UNIVERSITY VISION AND MISSION

VISION

B.S. Abdur Rahman Institute of Science & Technology aspires to be a leader in Education, Training and Research in Engineering, Science, Technology and Management and to play a vital role in the Socio-Economic progress of the Country.

MISSION

- To blossom into an internationally renowned University.
- To empower the youth through quality education and to provide professional leadership.
- 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.

VISION AND MISSION OF THE DEPARTMENT OF CHEMISTRY

VISION

To achieve excellence in the field of Chemical Sciences through academic and research programmes and to participate in the interdisciplinary programmes offered in the University.

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 industries and research Institutes to promote joint research projects.
- To provide required knowledge in Chemical Sciences for all programs in science and engineering

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES
M.Sc. (Chemistry)

PROGRAMME EDUCATIONAL OBJECTIVES:

- To demonstrate 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 analysis skills to solve complex chemical problems, e.g., analysis of data, synthetic logic, spectroscopy, structure and modeling, 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 demonstrate the ability 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 demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.

PROGRAMME OUTCOMES:

On successful completion of this Programme, students will have the ability to:

- think critically and analyze chemical problems.
- present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
- work effectively and safely in a laboratory environment.

- use technologies/instrumentation to gather 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
UNIVERSITY
B.S. ABDUR RAHMAN INSTITUTE OF SCIENCE & TECHNOLOGY
(Estd.u/s 3 of the UGC Act, 1956)
(FORMERLY B.S.ABDUR RAHMAN CRESCENT ENGINEERING COLLEGE)
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048.

REGULATIONS 2013
FOR
M.Sc. DEGREE PROGRAMMES

B.S. ABDUR RAHMAN UNIVERSITY, CHENNAI 48.
REGULATIONS - 2013 FOR M.TECH / MCA / M.Sc. DEGREE PROGRAMMES

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i) **"Programme"** means Post Graduate Degree Programme (M.Tech./ MCA / M.Sc.)

ii) **"Course"** means a theory or practical subject that is normally studied in a semester, like Applied Mathematics, Structural Dynamics, Computer Aided Design, etc.

iii) **"University"** means B.S.Abdur Rahman University, Chennai, 600048.

iv) **"Institution"** unless otherwise specifically mentioned as an autonomous or off campus institution means B.S.Abdur Rahman University.

v) **"Academic Council"** means the Academic Council of this University.

vi) **"Dean (Academic Affairs)"** means Dean (Academic Affairs) of B.S.Abdur Rahman University.

vii) **"Dean (Student Affairs)"** means Dean(Student Affairs) of B.S.Abdur Rahman University.

viii) **"Controller of Examinations"** means the Controller of Examinations of B.S.Abdur Rahman University who is responsible for conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

2.1 P.G. Programmes Offered

The various P.G. Programmes and their modes of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
M.Tech.	Part Time – Day / Evening
M.C.A.	Full Time
M. Sc.	Full Time

2.2 MODES OF STUDY

2.2.1 Full-time

Students admitted under "Full-Time" shall be available in the Institution during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

2.2.2 A full time student, who has completed all non-project courses desiring to do the Project work in part-time mode for valid reasons, shall apply to the Dean (Academic Affairs) through the Head of the Department, if the student satisfies the clause 2.3.4 of this Regulation. Permission may be granted based on merits of the case. Such conversion is not permitted in the middle of a semester.

2.2.3 Part time - Day time

In this mode of study, the students are required to attend classes for the courses registered along with full time students.

2.2.4 Part time - Evening

In this mode of study, the students are required to attend normally classes in the evening and on Saturdays, if necessary.

2.2.5 A part time student is not permitted to convert to full time mode of study.

2.3 ADMISSION REQUIREMENTS

2.3.1 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 University as specified in the Table shown for eligible entry qualifications for admission to P.G. programmes or any other degree examination of any University or authority accepted by this University as equivalent thereto.

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

2.3.3 All part-time students should satisfy other conditions regarding experience, sponsorship etc., which may be prescribed by this Institution from time to time.

2.3.4 A student eligible for admission to M.Tech. Part Time / Day Time programme shall have his/her permanent place of work within a distance of 65km from the campus of this Institution.

2.3.5 Student eligible for admission to M.C.A under lateral entry scheme shall be required to have passed three year degree in B.Sc (Computer Science) / B.C.A / B.Sc (Information Technology)

3.0 DURATION AND STRUCTURE OF THE P.G. PROGRAMME

3.1 The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min.No.of Semesters	Max.No.of Semesters
M.Tech. (Full Time)	4	8
M.Tech. (Part Time)	6	12
M.C.A. (Full Time)	6	12
M.C.A. (Full Time) – (Lateral Entry)	4	8
M.Sc. (Full Time)	4	8

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

i. Core courses
ii. Elective courses
iii. Project work / thesis / dissertation
iv. Laboratory Courses
v. Case studies
vi. Seminars
vii. Industrial Internship

3.3 The curriculum and syllabi of all PG. programmes shall be approved by the Academic Council of this University.

3.4 The minimum number of credits to be earned for the successful completion of the programme shall be specified in the curriculum of the respective specialization of the P.G. programme.

3.5 Each academic semester shall normally comprise of 80 working days. Semester-end examinations will follow immediately after the last working day.

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
01.	Civil Engineering	M.Tech. (Structural Engineering)	B.E / B.Tech. (Civil Engineering) / (Structural Engineering)
		M.Tech. (Construction Engineering and Project Management)	
02.	Mechanical Engineering	M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Auto / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace /Aeronautical / Material Science / Marine Engineering)
		M.Tech. CAD / CAM	
03.	Polymer Engineering	M.Tech. (Polymer Technology)	B.E./ B.Tech. degree Mech./Production/ Polymer Science or Engg or Tech / Rubber Tech / M.Sc (Polymer Sc./ Chemistry Appl. Chemistry)
04.	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 & Drives)	
05.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	B.E / B.Tech (EEE/ ECE / E&I / I&C / Electronics / Instrumentation)
		M.Tech.(VLSI and Embedded Systems)	B.E./ B.Tech. in ECE / Electronics / EIE / ICE / EEE
		M.Tech.(Signal Processing)	
06.	ECE Department jointly with Physics Dept	M.Tech. (Optoelectronics and Laser Technology)	B.E./B.Tech. (ECE / EEE / Electronics / EIE / ICE) M.Sc (Physics / Materials Science / Electronics / Photonics)
07.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation Engineering)	B.E./ B.Tech. (EIE/ICE/Electronics/ECE/ EEE)
08.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics) MCA
		M.Tech. (Software Engineering)	B.E. / B.Tech. (CSE / IT) MCA
		M.Tech (Network Security)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics) MCA
		M.Tech (Computer and Predictive Analytics)	
		M.Tech. (Computer Science and Engineering with specialization in Big Data Analytics)	
09	Information Technology	M.Tech. (Information Technology)	B.E /B.Tech. (IT/CSE/ECE/EEE/EIE/ICE/ Electronics) MCA
		M.Tech. (Information Security & Digital Forensics)	

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
10	Computer Applications	M.C.A.	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		M.C.A. (Full Time) – (Lateral Entry)	B.Sc Computer Science / B.Sc Information Technology / B.C.A
		M.Tech. (Systems Engineering and Operations Research)	BE / B.Tech. (Any Branch) or M.Sc., (Maths / Physics / Statistics / CS / IT / SE) or M.C.A.
		M.Tech. (Data & Storage Management)	
11	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the Subjects of Study.
		M.Sc. Mathematics	B.Sc. (Mathematics)
12	Physics	M.Sc.(Physics)	B.Sc.(Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
		M.Sc. (Material Science)	
13	Chemistry	M.Sc.(Chemistry)	B.Sc (Chemistry) of B.Sc. (Applied Science)
14	Life Sciences	M.Sc. Molecular Biology & Biochemistry	B.Sc. in any branch of Life Sciences
		M.Sc. Genetics	
		M.Sc. Biotechnology	
		M.Sc. Microbiology	
		M.Sc. Bioscience	

3.6 The curriculum of PG 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	Minimum prescribed credit range
M.Tech.	75 to 85
M.C.A.	120 to 130
M.Sc.	75 to 85

3.7 Credits will be assigned to the courses for all P.G. programmes as given below:

* One credit for one lecture period per week
* One credit for one tutorial period per week
* One credit each for seminar/practical session/project of two or three periods per week
* One credit for two weeks of industrial internship.

3.8 The number of credits registered by a student in non-project semester and project semester should be within the range specified below:

P.G. Programme	Non-project Semester	Project semester
M.Tech. (Full Time)	15 to 29	12 to 20
M.Tech. (Part Time)	6 to 18	12 to 16
M.C.A. (Full Time)	15 to 29	12 to 20
M.Sc. (Full Time)	15 to 25	12 to 20

3.9 The electives from the curriculum are to be chosen with the approval of the Head of the Department.

3.10 A student may be permitted by the Head of the Department to choose electives offered from other PG programmes either within the Department or from other Departments up to a maximum of three courses during the period of his/her study, provided the Heads of the Departments offering such courses also agree.

3.11 To help the students to take up special research areas in their project work and to enable the department to introduce courses in latest/emerging areas in the curriculum, "Special Electives" may be offered. A student may be permitted to register for a "Special Elective" up to a maximum of three credits during the period of his/her study, provided the syllabus of this course is recommended by the Head of the Department and approved by the Chairman, Academic Council before the commencement of the semester, in which the special elective course is offered. Subsequently, such course shall be ratified by the Board of Studies and Academic Council.

3.12 The medium of instruction, examination, seminar and project/thesis/ dissertation reports will be English.

3.13 Industrial internship, if specified in the curriculum shall be of not less than two weeks duration and shall be organized by the Head of the Department.

3.14 PROJECT WORK/THESIS/DISSERTATION

3.14.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department.

3.14.2 A student may however, in certain cases, be permitted to work for the project in an Industrial/Research Organization, on the recommendation of the Head of the Department. 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 committee meetings for evaluating the progress.

3.14.3 Project work / Thesis / Dissertation (Phase - II in the case of M.Tech.) shall be pursued for a minimum of 16 weeks during the final semester, following the preliminary work carried out in Phase-1 during the previous semester.

3.14.4 The Project Report/Thesis / Dissertation report / Drawings prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

3.14.5 The deadline for submission of final Project Report / Thesis / Dissertation is within 30 calendar days from the last working day of the semester in which Project / Thesis / Dissertation is done.

3.14.6 If a student fails to submit the Project Report / Thesis / Dissertation on or before the specified deadline he / she is deemed to have not completed the Project Work / Thesis / dissertation and shall re-register the same in a subsequent semester.

3.14.7 A student who has acquired the minimum number of total credits prescribed in the Curriculum for the award of Masters Degree will not be permitted to enroll for more courses to improve his/her cumulative grade point average (CGPA).

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member will be nominated by the HOD 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 of the students will 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 every semester.

5.0 CLASS COMMITTEE

5.1 Every class of the PG Programme will have a Class Committee constituted by the Head of the Department as follows:

i. Teachers of all courses of the programme

ii. One senior faculty preferably not offering courses for the class, as Chairperson.

iii. Minimum two students of the class, nominated by the Head of the Department.

iv. Class Advisor / Faculty Advisor of the class - Ex-Officio Member

v. Professor in-charge of the PG Programme - Ex-Officio Member.

