory.
- Find the applications of nuclear reactions.
- Acquire the knowledge of s- and p- block elements.
- Demonstrate the structure and applications of compounds of p-block elements.

CHD 6104 ANALYTICAL TECHNIQUES L T P C
3 1 0 4

OBJECTIVES:

To make the student

- identify the right analytical method for a given sample and state the principles and applications of different wet chemical methods
- state the principles and instrumentation of different separation techniques
- analyze the principles, instrumentation and applications of spectroscopic methods
- describe the principles, instrumentation and applications of electroanalytical techniques
- describe the concepts of photophysical processes and different thermal analytical methods

MODULE I QUANTITATIVE ANALYSIS 9

Volumetric analysis **:** neutralization, precipitation, complexometric and redox titrations – Gravimetric analysis (volatilization and precipitation methods) – Types of error – evaluation of analytical data

MODULE II CHROMATOGRAPHIC TECHNIQUES 9

Principle, instrumentation/procedure and applications of: Conventional chromatography **:** Paper, column and TLC – Advanced chromatography – GC HPLC and GPC – ion exchange chromatography – Electrochromatography **:** Capillary electrophoresis and gel electrophoresis .

MODULE III SPECTROSCOPY 9

Principle, instrumentation and applications of : Colorimetric analysis (estimation of Fe/Cu) – UV-Visible spectroscopy – IR spectroscopy – Atomic absorption and atomic fluorescence spectroscopy – Flame emission spectroscopy (estimation of Na/K/Ca) – ICP-AES

MODULE IV ELECTROANALYTICAL TECHNIQUES 9

Principle, practice and applications of **:** Conductometric titrations – high frequency titrations – potentiometric titrations – pH-metry and ion-selective electrodes – polarography – voltammetry – amperometric titrations – coulometry – electrogravimetry

MODULE V PHOTOPHYSICAL AND THERMAL METHODS 9

Jablonski diagram – Photophysical processes (radiative and non-radiative) **:** Fluorescence, phosphorescence – chemiluminescence and bioluminescence – Principle, instrumentation and applications of thermal analytical techniques – TGA, DTA, DSC.

L – 45; T – 15; Total Hours –45

REFERENCES:

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.

OUTCOMES:

The student will be able to

- identify the proper method and do the various chemical analysis
- isolate the compounds in a mixture by chromatographic techniques
- interpret the spectral data like UV-Visible, IR and describe the spectroscopic techniques
- apply electroanalytical techniques
- describe the photophysical processes and interpret the thermal analysis data

CHD 6105 ORGANIC CHEMISTRY PRACTICAL

L	T	P	C
0	0	4	2

OBJECTIVES:

To make the student conversant with

- Separation of two component mixture
- analyze the functional groups present in simple organic compounds.
- Basic purification techniques for organic solvents, reagents and compounds

LIST OF EXPERIMENTS

1. Qualitative analysis of simple organic compounds
2. Separation of organic compounds with two component mixtures and its qualitative analysis (minimum five mixtures to be done).
3. Single stage preparation of organic compounds followed by purification *via* distillation / recrystallization.
4. Determination of melting point - Determination of boiling point by capillary method.

P - 60; Total Hours –60

REFERENCES:

1. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall, 2008.
2. V.K Ahluwalia, R. Agarwal Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press, 2000.

OUTCOMES:

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

- Separate the different component mixtures of simple organic compounds.
- Analyze the functional groups present in simple organic compounds
- Purify the organic compounds by using recrystallisation and distillation techniques

CHD 6106	INORGANIC CHEMISTRY PRACTICAL- I	L	T	P	C
		0	0	4	2

OBJECTIVES:

The students will be trained

- the purification process such as distillation, extraction, etc.
- to identify individual common and rare cations present in the given mixture
- to estimate the chloride ions present in water
- to estimate the various ions by titrimetry
- to estimate the ions such as iron, cobalt, nickel, chromium and manganese and spectral techniques

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 tirtrations: Estimation of Ca^{2+}, Mg^{2+}, $Mn^{2+}$and Zn^{2+}
5. Spectrophotometric analysis of iron, cobalt, nickel, chromium and manganese

P - 60; Total Hours –60

REFERENCES:

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

OUTCOMES:

The students will be able to

- Distill water and other organic solvents
- Analyze the common and rare cations present in the given mixture
- Estimate the ions present in the sample by titrimetry
- Estimate the ions such as iron, cobalt, nickel, chromium and manganese present in the sample by spectral methods

CHD 6107 PHYSICAL CHEMISTRY PRACTICAL- I

L	T	P	C
0	0	4	2

OBJECTIVES:

To make the students trained to

- Determine the equivalent conductance of strong electrolyte
- Verify the Debye Huckel Onsager equation and Ostwald dilution law
- Do conductometric and potentiometric titrations
- Determine the EMF of a cell and ionization constant
- Verify Beer-Lambert law
- Find out ΔEP

List of Experiments

1. Equivalent conductance of strong electrolytes and verification of Debye Huckel Onsager equation
2. Verification of Ostwald dilution law using weak acid and determination of its dissociation constant
3. Temperature dependence of solubility of benzoic acid in water and DMSO
4. Determination of activity coefficients of an electrolyte at different molalities
5. EMF measurement
6. Potentiometric titration of mixture of halides
7. Conductometric titration of mixture of acids
8. Determination of Ionization constant using conductometric titration
9. Determination of ΔEP of a redox system by cyclic voltametry
10. Demonstration : Electroplating

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.

OUTCOMES:

The students will be able to

- Determine the equivalent conductance of strong electrolytes
- Verify the Ostwald dilution law
- Measure the activity coefficients at different molalities
- Determine the EMF of any cell
- Measure the amount of mixture of acids and ionization constant using conductometric titration
- Measure the amount of halides using potentiometric titration
- Verify Beer-Lambert law
- Understand the concept of electroplating

GED 6202 RESEARCH METHODOLOGY

L	T	P	C
4	0	0	4

OBJECTIVES:

The students will be trained to

- Select and Define a research problem
- Describe the Methodology of Research
- Acquire good laboratory practices
- Operate the software for Programming techniques
- Analyze and Interpret the Results
- Demonstrate the Plagiarism check by turtin

MODULE I RESEARCH METHODOLOGY- AN INTRODUCTION 12

Research: Objectives, Motivation and types - Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, 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.

MODULE II GOOD LABORATORY PRACTICES AND SAFETY 12

Introduction: History, definition, Principles, Good Laboratory Practices (GLP) and its application GLP training: Resources, Rules, Characterization, Documentation, quality assurance, Resources, Facilities: building and equipment, Personnel, GLP and FDA, Stepwise implementation of GLP and compliance monitoring. Safety Symbols, Science Safety Rules- Dress Code, First Aid, Heating and Fire Safety

MODULE III PROGRAMMING TECHNIQUES 12

Data analysis using Excel, Origin and Sigma plot Analyzing the chemical data and drawing chemical structures using Chemdraw and Chemsketch. Basics of C and C++ programme – MATLAB – Numerical Methods – Ordinary Differential Equation – Partial Differential Equation – Runge Kutta Method.

MODULE IV INTERPRETATION OF RESULTS AND ANALYSIS 12

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective) and cross verification,

correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc.

Conceptions of error of measurement, true score theory and generalisability theory. Measures of central tendency or averages – mean median and mode. Measures of dispersion – range, variance, and standard deviation: The normal distribution and the normal probability curve.

MODULE V SCIENTIFIC WRITING, TECHNICAL PUBLICATION AND RESEARCH PROPOSAL **12**

Different types of scientific and technical publications in the area of research, and their specifications, Ways to protect intellectual property – Patents, technical writing skills, definition and importance of impact factor and citation index - assignment in technical writing, The research problem, finding related literature, computer generated references sources and the research project, model research proposal. Plagiarism checking by Turtin –demonstration

L – 60; Total Hours –60

REFERENCES:

1 Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005 John Wiley & Sons Publishers, Inc
2 Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc
3 Guide to Publishing a Scientific paper, Ann M. Korner, 2004, Bioscript Press.
4 P Laake, H B Benestad, B R Olsen. Research Methodology in the medical and biological sciences. Academic Press, 2007.
5 R Arora. Encyclopaedia of Research Methodology in Biological Sciences. Anmol Publishing, 2004.
6 Kothari C.R., Research Methodology, Methods and Techniques, Wiley Eastern Ltd., NewDelhi, 1991.
7 Coghill M. and Gardson L.R., The ACS Style Guide Effective Communication of Scientific Information, 3rd Edn., Oxford University Press, 2006.
8 Willa Y. Garner, Maureen S. Barge, James, P, Good Laboratory Practice Standards: Applications for Field and Laboratory Studies (ACS Professional References Book).

OUTCOMES:

At the end of this course, the students should be able to:

- recognize the basic concepts of research and its methodologies
- Identify appropriate research topics
- Select and define appropriate research problem and parameters
- Prepare a project proposal (to undertake a project)
- Organize and conduct research (advanced project) in a more appropriate manner
- Write a research report and thesis

CHD 6201	REACTIVE INTERMEDIATES AND CONCERTED REACTIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- Structure and stability of carbanions
- name reactions and reagents in organic synthesis
- Different reaction intermediates in organic synthesis
- Types of pericyclic reactions with its applications.
- Types of photochemical reactions with its applications

MODULE I CARBANIONS 9

Structure and stability of carbanion - chemistry of enolates and enamines - kinetic and thermodynamic enolates – lithium and boron enolates in aldol and Michael reactions – Alkylation and acylation of enolates – nucleophilic addition to carbonyls – organolithium, organozinc, organocopper reagents (1,4-addition) in synthesis – Claisen, Dieckmann, Knoevenagel, Stobbe, Darzen and Acyloin condensation – Shapiro reaction and Julia olefination

MODULE II CARBOCATIONS AND RADICALS 9

Structure and stability of carbocations – classical and non-classical carbocations – rearrangements: Wagner-Meerwein, Pinacol-pinacolone, semi-pinacol – C-C bond formation involving carbocations – oxymercuration

Generation of radical intermediates – addition to alkenes, alkynes (inter and intramolecular) for C-C bond formation – Baldwin rules – Barton deoxygenation and decarboxylation – McMurry coupling.

MODULE III CARBENES, NITRENES AND YLIDES 9

Structure and generation of carbenes – addition and insertion reactions – Wolff rearrangement – structure of nitrene – generation and reactions of nitrene – Curtius, Hofmann, Schmidt, and Beckmann rearrangement reactions – chemistry of phosphorous and sulfur ylides – generation and reactions of ylide by carbenoid decomposition - Witting and related reactions – Peterson olefination.

MODULE IV 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 V ORGANIC PHOTOCHEMISTRY 9

Thermal *vs* photochemical reactions – n-pi* and pi-pi* transitions - allowed and forbidden transitions – Jablonski Diagram – sensitization and quenching – 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.

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. Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th Edition, Wiley Inter Science, New York, 2007.
4. Fleming I., Frontier Orbital and Organic Chemical Reactions, Wiley, 1976.
5. Graham Solomons T.W., Organic Chemistry, Volume I and II, 5th Edition, John Wiley and Sons, New York, 1992.
6. Paula Y Bruice, Organic chemistry, 7th edition, Pearson, 2014.
7. Sankararaman S., Pericyclic reactions – a Textbook: Reactions, Applications and Theory, Wiley-VCH, 2005.

OUTCOMES:

The student will be able to

- Give the structure and explain the stability of carbanions
- Write the name reactions and the reagents involved in the organic synthesis
- Speculate the reaction intermediates in organic synthesis
- Differentiate the types of pericyclic reactions
- Identify the types of photochemical reactions

CHD 6202	KINETICS AND CATALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- determination of rate law for the reactions
- classical and modern theories of reactions rates
- derive rate expressions for acid-base catalytic systems and enzyme catalysed systems
- effect of parameters which affect the rate constant
- Different type of phase equilibria
- Basic concepts of macro molecules and different types of Polymerization reactions

MODULE I CHEMICAL KINETICS 9

Methods of determining rate laws – 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.

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.

MODULE III PHASE EQUILBRIA 9

One component systems (water, CO_2, S) and two component system– classification – solid-gas (dehydration and rehydration of $CuSO_4$, $5H_2O$), solid-liquid systems –three component systems involving liquid-liquid equilibria.