5.2 The Class Committee shall be constituted by the respective Head of the Department of the students.

5.3 The basic responsibilities of the Class Committee are to review periodically the progress of the classes to discuss problems concerning curriculum and syllabi and the conduct of classes. The type of assessment for the course will be decided by the teacher in consultation with the Class Committee and will be announced to the students at the beginning of the semester. Each Class Committee will communicate its recommendations to the Head of the Department and Dean (Academic Affairs). The class committee, without the student members, will also be responsible for finalization of the semester results and award of grades.

5.4 The Class Committee is required to meet at least thrice in a semester, first within a week of the commencement of the semester, second, after the first

assessment and the third, after the semester-end examination to finalize the grades.

6.0 COURSE COMMITTEE

Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers teaching 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 teaching the common course belong to a single department or to several departments. The Course Committee shall meet as often as possible and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the Course Committee may also prepare a common question paper for the test(s).

7.0 REGISTRATION AND ENROLMENT

7.1 For the first semester every student has to register and enroll for all the courses.

7.2 For the subsequent semesters registration for the courses will be done by the student during a specified week before the semester-end examination of the previous semester. The curriculum gives details of the core and elective courses, project and seminar to be taken in different semester with the number of credits. The student should consult his/her Faculty Adviser for the choice of courses. The Registration form shall be filled in and signed by the student and the Faculty Adviser.

7.3 From the second semester onwards all students shall pay the prescribed fees and enroll on a specified day at the beginning of a semester.

7.4 A student will become eligible for enrolment only if he/she satisfies clause 9 and in addition he/she is not debarred from enrolment by a disciplinary action of the Institution. At the time of enrolment a student can drop a course registered earlier and also substitute it by another course for valid reasons with the consent of the Faculty Adviser. Late enrolment will be permitted on payment of a prescribed fine up to two weeks from the date of commencement of the semester.

7.5 Withdrawal from a course registered is permitted up to one week from the date of the completion of the first assessment test.

7.6 Change of a course within a period of 15 days from the commencement of the course, with the approval of Dean (Academic Affairs), on the recommendation of the HOD, is permitted.

7.7 Courses withdrawn will have to be taken when they are offered next if they belong to the list of core courses.

8.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

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. Such student has to rejoin only in the same semester from where he left. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / THESIS / 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. (Full time)	18 (III semester)
M.Tech. (Part time)	18 (V semester)
M.C.A. (Full time)	45 (V semester)
M.C.A. (Full time) – (Lateral Entry)	22 (V semester)
M.Sc. (Full time)	30 (IV semester) if project is in IV semester 18 (III semester) if project is in III semester

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 DISCIPLINE

10.1 Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which will tend to bring down the prestige of the Institution.

10.2 Any act of indiscipline of a student reported to the Head of the Institution will be referred to a Discipline and Welfare Committee for taking appropriate action.

10.3 Every student should have been certified by the HOD that his / her conduct and discipline have been satisfactory.

11.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

Attendance rules for all Full-time programme and Part-time – Day-time programmes are given in the following sub-clause.

11.1 A student should secure not less than 75% overall attendance in that semester taking into account the total no. of periods in all courses put together attended by the student as against the total no. of periods in all courses offered during that semester. If a student who could secure overall attendance between 65% and 75% only in a particular semester due to medical reasons (hospitalization / accident / specific illness) or due to participation in the College / University / State / National / International level sports events with prior permission from the Officials concerned shall be given exemption from the prescribed attendance requirement and he / she shall be permitted to appear for the current semester examinations.

The students who do not fulfill the above attendance requirement will not be permitted to write the semester end examination and will not be permitted to move to next semester. Such students should repeat all the courses of the semester in the next Academic year.

11.2 The faculty member of each course shall furnish the cumulative attendance details to the class advisor. The class advisor will consolidate and furnish the list of students who have earned less than 75% overall attendance, to the Dean (Academic Affairs) through the Head of the Department / School Dean. Thereupon, the Dean (Academic Affairs) shall issue orders preventing students from appearing for the semester end examination of all the courses of that semester.

11.3 A student who is awarded "U" grade in a course will have the option of either to write semester end arrear examination at the end of the subsequent semesters, or to redo the course whenever the course is offered. Marks earned during the redo period in the continuous assessment for the course, will be used for grading along with the marks earned in the semester-end (re-do) examination. If any student obtained "U" grade, the marks earned during the redo period for the continuous assessment for that course will be considered for further appearance as arrears.

11.4 If a student with "U" grade prefers to redo any particular course fails to earn the minimum 75% attendance while doing that course, then he/she will not be permitted to write the semester end examination and his / her earlier 'U' grade and continuous assessment marks shall continue.

12.0 ASSESSMENTS AND EXAMINATIONS

12.1 The following rule shall apply to the full-time and part-time PG programmes (M.Tech./ M.C.A. / M.Sc.)

For lecture-based courses, normally a minimum of two assessments will be made during the semester. The assessments may be combination of tests and assignments. The assessment procedure as decided in the Class Committee will be announced to the students right from the beginning of the semester by the course teacher.

12.2 There shall be one examination of three hours duration, at the end of the semester, in each lecture based course.

12.3 The evaluation of the Project work will be based on the project report and a Viva-Voce Examination by a team consisting of the supervisor concerned, an Internal Examiner and External Examiner to be appointed by the Controller of Examinations.

12.4 At the end of industrial internship, the student shall submit a certificate from the organization and also a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a Departmental Committee constituted by the Head of the Department.

13.0 WEIGHTAGES

13.1 The following shall be the weightages for different courses:

i) **Lecture based course**

Two continuous assessments	- 50%
Semester-end examination	- 50%

ii) **Laboratory based courses**

Laboratory work assessment	- 75%
Semester-end examination	- 25%

iii) **Project work**

Periodic reviews	- 50%
Evaluation of Project Report by External Examiner	- 20%
Viva-Voce Examination	- 30%

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

13.3 The markings for all tests, tutorial, assignments (if any), laboratory work and examinations will be on absolute basis. The final percentage of marks is calculated in each course as per the weightages given in clause 13.1.

14.0 SUBSTITUTE EXAMINATION

14.1 A student who has missed for genuine reasons any one of the three assessments including semester-end examination of a course may be permitted to write a substitute examination. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accident or admissions to a hospital due to illness, etc.

14.2 A student who misses any assessment in a course shall apply in a prescribed form to the Dean (Academic Affairs) through the Head of the department within a week from the date of missed assessment. However the substitute tests and examination for a course will be conducted within two weeks after the last day of the semester-end examinations.

15.0 COURSEWISE GRADING OF STUDENTS AND LETTER GRADES

15.1 Based on the semester performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and the corresponding grade points are as follows, but grading has to be relative grading

Letter grade	Grade points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-
AB	-

Flexible range grading system will be adopted

“W” denotes withdrawal from the course.

"U" denotes unsuccessful performance in a course.

“AB” denotes absent for the semester end examination

15.2 A student is considered to have completed a course successfully if he / she secure five grade points or higher. A letter grade ‘U’ in any course implies unsuccessful performance in that course.

15.3 A course successfully completed cannot be repeated for any reason.

16.0 AWARD OF LETTER GRADE

16.1 A final meeting of the Class Committee without the student member(s) will be convened within ten days after the last day of the semester end examination. The letter grades to be awarded to the students for different courses will be finalized at the meeting.

16.2 After finalization of the grades at the class committee meeting the Chairman will forward the results to the Controller of Examinations, with copies to Head of the Department and Dean (Academic Affairs).

17.0 DECLARATION OF RESULTS

17.1 After finalization by the Class Committee as per clause 16.1 the Letter grades awarded to the students in the each course shall be announced on the

departmental notice board after duly approved by the Controller of Examinations.

17.2 In case any student feels aggrieved about the results, he/she can apply for revaluation after paying the prescribed fee for the purpose, within one week from the announcement of results.

A committee will be constituted by the concerned Head of the Department comprising of the Chairperson of the concerned Class Committee (Convener), the teacher concerned and a teacher of the department who is knowledgeable in the concerned course. If the Committee finds that the case is genuine, it may jointly revalue the answer script and forward the revised marks to the Controller of Examinations with full justification for the revision, if any.

17.3 The “U” and “AB” grade once awarded stays in the grade sheet of the students and is not deleted when he/she completes the course successfully later. The grade acquired by the student later will be indicated in the grade sheet of the appropriate semester.

18.0 COURSE REPETITION AND ARREARS EXAMINATION

18.1 A student should register to re-do a core course wherein "W" grade is awarded. If the student is awarded "W" grade in an elective course either the same elective course may be repeated or a new elective course may be taken.

18.2 A student who is awarded “U” or “AB” grade in a course shall write the semester-end examination as arrear examination, at the end of the next semester, along with the regular examinations of next semester courses.

18.3 A student who is awarded “U” or “AB” grade in a course will have the option of either to write semester end arrear examination at the end of the subsequent semesters, or to redo the course whenever the course is offered. Marks earned during the redo period in the continuous assessment for the course, will be used for grading along with the marks earned in the end-semester (re-do) examination.

18.4 If any student obtained “U” or “AB” grade, the marks earned during the redo period for the continuous assessment for that course will be considered for further appearance as arrears.

18.5 If a student with “U” or “AB” grade prefers to redo any particular course fails to earn the minimum 75% attendance while doing that course, then he/she

will not be permitted to write the semester end examination and his / her earlier 'U' grade and continuous assessment marks shall continue.

19.0 GRADE SHEET

19.1 The grade sheet issued at the end of the semester to each student will contain the following:

(i) the credits for each course registered for that semester.

(ii) the performance in each course by the letter grade obtained.

(iii) the total credits earned in that semester.

(iv) the Grade Point Average (GPA) of all the courses registered for that semester and the Cumulative Grade Point Average (CGPA) of all the courses taken up to that semester.

19.2 The GPA will be calculated according to the formula

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i} \qquad Where\ \ n = number\ of\ courses$$

where C_i is the number of credits assigned for i^{th} course GP_i - Grade point obtained in the i^{th} course For the cumulative grade point average (CGPA) a similar formula is used except that the sum is over all the courses taken in all the semesters completed up to the point of time.

'W' grade will be excluded for GPA calculations.

'U', 'AB' and 'W' grades will be excluded for CGPA calculations.

19.3 Classification of the award of degree will be as follows:

CGPA	Classification
8.50 and above, having completed all courses in first appearance	First class with Distinction
6.50 and above, having completed within a period of 2 semesters beyond the programme period	First Class
All others	Second Class

However, to be eligible for First Class with Distinction, a student should not have obtained U grade in any course during his/her study and should have completed the PG Programme within a minimum period covered by the minimum duration (clause 3.1) plus authorized break of study, if any (clause 8). To be eligible for First Class, a student should have passed the examination in all 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 will not be counted. The students who do not satisfy the above two conditions will be classified as second class. For the purpose of classification, the CGPA will 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.

20.0 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

20.1 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

20.2 The award of the degree must be approved by the University.

21.0 POWER TO MODIFY

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

CURRICULUM & SYLLABI FOR M.SC. (CHEMISTRY)

(FOUR SEMESTERS / FULL TIME)

CURRICULUM

SEMESTER I

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CHB 6101	Organic Chemistry-I	3	0	0	3
2.	CHB 6102	Physical Chemistry-I	3	0	0	3
3.	CHB 6103	Inorganic Chemistry	3	0	0	3
4.	CHB 6104	Analytical Chemistry	3	0	0	3
5.	CHB 6105	Green Chemistry	3	0	0	3
6.	CHB 6106	Organic Chemistry Practical-I	0	0	6	3
7.	CHB 6107	Inorganic Chemistry Practical-I	0	0	6	3
						21

SEMESTER II

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CHB 6211	Organic Chemistry-II	3	0	0	3
2.	CHB 6212	Physical Chemistry-II	3	0	0	3
3.	CHB 6213	Coordination Chemistry	3	0	0	3
4.	CHB 6214	Nanotechnology	3	0	0	3
5.	CHB 6215	Molecular Spectroscopy	3	0	0	3
6.	CHB 6216	Organic Chemistry Practical-II	0	0	6	3
7.	CHB 6217	Inorganic Chemistry Practical-II	0	0	6	3
8.	CHB 6218	Synthesis and Characterization Laboratory	0	0	6	3
9.	CHB 6216	Seminar	0	0	2	1
						25

SEMESTER III

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CHB 7101	Organic Chemistry-III	3	0	0	3
2.	CHB 7102	Physical Chemistry-III	3	0	0	3
3.	CHB 7103	Advanced Inorganic Chemistry	3	0	0	3
4.		Elective-I	3	0	0	3
5.		Elective-II	3	0	0	3
6.	CHB 7104	Physical Chemistry Practical	0	0	12	6
						21

SEMESTER IV

Sl. No.	Course Code	Course Title	L	T	P	C
1.		Elective-III	3	0	0	3
2.		Elective-IV	3	0	0	3
3.	CHB 7211	Project Work	0	0	20	10
						16

TOTAL CREDITS : 83

LIST OF ELECTIVES

Sl. No.	Course Code	Course Title
1.	CHBY 01	Pharmaceutical Chemistry
2.	CHBY 02	Pharmaceutical Technology
3.	CHBY 03	Medicinal Chemistry
4.	CHBY 04	Pharmaceutical Industrial Management
5.	CHBY 05	GMP, Quality Assurance and Validation
6.	CHBY 06	Polymer Chemistry
7.	CHBY 07	Polymer Technology
8.	CHBY 08	Electrical Properties of Polymeric Materials
9.	CHBY 09	Polymer Structure and Property Relationship
10.	CHBY 10	Physical Chemistry of Polymers
11.	CHBY 11	Industrial Catalysis
12.	CHBY 12	Concepts and Techniques in Catalysis
13.	CHBY 13	Environmental Chemistry
14.	CHBY 14	Water and Waste Water Treatment
15.	CHBY 15	Solid Waste Management and Air Pollution
16.	CHBY 16	Industrial Electrochemistry
17.	CHBY 17	Corrosion and Corrosion Control
18.	CHBY 18	Electrochemical Protection System
19.	CHBY 19	Metal Coating Technology
20.	CHBY 20	Protective Coatings
21.	CHBY 21	Fuel Cells and Applications
22.	CHBY 22	Advanced Batteries and Systems
23.	CHBY 23	Electrochemical Material Science
24.	CHBY 24	Electrochemical Energy Conversion and Storage
25.	CHBY 25	Inorganic Chemical Technology
26.	CHBY 26	Organic Chemical Technology

27.	CHBY 27	Textile Chemistry
28.	CHBY 28	Biochemistry
29.	CHBY 29	Chlor-alkali Technology
30.	CHBY 30	Unit Operations and Unit Processes

SEMESTER I

CHB6101 ORGANIC CHEMISTRY-I

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student conversant with

- the basic concepts in stereochemistry.
- all the major types of organic reaction mechanisms.
- concepts of aromaticity

MODULE I STEREOCHEMISTRY I **9**

Introduction to molecular symmetry and point groups – optical isomerism – conditions for optical activity – Newmann, Sawhorse and Fisher projection formulae – Interconversion – 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, allenes and spiranes, cyclophanes, helical chirality - ANSA compounds.

MODULE II REACTIVE INTERMEDIATES & REACTION MECHANISM **9**

Formation and stability of carbonium ions, norbornyl cation and other non-classical carbocations and classical carbocations, Bredt's rule, carbanions, carbenes, nitrenes, free radicals, arynes, ylides - methods of generation and reactivity and applications - Kinetic and nonkinetic methods to determine the reaction mechanism: Thermodynamic and Kinetic controlled reactions Non-kinetic methods -Kinetic methods – methods of determining mechanism.

MODULE III NUCLEOPHILIC SUBSTITUTIONS **9**

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.

MODULE IV AROMATICITY AND AROMATIC ELECTROPHILIC SUBSTITUTION REACTIONS 9

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, ferrocenes, fullerenes, azulenes, fulvenes, azirines, heteroaromatic systems and charged ring systems – NMR and aromaticity - Reactions of aryl diazonium salts – aromatic electrophilic substitution reactions and mechanisms.

MODULE V ELIMINATION AND ADDITION REACTIONS 9

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 a, 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 – Peterson's and Julia elimination.

Total Hours: 45

REFERENCES:

1. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009.
2. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A – Structure and Mechanisms, 5th Edition, Springer, 2007.
3. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007.
4. Graham Solomons T.W., Craig Fryhle, Organic Chemistry,9th Edition, John Wiley and Sons, New York, 2007.
5. Morrison R.T., Boyd R.N. and Battacharjee S.K., Organic Chemistry, 7th Edition, Pearsons, 2007.
6. Eliel E.L. and Wilen S.H., Stereochemistry of Organic Compounds, John Wiley India, 2009.

7. Nasipuri D., Stereochemistry of Organic Compounds, 2nd Edition, Wiley Eastern Ltd., 1991.

8. Kalsi P.S., Stereochemistry of Organic Compounds, Wiley Eastern Ltd., New Delhi, 1992.

9. Peter Sykes, Guidebook to Mechanism in Organic Chemistry, Orient Longman, 2005.

OUTCOMES:

The students will be able to

- acquire the skills for correct stereochemical assignment and interpretation in rather simple organic molecules.
- formulate his/her own reasoned opinions in the mechanistic side of organic reactions.

CHB6102 PHYSICAL CHEMISTRY-I L T P C
3 0 0 3

OBJECTIVES:

To make the student conversant with

- Basic principles of chemical thermodynamics
- Different type of phase equilibria
- Advanced concepts in electrochemistry

MODULE I CHEMICAL THERMODYNAMICS-1 9

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.

MODULE II CHEMICAL THERMODYNAMICS-2 9

Clausius-Clapeyron equation - determination of partial molar quantities - thermodynamic aspects of extract ion of metals- reduction of oxides and sulphides - Ellingham diagram and its significances - partial molar properties – chemical potential – vant Hoff's equation – Gibbs-Duhem equation.

MODULE III STATISTICAL THERMODYNAMICS 9

Objectives of statistical thermodynamics – probability – microstates and macrostates for distinguishable and indistinguishable particles – permutation and combinations – Maxwell-Boltzmann statistics – third law of thermodynamics and exception to this law – use of partition function for obtaining thermodynamic functions.

MODULE IV PHASE EQUILBRIA 9

Two component systems – classification – solid-gas (dehydration and rehydration of $CuSO_4$, $5H_2O$), solid-liquid systems – benzene-picric acid system, salt-water system fractional distillation – three component systems involving liquid-liquid equilibria.

MODULE V ELECTROCHEMISTRY 9

Ion-solvent and ion-ion interactions, ion transport in solutions – electrochemical cells electrical double layer – various models – electrocapillary phenomena – electrokinetic phenomena – electroosmosis – streaming potential and electrophoresis – Tiselius apparatus – kinetics of electrode processes – Butler-Volmer equation - Tafel equation.

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. Philip H. Reiger, Electrochemistry, Prentice Hall Inc., New Delhi, 1987.
5. Kuriacose J.C. and Rajaram J., Thermodynamics for Students of Chemistry, 3rd Edition, S. Chand and Co., New Delhi, 2001.
6. Crow D.R., Principles and Application of Electrochemistry, Chapman and Hall, 1988.
7. Cotton F.A., Chemical Application of Group Theory, 3rd Edition, Wiley, New York, 2003.

OUTCOMES:

The students will be able to

- identify thermodynamics property of any system to apply it for various systems
- acquire the knowledge of phase equilibria for various systems
- get knowledge about various electrochemical phenomena

CHB6103 INORGANIC CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the student conversant with

- Periodic properties of elements,
- Types of non-valence forces,
- Types of crystal structure,
- Bonding in inorganic molecules,
- Concepts of non-aqueous solvents,

MODULE I ATOMIC STRUCTURE 9

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

MODULE II NON-VALENCE FORCES 9

vander Waals' forces – hydrogen bond – clathrates, metallic bond – free electron theory of metals, ionic solids – lattice energy – Born-Haber cycle.

MODULE III CRYSTAL STRUCUTRE 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.

MODULE IV COVALENT BOND 9

Valence bond theory – hybridization and resonance – diatomic and polyatomic systems - VSEPR theory - molecular orbital theory – LCAO approximation for diatomic and polyatomic systems.

MODULE V AQUEOUS AND NON-AQUEOUS CHEMISTRY 9

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.

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

- Recognize the different non valence forces and their influence on the physical & chemical properties
- Learn structural arrangements and its stability based upon physical parameters.
- Acquire the knowledge of structure of different types of solids.
- Demonstrate an understanding of the basic principles of periodicity.
- Illustrate an understanding of the principles of molecular orbital theory.
- Demonstrate an understanding of the basic principles of acid – base chemistry and non – aqueous solvents.
- Demonstrate an understanding of VSEPR theory.

CHB6104 ANALYTICAL CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the student

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

MODULE I WET CHEMICAL METHODS OF ANALYSIS 9

Volumetric analysis – neutralization, precipitation, complexometric and redox titrations - Gravimetric analysis – volatilization and precipitation methods - Types of error – evaluation of analytical data - Colorimetric analysis – principle and applications.

MODULE II INTRODUCTION TO MOLECULAR SPECTROSCOPY 9

Molecular spectroscopy: UV, Visible, IR absorption and Introduction to NMR spectroscopy - Fluorescence, phosphorescence and chemiluminescence methods - Atomic absorption and atomic fluorescence spectroscopy - Emission spectroscopy, flame photometry and ICP-AES principle, instrumentation and analytical applications.

MODULE III ELECTROANALYTICAL TECHNIQUES 9

Conductometry and high frequency titrations - potentiometry, pH-metry and ion-selective electrodes - coulometry – voltammetry - polarography, amperometric titrations and anodic stripping voltammetry - principle, practice and applications.

MODULE IV SEPARATION TECHNIQUES **9**

Chromatography – paper, column, TLC, GC, HPLC and GPC techniques – ion exchange techniques – Capillary electrophoresis – principle, instrumentation and applications.

MODULE V THERMAL METHODS OF ANALYSIS **9**

Thermal analytical techniques – TGA, DTA, DSC – principle, instrumentation and applications.