MODULE IV CATALYSIS 9

Acid-base catalysis – general scheme – specific and general catalysis – catalytic constants –mechanism of acid-base catalysed reaction – catalysis by transition metal ions and their complexes – supported transition metal complexes as catalysts – enzyme catalysis – theory and applications. solid catalysts – metal-

metal oxides – geometric factor – electronic factor - zeolites – phase transfer catalysis.

MODULE V CHEMISTRY OF MACROMOLECULES 9

Basic concepts - classification, nomenclature, molecular weights, molecular weight

distribution, glass transition, degree of crystallinity, morphology, and viscosity molecular weight, mechanical property - molecular weight relationships. Molecular weights and Methods of determination, molecular weight distribution, size and shape of macromolecules. Intrinsic viscosity, Mark-Houwink relationship. Chain polymerization, controlled radical polymerizations (INIFERTER, ATRP, RAFT, SET). Living Polymerizations. Ziegler-Natta and metathesis polymerizations.

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. Nash L.K. and Addison, Elements of Statistical Thermodynamics, Wiley Publication Co., 1971.
5. Gupta M.C., Statistical Thermodynamics, Wiley Eastern, New Delhi, 1990.
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

OUTCOMES:

The student will be acquainted with

- differential rate laws, integrated rate laws, temperature dependence of reaction rates,
- Derivation of rate law for the complex reactions such as parallel ,reversible and consecutive reactions

- the knowledge of phase equilibria for various systems
- different types of catalysts and catalyzed reactions
- Basic analytical techniques to analyze the catalyst
- Basic concepts of macro molecules and different types of Polymerization reactions

CHD6203	TRANSITION AND INNER TRANSITION ELEMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the students conversant with the

- Structure and bonding of coordination compounds
- Bonding theories of coordination compounds
- Spectra and magnetic properties of coordination compounds
- Reactions of coordination compounds
- Inorganic solid state chemistry
- Chemistry of lanthanides and actinides

MODULE I STRUCTURE AND BONDING OF COORDINATION COMPOUNDS 9

Nomenclature, structure and stability – geometry and isomerism - absolute configuration, Valence bond theory – hybridization - crystal field theory – crystal field splitting, crystal field stabilization energy – thermodynamic and structural implications, Jahn Teller effects, ligand field theory - molecular orbital theory – pi bonding.

MODULE II SPECTRA OF CO-ORDINATION COMPOUNDS 9

Free ion terms, transformation in crystal field, energy diagrams in weak and strong field cases – Orgel Diagram- Tanabe – Sugano diagrams, selection rules - magnetic properties – Van Vleck equation, magnetic susceptibility – experimental methods - ESR spectra of transition metal ions.

MODULE III REACTIONS OF CO-ORDINATION COMPOUNDS 9

Stability of complexes – thermodynamic aspects, successive and overall formation constants – experimental methods. Inert and labile complexes - substitution reactions in square-planar and octahedral complexes - electron transfer reactions - photochemical reactions.

MODULE IV INORGANIC SOLID STATE CHEMISTRY 9

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 and graphite - Polymorphism and *X-Ray Diffraction*. Preparation of non-molecular solids - band theory of solids - defects and non-stoichiometry, electrical and magnetic properties, superconductivity, amorphous solids, nonsolids.

MODULE V f- BLOCK ELEMENTS 9

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

L – 45; Total Hours –45

REFERENCES:

1. Cotton F.A., Wikinson G. and Gaus P., Basic Inorganic Chemistry, 3rd Edition, John Wiley and Sons, 2003.
2. Shriver D.F. and Atkins P.W., Inorganic Chemistry, 3rd Edition, (ELBS), Oxford University Press, Oxford, 2004.
3. Huheey J.E., Keiter E.A. and Keiter R.L., Inorganic Chemistry, 4th Edition, Addison Wesley Publication, London, 1993.
4. Cotton F.A., Wikinson G., Murillo C.A. and 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. Meissler G.L. and Tarr D.A., Inorganic Chemistry, 3rd Edition, Pearson Education, Singapore, 2004.

OUTCOMES:

Students will be able to

- Find the isomerism and nature of bonding involved in coordination compounds.
- Demonstrate and analyze the spectra of coordination compounds.
- Interpret the stability and reaction of transition metal complexes.
- Correlate the relationship between structure and properties of solid inorganic compounds.
- Analyze and compare the transition metals and lanthanides

CHD6204 MOLECULAR SPECTROSCOPY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the students

- learn molecular spectroscopy as an important tool to understand molecular structure and its characteristics.
- acquire a basic idea of different electromagnetic regions and instrumentation such as rotational, vibrational and electronic spectroscopy of diatomic and polyatomic molecules
- acquire the skill to determine the functional groups present in unknown molecules using vibrational (IR) spectra and to calculate the absorption of molecules in Electronic (UV-Visible) region using Woodward-Fischer rule
- learn the magnetic properties of electrons and nucleus of atoms, molecules and free radicals, using of nuclear magnetic resonance and electron spin resonance spectra and the learn hyperfine interactions of nuclei present in a molecule
- identify the unknown molecular weight and formula of organic compounds

MODULE I ELECTROMAGNETIC RADIATION AND ROTATIONAL SPECTROSCOPY **9**

Characterization of electromagnetic radiation – regions of the spectrum – basic elements of practical spectroscopy – enhancement of spectra – Microwave spectroscopy – rotational spectra of molecules – applications.

MODULE II INFRA-RED & RAMAN SPECTROSCOPY **9**

Infra-red spectroscopy – harmonic and unharmonic vibrations – dissociation energy of diatomics – vibrating rotator – PQR branches in IR spectra – Fermi resonance – Raman spectroscopy – mutual exclusion principle.

MODULE III ELECTRONIC SPECTROSCOPY **9**

Electronic spectra of diatomic molecules: Born Oppenheimer approximation,Franck-Condon principle, selection rules, intensity of electronic transition, vibronic coupling, types of electronic transition - UV-Visible spectroscopy –solvent effects – Woodward-Fischer rule to conjugated dienes.

MODULE IV SPIN RESONANCE SPECTROSCOPY **9**

Proton magnetic resonance spectroscopy – relaxation processes – chemical shift – coupling – ^{13}C NMR spectra – Electron spin resonance spectroscopy – hyperfine interactions.

MODULE V MASS SPECTROMETRY 9

Reactions of ions in gas phase – effect of isotopes – nitrogen rule –determination of molecular formula – fragmentations and rearrangements –metastable ions – fragmentation of organic compounds. Application of Mass spectroscopy with GC.

L – 45; Total Hours –45

REFERENCES:

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. Robert M. Silverstein, Francis X. Webster, David Kiemle, Spectrometric Identification of Organic Compounds, 7th Edition, Wiley, 2005.

OUTCOMES:

The students will be

- able to gain the theoretical knowledge of the various spectroscopic methods.
- familiar with modern spectrometers and methods, which are applied in industrial and scientific laboratories in the field of synthesis and structural determination.

CHD6205	SYNTHETIC ORGANIC CHEMISTRY PRACTICAL	L	T	P	C
		0	0	4	2

OBJECTIVES:

To make the students

- Identify organic compounds by TLC technique and purify them by column chromatography.
- expertise in multi step synthesis of organic compounds.

List of Experiments

1. Identification and purification of organic compounds by thin layer and column chromatographic techniques.
    1. Two to three stage preparation of organic compounds (minimum six synthesis to be done) involving reactions like Beckmann rearrangement, bromination, oxidation, Grignard reaction, reduction, dye preparation, synthesis of aspirin, addition of HBr, nitration, sulphonation, dehydration, green synthesis, esterification, hydrolysis, alkylation, Click reaction, MCR, etc
2. Isolation and characterization of above synthesized compounds by melting point / boiling point, NMR, IR and mass spectroscopic techniques.

P - 60; Total Hours –60

REFERENCES:

1. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry (4th Edition), Longmann group, 2008.
2. N.S. Gnanapragasam, G. Ramamurthy, Organic Chemistry – Lab manual, S. Viswanathan Co. Pvt. Ltd., 1998.
3. V.K. Ahluwalia S Dhingra Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press, 2000.
4. Robert M. Silverstein, Francis X. Webster, David Kiemle, Spectrometric Identification of Organic Compounds, 7th Edition, Wiley, 2005.
5. Kemp W., Organic Spectroscopy, 3rd Edition, ELBS, McMillan, London, 1991.

OUTCOMES:

The students will be able to

- Identify organic compounds by TLC technique and purify them by column chromatography.
- perform laboratory synthesis independently
- characterize organic compounds by spectral techniques.

CHD 6206	INORGANIC CHEMISTRY PRACTICAL-II	L	T	P	C
		0	0	4	2

OBJECTIVES:

The students will be trained to

- estimate the metal components present in alloys
- prepare different complexes
- characterize the complexes by spectral techniques
- synthesis of green reagents

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, 6th 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.

OUTCOMES:

The students will be able to

- estimate the various metal ions present in alloys by titrimetry and gravimetry
- prepare different complexes
- characterize the complexes by spectral techniques
- synthesis green reagents

CHD 6207	PHYSICAL CHEMISTRY PRACTICAL- II	L	T	P	C
		0	0	4	2

OBJECTIVES:

To make the students trained to

- Expertise in the applied concepts of polarimetry, viscometry, electrochemistry, thermodynamic parameters, Phase equilibrium, adsorption. etc.
- Determine the rate constant
- Identify the compounds using UV, IR etc
- Saponify oils and fats
- Draw structures and graph using softwares and prepare reports

List of Experiments

1.Determination of CST in phenol-water system.
2.Determination of sucrose content in cane sugar by polarimetry
3.Verification of freundlich adsorption isotherm- Adsorption of acetic acid and oxalic acid on activated carbon
4.Determination of thermodynamic parameters
5.Determination of order of the reaction
6.Identification of compounds by spectral techniques
7.Uses of computer packages : Microsoft (word, excel and power point), origin, chemsketch and chemdraw
8. Determination of rate constant
9.Saponification of oils and facts.
10.Determination of molecular weight of a polymer by viscometric method.

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.

OUTCOMES:

The students will be able to

- Measure the absorption capacity of various materials
- Draw the phase diagram for phenol water system and analyze it
- Measure the different thermodynamic parameters
- Identify the compound using spectral techniques.
- Draw chemical structures using chemsketch and chemdraw
- Draw graphs using excel and origin software
- Prepare the final dissertation report using MS word by themselves
- Determine the rate constant of first and second order reactions
- Determine the molecular weight of a polymer

CHD 7101	SYNTHETIC AND SPECTROSCOPIC ORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- Knowledge of the increasingly important role played by organic and transition metals reagents and catalysts with their corresponding proposed reaction mechanisms.
- Knowledge for rational mechanism-based design of synthetic strategies for complex organic molecules.
- NMR, IR and mass spectral data for structural elucidation of organic compounds.

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, LDA, Gilman's reagent, phase transfer catalysts, Wittig, 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 STRATEGIES FOR SYNTHESIS - 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 STRATEGIES FOR SYNTHESIS - 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 NMR, IR AND MASS SPECTROSCOPY 9

NMR phenomenon – spin nuclei (1H and 13C) – chemical shift – structural correlation to coupling constant – examples of AB, AX, AA'BB' and ABX systems – 13C NMR and its chemical shifts – NOE effects – application of DEPT techniques to the analysis

of CH multiplicities in C13 NMR – Infared spectroscopy - organic functional group identification through IR spectroscopy – Mass spectrophotometry – deduction of structure through mass spectral fragmentation of organic molecules – HRMS.

MODULE V INTERPRETATION OF SPECTRAL DATA 9

Case studies: Structure elucidation problems of organic molecules using NMR (1H and 13C), IR and Mass spectroscopic techniques –Illustration of practical applications of 1H-1H COSY, 1H-13C COSY.

L – 45; Total Hours –45

REFERENCES:

1. 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. Jerry March, Advanced Organic Chemistry, 4th Edition, Wiley-Interscience, New York, 2007.
4. Stuart G. Warren, Organic Synthesis: The Disconnection Approach Wiley India, 2007.
5. Macomber, R. S. A complete introduction to modern NMR spectroscopy, Wiley, 1997.
6. Kemp, William. Organic Spectroscopy, 4th Edition, ELBS-Macmillan, 1999.
7. Silverstein, R. M.; Bassler, G. C. Spectroscopic identification of organic compounds, 2nd Edition, Wiley, 1997.

OUTCOMES:

The students will be able to

- Identify various reagents for application in organic synthesis.
- Be equipped as a more competent synthetic organic chemist due to being capable of design the synthesis of complex drug or drug like organic molecules.
- Apply the spectroscopic techniques like NMR, IR and Mass for arriving at the structure of an organic molecule.

CHD 7102	QUANTUM CHEMISTRY AND GROUP THEORY	L	T	P	C
		3	1	0	4

OBJECTIVES:

To make the student conversant with

- understand the origin of classical mechanics and the background of quantum mechanics
- derive and use of Schrodinger equation to simple systems
- able to construct the molecular orbital for molecules
- gain the basics of quantum statistics and how it is applied to systems of chemical interest
- learn the concepts symmetry elements and operations, able to assign the point group of molecules

MODULE I INTRODUCTION TO QUANTUM CHEMISTRY 9

Review of essential mathematical concepts. General introduction to classical and quantum mechanics. Classical mechanics: black body radiation, photo electric effect, heat capacity of solids and inadequacy of classical mechanics. Quantum mechanics: historical background, principles and postulates. Operators and their properties. Eigen value – Eigen functions.

MODULE II SOLUTIONS OF SCHRODINGER EQUATION AND APPROXIMATE METHODS 9

Schrodinger equation, Discussion of solutions of the Schrodinger equation to few systems: particle in a box, 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 QUANTUM OF MOLECULES AND QUANTUM STATISTICS 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. Case studies

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 9

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

L – 45; T – 15; Total Hours –60

REFERENCES:

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.

OUTCOMES:

The students will be able to

- Basic aspects of quantum chemistry of atoms and molecules
- Importance of quantum chemistry and how to apply this knowledge to atomic and molecular structure

- Able to understand clearly the microscopic and inner details of chemical reactions in chemistry point of view
- In depth knowledge and understanding of photochemical reactions
- Assign the symmetry elements and point group of molecules/ion/complexes
- Indentify the symmetry in molecules and explain the character table of C_{2v} and C_{3v} point groups

CHD 7103	ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with the

- structure and bonding of organometallic compounds
- Structure and electron count of metal clusters
- Reactions of organometallic compounds
- Different types of bio-inorganic molecules
- Use of spectroscopic tools to characterize the organometallic compounds

MODULE I ORGANOMETALLIC COMPOUNDS 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 SPECTROSCOPIC CHARACTERIZATION OF INORGANIC AND ORGANOMETALLIC COMPOUNDS 9

Infrared and Raman spectroscopy of simple inorganic molecules; predicting number of active modes of vibrations, analysis of representative spectra of metal complexes with various functional groups. Applications of 1H and 13C NMR in inorganic and organometallic chemistry, fluxionality and dynamics; deriving activation and thermodynamic parameters; NMR spectral analyses of B, Al, Si, F and P containing compounds. Elementary aspects of Electron paramagnetic resonance (EPR) spectroscopy of inorganic compounds - gvalues, hyperfine and super hyperfine coupling constants; selected applications in inorganic chemistry.

L – 45; Total Hours –45

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.

OUTCOMES:

Students will be able to

- Classify the variety of metal-carbon bonds involved in organometallic compounds.
- Find the structure and stability of metal clusters.
- Illustrate reactivity and stereochemistry of organometallic compounds.
- Learn the importance of bioinorganic molecules in life
- Analyze the use of spectroscopic tools to find the structure of any unknown organometallic compound.

CHDY 001	GREEN CHEMISTRY	L	T	P	C
		3	0	2	4

OBJECTIVES:

To make the students conversant with the

- principle and advantages of green chemistry.
- principle and uses of microwave as a green technology.
- Applications of ionic liquids and phase transfer catalyst
- Application of supported catalysts and bio catalyst for green synthesis various alternative reagents and chemicals for green synthesis.

MODULE I INTRODUCTION TO GREEN CHEMISTRY 9

Green chemistry-relevance and goals, Anastas' twelve principles of green chemistry - Tools of green chemistry: alternative starting materials, reagents, catalysts, solvents and processes with suitable examples.

MODULE II MICROWAVE ASSISTED ORGANIC SYNTHESIS (MAOS) 9

Microwave activation – advantage of microwave exposure – specific effects of microwave – Neat reactions – solid supports reactions _ Functional group transformations – condensations reactions – oxidations – reductions reactions – multi-component reactions.

MODULE III IONIC LIQUIDS AND PHASE TRANSFER CATALYSIS 9

Introduction – synthesis of ionic liquids – physical properties – applications in alkylation – hydroformylations – epoxidations – synthesis of ethers – Friedel-craft reactions – Diels-Alder reactions – Knoevenegal condensations – Wittig reactions – Phase transfer catalyst - Synthesis – applications.

MODULE IV SUPPORTED CATALYSTS AND BIO-CATALYSTS FOR GREEN CHEMISTRY 9

Introduction – the concept of atom economy – supported metal catalysts – mesoporous silicas –the use of Biocatalysts for green chemistry - modified bio catalysts – fermentations and biotransformations – fine chemicals by microbial fermentations – vitamins and amino acids – Baker's yeast mediated biotransformations – Bio-catalyst mediated Baeyer-Villiger reactions – Microbial polyester synthesis.

MODULE V ALTERNATIVE SYNTHESIS, REAGENTS AND REACTION CONDITIONS 9

Photochemical alternative to Friedel-crafts reactions - Dimethyl carbonate as a methylating agent – the design and applications of green oxidants – super critical carbon dioxide for synthetic chemistry.

PRACTICALS

1. Synthesis of organic compounds by green methods.
2. Synthesis of metal complexes by green methods.

L – 45; P – 30; Total Hours –60

REFERENCES:

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).

OUTCOMES:

The students will demonstrate the

- principles and advantages of green chemistry.
- principles and uses of microwave as a green technology.
- Applications of ionic liquids and phase transfer catalyst
- Supported catalysts and bio catalyst for green synthesis
- various alternative reagents and chemicals for green synthesis.

CHDY 002 PHOTOPHYSICS AND PHOTOCHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the students conversant with the

- basic laws of photophysics and photochemistry.
- principle and instrumentation of different types of spectrofluorimeter.
- Basics of fluorescence spectroscopy
- Different types of photochemical reactions
- Applications of solar energy materials.

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 relaxations, fluorescence, phosphorescence, Stokes Shift, Kasha's rule.

MODULE II INSTRUMENTATION TECHNIQUES 9

Spectrophotometer, light Sources, photochemical quauntum yield and intensity measurements, detectors-PMT, Diode-array. Spectrofluorimeter – Steady state and Time-resolved fluorimeter. Study using time resolved techniques – pump-probe methods and instrumentation: Lasers-nanosecond, picosecond and femtosecond. Measurement of – Triplet quantum yield and Time resolved absorption spectrum. Fluorescence standards – lifetime and quantum yield.

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

Electron transfer – rate – excited state oxidation potential, Rehmweller equation, Energy transfer – Dextor and Forster – distance dependance, proton transfer -ESIPT, addition reactions - Paterno-Büchi Reaction, elimination reactions - Norrish type I and II reactions.Photoisomerisation, photosensitization, photooxygenation, ene reaction.

MODULE V APPLICATIONS 9

Artificial Photosynthesis –Photovoltaic effect – Silicon solar cells - Organic Solar Cells – DSSC, Bulk heterojunction– Inorganic solar cell, Quantum dots solar cells, perovskite solar cells. Sensors – chemosensors – fluorimetric sensors – biosensors - Limit of detection. Aggregation induced emission – AIE nanodots – bioimaging. Photocatalysis.

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.

OUTCOMES:

The students will be able to

- 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
- describe the interaction of excited states with their surroundings and analyse photoinduced electron transfer and excitation energy transfer with quantitative models
- describe the structure and function of photosynthetic reaction centres, and explain the function of photosynthetic antenna systems
- apply the knowledge of photochemistry in various fields.

CHDY 003 BIO-ORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student conversant with

- The structures of mono, di and poly saccharides in nature.
- understand the structures and functions of bioorganic molecules and antibiotics

MODULE I CARBOHYDRATES 10

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 - carbohydrate metabolism: glycolysis - citric acid cycle.

MODULE II PROTEINS 9

Amino acid: classification - amino acid degradation (urea cycle) - 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 10

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 ANTIBIOTICS 7

Antibiotics: structural elucidation of penicillin-V, chloromycetin, streptomycin and terramycin.

L – 45; Total Hours – 45

REFERENCES:

1. Singh, J. and Yadav, L.D.S., “Advanced Organic Chemistry”, Ninteenth Edition, A pragati Edition, Meerut, 2013.
2. Khan, M.A., “Chemistry of Natural products”, First Edition, Omega Publcations, New Delhi, 2011.
3. Ahluvalia, V.K., “Chemistry of Natural Products”, First Edition, Vishal Publishing Co, Jalandhar, 2008.
4. Faber, K., “Biotransformations in Organic Chemistry”, Fifth Edition, Springer, New York, 2008.
5. Stryer, L., “Biochemistry”, Fifth Edition, W.H. Freeman and Company, San Francisco, 2002.
6. Jain, J.L., “Fundamentals of Biochemistry”, Fourth Edition, S. Chand & Company Limited, New Delhi, 2007.

OUTCOMES:

The students will be able to

- Recognise and identify the different types of carbohydrate in nature.
- Correlate the structure with its function of the bioorganic molecules.
- Depict the utility of antibiotics

CHDY 004	CHEMISTRY OF HETEROCYCLIC AND NATURAL PRODUCTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- The structure and reactivity of the naturally occurring heterocyclic compounds
- Structure and function of terpenoids and vitamins

MODULE I HETEROCYCLES 9

Nomenclature of heterocycles – classification – Synthesis and reactivity of pyrole, furan, thiophene, pyridine, pyran, indoles, quinolines, isoquinolines, benzopyran, chromones, coumarins – application of heterocylic compounds towards material and medicinal chemistry.

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

Methods to elucidate the structure of terpenes – structural elucidation of α-pinene, zingiberene, cadinene, α-santonin, abietic acid and squalene - biosynthesis of mono- and di- terpenoids

MODULE V VITAMINS 9

Classification – structural elucidation of vitamins – A, B_1, B_2, B_6, B_{12}, ascorbic acid, E and K

L – 45; Total Hours – 45

REFERENCES:

1. Alan, R Katritzky, Advances in Heterocyclic Chemistry, Elsevier Acad. Press, 2004.
2. T. L. Gilchrist, Heterocyclic chemistry, Pearson, 2009.
3. Clayden, J.; Greeves, N.; Warren, S.; and Wothers. P. Organic Chemistry, Oxford University Press, 2000.
4. Khan, M.A., “Chemistry of Natural products”, First Edition, Omega Publcations, New Delhi, 2011.
5. Ahluvalia, V.K., “Chemistry of Natural Products”, First Edition, Vishal Publishing Co, Jalandhar, 2008.
6. Faber, K., “Biotransformations in Organic Chemistry”, Fifth Edition, Springer, New York, 2008.

OUTCOMES:

The students will be able to

- Recognize the structure and reactivity of heterocyclic compounds.
- Acquaint with the structure and synthesis of terpenoids and alkaloids
- Evaluate the biosynthesis and structure of steroids
- Evaluate the structure of vitamins to its biological functions.

CHDY 005 BIOCHEMISTRY

L	T	P	C
3	0	2	4

OBJECTIVES:

The student are trained about

- Mechanism of enzymes and coenzymes.
- Carbohydrate metabolism
- Lipid metabolism and biological oxidation.
- Biochemistry of amino acids
- Biochemistry of proteins

MODULE I ENZYMES AND COENZYMES 9

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 9

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 9

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 9

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

Biosynthesis of RNA, DNA replication, carcinogensis and DNA repair mechanism.

MODULE V BIOCHEMISTRY OF PROTEINS 9

Genetic code and protein synthesis, components of protein synthesis, inhibition of protein synthesis. Regulation of gene expression (Prokaryote and Eukaryote).

PRACTICALS

1. Preparation of standard buffers (citrate, phosphate and carbonate) and measurement of pH.
2. Titration curve for amino acids.
3. Separation of amino acids by chromatography.
4. The separation of lipids by TLC.
5. Quantitative estimation of amino acids.
6. The determination of glucose by means of the enzyme glucose oxidase.
7. Enzymatic hydrolysis of glycogen by α and β-amylase.
8. Effects of temperature on the activity of α- amylase.
9. Estimation of cholesterol in Blood.
10. Estimation of Glucose in blood and urine.
11. Estimation of Urea in blood.
12. Estimation of ketone bodies in blood.
13. Qualitative analysis of inorganic as well as organic constituents of Urine.