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

- Do various chemical analysis and physico-chemical techniques
- Analyse the data obtained

CHB6105 GREEN CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the students conversant with the

- principles and advantages of green chemistry.
- principles and uses of microwave as a green technology.
- various alternative reagents and chemicals in 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.

Total Hours: 45

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 be able to

- Use the various alternative resources for green technology in organic synthesis.
- Apply the concept of microwaves and ionic liquids in various chemical reactions.

CHB6106 ORGANIC CHEMISTRY PRACTICAL-I

L	T	P	C
0	0	6	3

OBJECTIVES:

To make the student conversant with

- separation of two component mixture and to analyze the functional groups present in simple organic compounds.
- simple organic synthesis and subsequently learn the different purification methods.

LIST OF EXPERIMENTS :

1. Qualitative analysis of simple organic compounds and two component mixtures.
2. Purification of organic solvents and reagents - Purification of liquids by distillation – Purification of solids by recrystallization – Determination of melting point – Determination of boiling point by capillary method.
3. Preparation of simple organic compounds (based on conventional, green, microwave, sonochemistry and photochemical synthesis) and their identification by physical and chemical methods.
4. Demostration of the molecular model.

Total Hours:90

REFERENCES:

1. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall, 2008.
2. N.S. Gnanapragasam, G. Ramamurthy, Organic Chemistry – Lab manual, S. Viswanathan Co. Pvt. Ltd., 1998.
3. 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 and analyze the different component mixtures of simple organic compounds.
- Purify the organic compounds by using recrystallisation and distillation techniques.
- Independently perform synthesis of simple organic compounds.

CHB6107 INORGANIC CHEMISTRY PRACTICAL-I

L	T	P	C
0	0	6	3

OBJECTIVES:

The students will learn

- the basics of inorganic chemistry practical such as distillation, extraction, etc.
- to identify individual ions present in water and mixture of salt and the chemistry behind it
- the estimation of various ions by titrimetry 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
6. Estimation of Na/K/Ca by flame photometer

P: 90

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 solvents
- Identify various ions present in water and mixture of salt
- Estimate the ions present in the sample by different techniques

SEMESTER II

CHB6211 ORGANIC CHEMISTRY-II L T P C
3 0 0 3

OBJECTIVES:

To impart

- 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 new and novel organic reactions.

MODULE I STEREOCHEMISTRY II 9

Conformational analysis and reactivity of cyclic and acyclic systems – topicity – prochirality - enantiotopic and diastereotopic atoms, groups and faces – asymmetric synthesis - stereoselective, stereospecific reactions - enantioselective synthesis - optical purity and enantiomeric excess - Cram's rule – Prelog's rule – Fehn Anns model -methods of resolution – kintetic, dynamic kinetic resolution - Sharpless epoxidation.

MODULE II REARRANGEMENTS 9

General mechanistic considerations, nature of migration, migratory aptitude - nucleophilic, electrophilic and free radical rearrangements – Wagner-Meerwein, Demyanov, Favorskii, Fritsch-Butternberg - Wiechell, Neber, Hofmann, Curtius, Beckmann, Schmidt, Lossen, Wolff, Baeyer – Villiger, Stevens, Wittig, Chapman, Wallach, Orton, Bamberger, Pummerer and Von Ritchter rearrangements.

MODULE III 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 IV MULTISTEP SYNTHESIS **9**

Strategies for synthetic analysis and planning – functional group introduction, removal and interconversion - activating groups – protection and deprotection of hydroxyl, amino, carbonyl and carboxylic acid groups - retrosynthetic analysis, synthons and synthetic equivalent groups - C-C, C=C, C-O bond forming reactions – linear and convergent synthesis - control of stereochemistry – reactive umpolung - analysis and synthesis of a few target molecules.

MODULE V APPLICATIONS OF ORGANIC SPECTROSCOPY **9**

Structure determination of organic compounds by 13C, 2D NMR, DEPT, COSY, NOESY and Mass spectroscopic techniques.

Total Hours: 45

REFERENCES:

1. Jerry March, Advanced Organic Chemistry, 4th Edition, Wiley-Interscience, New York, 2007.
2. Morrison R.T., Boyd R.N. and S. K. Battacharjee Organic Chemistry, 7th Edition, Pearsons, 2007.
3. Lowry T.H. and Richardson K.S., Mechanism and Theory in Organic Chemistry, 2nd Edition, Harper and Row Publishers, 1981.
4. Michael B. Smith and Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure 7th Edition, Wiley Intersciences, New York, 2009.
5. Finar I.L., Organic Chemistry, Volume II, 5th Edition, ELBS Longmann Group Ltd., London, 1980.
6. Stuart G. Warren, Organic Synthesis: The Disconnection Approach Wiley India, 2009.
7. Achesen R.M., Chemistry of Heterocyclic Compounds, Wiley Eastern, 1973.
8. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A – Structure and Mechanisms, 5th Edition, Springer, 2007.
9. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007.

OUTCOMES:

The student will

- acquire the skills for determining and interpreting absolute stereochemical assignment in the cases of complex organic molecules.
- will be competent in designing synthesys for unknown and complex molecule.

CHB6212 PHYSICAL CHEMISTRY-II

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student

- learn the inadequacy of classical mechanics and the origin of quantum mechanics
- derive and Solve Schrodinger equation
- apply the principles of quantum mechanics to small atoms and molecule
- learn the quantum statistics and how it is applied to systems of chemical interest.
- learn the key concepts associated with introductory statistical thermodynamics

MODULE I INTRODUCTION TO QUANTUM CHEMISTRY 9

Inadequacy of classical mechanics – black body radiation, photo electric effect, heat capacity of solids – Planck's quantum theory – quantum mechanical operators – Hamiltonian operators - momentum operators, permutation operators – eigen value – eigen function equations.

MODULE II QUANTUM CHEMISTRY OF ATOMS 9

Postulates of quantum mechanics, Schrodinger wave equation and its solution to a particle in a box, rigid rotor and harmonic oscillators – H atom solutions – variation method – perturbation method – helium atom – SCF and Hartree-Fock methods.

MODULE III QUANTUM CHEMISTRY AND PHOTOCHEMISTRY OF MOLECULES 9

Born Oppenheimer approximation LCAO – MO method of H_2+ and H_2 – electronic configuration and properties of homo and hetero nuclear diatomic molecules – valence bond – covalent – resonance – polarity of bonds – 3 electron bonds - Localized and delocalized bonds – hybridization – Huckel theory of conjugated molecules – cyclic systems – Woodward Hoffman rules. Stern-Volmer relation, energy transfer efficiency - bimolecular quenching, chemiluminescence – luminescence for sensors and switches, charge transfer excited state.

MODULE IV QUANTUM STATISTICS **9**

Molar partition functions – evaluation of translational, rotational, vibrational and electronic partition functions – application to monoatomic gases (ortho-para hydrogen) and solids, quantum statistics – Fermi-Dirac and Bose-Einstein statistics.

MODULE V MOLECULAR SYMMETRY AND GROUP THEORY **9**

Symmetry elements and symmetry operations – group postulates – types of groups – point groups – representation of molecular point groups – great orthogonality theorem – character tables for point groups – point groups and geometry of H_2O, NH_3, CH_4, CO_2, $[Ni(CN)_4]^{2-}$, C_6H_6 and $[Co(NH_3)_6]^{3+}$ molecules – applications of group theory.

Total Hours: 45

REFERENCES:

1. Atkins P. and Paula J.D., Physical Chemistry, 7th Edition, Oxford University Press, London, 2002.
2. Castellan G.W., Physical Chemistry, 3rd Edition, Narosa Publishing House, 2004.
3. Laidler K., Chemical Kinetics, 2nd Edition, Harper and Row, New Delhi, 1997.
4. McQuarrie D.A., Quantum Chemistry, 1st Edition, University Science Books, Mill Valley, California, 2003.
5. Hanna M.W., Quantum Mechanics in Chemistry, 3rd Edition, Addition Wesley, London, 1981.
6. Rajaram J. and Kuriacose J.C., Kinetics and Mechanism of Chemical Transformation, McMillan India Ltd., New Delhi, 1993.
7. Adamson W., Physical Chemistry of Surfaces, 5th Edition, Wiley, 1990.
8. Levine I.N., Quantum Chemistry, 5th Edition, Pearson Education, 2000.

OUTCOMES:

The student will get

- basic idea about quantum chemistry
- the mathematics associated with quantum statistics including certain aspects of linear algebra
- the quantum chemistry and how to apply this knowledge to atomic and molecular structure

CHB6213 CO-ORDINATION CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the students conversant with the

- nomenclature of co ordination compounds
- isomerism in co ordination compounds
- bonding theories of co ordination compounds
- spectra of co ordination compounds
- various reactions of co ordination compounds
- chemistry of 'd' and 'f' block elements

MODULE I COORDINATION COMPOUNDS 9

Nomenclature, structure and stability – geometry and isomerism - absolute configuration – ORD and CD spectra - stability of complexes – thermodynamic aspects, successive and overall formation constants – experimental methods.

MODULE II THEORIES OF METAL- LIGAND BOND 9

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 III SPECTRA OF CO-ORDINATION COMPOUNDS 9

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

MODULE IV REACTIONS OF CO-ORDINATION COMPOUNDS 9

Inert and labile complexes - substitution reactions in square-planar and octahedral complexes - electron transfer reactions - photochemical reactions.

MODULE V COMPARATIVE CHEMISTRY OF OXIDATION STATES OF D AND 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.

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

- demonstrate an understanding of nomenclature and isomerism
- illustrate an understanding of the principles of theories of metal-ligand bond.
- demonstrate an understanding of spectra of coordination compounds.
- analyze the spectra of transition metal ions.
- analyze Tanabe – Sugano diagrams.
- interpret the stability of complexes.
- understand the substitution reactions in transition metal complexes.
- demonstrate an understanding of chemistry of ‘d’ and ‘f’ block elements.
- analyze and compare the transition metals and lanthanides

CHB6214 NANOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To make the students conversant with the

- definition and significance of nanoscale and types of CNT
- different methods of preparation of nanomaterials
- various tools for characterizing nanomaterials

MODULE I INTRODUCTION 9

Definition of nano - significance of the nanoscale - new materials: nanomaterials - properties of nanomaterials - nanomaterial science - nanoscale in one dimension -thin films, layers and surfaces - nanoscale in two dimensions - carbon nanotubes- inorganic nanotubes, nanowires, biopolymers- nanoscale in three dimensions – nanoparticles, fullerenes, carbon 60, dendrimers, quantum dots- applications of nanomaterials- current applications- sunscreens and cosmetic, composites, clays, coatings and surfaces, tougher and harder cutting tools.

MODULE II PREPARATION OF NANOMATERIALS 9

Methods of preparation of nanomaterials, bottom-up and top-down approach, sol-gel synthesis, inert gas condensation, mechanical alloying or high-energy ball milling, plasma synthesis, and electrodeposition.