L – 45; P-30;Total Hours –75

REFERENCES:

1. Conn E.E. and Stumph P.K., Outline of Biochemistry, John Wiley and Sons, New York.
2. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, Macmillan Worth Publishers.
3. Stryer L., Biochemistry, W.H., Freeman and Company, San Francisco.
4. Harrow B. and Mazur A., Text book of Biochemistry, W.B. Saunders Co., Philadephia.
5. Harpers Review of Biochemistry, Lange Medical Publication.
6. Jayaraman J., Laboratory Manual in Biochemistry, Wiley Eastern Limited.
7. Plummer David J., An Introduction to Practical Biochemistry, McGraw Hill, New Delhi.
8. Singh S.P., Practical Manual to Biochemistry, CBS Publisher, New Delhi.

OUTCOMES:

The students are acquainted with the

- Mechanism of enzymes and coenzymes.
- Carbohydrate metabolism
- Lipid metabolism and biological oxidation.
- Biochemistry of amino acids
- Biochemistry of proteins
- Different types of textile mat

CHDY 006 PHARMACEUTICAL TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To make the student learn about the

- pre formulation studies
- additives used in formulations
- evaluation of drug and packaging
- cosmetic preparations
- manufacturing the packaging materials

MODULE I PRE-FORMULATION STUDIES 9

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 LIQUID DOSAGE FORMS 9

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.

MODULE III SEMISOLID DOSAGE FORMS 9

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 IV SUPPOSITORIES 9

Ideal requirements, bases, manufacturing procedure, packaging and evaluation.
Pharmaceutical Aerosols: Definition, propellants, general formulation, manufacturing and packaging methods, pharmaceutical applications.

MODULE V COSMETOLOGY AND COSMETIC PREPARATIONS 9

Structure of skin, formulation of cold cream, vanishing cream, cleansing cream, all purpose cream, protective cream, antiperspirants, deodorant, face powder - Hair structure, Shampoos, Conditioner, Shaving and after shaving products, Dentrifice and Mouthwash, Lipstick, Nail lacquer.

L – 45; Total Hours –45

REFERENCES:

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. Harrys Cosmetology.
7. Balsam and Sagarin, Cosmetics: Science and Technology.
8. Thomssen E.G., Modern Cosmetics, Universal Publishing Corporation.
9. Mittal B.M. and Saha R.N., A Handbook of Cosmetics, Vallabh Prakashan.

OUTCOMES:

The students will be familiar with the

- pre formulation studies
- additives used in formulations
- evaluation of drug and packaging
- manufacturing the packaging materials
- preparation of cosmetics

CHDY007	GMP, QUALITY ASSURANCE AND VALIDATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student learn about the

- good manufacturing practices
- documentation, quality management and control
- Validation methods
- IPQC problems
- Sampling and operating characteristics curves

MODULE I GOOD MANUFACTURING PRACTICE 9

Requirements of GMP, CGMP1, GLP, USFDA, WHO guidelines and ISO 9000 series.'

MODULE II DOCUMENTATION AND MAINTENANCE 9

Documentation - Protocols, Forms and maintenance of records in Pharmaceutical industry - Preparation of documents for new drug approval and export registration.

MODULE III QUALITY ASSURANCE 9

Basic concept of C, Quality assurance systems, Sources and control of quality variation - raw materials, containers, closures, personnel, environment etc.

MODULE IV VALIDATION 9

Concepts in validation, validation of manufacturing and analytical equipment, Process validation in manufacturing dosage formulations, applications of process validation.

MODULE V QUALITY CONTROL 9

In process quality control tests, IPQC problems in pharmaceutical industries - Sampling plans, Sampling and operating characteristics curves.

L – 45; Total Hours –45

REFERENCES:

1. Willing, Tuckerman and Hitchings, Good Manufacturing Practices for Pharmaceuticals.

2. OPPI, Quality Assurance.
3. Loftus and Nash, Pharmaceutical Process Validation.
4. Florey, Analytical Profile of Drugs (All volumes).
5. Indian Pharmacopoeia.
6. MODULEed States Pharmacopoeia.
7. British Pharmacopoeia.
8. Garfield, Quality Assurance Principles for Analytical Laboratories.

OUTCOMES:

The student will be able to demonstrate the

- implement the various guidelines for manufacturing chemicals and pharmaceuticals
- document each and every process for quality management
- adopt the quality assurance systems for the process undertaken
- validate the process, equipments, formulation
- assess the samples using quality control test

CHDY008	MEDICINAL AND PHARMACEUTICAL CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student to learn

- The basic factors governing drug design
- The synthesis and drug action of anti-malarial, anti-bacterial and anti-tuberculosis drugs, etc.

MODULE I INTRODUCTION TO DRUG DESIGN 9

Factors governing drug design – advantages – types of drug – literature survey for preparation of drugs – characterization and structural elucidation of drugs using different spectral methods.

MODULE II ANALGESICS, ANTIHISTAMINES AND ANTIMALARIALS 9

Analgesics – narcotic analgesics – morphine analogues – synthesis of codeine – synthetic narcotic analgesics –— antipyretic analgeics – salicyclic acid analogues –— para amino phenol derivatives – Antihistamines-structure, synthesis, activity promethazine, chlorpheneraminemaleate - Antimalerials – classification- structure, synthesis, drug action - quinine-4-amino and 8-amino quinolines – chloroquine.

MODULE III ANTIBIOTICS AND ANTIBACTERIALS 9

Synthesis and mode of action -Antibiotics – pencillin, D-pencillamine, semisythetic pencillin – chloramphenicol streptomycin, tetracyclines, cephalosporins,-Antibacterials – 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 STEROIDS AND RELATED DRUGS 9

Introduction, classification, nomenclature and stereochemistry - (A) Androgens - testosterone (B) Estrogens and progestational agents – progesterone, estradiol, (C) Adrenocorticoids – prednisolone, dexamethasone- prostaglandins: misoprostol.

L – 45; Total Hours –45

REFERENCES:

1. J. B. Stenlake, Medicinal and Pharmaceutical Chemistry, Volume 1, Viva /b S Publication, 1979.
2. A. Berger, Medicinal Chemistry, Wiley Interscience, New York, Volume 1 and 2, 1990.
3. Bentely and Driver's Textbook of Pharmaceutical Chemistry, Oxford University Press, 1985.
4. David A. Williams, David A. Williams A, William O. Foye, Thomas L. Lemke, Foye's Principles of Medicinal Chemistry, Wolter Kluwer, 2008.
5. J. B. Stenlake, The Chemical Basis of Drug Action Volume 2, Viva /b S Publication, 1979.

OUTCOMES:

The student will be familiar with

- The drug design,
- The functions of various drugs
- the drug action and uses

CHDY 009 POLYMER CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the student conversant with the

- basic concepts of polymers, molecular weight and its distribution
- kinetics and mechanism of Addition, Coordination and Condensation polymerization
- various polymerization techniques
- various testing methods for mechanical, thermal and electrical properties
- preparation, properties and applications of polymeric materials.

MODULE I BASIC CONCEPTS OF POLYMERS 9

Basic concepts of polymers – classification of polymers: source, structure, processing behavior, composition and structure, mechanism, application – copolymer: types – terpolymer: Definition – nomenclature of polymers – tacticity – crystalline and amorphous polymers – thermal transitions – factors affecting crystallinity and glass transition temperature – Molecular weight of polymer – number, weight and viscosity average molecular weights – molecular weight distribution (problems)

MODULE II KINETICS AND MECHANISM OF POLYMERISATION REACTIONS 9

Kinetics and mechanism of addition polymerization: free radical, cationic and anionic polymerizations – Trommsdroff effect – living polymers – Ziegler-Natta catalysts – coordination polymerization – Kinetics of polycondensation reactions – copolymer equation– Reactivity ratio and copolymerization behavior.

MODULE III POLYMERISATION TECHNIQUES 9

Polymerisation techniques – homogenous and heterogeneous polymerization – bulk, solution, suspension and emulsion polymerization – merits and demerits – interfacial, and melt polycondensation.

MODULE IV POLYMER TESTING AND ANALYSIS 9

Mechanical properties: tensile strength, flexural strength, Izod impact – thermal properties : TGA and DSC – electrical properties: dielectric strength (measurement methods and factors affecting) ; dielectric constant and dissipation factor (definitions

only),– molecular weight: determination by GPC and viscometry.

MODULE V POLYMERIC MATERIALS 9

Preparation, properties and applications – thermoplastics : LDPE, HDPE, PVC, PTFE, PET and Nylons – thermosets : phenolic resins, epoxy resins, unsaturated polyesters and polyurethanes – polymer blends and alloys – reinforced plastics.

L – 45; Total Hours – 45

REFERENCES:

1. Billmeyer F.N., Text Book of Polymer Science, 3rd Edition, John Wiley and Sons, New York, 1994.
2. George Odian, Principles of Polymerisation, 3rd Edition, McGraw Hill Book Company, New York, 1991.
3. Young R.S., Introduction to Polymers, Chapman and Hall Ltd., London, 1981.
4. P. J. Flory., Principles of Polymer Chemistry, Cornell Press (recent edition).
5. Vishu shah., Handbook of plastics testing and failure analysis, John Wiley and Sons, New Jersey, 2007.
6. I.M. Ward and D.W. Hadley, An Introduction to the Mechanical Properties of Solid Polymers, John Wiley and Sons, Chichester, England, 1993.
7. C.C. Ku and R. Liepins, Electrical Properties of Polymers, Hanser Publications, Munich, 1987.
8. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, New York, 1998.
9. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
10. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.

OUTCOMES:

The student will be able to

1) classify various polymers, calculate molecular weight of polymers, explain the theory of crystallinity and thermal transitions.
2) derive the rate equations and explain the mechanism of polymerization reactions
3) compare and contrast the various polymerization techniques with its merits and demerits.
4) analyze and test the polymers for the mechanical, thermal and electrical properties
5) summarize the preparation, properties and applications of different polymeric materials

CHDY 010 NANOTECHNOLOGY L T P C
3 0 2 4

OBJECTIVES:

To make the students conversant with the

- definition and significance of nanoscale materials and their properties
- basic knowledge on nanoscience and nanotechnology which includes the exotic properties of materials at nanoscale
- various techniques available for the processing and characterization of nanostructured materials
- applications in selected fields and impacts of nanotechnology

MODULE I INTRODUCTION OF NANOMATERIALS 9

Introduction to nanomaterials, Properties of nanomaterials, role of size, stabilizing agent, medium in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state.

Nanostructures: Zero-, One-, Two- and Three-dimensional structures, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface Plasmon Resonance, Change of bandgap; Application: catalysis, electronic devices.

MODULE II PREPARATION OF NANOMATERIALS 9

Methods of preparation of nanomaterials, top-down approach and bottom-up: Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Sol-gel synthesis; Microemulsions or reverse micelles, Ball milling synthesis; lithography, Plasma Laser deposition (PLD) techniques, Solvothermal synthesis; Thermolysis routes, Microwave assisted synthesis; Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis, inert-gas condensation synthesis.

MODULE III CHARACTERIZATION TECHNIQUES 9

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), TEM and EDAX and SAED analysis, Atomic force Microscopy (AFM). X-ray Photoelectron spectroscopy (XPS), Raman technique for nanomaterials characterization.

Introduction to advanced Scanning Probe Microscopy Techniques Scanning

Tunnelling Mode (STM), Piezoelectric force microscopy (PFM).

MODULE IV APPLICATIONS AND ENVIRONMENTAL IMPACTS 9

Current applications - sunscreens and cosmetic, composites, clays, coatings and surfaces, tougher and harder cutting tools. Short-term Applications – Paints, remediation, fuel cells, displays, batteries, fuel additives, catalysts. Long - term Applications - lubricants, magnetic materials, medical implants machinable ceramics, water purification, military battle suits.

Biomedical applications – Photodynamic therapy in targeted drugs, biosensors, quantum dot technology in cancer treatment, MRI applications. Nanosensors: pH, heat, humidity, gas, toxic chemicals sensors and sensors for aerospace and defence. Environmental Impacts: toxicological health effects, relevant parameters in nanoparticles toxicology, integrated concept of risk assessment of nanoparticles.

MODULE V CARBON NANOSTRUCTURES 9

Carbon nanostructures: Introduction. Fullerenes, carbon nanotubes, graphite, graphene oxide, carbon quantum dots nanostructures. Properties & applications (mechanical, optical and electrical). Functionalization of and reactivity of carbon nanomaterials, graphene oxide, carbon nanotubes.

Applications of carbon nanostructures - field emission, conductive or reinforced plastics, energy storage, conductive adhesives and connectors, molecular electronics, thermal materials, structural composites, fibers and fabrics, catalyst support, CNT ceramics, biomedical applications, air, water and gas filtration.

PRACTICALS

1. Synthesis and characterization of nanoparticles

a) Copper oxide b) Titanium oxide c) Zinc oxide

d) Iron oxide e) Graphene oxide f) Carbon quantum dots

g) Copper nanoparticles h) Silver nanoparticles i) Ag/Cu nanoclusters etc.,

2. Demonstration of analysis of nanoparticles by

a) XPS b) TEM c) XRD d) CV e) Fluorescence f) SEM

L – 45; P – 30; Total Hours –75

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

OUTCOMES:

The students will be able to

- differentiate the nanomaterials based on their dimensions
- acquire knowledge of various synthetic methods and characterization techniques
- select the appropriate nanomaterials for specific applications
- biomedical applications
- application of carbon nano structure

CHDY 011	CONCEPTS AND TECHNIQUES IN CATALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objectives of this course is to

- impart the basic concepts involved in catalytic processes.
- learn the different preparation methods of catalysts such as by precipitation, impregnation, mixing method, ion-exchange, etc.
- develop a knowledge in the physic-chemical and spectral characterization methods for catalytic materials.
- evaluate the catalysts using different catalytic reactors
- use different types catalysts for various organic reactions in detail.

MODULE I 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

MODULE II HETEROGENEOUS CATALYSTS AND THEIR SYNTHESIS **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)

Hydrothermal synthesis, sol-gel process, impregnation method, ion-exchange method - MODULE operations in catalyst manufacture - drying, calcination, spray drying

MODULE III CATALYSTS CHARACTERIZATION **9**

Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFT), Diffuse Reflectance UV-Visible Spectroscopy (DRSUV), X-ray Powder Diffraction (XRD), Brunauer-Emmett-Teller (BET) Surface Area Analysis, Barrett-Joyner-Halenda (BJH) Pore Size and Volume AnalysisMagic Angle Spinning Nuclear Magnetic Resonance

(MAS NMR) (^{29}Si, ^{27}Al, ^{31}P), Auger Electron Spectroscopy (AES), Scanning Electron Microscopy and Energy Dispersive Spectroscopy (SEM/EDAX), Electron Probe Micro-Analyzer (EPMA), Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), X-ray Photoelectron Spectroscopy (XPS), Extended X-ray Absorption Fine Structure Spectroscopy (EXAFS), Transmission Electron Microscopy (TEM), Electron Spin Resonance Spectroscopy (ESR).

MODULE IV CATALYTIC REACTORS **9**

Integral and fixed bed reactors - differential reactors - stirred flow reactors - microcatalytic reactors of pulse type - static reactors – high pressure reactors - reaction monitoring by GC and GC-MS.

MODULE V CATALYTIC REACTIONS **9**

Catalytic asymmetric synthesis - C-C, C-H bond formation, oxidation - acid catalysed isomerisation - heterogeneous hydrogenation, dehydrogenation, cyclo dehydrogenation, oxidation - Homogeneous catalysis by transition metal complexes - metathesis of olefins - synthetic fuels.

L – 45; Total Hours –45

REFERENCES:

1. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan Publishers India Limited, 2000.
2. John Meurig Thomas and W. John Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley, 1997.
3. Herman Pines, The Chemistry of Catalytic Hydrocarbon Conversions, Academic Press, 1981.
4. J.W. Niemantsverdriet, Spectroscopy in Catalysis, 2nd Edition, John Wiley and Sons, 2008.
5. 2Gadi Rothenberg, Catalysis: Concepts and Green Applications, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2008.
6. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis: Principles and Applications, Narosa Publishing House, 2002.
7. Julian R.H. Ross, Heterogeneous Catalysis: Fundamentals and Applications, Elsevier, 2011.
8. Gerhard Ertl, Handbook of Heterogeneous Catalysis, 2nd Edition, Volume 6, Wiley-VCH-Verlag, 2008.

9. Charles N. Satterfield, Heterogeneous Catalysis in Practice, McGraw-Hill, 1980.
10. Jens Hagen, Industrial Catalysis: A Practical Approach, 2nd Edition, Wiley, 2006.
11. Jens Weitkamp, Lothar Puppe (Editors), Catalysis and Zeolites: Fundamentals and Applications, Springer, 1999.
12. R.A. Sheldon and Herman van Bekkum (Editors), Fine Chemicals through Heterogeneous Catalysis, John Wiley and Sons, 2008.
13. Michel Che and Jacques C. Védrine (Editors), Characterization of Solid Materials and Heterogeneous Catalysts: From Structure to Surface Reactivity, John Wiley and Sons, 2012.

OUTCOMES:

The students will be acquainted with

- Concepts of catalytic process
- Methods of preparation of catalysts
- Characterization of catalytic materials
- Choosing the catalyst for various reactions

CHDY 012 POLYMER TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn about

- Classification of polymeric materials.
- the process of elastomers
- different types of moulding
- characterization of polymers
- 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 – reinforced plastics.

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 CHARACTERISATION 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, chemical, thermal, electrical and optical properties.

L – 45; Total Hours –45

REFERENCES:

1. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
2. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science and Engineering, 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.

OUTCOMES:

The students will be familiar with the

- classification of polymeric materials.
- the process of elastomers
- different types of moulding
- characterization of polymers
- effect of structure on polymer properties

CHDY 013 INORGANIC CHEMICAL TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To make the student to learn about the

- fuel and industrial gases
- chemicals used in fertilizers and glass industries
- principles of metallurgic processes

MODULE I FUEL AND INDUSTRIAL GASES 9

Fuel and industrial gases – production and uses of producer gas, water gas, coke oven gas, acetylene, natural gas and LPG: Liquefaction of gases – noble gases, carbon dioxide, hydrogen, oxygen, nitrogen.

MODULE II HEAVY CHEMICALS 9

Chloralkali industry – soda ash, caustic soda and chlorine. Chemicals from sea – sodium chrloride, magnesium chloride and bromine.

MODULE III ACIDS AND FERTILIZERS 9

Sulphur and sulphuric acid – nitric acid – ammonia – nitrogenous fertilizers – phosphorous – phosphoric acid – phosphatic fertilizers – potassic fertilizers.

MODULE IV SILICATE INDUSTRIES 9

Silicate industries – refractories – abrasives – ceramics – glass – cement, lime and gypsum.

MODULE V PRINCIPLES OF METALLURGICAL PROCESSES 9

Principles of Metallurgical Processes – ore benefication- pyrometallurgy, hydrometallurgy, powder metallurgy and electrometallurgy - Explosives and propellants – nuclear materials.

L – 45; Total Hours –45

REFERENCES:

1. B. Norris Shreve and Joseph A. Brink, Chemical Process Industries, McGraw Hill, Kogakusha Ltd., 1991.
2. M. Gopala Rao and Marshall Sitty (Editors), Dryden’s Outlines of Chemical

Technology, Affiliated East West Press Pvt. Ltd., 1992.
3. B.K. Sharma, Industrial Chemistry, GOEL Publishing House, 1991.
4. James A. Kent (Editors), Riegel's Industry Chemistry, Asia Publishing House, 1989.

OUTCOMES:

The student will be familiar with the

- use of caustic soda, sodium chloride
- N,P and K fertilizers
- Ceramics, glass, etc.
- Powder and extractive metallurgy

CHDY 014 ORGANIC CHEMICAL TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn about the

- industrial organic synthesis
- pharmaceuticals, pesticides and dyes

MODULE I BASIC PRINCIPLES OF CHEMICAL TECHNOLOGY 9

Classification of chemical technological processes – chemical equilibrium in technological processes – rates of technological processes – designing and modeling chemical technological processes and reactors.

MODULE II INDUSTRIAL ORGANIC SYNTHESIS 9

Raw materials – manufacture of methyl alcohol, ethyl alcohol, ethylene, 1,3-butadiene, acetylene, ethyl benzene, cumene, linear alkyl benzenes and alkyl phenols.

MODULE III SYNTHETIC ORGANIC CHEMICALS 9

Chemicals derived from ethylene – polyethylene, ethylene oxide, ethylene dichloride chlorinated hydrocarbons – chemicals derived from propylene – isopropyl alcohol, polypropylene, acrylontrile, propylene oxide – oxidation of butane – esters – maleic anhydride – acetone – ethyl methyl ketone – disphenol – DDT – aniline.

MODULE IV PHARMACEUTICALS AND PESTICIDES 9

Introduction – manufacture – aspirin, Phenobarbital, penicillin, malathion, parathion and naled.

MODULE V DYES 9

Classification – raw materials – intermediates – manufacture – azodyes – triphenylmethane dyes – xanthene dyes. Indigoid and thioindigoid dyes, sulphur dyes, phthalcoanines – optical brighteners.

L – 45; Total Hours –45

REFERENCES:

1. P.H. Groggins, MODULE Processes in Organic Synthesis, McGraw Hill Book Co., Kogakusha, 1984.
2. Peter Wiseman, An Introduction to Industrial Organic Chemistry, 2nd Edition,

Applied Science Publishers Ltd., London, 1979.

3. J.A. Kent, Reigel's Hand Book of Industrial Chemistry, 7th Edition, vanNostrand Reinhold Co., New York, 1974.

OUTCOMES:

The student will be familiar with the

- industrial organic processes with enes, alcohols, esters, ketones, etc.
- Manufacture of aspirin, penicillin xanthenes dyes, etc.

CHDY 015 WATER AND SOLID WASTE MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

To make the student to learn about the

- Quality standard for drinking water
- Industrial water treatment methods
- Waste Water analysis and treatment
- Solid waste collection and disposal

MODULE I REQUIREMENTS OF WATER AND PRELIMINARY TREATMENT 9

Requirements of water – quality standards for drinking water – object of water treatment – conventional treatment – turbidity removal – cause of turbidity – coagulation – common coagulants – theory of coagulation – mixing basins – flocculation – principle and design of flocculators – sedimentation – settling tanks – settling velocity – surface loading rate – efficiency of settling tanks – sludge removal mechanism.

MODULE II INDUSTRIAL WATER TREATMENT 9

Filtration – size and shape characteristics of filtering media – sand filters – hydraulics of filtration – design considerations – radial, upflow, high rate and multimedia filters – pressure filter - Water softening – lime soda, zeolite and demineralization processes – industrial water treatment for boilers.

MODULE III TREATMENT METHODS 9

Taste and odour control – absorption – activated carbon treatment – removal of colour – iron and manganese removal – aeration, oxidation, ion exchange and other methods – effects of fluorides – fluoridation and defluoridation – desalination – corrosion prevention and control – factors influencing corrosion – Langelier index – corrosion control measures.

MODULE IV WASTEWATER TREATMENT 9

Wastewater treatment – pre and primary treatment – equalization neutralization – screening and grid removal – sedimentation – oil separation gas stripping of volatile organics – biological oxidation – lagoons and stabilization basins – aerated lagoons – activated sludge process – trickling filtration – anaerobic decomposition – sludge handling and disposal.

MODULE V SOLID WASTE MANAGEMENT 9

Solid waste – definition – characteristics – perspectives – types of solid waste – sources – Solid waste generation – on-site handling, storage and processing – collection of solid waste – transfer and transport – disposal and conversion – biological conversion, thermal conversion and land fill

L – 45; Total Hours –45

REFERENCES:

1. W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edition, McGraw Hill Inc., 1989.
2. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw Hill Inc., 1985.
3. Metcalf and Eddy, Waste Water Engineering, 3rd Edition, McGraw Hill Inc., 1991.
4. Gilbut M. Masters, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd., 1991.
5. C.S. Rao, Environmental Pollution Control Engineering, Wiley Eastern Ltd., 1994.
6. S.P. Mahajan, Pollution Control in Process Industries, Tata McGraw Hill Publishing Company Ltd., 1994.