MODULE III CHARACTERIZATION TECHNIQUES AND APPLICATION 9

Atomic Force Microscopy (AFM): Contact and Tapping Mode - Scanning Electron microscopy (SEM), Transmission electron microscopy (TEM), Introduction to advanced Scanning Probe Microscopy - Electrostatic Force Microscopy (EFM) - Magnetic Force Microscopy (MFM) - Scanning Thermal Microscopy (SThM), Scanning Tunnelling Mode (STM), Piezoelectric force microscopy (PFM), Scanning Capacitance Microscopy (SCM), X-ray Photoelectron spectroscopy (XPS), Powder XRD - Nanoindentation.

Short-term Applications – Paints, remediation, fuel cells, displays, batteries, fuel additives, catalysts.

Longer-term Applications - Carbon nanotube composites, lubricants, magnetic materials, medical implants machinable ceramics, water purification, military battle suits.

MODULE IV CARBON NANOTUBES 9

History - production methods - arc method, laser method, chemical vapor deposition, ball milling, other methods - purification methods- gas phase, liquid phase, intercalation, - dispersion - fictionalization -chopping, oxidation, and "wrapping" of CNTs.

MODULE V PROPERTIES CARBON NANOTUBES 9

Electrical conductivity, strength and elasticity, thermal conductivity and expansion, field emission, high aspect ratio, highly absorbent, applications - 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, other applications.

Total Hours: 45

REFERENCES:

1. Pradeep T., Nano: The Essentials Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill, New Delhi, 2007.
2. Mark Ratner and Daniel Ratner, Nano Technology, Pearson Education, New Delhi, 2003.
3. Tlusty J, Machining Processes and Equipment, 2nd Edition, Prentice Hall, 2000. Viswanathan B., Nano Materials

OUTCOMES:

The students will be able to

- know the significance of nanoscale & its dimensions
- acquire knowledge of various characterization techniques
- know the short term and longer term applications of nanomaterials

CHB6215 MOLECULAR SPECTROSCOPY L T P C
3 0 0 3

OBJECTIVES:

To make the students

- learn molecular spectroscopy as an important tool to understanding molecular structure and its characteristics.
- acquire a basic idea of different electromagnetic regions and instrumentation of various modern spectrometers
- demonstrate an understanding of the 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 maximum (maximum) absorption of molecules in Electronic (UV-Visible) region using Woodward-Fischer rule
- learn the magnetic properties of electrons and nucleus of atoms and free radicals, using spin angular momentum with the help of nuclear magnetic resonance and electron spin resonance spectra
- identify the unknown molecular formula of fragmented metastable ions of organic compounds
- learn hyperfine interactions of nuclei present in a molecule

MODULE I ELECTROMAGNETIC RADIATION AND ROTATIONAL SPECTROSCOPY 9

Characterization of electromagnetic radiation – regions of the spectrum – basic elements of practical spectroscopy – enhancement of spectra – Applications of group theory – 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 SPIN RESONANCE SPECTROSCOPY 9

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

MODULE IV 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.

MODULE V 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.

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

- get the theoretical knowledge of the various spectroscopic methods on the basis of the examples from the science and industry.
- become familiar with modern spectrometers and methods, which are applied in industrial and scientific laboratories in the field of synthesis and structural determination

CHB6216 ORGANIC CHEMISTRY PRACTICAL-II

L	T	P	C
0	0	6	3

OBJECTIVES:

To make the students

- identify organic compounds by TLC and purify them by column chromatography.
- expertise in synthesis of organic compounds.
- learn to extract, identify and characterize organic compounds isolated from natural products.

LIST OF EXPERIMENTS:

1. Identification and purification of organic compounds by thin layer and column chromatographic techniques.
2. Multistep synthesis of organic compounds - isolation and characterization of the products by various spectroscopic techniques.
3. Isolation, characterization and identification of curcumin (from turmeric), piperine (from black pepper) and cumin oil (from cumin seeds).

Total Hours: 90

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

- independently perform two or more step organic synthesis.
- identify the synthesized compounds by TLC and purify it by column chromatography.
- extract, identify and characterize the compounds isolated from natural products.

SEMESTER III

CHB6217 INORGANIC CHEMISTRY PRACTICAL-II

L	T	P	C
0	0	6	3

OBJECTIVES:

To make the students

- estimate various ions present in alloys
- prepare different complexes and characterize it

LIST OF EXPERIMENTS :

1. Estimation of alloys by gravimetry and titrimetry: brass (Cu & Zn), bronze (Cu & Sn) and ferro nickel (Fe & Ni)
2. 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

Total Hours: 90

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

- identify various ions present in alloys
- estimate the amount of ions by complexometric and gravimetric methods
- prepare and characterize various complexes and analyse the samples thoroughly

CHB6218	SYNTHESIS AND CHARACTERIZATION LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES:

To make the students demonstrate the

- synthesis of materials by various methods
- analysis by flame photometry
- analysis by spectrophotometry
- analysis by thermal methods
- interpretation of NMR spectra and XRD pattern
- interpretation of IR and Raman spectra

LIST OF EXPERIMENTS

1. Synthesis of materials by different techniques
   (i) Polymer synthesis
   (ii) nanomaterials
   (iii) photonic materials
   (iv) porous materials
2. Characterization of materials by UV–Vis, FT-IR, Fluorescence, GC, HPLC, TG/DTA/DSC and XRD
3. Morphology of materials

REFERENCES:

1. Brinker C.J. and Schere G.W., Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing, Academic Press 1990.
2. Patnaik, P.Dean's Analytical Chemistry Handbook, 2nd Edition, McGraw-Hill, 2004.
3. Byrappa K. and Masahiro Yoshimura, Handbook of Hydrothermal Technology, Norwich, New York: Noyes Publications, 2001.

OUTCOMES:

The students will be able to

- synthesize nanomaterials by various methods
- analyze the elements present in ceramic materials by flame photometry.
- analyze the elements by spectrophotometry.

CHB7101 ORGANIC CHEMISTRY-III L T P C
3 0 0 3

OBJECTIVES:

To make the students conversant with

- all major types of organic name reaction with mechanisms.
- all types of pericyclic and photochemicals reactions with its applications.
- the structure and synthesis of various natural compounds.

MODULE I NAME REACTIONS 9

Stork enamine, Birch reduction - Aldol, Claisen, Benzoin, Stobbe condensations - Michael addition, Mannich reaction, Wittig, Robinson annulation, Dieckmann, Shapiro, Koenigs-Knorr, Polonowski, Hofmann-Loffler, Reformatsky, Darzen's, Simmons-Smith, Gattermann-Koch, Mitsunobu reaction, Buchwald and Hartwig.

MODULE II ORGANIC PHOTOCHEMISTRY 9

Thermal vs photochemical reactions – n-pi* and pi-pi* transitions - allowed and forbidden transitions – Jablonski Diagram - fluorescence and phosphorescence – internal conversion and intersystem crossing -– sensitization, quenching and quantum efficiency – photochemical reaction of ketones – Norrish type I and II, Paterno-Buchi and Barton reactions - photochemical oxidation and reduction, photochemical reactions of olefins - cis-trans isomerisation, di-pi-methane and Fries rearrangements.

MODULE III PERICYCLIC REACTIONS 9

Definition – electrocyclic, cycloaddition, sigmatropic, chelotropic and ene reactions - Woodward-Hoffmann rules – Frontier orbital, Mobius-Huckel and orbital symmetry correlation approaches - Stereospecificity and regiospecificity of pericyclic reactions – pericyclic reactions in organic synthesis – Diels-Alder reaction, 1,3-dipolar cycloaddition, Claisen, Cope, Aza cope.

MODULE IV HETEROCYCLES, ALKALOIDS, TERPENOIDS AND STEROIDS 9

Nomenclature of condensed heterocycles - Synthesis and reactivity of indoles, quinolines, isoquinolines, benzopyran, chromones, coumarins - Alkaloids –

classification - synthesis of cocaine and atropine - terpenoids - Classification – isoprene rule – stereochemistry and synthesis of car-3-ene, menthol, zingiberene – Steroids – classification – structure and stereochemistry of cholesterol, synthesis of cortisone, estrone.

MODULE V CARBOHYDRATES, PROTEINS, NUCLEIC ACIDS 9

Monosaccharides – classification – cyclic structure of monosaccharides – mutarotation – epimers – glycals - glycosides – Ferrier rearrangement – anomers – Hudson rules – derivatives of monosaccharides – Vitamin C - disaccharides – trisaccharides – polysaccharides – amino acids – classification – peptides - proteins – classification - structure - nucleic acids.

Total Hours: 45

REFERENCES:

1. Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th Edition, Wiley Inter Science, New York, 2007.
2. Fleming I., Frontier Orbital and Organic Chemical Reactions, Wiley, 1976.
3. Graham Solomons T.W., Organic Chemistry, Volume I and II, 5th Edition, John Wiley and Sons, New York, 1992.
4. Finar I.L., Organic Chemistry, Volume II, 5th Edition, ELBS Longman Group Ltd., London, 1975.
5. Sankararaman S., Pericyclic reactions – a Textbook: Reactions, Applications and Theory, Wiley-VCH, 2005.
6. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part A – Structure and Mechanisms, 5th Edition, Springer, 2007.
7. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Springer, 2007.

OUTCOMES:

The student will

- be skilled in predicting the product due to photochemical and pericyclic reaction mechanism.
- acquire the skill of relating all the biomolecules/natural products and propose synthetic routes.

CHB7102 PHYSICAL CHEMISTRY - III

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student learn

- the basic aspects of both experimental and theoretical chemical kinetics
- derive rate expressions for acid-base catalytic systems and enzyme catalysed systems
- write mechanisms for reactions catalysed by transition metal complexes
- relate the catalytic activity of heterogeneous catalysts to their physicochemical properties
- learn the principle and instrumentation of surface characterization techniques

MODULE I 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 –study of kinetics by stopped flow techniques – flash photolysis.

MODULE II MECHANISM OF SOLUTION PHASE REACTION **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 CATALYSIS **9**

Acid-base catalysis – general scheme – Arrhenius complex – Vant Hoff's complex – specific and general catalysis – catalytic constants – Bronsted relationship – Hammett acidity functions – 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.

MODULE IV SURFACE PHENOMENA AND HETEROGENEOUS CATALYSIS 9

Diffusion – adsorption – surface reaction – various adsorption isotherms – determination of surface area – pore volume and pore size – thermodynamics of interfaces – solid catalysts – metal-metal oxides – geometric factor – electronic factor - zeolites – phase transfer catalysis – colloidal electrolytes – reactions on surfaces – surface characterization techniques – ESCA, AES and SIMS.

MODULE V NON-EQUILIBRIUM THERMODYNAMICS 9

Steady state – conservation of energy and mass – entropy production and entropy flow in open system – fluxes and forces – transformation of properties of rates and affinity – microscopic reversibility and Onsager reciprocal relation – thermokinetic effect – irreversible thermodynamics for non-linear regime.

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. Rohatgi, Mukharjii K.K., Fundamentals of Photochemistry - Wiley Eastern
8. Introduction to Photochemistry - Wells
9. Photochemistry of solutions - C.A. Parker, Elsevier
10. Essentials of Nuclear Chemistry, J. Arnikar, John Wiley.
11. Friendlander, Kennedy & Miller, Nuclear and Radio Chemistry, ohm Wiley.