OUTCOMES:

The student will be familiar with the

- quality requirement of water,
- analysis and treatment methods.
- the types of solid waste, collection and disposal

CHDY 016	INDUSTRIAL ELECTROCHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student to learn about the

- basics of electrolysis
- electrometallurgy
- metal refining
- electrosynthesis
- 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 molten salt 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.

OUTCOMES:

The student will be familiar with the

- electrowinning,
- electrorefining,
- electrochemical metal finishing,
- electrosynthesis
- electrodialysis.

CHDY017	ELECTROCHEMICAL PROTECTION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student to learn about the

- cathodic protection
- Sacrificial anode system
- Impressed current cathodic protection
- Design of Anodic and cathodic protection

MODULE I CATHODIC PROTECTION 9

Fundamental aspects, Definition of cathodic protection using Evans diagram and Pourbaix diagram, Derivation of protective potential for steel protective potentials of different metals. Criteria for cathodic protection, half cells used in cathodic protection potential measuring devices, rectifiers, zero current ammeter, automatic control MODULEs, holiday detectors.

MODULE II SACRIFICIAL ANODE SYSTEM 9

Principle of sacrificial anodes, required properties of galvanic anodes, anode life, current output. Advantages and limitations of sacrificial anodes-shape - and size of anodes, inserts, back-fills: Magnesium anode-electrochemical properties, current density, anode consumption, composition field of application. Aluminium anode - electrochemical properties, composition, field of application - Zinc alloy anodes - electrochemical properties, composition, field of application.

MODULE III IMPRESSED CURRENT CATHODIC PROTECTION 9

Principle of impressed current system - DC power sources, cables, advantages and limitation, required properties of impressed current anode. Consumable anodes, Scrap steel, Aluminum -properties consumption - field of application. Permanent anodes, Graphite, High Silicon Iron, magnetite, platinum and platinum alloys platinised titanium, platinised Niobium, platinised tantalum, Metal oxide anodes lead alloy anode, properties, composition, consumption, field of application. Back fills for impressed current anodes.

MODULE IV DESIGN OF CATHODIC PROTECTION 9

Cathodic protection to buried structures - Field data, soil resistivity, pH determination redox potential measurement, potential measurement, long line

current survey, coating resistance, current drainage survey - Designing of sacrificial anode system, designing of impressed current system - Designing of CP to buried pipe line, ship hull and storage tank.

MODULE V Design of Anodic protection 9

Anodic protection: Principles of anodic protection-description of electrochemical passivity, characteristics of anodic polarisation curves, the passive metal layer and mechanism of iron passivity, passivity breakdown. Equipments for anodic protection-characteristics of cathodes, platinum clad cathode, Hastelloy - cathodes, stainless steel cathode. Reference electrodes-calomel half cell, silver/silver chloride half cell, mercury/mercury sulphate half cell, metal oxide and metals as reference electrodes. Design, operation and maintenance of anodic protection system. Establishing electrochemical parameters, operation and maintenance applications.

L – 45; Total Hours –45

REFERENCES:

1. John H. Morgan, Cathodic Protection, New Age International, 2nd Edition, 1987.
2. Glen, L. Riggs, Anodic Protection, Kluwer Academic Publication, 1981.

OUTCOMES:

The students will be familiar with the

- cathodic protection
- Sacrificial anode system
- Impressed current cathodic protection
- Design of Anodic and cathodic protection

CHDY 018 PROTECTIVE COATINGS L T P C
3 0 0 3

OBJECTIVES:

To make the student to learn the

- organic and inorganic coatings to protect the surface.
- Electroplating
- Evaluation of paints
- Special paints
- Inorganic coating materials

MODULE I PIGMENTS AND RESINS 9

Pigments and additives used in paints - properties and functions - Inorganic, organic and metallic pigments - 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 - phosphating, chromating of ferrous and non-ferrous metals - ceramic coatings.

L – 45; Total Hours –45

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.

OUTCOMES:

The students will be familiar with the

- Surface preparation methods
- Different types of paints, their constituents and fictions
- Constituents and functions of paints
- Inorganic coating methods

CHDY 019 CHEMISTRY OF CARBOHYDRATES L T P C
3 0 0 3

OBJECTIVES:

To make the student conversant with

- The basic concepts in carbohydrates
- Structural and spectroscopic analysis of sugars
- Various synthetic methodologies of carbohydrates
- Carbohydrates as chiral synthons
- 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, anomericity, Naturally occurring 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 10

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 10

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

MODULE V GLYCANS AND GLYCOCONJUGATES 8

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

REFERENCES:

1. J.F. Kennedy and C.A. White, Bioactive Carbohydrates, Ellis Horwood, New York, 1983
2. R.W. Binkley, Moden Carbohydrate Chemistry, Marcell and Dekker, New York., 1988
3. J.F. Kennedy (Ed.) Carbohydrate Chemistry, Oxford University Press, Oxford, 1988.
4. E.A. Davidson, Carbohydrate Chemistry, Holt, Rinehart & Winston Inc., Mew York, 1967.
5. A.F.Bochkov and G.E. Zaikov, Chemistry of the O-Glycosidic Bond Formation and Cleavage, Pergamon, Oxford, 1979.
6. S.Hanessian, Total Synthesis of Natural Products: The Chiron Approach, Pergamon, Oxford. 1983.

OUTCOMES:

The students will be able to

- Recognize the different types of carbohydrates
- Acquire knowledge about the structural and spectroscopic analysis of carbohydrates
- Recognize and depict the mechanism of carbohydrate based chemical reactions
- Identify chiral based carbohydrates as synthons
- Understand the basics of glycans, glycoproteins and glycoconjugates.

CHDY 020	ADVANCED CONCEPTS IN ORGANIC SYNTHESIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- Different organometallic reactions in organic synthesis
- Various types of coupling reactions
- Transition metal based chemical reactions
- Oxidation and reduction reactions
- Few named 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

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.

OUTCOMES:

The students will be able to

- Gain understanding on the various metals in organic reactions
- Depict the mechanism of organometallic reactions.
- Illustrate organic chemical reactions using transition metals.
- Understand the metal mediated oxidation and reduction of organic compounds
- Recognise the organometallic based named reactions.

CHDY 021	POLYMER STRUCTURE AND PROPERTY RELATIONSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student to learn the

- structure of polymers
- various properties of polymers

MODULE I STRUCTURE OF POLYMERS 9

Linear, branched, cross linked, and network polymers - homochain and hetero atomic chain polymers - Copolymers - Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques - Volumetric properties - molar volume, density, vanderWaals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

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

MODULE III THERMODYNAMIC AND TRANSITION PROPERTIES 9

Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm - other transitions like β-transitions, upper and lower glass transition temperatures - Prediction of Tg and Tm of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy - Calculation of heat capacities of polymers.

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 9

Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - 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.

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.
8. C.C. Ku and R. Liepins, Electrical Properties of Polymers, Hanser Publications, Munich, 1987.
9. F. Bueche, Physical Properties of Polymers, Wiley, New York, 1962.
10. J. Mort and G. Pfister, (Editor), Electronic Properties of Polymers, Wiley Interscience, New York, 1982.

OUTCOMES:

At the end of the course, the students will be familiar with the

- structure of polymers
- effect of polymer structure on the properties such as mechanical, electrical and optical properties

CHDY 022 ELECTRICAL PROPERTIES OF POLYMERIC MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn

- The blend morphology
- Effect of structural features
- Resistivity, thermal behavior and electrical behavior of polymeric materials

MODULE I POLYMER BLENDS 9

Introduction – 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 RESISTIVITY 9

General features – polymer as wide band gap insulators – theories –trapping – carrier injection – effects of structural features – effects of additives.

MODULE III DIELECTRIC BEHAVIOUR 9

Mechanism of laws – relaxation – non-polar polymers – amorphous dipolar polymers – crystalline dipolar polymers – effects of structures, additives and impurities – testing of degradation in polymers.

MODULE IV THERMAL PROPERTIES 9

Specification of thermal evaluation and classification of electrical insulation – determination of resistivity – relating resistance of solid insulating materials – relating resistance of insulating materials to breakdown by surface discharges – artificial pollution tests of HV insulator – AC, DC.

MODULE V BREAKDOWN TESTING ANALYSIS 9

Breakdown test methods – statistical analysis – graphical techniques – numerical techniques.

L – 45; Total Hours –45

REFERENCES:

1. J. Kreschurity, concise Encyclopedia of polymer Science and Engineering, John Wiley and Sons, New York, 1990.

2. M.E. Balrd, Electrical Properties of Polymeric Materials, The Plastic Institute, London.
3. A. Bradwell (Editor), Electrical Insulation, Peter Peregrinus Ltd., 1983.
4. Tiller Shugg W., A Handbook of Electrical and Electronic Materials, Van Nostrand Reinhold, New York, 1986.
5. L.A. Dissado and J.C. Fothergil, Electrical Degradation and Breakdown in Polymers, Peter Perenguins Ltd., London, 1992.

OUTCOMES:

The student will be able to

- mention the properties and applications of polymer blends
- discuss the resistivity and dielectric behaviour of polymeric materials
- discuss the thermal properties and breakdown testing analysis of polymers.

CHDY 023 CORROSION AND CORROSION CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student conversant with the

- Causes and theories of corrosion
- Different types of corrosion
- Basic concepts to prevent corrosion and testing of corrosion by various diagrams.
- Factors influencing corrosion
- Control of corrosion using various methods.

MODULE I CORROSION **9**

Causes and effects of corrosion – theories of corrosion – oxidation – direct atmospheric effect – electrochemical corrosion – hydrogen evolution – presence and absence of oxygen – corrosion by gaseous reduction.

MODULE II FORMS OF CORROSION **9**

Galvanic bimetal corrosion – differential aeration corrosion – concentration cell corrosion – erosion corrosion – pitting corrosion – underground soil corrosion – intergranular corrosion – stress corrosion – seasonal cracking of alloys – 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 – 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 – impressed current cathodic protection – modification of environment – deaeration – dehumidification – inhibitors – protective coatings – preparation of materials for coating – metallic and non-metallic – organic coatings – special paints – varnish, enamel and lacquers.

L – 45; Total Hours –45

REFERENCES:

1. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill Book Company, 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 and Hall, UK, 1988.

OUTCOMES:

Students will become familiar with the

- basic concepts of corrosion,
- factors which influence the corrosion
- mechanism of corrosion
- control of corrosion in real situation.

CHDY 024 METAL COATING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To make the student to know about

- the different surface coating methods to preserve the metal surface
- different methods of coating
- 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 and non aqueous.

MODULE II METHODS OF COATING I 9

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

MODULE III Methods of coating II 9

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

MODULE IV METHODS OF COATING III 9

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

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. T.S. Sudarsan, Surface Modification Technologies, Marcel Dekker Inc., 1989
2. D.R. Gabe, Principles of Metal Surfaces Treatment and Protection, Pergmon Press 1972.

OUTCOMES:

The student will be familiar with the

- pretreatment methods before coating
- Galvanizing and tinning and cladding
- Chemical vapour deposition
- Sputtering and laser alloying methods to preserve the metal surface.

CHCY 025 ADVANCED BATTERIES AND SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

The students will be trained about the

- different types of batteries
- design and operation of different types of batteries

MODULE I Ni-MH BATTERIES 9

Advanced Ni-MH Batteries: Introduction to Ni-MH batteries, overview of Ni MH, Improvement in hydrogen storage alloys, improvement in Cathode materials, improvement in separator and cell design.

MODULE II Li- ion BATTERIES 9

Advanced Li-ion Batteries: Lithium-ion battery, The Principle carbonaceous anode materials, cathode material Electrolyte, separator.

MODULE III PERFORMANCE OF LITHIUM BATTERIES 9

Advanced Cathode materials for Lithium Batteries: The intercalative reactions, relationships between performance requirements and materials characteristics D stability, capacity, voltage, energy, power, cycle life, shelf life.

MODULE IV Li/POLYMER BATTERIES 9

Li/polymer Batteries: Polymer cathode for Li battery, Polymer Cathode in SPE, conductivity, ion transport mechanisms, plasticized electrolytes.

MODULE V ULTRA CAPACITORS 9

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

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.
2. M. Barak, Electrochemical Power Sources, IEEE Series, Peter Peregrinus Ltd.
3. Lindar D., Handbook on Batteries and Fuel Cells, McGraw Book Co., New

York, 1955.