12. B.G. Harvey, Nuclear Chemistry

13. Principals of solid state, H. V. Keer, Wiley Eastern,

14. Solid state chemistry, N. B. Hannay

15. Solid state chemistry, D. K. Chakrabarty, New Age International

OUTCOMES:

The student will become familiar with

- differential rate laws, integrated rate laws, temperature dependence of reaction rates, and reaction mechanisms and parallel and consecutive reactions
- Knowledge about catalysts and catalyzed reactions
- Basic analytical techniques to analyze the catalyst

CHB7103 ADVANCED INORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student conversant with the

- structure and bonding in organometallic compounds
- reactions in organometallic compounds
- molecular polyhedra in inorganic solids
- inorganic solid state
- basics of photochemistry

MODULE I ORGANOMETALLIC COMPOUNDS 9

18 electron rule: metal carbonyls, metal nitrosyls, metal alkyl and aryl complexes - preparation, structure, bonding, stereochemical non-rigidity.

MODULE II METAL CARBON PI COMPLEXES 9

Metal-alkene, alkyne and allyl complexes, cyclopentadiene and benzene complexes – preparation, structure and bonding - catalysis by organometallic compounds – hydrogenation, hydroformylation, stereoregular polymerization – Wacker process.

MODULE III 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 B12, nitrogenase - electron transfer and redox systems - photosynthesis.

MODULE IV BONDING AND MOLECULAR POLYHEDRA IN INORGANIC SOLIDS 9

Boranes, borazines, silicates, phosphorous-nitrogen, sulphur-nitrogen compounds, metal clusters - inert gas compounds.

MODULE V INORGANIC SOLID STATE AND PHOTOCHEMISTRY 9

Preparation of non-molecular solids - band theory of solids - defects and non-stoichiometry, electrical and magnetic properties, superconductivity,

amorphous solids, nonsolids - photochemistry – photophysical processes, spontaneous and stimulated emission of radiation, chemical actinometry, solar energy conversion and applications.

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

- demonstrate basic principles of organometallic compounds.
- illustrate stereochemistry of organometallic compounds.
- demonstrate the basic principles of bioinorganic chemistry.
- demonstrate the bonding in inorganic solids.
- illustrate the basic principles of inorganic solid state.
- learn the basic principles of photochemistry
- illustrate the basic principles of band theory of solids.

CHB7104	PHYSICAL CHEMISTRY PRACTICAL	L	T	P	C
		0	0	6	3

OBJECTIVES:

To make the students

- expertise in the applied concepts of kinetics, electrochemistry, thermodynamics, phase equilibrium, adsorption, etc.
- draw structures and graph using softwares and prepare reports

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. Conductometric titrations: acid-base and precipitation titrations
4. EMF measurement
5. Potentiometric titrations
6. Redox and precipitation titrations
7. Acid base titration by pH metry
8. Determination of rate constant
9. Saponification of ethyl acetate
10. Determination of CST in phenol-water system
11. Phase diagram of a ternary system-nitrobenzene-acetic acid-water or water-acetic acid-chloroform
12. Temperature dependence of solubility of benzoic acid in water and DMSO
13. Determination of activity coefficients of an electrolyte at different molalities
14. Verification of Beer-Lambert equation
15. Determination of sucrose content in cane sugar by polarimetry
16. Determination of DEp of a redox system by cyclic voltametry
17. Verification of Freundlich isotherm - Adsorption of acetic acid, oxalic acid on activated carbon

18. Molecular weight of a polymer by viscometry
19. Experiments on electroplating and electroless plating.
20. Uses of computer packages: Microsoft (word, excel and powerpoint), origin, chemsketch and chemdraw

Total Hours: 180

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 EMF of any cell
- determine the rate constant
- measure the adsorption capacity of various materials
- draw the phase diagram for 2 and 3 component systems and analyze it
- determine the optical rotation of chiral molecules
- determine the molecular weight of the polymer by viscometry
- draw chemical structures using chemsketch and chemdraw
- draw graphs using excel and origin software
- prepare the final dissertation report using MS word by themselves

CHBY01 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 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. Analgesics – narcotic analgesics – morphine analogues – synthesis of codeine – synthetic narcotic analgesics – synthesis and use of pethidines, methodones, dexdtropropoxyfene – narcotic antagonists – nalorphine – naloxone – antipyretic analgeics – salicyclic acid analogues – methyl salicylate – para amino phenol derivatives – structure synthesis and use of paracetamol, phenacetin, aspirin and salol.

MODULE II ANTIHISTAMINES AND ANTIMALARIALS 9

Antihistamines – classification H1 and H2 receptor antagonists – structure, synthesis, activity and use of diphenydramine, cyclizinc, chlorpheneramine maleate and promethazine. Antimalerials - classification - quinine-4-amino and 8-amino quinolines – chloroquine phosphate – pyrimidines – acidines - Sedatives – barbiturates – structure, synthesis, action and use of phenobarbitol – benzodiazephines – mode of action structure and synthesis of diazepam and nitrazepam.

MODULE III ANTIBIOTICS AND ANTIBACTERIALS 9

Antibiotics – pencillin, D-pencillamine, phenoxy methyl pencillin – chloramphenicol – Antibacterials – norfloxacin, ciprofloxacin, trimethoprim sulphadrugs – mode of action – preparation of sulphanilamide, sulphadiazine, sulphathiazole, sulphapyridine, sulphadimidine, sulphagaudine and sulphamethoxazole. Antifungals – action, use and synthesis of clotrimazole, micronazole and isoconazole.

MODULE IV ANTIHYPERTENSIVE AND ANTITUBERCULAR DRUGS 9

Antihypertensive drugs – synthesis and mode of action of methyldopa, pargline, bertyline, hydralazine and propranolol – Antitubercular drugs – synthesis of PAS, ethambutol, pyrazinamide and isoniazid.

MODULE V ANTIDIARRHEAL AGENTS 9

Antitussives and antineoplastic drugs – antidiarrheal agents – cimetidine, domperidone and loperamide - Expectorants – antitussives – guaiphenesin, ambroxal, bromohexine and dextromethorphan, Antineoplastic drugs – alkylating agents – nitrogen mustards – sulphonic acid esters.

Total Hours: 45

REFERENCES:

1. A. Berger, Medicinal Chemistry, Wiley Interscience, New York, Volume 1 and 2, 1990.
2. Asutoshkar, Medicinal Chemistry, Wiley Eastern Ltd., Chennai, 1992.
3. Bentely and Driver's Textbook of Pharmaceutical Chemistry, Oxford University Press, 1985.
4. H.J. Roth and A. Kleemann, Pharmaceutical Chemistry, Volume 1, Drug Synthesis, 1988.
5. David A. Williams, David A. Williams A, William O. Foye, Thomas L. Lemke, Foye's Principles of Medicinal Chemistry, Wolter Kluwer, 2008.
6. J. B. Stenlake, Medicinal and Pharmaceutical Chemistry, Volume 1, Viva /b S Publication, 1979.
7. J. B. Stenlake, The Chemical Basis of Drug Action Volume 2, Viva /b S Publication, 1979.

OUTCOME:

The student will be familiar with

- The drug design, functions and uses

CHBY02 PHARMACEUTICAL TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student learn about the

- preformulation studies
- additives used in formulations
- evaluation of drug and packaging
- cosmetic preparations

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.

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:

To make the student familiar with

- Organoliptic properties and their effect on formulation
- Manufacturing and packaging suspension, emulsions and cosmetics

CHBY03 MEDICINAL CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To make the student learn the classification, nomenclature and stereochemistry of steroids, antibiotics, anti-septics and anti-thyroids

MODULE I STEROIDS AND RELATED DRUGS 8

Introduction, classification, nomenclature and stereochemistry - (A) Androgens and anabolic steroids-testosterone, stanazolol, (B) Estrogens and progestational agents – progesterone, estradiol, (C) Adrenocorticoids – prednisolone, dexamethasone, betamethasone.

MODULE II ANTIBIOTICS 8

Penicillins, semi-synthetic penicillins, streptomycin, tetracyclines, cephalosporins, chloramphenicol, fluoroquinolones - antimycobacterial agents: pas, ethambutol, isoniazid, dapsone

MODULE III ANTI-INFECTIVES 8

Antimalarials: cholroquine, primaquine, pyrimethamine - antiamoebics: metronidazole, tinidazole, diloxanide - antiseptics and disinfectants: benzalkonium chloride - anthelmintics: mebendazole - antifungals

MODULE IV ANTIVIRALS AND PROSTAGLANDINS 8

Anti- HIV agents: zidovudine, zalcitabine, saquinavir - antivirals: amantadine, acyclovir, lamivudine - prostaglandins: misoprostol, carboprost.

MODULE V ANTITHYROIDS AND HYPOGLYCAEMICS 8

Thyroid and antithyroids: carbimazole, levothyroxine, propylthiouracil, methimazole, insulin - oral hypoglycaemics: chlorpropamide, metformin, tolbutamide, glybenclamide.

Total Hours: 90

PRACTICAL 20

1. Synthesis of selected drugs involving two or more steps.
2. Establishing the pharmacopoeial standards of the drugs synthesized.

SUGGESTED PRACTICALS:

1. Synthesis of methyl salicylate and to establish pharmacopoeial standards of methyl salicylate.
2. Synthesis of Paracetamol and to establish pharmacopoeial standards of Paracetamol.
3. To synthesize Benzocaine and to establish pharmacopoeial standards of Benzocaine.
4. Synthesis of Phenytoin and to establish pharmacopoeial standards of Phenytoin.
5. Synthesis of Hydantoin and to establish pharmacopoeial standards of Hydantoin.
6. Synthesis of Barbituric acid and to establish pharmacopoeial standards of Barbituric acid.

REFERENCES:

1. Pharmacopoeia of India, Ministry of Health, Govt. of India.
2. Wolff ME, Ed. Burger's Medicinal Chemistry, John Wiley and Sons, New York.
3. Delagado J.N. and Remers W.A.R. (Editors), Wilson and Gisworld's Text Book of Organic Medicinal and Pharmaceutical Chemistry, J. Lippincott Co., Philadelphia.
4. Foye W C, Principles of Medicinal Chemistry, Lea and Febiger, Philadelphia.
5. Singh Harkrishan and Kapoor, V.K., Organic Pharmaceutical Chemistry, Vallabh Prakashan, New Delhi.
6. Nogrady T, Medicinal Chemistry – A Biochemical Approach, Oxford University Press, New York, Oxford.
7. Finar I.L., Organic Chemistry, Volume I and II, ELBS Longman, London.
8. Hanch C, Comprehensive Medicinal Chemistry, Volume IV, Quantitative Drug Design, Pergamon Press, Oxford.
9. Mann P G and Saunders B C, Practical Organic Chemistry, ELBS Longman, London.

10. Furniss B A, Hannaford A J, Smith P W G and Tatehell A R, Vogel's Textbook of Practical Organic Chemistry, The ELBS Longman, London.

11. J. B. Stenlake, Medicinal and Pharmaceutical Chemistry, Volume 1, Viva /b S Publication, 1979.

12. J. B. Stenlake, The Chemical Basis of Drug Action Volume 2, Viva /b S Publication, 1979.

OUTCOME:

- The students will gain knowledge in the mode of action and uses of drugs.

CHBY04 PHARMACEUTICAL INDUSTRIAL MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVES:

To make the student learn the

- concept of management
- principles of economics
- principles of sales promotion
- market segmentation, targeting and production management

MODULE I CONCEPT OF MANAGEMENT **9**

Administrative Management - Planning, Organizing, Staffing, Directing and Controlling.- Entrepreneurship development, Operative Management - Personnel, Materials, Production, Financial, Marketing, Time/space, Margin/ Morale - Principles of Management -Coordination, Communication, Motivation, Decision making, leadership, Innovation Creativity, Delegation of Authority / Responsibility. Record Keeping, - Identification of key points to give maximum thrust for development and perfection.

MODULE II ECONOMICS AND ACCOUNTANCY **9**

Principles of economics with special reference to the Laws of demand and supply, demand schedule, demand curves labor welfare, general principles of insurance and inland and foreign trade, procedure of exporting and importing goods.

Principles of Accountancy, Ledger posting and book entries preparation of trial balance, columns of a cash book, Bank reconciliation statement, rectification of errors, profits and loss account, balance sheet, purchase, keeping and pricing of stocks, treatment of cheques bills of exchange, promissory notes and bundles documentary bills.

MODULE III PHARMACEUTICAL MARKETING AND SALESMANSHIP **9**

Functions, buying, selling, transportation, storage financed feedback information, channels of distribution, wholesale, retail, department store, multiple shop and mail order business.

Principle of sales promotion, advertising, ethics of sales, merchandising, literature, detailing, Recruitment, training, evaluation, compensation to the pharmacist.

MODULE IV MARKET RESEARCH 9

Measuring and Forecasting Market Demand Major concept in demand measurement, Estimating current demand geodemographic analysis - Estimating industry sales, Market share and future demand - Market segmentation and Market targeting.

MODULE V MATERIALS AND PRODUCTION MANAGEMENT 9

A brief exposure of basic principles of management major areas, scope, purchase, stores, inventory control and evaluation of materials management.

A brief exposure of the different aspects of Production Management – Visible and Invisible inputs, Methodology of Activities Performance Evaluation Technique Process – Flow, Process Know-how, Maintenance Management.

Total Hours: 45

REFERENCES:

1. Beri, Market Research, Tata McGraw Hill.
2. Chary S.N, Production and Operative Management, Tata McGraw Hill.
3. Datta A.K., Material Management/PHI.
4. Chadwick Leslie, The Essence of Management Accounting/PHI.
5. Massie L. Joseph, Essentials of Management/PHI.
6. Barthwal R.R, Industrial Economics, New Age International.
7. Shreenivasan K.R., An Introduction to Industrial Management, Vikas.
8. Daver Rustam S., Salesmanship and Publicity, Vikas.
9. Mukopadhyay Sekhar, Pharmaceutical Selling, Sterling Publishers.
10. Koontz H. and Weihrich H, Essentials of Management, Tata McGraw Hill.
11. Vidyasagar Pharmaceutical Industrial Management, Pharma Book Syndicate.

OUTCOME:

- The students will be conversant with the principles of management, insurance and marketing strategies.

CHBY05 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

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.

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. United States Pharmacopoeia.

7. British Pharmacopoeia.

8. Garfield, Quality Assurance Principles for Analytical Laboratories.

OUTCOMES:

- The students will be familiar with the quality assurance, validation and quality control in management

CHBY06 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 mechanical and electrical testing methods
- Effect of polymer structure on mechanical, electrical and optical properties.

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 – Molecular weight of polymer – number, weight and viscosity average molecular weights – molecular weight distribution (problems) – fractionation of polymers.

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, Compressive strength, Izod impact, Rockwell hardness – electrical properties: dielectric

constant, dissipation factor, and dielectric strength – molecular weight: determination by GPC and viscometry (problems).

MODULE V STRUCTURE-PROPERTY RELATIONSHIP 9

Factors affecting crystallinity and glass transition temperature, Effect of polymer structure on mechanical, electrical and optical properties.

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. R.J. Samuels, Structured Polymer Properties, John Wiley and Sons, New York, 1974.
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. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.

OUTCOMES:

- The students will become familiar with the basic concepts of polymers, mechanism and kinetics of polymerization, polymerization techniques, molecular weight determination.
- This knowledge would help the students to synthesize polymers and mechanism involved in it.
- It will enable the students to interpret their experimental data using the characterization techniques and structure-property relationship for their final semester research project.

CHBY07 POLYMER TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn

- the classification of polymeric materials.
- the process of elastomers
- different types of moulding and characterization of polymers

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.

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.

OUTCOME:

- The students will be familiar with the different types of polymeric materials, their properties and characterization techniques.

CHBY08	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.

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.

OUTCOME:

- The student will be familiar with the electrical behavior of polymeric materials

CHBY09	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 -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.

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

CHBY10 PHYSICAL CHEMISTRY OF POLYMERS

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn about the

- conformation and configuration of polymers
- amorphous and crystalline state of polymers
- viscosity and flow properties of polymers

MODULE I STEREOCHEMISTRY OF POLYMERS 9

Potential energy and conformational energy of molecules - Staggered and eclipsed states - conformations and configurations, isomeric states and isomerism in polymers - tacticity, stereoisomerism, geometric isomerism - Unperturbed and Gaussian chains - Random coils and average end to end distance - Freely jointed and freely rotating chain models - Random flight analysis.

MODULE II FLOW PROPERTY OF POLYMERS 9

Study of molecular weights of polymers: principle of determination of molecular weights by viscometry, osmometry, dynamic and static light scattering techniques, gel permission chromatography, end group analysis.

Energy driven and entropy driven elasticity - Thermoelasticity -Thermodynamic treatment of rubbers - entropic and energetic contributions to the elastic force in rubbers - Statistical mechanical theory.

MODULE III PHYSICAL STATE OF POLYMERS 9

Amorphous State - Transition temperatures - Glass transition temperature - Free volume, kinetic and thermodynamic views of glass transition - Factors influencing glass transition temperature.

Crystalline State - Crystal systems, unit cells, primitive cell, Bravis lattices, polymorphism - Polymer single crystals, lamellae, spherulites, supermolecular structures, fringed micelle model - Degree of crystallinity, factors affecting crystallinity - X-ray diffraction.

MODULE IV ORIENTATION OF POLYMERS **9**

Chain orientation - Concept of chain orientation - orientation in amorphous and crystalline polymers – uniaxial and biaxial orientation practical significance - Orientation processes - fibre spinning, blown film extrusion, solid state extrusion, profile extrusion - Properties of oriented polymers - Birefringence.

MODULE V PHYSICAL PROPERTIES OF POLYMERS **9**

Polymer solutions - terms and definitions, types of solutions - Hilderbrand approach, Flory Huggins theory -Thermodynamic view of miscibility, upper critical solution temperature (UCST), lower critical solution temperature (LCST) - Concentration regimes in polymer solutions - theta conditions, size and shape of polymer molecules in solution, solubility parameter.

Total Hours: 45

REFERENCES:

1. S. Glasstone and D. Lewis, Elements of Physical Chemistry, Macmillan India Press, Madras, 1995.
2. Paul C. Painter and Michael M. Coleman, Fundamentals of Polymer Science, Technomic Publishing Co. Inc., Lancaster, USA, 1994.
3. Ulf W. Gedde, Polymer Physics, Chapman and Hall, 1995.

OUTCOME:

- The students will be familiar with the stereochemistry and all the physical properties of polymers.

CHBY11 INDUSTRIAL CATALYSIS L T P C
3 0 0 3

OBJECTIVES:

The objective of this course is to provide basic knowledge about

- the preparation of industrial catalysts by precipitation, impregnation, mixing method, ion-exchange methods
- the basic principles and characteristics of catalysts, the basic requirements for industrial catalysts.
- the physico-chemical characterisation of different catalysts
- the evaluation of catalyst and catalytic reactor types.
- the various types of catalysts and catalytic materials in organic transformations.

MODULE I SYNTHESIS OF HETEROGENEOUS CATALYSTS AND STRUCTURAL ASPECTS 9

ZSM-5, Zeolite Y, Zeolite β, AlPO-5,11, MCM-41,48, SBA-15, KIT-6, Heteropoly acids, supported catalysts, perovskites and spinels

MODULE II CATALYSTS CHARACTERIZATION TECHNIQUES 9

X-ray Powder Diffraction (XRD), Brunauer-Emmett-Teller (BET) Surface Area Analysis, Barrett-Joyner-Halenda (BJH) Pore Size and Volume Analysis, Fourier Transform Infrared Spectroscopy (FT-IR), Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFT), UV-Visible, Diffuse Reflectance UV-Visible Spectroscopy (DRSUV), Thermo gravimetric/ Differential Thermal Analyzer (TG/DTA), Temperature-programmed Desorption/ Reduction/ Oxidation/ Sulfidation (TPD / TPR / TPO / TPS), Magic 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 III HOMOGENEOUS AND HETEROGENEOUS CATALYSIS 9

Conversion, selectivity, contact time on stream, kinetics of heterogeneous catalysis, adsorption, phase transfer catalysis, super acid catalysis, intramolecular catalysis, enzyme catalysis, semi-conductor catalysis and photocatalysis - Promoters, stabilizers, catalyst deactivation by poisoning, fouling and sintering

MODULE IV OPERATING CATALYTIC PROCESS 9

Mechanism of performing mass and heat balance – reactors – batch reactor, flow reactor and fluidized bed reactor – plug-flow and back-mixed reactors, isothermal and adiabatic reactors.

MODULE V INDUSTRIAL CATALYTIC PROCESSES 9

Cracking, reforming, alkylation, isomerization, hydrogenation/ dehydrogenation, dehydrocycisation, dehydrosulphurization, hydrocracking, oxidation, metathesis, carbonylation and polymerization – synthetic fuels – hydrogen generation

Total Hours: 45

REFERENCES:

1. Herman Pines, The Chemistry of Catalytic Hydrocarbon Conversions, Academic Press, 1981.
2. Ronald Pearce, William R. Patterson Editors, Catalysis and Chemical Processes, Wiley, 1981.
3. Jens Hagen, Industrial Catalysis: A Practical Approach, 2nd Edition, Wiley, 2006.
4. Charles N. Satterfield, Heterogeneous Catalysis in Industrial Practice, 2nd Edition, McGraw-Hill, 1993.
5. Ruud I. Wijngaarden, K. Roel Westerterp, Alexander Kronberg, A.N.R. Bos, Industrial Catalysis: Optimizing Catalysts and Processes, John Wiley and Sons, 2008.
6. Jens Weitkamp, Lothar Puppe (Editors), Catalysis and Zeolites: Fundamentals and Applications, Springer, 1999.

7. George Gerald Henderson, Catalysis in Industrial Chemistry, Hard Press Editions, 2012.

8. C. H. Bartholomew and Robert J. Farrauto, Fundamentals of Industrial Catalytic Processes, John Wiley and Sons, 2011.

9. Michel Che and Jacques C. Védrine, Characterization of Solid Materials and Heterogeneous Catalysts: From Structure to Surface Reactivity, John Wiley and Sons, 2012.