OUTCOMES:

The student will have

- A thorough understanding about batteries and their components
- Understand the working up of the batteries

CHDY 026 ELECTROCHEMICAL MATERIAL SCIENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn about the

- Different types of semiconductors
- Preparation and properties of the semiconductors
- Application in photovoltaic cells

MODULE I SEMICONDUCTORS 9

Semiconductors, n-type and p-type semiconductors, conductivity of semiconductors, applications, of semiconductors, Photo conductivity, Photo conducting materials, electronic transitions in photoconductors, trapping and recombination, general mechanism of photoconductivity, life-time of majority carriers, preparation of CdS photoconductors by the sintering technique, ohmic contacts, fabrication of photo conductive cells and their applications.

MODULE II METHODS OF PREPARATION 9

Thin films of semiconductors, methods of preparation: vacuum evaporation, sputtering, molecular beam epitaxy, hot wall epitaxy, chemical bath deposition, spray pyrolysis, electrodeposition, liquid phase epitaxy, chemical vapor deposition, structural, electrical and optical characterization, mechanical properties of thin films, effect of grain boundaries.

MODULE III LUMINESCENCE 9

Luminescence, various types of luminescence (definitions only) model of luminescence in sulphide phosphors, applications, basic aspects of superconductivity, super conducting materials, high temperature, super conducting materials, method of preparation and applications.

MODULE IV 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 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. B.S. Saxena, R.C. Gupta and P.N. Saxena, Fundamentals of Solid State Physics, Pragati Prakashan Educational Publishers, Meerut, 2001.
2. K.L. Chopra and I. Kaur, Thin Film Devices and their Applications, Plenum Press, New York, 1983.
3. A.C. Rose D. Innes and E.H. Rhoderick, Introduction to Superconductivity, Robert Maxwell Publishers, 1988.
4. Photoelectrochemical Solar Cell, Edited By K.S.V. Santhanam and M. Sharon, Elsevier Science Publishers, BV New York 1988.
5. C. Hu and R.M. White, Solar Cells, McGraw Hill Book Company, New Delhi, 1983
6. R.K. Kotnala and N.P. Singh, Essentials of Solar Cells, Allied Publishers Pvt. Ltd., Chennai, 1992
7. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London 1983.
8. W.E. Hatified and J.H. Miller (Editors), High Temperature Superconducting Materials, Marcel Dekker, New York 1988.

OUTCOMES:

The students will be acquainted with

- Types of semi conductors
- Preparation and properties of semi conductors
- Applications in photovoltaic cells
- Applications in solar cells

CHDY027	ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the students to learn about

- Fundamentals of a battery
- Factors affecting battey performance
- Selection and application o batteries
- Testing and evaluation of batteries
- Fuel cells and super capacitors

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, relationship between the energy changes accompanying a cell reaction and concentration of the reactants, 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, thermodynamic calculation of the capacity of a battery, calculation of the capacity of a battery, calculation of operating parameters for a lead acid battery from calorimetric measurements, 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 age and 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.

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 - I.E. polarization and flash current method A.C. methods, 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 – 45; Total Hours –45

REFERENCES:

1. Barak, Electrochemical Power sources, IEEE Series, Peter Peregrinus Ltd., Steverage, UK 1980, 1997.
2. N. Corey Cahoon and George W. Heise, Primary Battery (Volume I and II), John Wiley New York, 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.

OUTCOMES:

The students will be familiar with

- electrochemical cells and their types
- factors affecting battery performance
- application of batteries
- testing in fuel cells

CHDY 028 FUEL CELLS AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

The primary objective of the course is make the student conversant with

- classification and types of fuel cell
- outline components of fuel cells
- performance for fuel cells
- hydrogen storage and production
- the 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 - bi-polar plates, humidifiers and cooling plates - fuel cell stack

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

MODULE IV PRODUCTION AND STORAGE OF HYDROGEN FUEL 9

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

MODULE V FUEL CELL APPLICATIONS 9

Automotive applications – road map to market – automotive industry and the environment – distributed power generation – grid-connect applications – non-grid connect applications – residential power – portable power – combined heat and power

L – 45; Total Hours –45

REFERENCES:

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, From Fundamentals to Applications, Springer, 2006.
6. Prospects for Hydrogen and Fuel Cells, International Energy Agency, OECD Publishing, 2005.

OUTCOMES:

The student will be able to

1) classify fuel cells and elaborate the different types of fuel cells.
2) explain the various components of the fuel cells
3) calculate the open circuit voltage, efficiency and voltage losses, explain fuel cycle analysis and prove the laws of thermodynamics for fuel cell.
4) describe the various methods for production and storage of hydrogen.
5) list out the applications of fuel cells.

CHDY029	PHOTOCHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the students conversant with the

- Principles and concepts of photochemistry.
- Measurement of fluorescence and phosphorescence
- Different types of photochemical reactions
- Different types of photochemical reactions
- Applications of solar energy materials.

MODULE I PRINCIPLES AND CONCEPTS 9

An overview of: Laws of photochemistry, Beer-Lambert law, electronic energy levels, atomic and molecular term symbols, singlet-triplet state, intensity and strength of electronic transition, selection rules for electronic transition, Jablonski diagram and photophysical processes, Franck-Condon principle.

Excited state lifetime, steady state and time resolved emission, factors affecting excited state energy: solvent effect, TICT.

Excited state kinetics, quantum yield expressions, excimer and exciplex, kinetics of luminescence quenching: static and dynamic, Stern-Volmer analysis, deviation from Stern-Volmer kinetics. Photoinduced electron transfer rates, free energy dependence of electron transfer on rate, Photoinduced energy transfer, FRET, rate and efficiency calculation of FRET.

MODULE II METHODS 9

Measurement of fluorescence and phosphorescence and lifetimes. Introduction to time-resolved techniques for absorption and emission measurements, detection and kinetics of reactive intermediates. Examples of low temperature matrix isolation of reactive intermediates.

MODULE III REACTIONS 9

Photochemistry of alkene, cis-trans isomerization, photocycloaddition reactions of alkene, photochemical electrocyclic and sigmatropic reactions, di-pi-methane rearrangment, electron transfer mediated reactions of alkene. Photochemistry of carbonyl compounds, Norrish type I and type II reactions, enone and dienone cycloadditions. Photochemistry of aromatic systems, electron transfer and nucleophilic substitution reactions. Photochemistry of nitro, azo and diazo compounds. Photochemistry involving molecular oxygen, generation and reactions

of singlet oxygen. Photo-fragmentation reactions (Barton, Hofmann-Loffler-Freytag)

MODULE IV REACTIONS IN AROMATIC COMPOUNDS 9

Photochemistry of aromatic systems, electron transfer and nucleophilic substitution reactions. Photochemistry of nitro, azo and diazo compounds. Photochemistry involving molecular oxygen, generation and reactions of singlet oxygen. Photo-fragmentation reactions (Barton, Hofmann-Loffler-Freytag)

MODULE V APPLICATIONS 9

Fluorescence based sensors – examples of molecular and supramolecular systems. Conversion of solar energy to chemical and other forms of energies, solar photovoltaic cell, basic principle and design of the cell.

L – 45; Total Hours –45

REFERENCES:

1. Fundamental of Photochemistry, K. K. Rohatgi-Mukherjee, New Age International (P) Ltd., New Delhi, 1986.
2. Principles of Fluorescence Spectroscopy, 3rd Ed., J. R. Lakowicz, Springer, New York, 2006.
3. Fundamentals of Photoinduced Electron Transfer, G. J. Kavarnos, VCH publishers Inc., New York, 1993.
4. Molecular Fluorescence: Principles and Applications, B. Valeur, Wiley-VCH Verlag 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.

OUTCOMES:

To make the students acquainted with the

- basic concepts of photochemistry and derivation of quantum yield , life time, energy calculations etc.
- Instrumentation part and acquiring photophophysical parameters
- Conduct of chemical reactions in presence of UV-Visible light radiation
- Analyze the mechanism of various aliphatic and aromatic photochemical reactions
- Utilization of photochemical concepts to real time applications such as sensors and energy fields.

CHDY 030	SOLAR ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students will be conversant with the

- Sustainable energy conversion processes
- Fundamentals of solar cells
- Solar electrical energy conversion
- Nanomaterials as photovoltaics
- Different types of solar cells

MODULE I INTRODUCTIONS TO SUSTAINABLE ENERGY CONVERSION PROCESSES 9

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, I-V 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)Se2 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. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London 1983.

OUTCOMES:

The students will be acquainted with the

- Current scenario of energy crisis and need of energy conversion and storage
- Understanding of the design, principle and working of a solar cell
- Identification of specific type of solar cell for the chosen study and analysis
- Comparison of various types of nanomaterials significant in solar energy field and effective utilization of the one which shows better performance.
- Manufacture of a new solar cell device using the available resources and effective utilization of the concepts and design discussed.

CHDY 031 CHEMICAL AND ELECTROCHEMICAL ENERGY SYSTEMS

L	T	P	C
3	0	2	3

OBJECTIVES:

To make the students conversant with the

- Energy options and their environmental effects
- Nuclear reactor kinetics and control
- Batteries for electric vehicles
- Electrochemical power sources
- Energy conversion: processes

MODULE I INTRODUCTION **9**

Available energy options, their advantages and disadvantages. Environmental effects, comparative evaluation of energy options and energy needs. Fossil fuels: petroleum, natural gas and coal -Origin, processing and production of value added products -available current conversion technologies.

MODULE II NUCLEAR ENERGY: **9**

Principles of Fission -Fission reactors, U enrichment and processing of spent fuels. Nuclear reactor kinetics and control -nuclear fusion -magnetic and other confinement -evaluation of the option of nuclear energy.

MODULE III ELECTROCHEMICAL POWER SOURCES **9**

Electrochemical power sources -theoretical background on the basis of thermodynamic and kinetic considerations.Primary cells -various types, especially magnesium and aluminium based cells -magnesium reserve batteries.Secondary cells: classification based on electrolyte type, temperature of operation on the basis of electrodes -chemistry of the main secondary batteries -Batteries for electric vehicles -present status.

MODULE IV FUEL CELLS **9**

Fuel cells -classification -chemistry of fuel cells -detailed description of hydrogen/oxygen fuel cells -methanol -molten carbonate solid polymer electrolyte and biochemical fuel cells.

MODULE V SOLAR ENERGY CONVERSION DEVICES **9**

Solar energy conversiondevices -photovoltaic cells -photoelectrochemical cells -

semiconductor electrolyte junctions photocatalytic modes for fuel conversion process -photobiochemical options.Hydrogen as a fuel -production (thermal, electrolysis, photolysis and photoelectrochemical) storage and applications of hydrogen storage.Other methods of energy conversion: processes especially in the form of storage as chemical energy.

L – 45; P – 30; Total Hours –75

REFERENCES:

1. C. A. Vincent Modern Batteries, Edward Arnold, 1984.
2. R. Narayanan and B. Viswanathan, Chemical and Electrochemical energy systems, Orient Longmans, 1997.
3. K. Sriram, Basic Nuclear Engineering, Wiley Eastern, 1990.

A. S. J.. Appleby and F. K. Foulkes, Fuel cell Hand Book, Von Nostrand Reinhold, 1989.

4. D. Linden, Hand book of batteries and Fuel cells, McGraw Hill Book Company, 1984.
5. T. Ohta, Solar Hydrogen energy systems, Peragamon Press, 1979.
6. M. Gratzel, Energy Resources through photochemistry and catalysis, Academic Press, 1983.
7. T. Ohta, Energy Technology, Sources, Systems and Frontiers conversions, Pergamon, 1994.
8. J. G. Speight, The chemistry and technology of petroleum, Marcel Dekker Inc. (1980).

OUTCOMES:

At the end of the course, the students will be

- able to suggest the best options for generating power from fossil fuels.
- familiar with the nuclear reaction, kinetics and their control in nuclear reactors
- construct basic batteries using various electrode & electrolyte materials
- develop the basic fuel cells using hydrogen, methanol and oxygen
- produce hydrogen from different methods in the laboratory

CHDY 032	ELECTROCHEMICAL APPROACHES TO FUNCTIONAL SUPRAMOLECULAR SYSTEMS	L	T	P	C
		3	0	2	3

OBJECTIVES:

To make the students conversant with the

- electron transfer and activated complex theory
- types of electrodes and its electrode reactions
- Spectroscopic Techniques
- Electrochemical synthesis of nanomaterials
- Photo-electrochemistry and its functionalities

MODULE I FUNDAMENTAL CONCEPTS IN ANALYTICAL ELECTROCHEMISTRY **9**

Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, The charged interface, Potential step and potential sweep experiments, Reactions controlled by rate of electron transfer and activated complex theory.

MODULE II ELECTRODE TYPES AND STUDY OF ELECTRODE REACTIONS: **9**

Carbon electrodes, Semiconductor film electrodes, Microelectrodes, Ultra-micro electrodes, Ion-selective electrodes, Porous electrodes and non uniform reaction rates, Hydrodynamic/Rotating disk electrodes, Semiconductor electrodes and electrical capacitance Cyclic voltammetry in reversible, quasi-reversible and irreversible systems, Study of reaction mechanisms

MODULE III ELECTROCHEMICAL AND SPECTROSCOPIC TECHNIQUES: **9**

Surface modification in charge transfer and interfacial activity Electron transfer in DNA and biosystems Spectro-Electrochemical and Spectroscopic Techniques: Impedance Spectroscopy, Scanning Electrochemical Microscopy, Electrochemical AFM and STM, Electrochemical Quartz Crystal Microbalance.

MODULE IV ELECTROCHEMICAL MATERIALS AND SENSORS: **9**

Electroactive Fullerenes, Carbon Nanotubes, Biomolecules, Controlled Potential Techniques, Electrochemical synthesis of nanomaterials, nanowires and

conducting polymers, Functional nanoparticles as catalysts and sensors, MOSFETS and ISFETS, Solid state molecular devices

MODULE V ELECTROCHEMICAL ENERGY SYSTEMS: 9

Photo-electrochemistry, Monitoring photolytic intermediates, Electroluminescence and devices and sensors, Electro - chemiluminescence, Digital simulation of electrochemical problems, Sample BASIC programs Fuel cells: Electrode materials, Diagnostic tools in fuel cell research, Determination of injection efficiency and electron diffusion length under steady state condition, Small-amplitude time-resolved methods, Organic solar cells.

Total Hours – 45

REFERENCES:

1. Allen J. Bard and Larry R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd edition 2001, John Wiley & Sons
2. .Allen J. Bard (Ed), Electroanalytical Chemistry, Vol.13, Plenum Press 1983
3. Joseph Wang, Analytical Electrochemistry, 3rdedition 2006, John Wiley & Sons
4. Paola Ceroni, Alberto Credi and Margherita Venturi (Ed), Electrochemistry of Functional Supramolecular Systems, 2010, John Wiley & Sons
5. Kosuke Isutzu, Electrochemistry in Non-aqueous Solutions, Wiley –VCH Verlag GmbH& Co. 2002
6. K. Kalyanasundaram (Ed), Dye-Sensitized Solar Cells, EPFL Press, 1st Edition 2010(ISBN 978-2-940222-36-0)
7. J. Newman, Electrochemical Systems, Wiley-Interscience, 3rd edition 2004

OUTCOMES:

At the end of the course, the learners should be able to comprehend with

- electron transfer and activated complex theory
- types of electrodes and its electrode reactions
- Electrochemical and Spectroscopic Techniques
- Electrochemical synthesis of nanomaterials
- Photo-electrochemistry and its functionalities

CHDY 033 ORGANIC ELECTRONIC DEVICES L T P C
2 0 2 3

OBJECTIVES:

This course will enable students to:

- understand basic properties of organic /polymeric molecular materials with examples and discuss their applications to organic electronic devices
- understand about the organic electronics devices: organic LEDs, Organic FETs, and organic photovoltaics (OPVs).
- Role of electrode and interface materials structure on their performance in devices.
- understand the issues concerning device fabrication (device architectures), patterning, encapsulation and characterization.

MODULE I FUNDAMENTALS OF ORGANIC SEMI CONDUCTORS 9

General over review of organic/polymer semicondutctor materials and its fundamentals-. properties and mechanism of organic Semiconductors.

MODULE II ORGANIC ELECTRONIC DEVICE ARCHITECTURES 9

Basic device architectures and functions of organic electronic devices: OLEDs & PLEDs, Organic Transistors, Organic solar cells and Flexible displays.

MODULE III CHARACTERISTICS OF MATERIALS FOR ORGANIC ELECTRONIC DEVICES 9

Essential characteristics of the electrode and interface materials for organic electronic devices. -Organic electronic materials and their processing techniques

MODULE IV CHARACTERIZATION OF ORGANIC ELECTRONIC DEVICES 9

Fabrication and characterization of organic electronic devices: OLED, OFET and OPV-Basic challenges in fabrication of devices and its remedies.

MODULE V R&D IN NOVEL MATERIALS 9

Current R&D in novel materials (electrode, interface, organic semiconductor materials) for organic electronic devices.

LAB EXPERIMENTS:

- Synthesis and characterization P3HT, thiophene and benzodithiophene based polymers (organic semiconducting polymers)
- Optical properties (UV-Visible, fluorescence) of organic semiconducting polymers
- Electrochemical properties (cyclic voltammetry) of organic semiconducting polymers
- Thermal properties (TGA) of organic semiconducting polymers
- Fabrication and characterization of opto electronic devices (OLED, OPV, OFET etc)

Total Hours –45

REFERENCES:

1. Sam-Shajing Sun and Larry R, *Introduction to Organic Electronic and Optoelectronic Materials and Devices*, Dalton Eds., CRC Press, 2008.
2. Chrisoph Brabec, Vladimir Dyakonov, Ullrich Scherf, *Organic Photovoltaics. Materials, Device Physics, and Manufacturing Technologies*, Eds., Wiley-VCH, 2008.
3. Zhenan Bao, Jason Locklin *Organic Field-Effect Transistors*, CRC Press, 2007.
4. Klaus Mullen and Ullrich Scherf *Organic Light-Emitting Devices, Synthesis, Properties and Applications*, Eds., Wiley-VCH, 2006.

OUTCOMES:

At the end of the course, the students is able to

- understand basic properties of organic /polymeric molecular materials and discuss their applications to organic electronic devices
- design the organic electronics devices: organic LEDs, Organic FETs, and organic photovoltaics (OPVs).
- Interpret the role of electrode and interface materials structure on their performance in devices.
- understand the issues concerning device fabrication (device architectures), patterning, encapsulation and characterization.

CHDY 034 CARBON AND CERAMIC NANOMATERIALS

L	T	P	C
2	0	2	3

OBJECTIVES:

To make the students conversant with the

- definition and significance of nanoscale carbon materials
- familiar with the synthetic methodologies for carbon based nanomaterials
- characterization of carbon nanomaterials
- applications of carbon nanomataerials

MODULE I INTRODUCTION OF CARBON AND CERAMIC NANOFORMS **9**

Carbon naonomaterials-introduction-history-classification-zero dimensional (carbon nanodots), one dimensional (carbon nanosheets), two dimensional (carbon nanotubes), three dimensional (graphite)-fullerenes, etc. Structure and properties-optical, electrical, surface-sources of carbon nanomaterials.

MODULE II SYNTHETIC METHODOLOGIES **9**

Top-down approaches-laser irradiation, pyrolysis, sonochemical, ball milling, chemical vapour deposition- and bottom up approaches-hydrothermal, solvothermal, precipitation,polymer assisted synthesis-waste to value added conversion-biomass conversion, chemical precursors, doped carbon nanomaterials-surface modification and functionalization-stabilization etc.

MODULE III CHARACTERIZATION OF CARBON AND CERAMIC NANOMATERIALS **9**

Material characterization-Raman, X-ray photoelectron spectroscopy-surface bonding nature-binding energy, HR-Scanning electron microscopy-elemental mapping-HR-Transmission electron microscopy-image J software for histogram plotting-Atomic force microscopy-surface topography-BET surface area analyzer-pore size and pore volume analysis-physorption and chemisorptions-FT-IR-functional group analysis-1H NMR and 13CNMR analysis-solid state NMR analysis and interpretation

MODULE IV APPLICATIONS OF CARBON AND CERAMIC NANOMATERIALS **9**

Applications of carbon and ceramic nanomaterials

MODULE V ADVANCED EMERGING FIELDS **9**

Electronics-solid state emission-LEDs and OLEDs-Automobile-break materials-fuel blending-exhaust water filter for Cox, Sox and NOx-Biofields-invitro and in-vivo bioimaging, biomolecule sensing, photodynamic therapy, targeted drug delivery and thernastic agents-Chemosensors-metal ion sensors-explosive sensing (nitro compounds)-chemical sensing etc. Polymer-Fiber reinforced plastics, biopolymers, fillers, hybrid polymers, chemiluminescent polymers etc.

LAB EXPERIMENTS:

- Exfoliation of graphite to graphene sheets
- Synthesis of doped carbon nano materials
- Synthesis of ceramic nanomaterials such as silica, alumina, titania, zirconia, silicon nitride, silicon carbide
- Conversion of biomass
- Functionalisation of carbon and ceramic nanomaterials
- Characterization of carbon and ceramic nanomaterials

Total Hours –45

REFERENCES:

1. Mahmut Kus, Duygu Akin Kara, in Handbook of Nanomaterials for Industrial Applications, 2018

OUTCOMES:

To make the students conversant with the

- definition and significance of nanoscale carbon and ceramic materials
- familiar with the synthetic methodologies for carbon and ceramic nanomaterials
- characterization of carbon and ceramic nanomaterials
- applications of carbon and ceramic nanomataerials

CHDY 035 BIOMASS TO ENERGY CONVERSION

L	T	P	C
3	0	0	3

OBJECTIVES:

This course will enable students to:

- understand basic structure, property and reactions of carbohydrates.
- understand the structure, properties and applications of cellulose, hemicelluloses and lignin.
- Understand various biomass pretreatment techniques.
- Understand the role of enzymes in hydrolysis of lignocellulose
- understand the biochemical and thermochemical conversion of lignocelluloses into alcohol and fuel.

MODULE I **7**

Basic biomass properties, Cell wall and plant anatomy, Fiber morphology, Basic Carbohydrate chemistry, Structure and stereochemistry, Reduction of monosaccharide, Oxidation of monosaccharide, Oligosaccharides and Polysaccharides

MODULE II **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 III **9**

Biomass pretreatment/fractionation, Dilute acid pretreatment, Steam explosion pretreatment, Ammonia fiber explosion (AFEX) pretreatment, Organosolv pretreatment

MODULE IV **7**

Enzymatic hydrolysis of lignocelluloses, Cellulases from Trichoderma reesei, Cellulosome cellulases of Clostridium cellulovorans, Enzymatic hydrolysis modes for cellulose

MODULE V **13**

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, Gasification process, Pyrolysis process of lignocellulose to liquid fuels, Pulping technology, Mechanical pulping and chemical pulping, Sulfate Process (Kraft pulping), Sulfite Process and bioethanol production

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, Avelino Corma, Synthesis of Transportation Fuels from Biomass: Chemistry, Catalysts, and Engineering, Chemical Review 2006, 106, 9, 4044-4098.

OUTCOMES:

Students will be able to describe:

- the structure, property and reactions of carbohydrates.
- the structure, properties and applications of cellulose, hemicelluloses and lignin.
- The various biomass pretreatment techniques.
- the role of enzymes in hydrolysis of lignocelluloses.
- the biochemical and thermochemical conversion of lignocelluloses into alcohol and fuel.

CHDY 036 INDUSTRIAL POLLUTION CONTROL L T P C
3 0 0 3

OBJECTIVES:

This course will enable students to:

- understand the environmental pollution and the environmental standards.
- understand the concept of pollution prevention.
- Understand various air pollution control methods.
- Understand various water pollution control methods.
- understand the biological treatment and solid wastes disposal

MODULE I INTRODUCTION 7

Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents.

MODULE II POLLUTION PREVENTION 10

Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.

MODULE III AIR POLLUTION CONTROL 8

Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers.

MODULE IV WATER POLLUTION CONTROL: 7

Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.

MODULE V BIOLOGICAL TREATMENT 13

Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying. **Solids**

Disposal: Solids waste disposal – composting, landfill, briquetting / gasification and incineration.

Total Hours –45

REFERENCES:

1. Thomas T. Shen, Industrial Pollution Prevention, Springer, 1999.
2. Nancy J. Sell, Industrial Pollution Control: Issues and Techniques, 2nd Edition, Wiley, 1992.

OUTCOMES:

Students will be able to describe:

- environmental pollution and the environmental standards.
- the concept of pollution prevention.
- various air pollution control methods.
- water pollution control methods.
- various biological treatment and solid wastes disposal methods.