OUTCOMES:

This course will provide a clear knowledge about

- the catalysts presently in industrial processes
- the catalyst preparation and their importance in industrial processes.
- the role of catalyst in different industrial processes.

CHBY12 CONCEPTS AND TECHNIQUES IN CATALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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 CATALYSIS FUNDAMENTALS 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 - Unit operations in catalyst manufacture - drying, calcination, spray drying

MODULE III CATALYSTS CHARACTERIZATION 9

X-ray Powder Diffraction (XRD), Brunauer-Emmett-Teller (BET) Surface Area Analysis, Barrett-Joyner-Halenda (BJH) Pore Size and Volume Analysis, Fourier Transform Infrared Spectroscopy (FT-IR), Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFT), UV-Visible, Diffuse Reflectance UV-Visible Spectroscopy (DRSUV), Thermo gravimetric/ Differential Thermal Analyzer

(TG/DTA), Temperature-programmed Desorption/ Reduction/ Oxidation/ Sulfidation (TPD / TPR / TPO / TPS), Magic 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

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. Gadi 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:

By the conclusion of this course, each student will have thorough knowledge

- about the catalysts and their preparation methods
- about the characterization techniques and the role of catalysts in different chemical reaction.
- to work with catalysts.

CHBY13 ENVIRONMENTAL CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn about the

- Environment and ecosystem
- Waste water handling and analysis
- Sludge management and siposal

MODULE I CHEMICALS AND ENVIRONMENT **9**

Environmental segments- ecosystem and natural cycles of the environment – chemical and photochemical reactions in the atmosphere – ozone chemistry – oxides of sulphur and nitrogen – organic compounds – green house and global warming – acid rain – environmental fate of pollutants – biological activity – biodegradation of carbohydrates, fats and oil, proteins, detergents and pesticides.

MODULE II CHEMICAL TOXICOLOGY **9**

Toxic chemicals in the environment – toxic effects – biochemical effects of arsenic, cadmium, lead, mercury, copper, chromium - biochemical effects of some gaseous pollutants, cyanide, pesticides and asbestos – air pollutants – air quality standards – sampling and analysis – air pollution control – noise pollution – injurious effects of noise.

MODULE III WATER POLLUTION **9**

Water quality parameters and standards – turbidity, colour, pH, acidity, solids, hardness, chlorides, residual chlorine, sulphates, fluorides, phosphates, Fe and Mn, nitrogen, DO, BOD, COD, grease and volatile acids – analytical techniques in water analysis – soil pollution.

MODULE IV WASTEWATER TREATMENT **9**

Primary treatment – equalization, neutralization, proportioning, sedimentation, oil separation, floatation, coagulation – aeration – air stripping of volatile organics - biological treatment process – lagoons, activated sludge process, trickling filtration, anaerobic decomposition – adsorption – theory of adsorption – properties of activated carbon – ion – exchange, chemical oxidation – ozone, hydrogen peroxide and chlorine – wet oxidation - photochemical oxidation.

MODULE V SLUDGE HANDLING AND DISPOSAL 9

Characteristics of sludge – disposal methods – aerobic digestion, gravity thickening, floatation, thickening, centrifugation, specific resistance, vacuum filtration, pressure filtration, sand bed drying, land disposal, incineration – energy and environment – non – renewable and renewable energy – energy sources and resources – energy conservation – nuclear energy and the environment – disposal of nuclear waste - wastewater reclamation and reuse – effluent disposal.

Total Hours: 45

REFERENCES:

1. De A.K., Environmental Chemistry, 5th Edition, New Age international Publication, New Delhi 2004.
2. Sethi M.S., Environmental Chemistry, Shri Sai Printographers, New Delhi, 1994.
3. C.N. Sawyer, Chemistry for Environmental Engineering, 4th Edition, McGraw Hill Inc., 1994.
4. APHA AWWA WPCF, “Standard Methods for the Examination of Water and Waste Water”, 17th Edition, Washington DC, 1989.
5. Metcalf and Eddy, Wastewater Engineering, 3rd Edition, McGraw Hill, Inc. 1991.
6. Wesley W., Eckenfelder, Jr., Industrial Water Pollution Control, McGraw Hill Book Company, 1989.

OUTCOME:

- The student will be familiar with the waste water analysis and treatment

CHBY14 WATER AND WASTE WATER TREATMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student to learn about the

- Quality standars for drinking water
- Industrial water treatment methods
- Waste Water analysis and treatment

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.

MODULE V ADSORPTION AND OXIDATION PROCESSES 9

Chemical process – adsorption – theory of adsorption – ion exchange process – chemical oxidation – advanced oxidation process – sludge handling and disposal – miscellaneous treatment processes.

Total Hours: 45

REFERENCES:

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

OUTCOME:

- The student will be familiar with the quality requirement of water, analysis and treatment methods.

CHBY15 SOLID WASTE MANAGEMENT AND AIR POLLUTION **L T P C**
3 0 0 3

OBJECTIVES:

To make the student to learn about the

- Solid waste collection and disposal
- Air quality and air pollution control

MODULE I SOLID WASTE **9**

Solid waste – definition – characteristics – perspectives – types of solid waste – sources – properties of solid waste – physical and chemical composition – changes in composition – solid waste management – materials flow – reduction in raw materials usages and solid waste quantities – reuse of solid waste materials.

MODULE II SOLID WASTE COLLECTION AND DISPOSAL **9**

Solid waste generation – on-site handling, storage and processing – collection of solid waste – transfer and transport – processing techniques – ultimate disposal.

MODULE III ENERGY RECOVERY **9**

Energy recovery – processing techniques – materials recovery systems – recovery of biological conversion products and thermal conversion products – materials and energy recovery system.

MODULE IV AIR POLLUTION **9**

Air pollution – global implication of air pollution – units of measurement – sources of pollutants – classification of pollutants – meteorology and natural purification processes – influence of meteorological phenomena on air quality – effects on man and vegetation - Effects of pollutants on human beings, animals, vegetation, buildings and materials.

MODULE V ANALYSIS AND CONTROL DEVICES **9**

Sampling and analysis – particulars and gaseous pollutants – methods for monitoring air pollutants – air quality control devices for particulate and gaseous

contaminants – major polluting industries – measures to check industrial pollution.

Total Hours: 45

REFERENCES:

1. Howard S. Revay, Donald R. Rowe and George Technobanoglous, Environmental Engineering, McGraw Hill Inc., 1985.
2. Gilbut M. Masters, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd., 1991.
3. S.K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 1990.
4. V.P. Kudesia, Air Pollution, Pragati Prakashan Publishers, 1992.
5. M.N. Rao and H.V.N. Rao, Air Pollution, Tata McGraw Hill Publishing Company Ltd., 1994.

OUTCOMES:

The students will be familiar with the types of

- solid waste, collection and disposal
- air pollutants and control measures

CHBY16 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 and electrosynthesis

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.

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.

OUTCOME:

- The student will be familiar with the electrowinning, electrorefining, electrochemical metal finishing, electrosynthesis and electrodialysis.

CHBY17 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.

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.

OUTCOME:

- Students will become familiar with the basic concepts of corrosion, factors which influence the corrosion and gain the knowledge about the control of corrosion in real situation.

CHBY18 ELECTROCHEMICAL PROTECTION SYSTEM **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 units, 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.

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.

OUTCOME:

- The students will be familiar with the different protection methods to preserve metal surfaces.

CHBY19 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

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.

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.

CHBY20 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.

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.

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

CHBY21 FUEL CELLS AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

The primary objective of the course is to provide

- thorough understanding of the chemistry and characteristics of fuel cells
- the design and operation of different types of fuel cells
- outline the components, performance and operating issues for various fuel cells
- the design and analysis based on the thermodynamics and electrochemistry
- the production and storage of hydrogen

MODULE I INTRODUCTION AND TYPES OF FUEL CELLS 9

Introduction - Definition - History - Difference between batteries and fuel cells - chemistry of fuel cells - hydrogen-oxygen fuel cell - types of fuel cell (based on temperature and electrolyte) - 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 - fuel cell stack, bi-polar plate, humidifiers and cooling plates.

MODULE III FUEL CELLS PERFORMANCE and APPLICATIONS 9

Thermodynamics of fuel cells - electrochemical kinetics of fuel cells - Fuel cell efficiency - performance characteristics: current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects Fuel cells for automotive applications - technology advances in fuel cell vehicle systems - road map to market – automotive industry and the environment.

MODULE IV FUELING AND STORAGE **9**

Hydrogen as energy source Its merit as a fuel; hydrogen storage: compressed hydrogen, liquid hydrogen, metal hydrides, carbon fibers - onboard hydrogen storage - reforming: steam reforming, partial oxidation, auto thermal reforming – CO removal, fuel cell technology based on bio-mass.

MODULE V FUEL CYCLE ANALYSIS **9**

Introduction to fuel cycle analysis – application to fuel cell and other competing technologies like battery powered vehicles, SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.

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

- Have thorough understanding of performance behavior, operational issues and challenges for all major types of fuel cells
- Understand the impact of this technology in a global and societal context
- Sufficient knowledge for working in a fuel cell industry

CHBY22 ADVANCED BATTERIES AND SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- The primary objective of the course is to provide about the different types of batteries
- The design and operation of different types of batteries

MODULE I **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 **9**

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

MODULE III **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 **9**

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

MODULE V **9**

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

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

CHBY23 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/CU2S 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.

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

- familiar with p & n type semiconductors
- luminescence and photovoltaic properties of semiconductors
- application in solar cells

CHBY24 ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE **L T P C 3 0 0 3**

OBJECTIVES:

To make the student to learn about the

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

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.

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.

OUTCOME:

- The students will be familiar with the reversible and irreversible cells and their applications in various fields

CHBY25 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.

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

CHBY26 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.

Total Hours: 45

REFERENCES:

1. P.H. Groggins, Unit 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.

CHBY27 TEXTILE CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

To make the student to learn about the

- Physical and chemical properties of fibres
- Dye chemistry, dying and printing

MODULE I PROPERTIES OF TEXTILE MATERIALS 9

Textile fibres- classification- chemical structure – physical and chemical properties of cotton, wool, silk, viscose, rayon and synthetic fibres.

MODULE II PREPARATORY PROCESSES 9

Brief outline on desizing, singeing and mercerization, scouring –bleaching with hypochlorites and peroxides.

MODULE III DYEING 9

Theory of colours- dye chemistry - preparation of simple dyes and intermediates - introduction to theory of dyeing - application of direct, vat, azoic, reactive, sulphur disperse and acid dyes and mineral colours.

MODULE IV PRINTING 9

Stages involved in printing- printing paste ingredients, styles and method of printing - outline of printing of cotton fabrics with reactive dyes and polyester fabrics with disperse dyes.

MODULE V FINISHING 9

Classification – Calendering, Crease Proofing and Shrink Proofing.

Total Hours: 45

REFERENCES:

1. Trotman R., Dyeing and Chemical Technology of Textile Fibres, Charles Griffin and Co. Ltd., London, 1985.
2. Shenai V.A., Technology of Textile Processing, Volume II, IV and V, Sevsak Publications.

OUTCOMES:

The students will be familiar with the

- Different types of textile materials
- Dye chemistry
- Printing on fabrics

CHBY28 BIOCHEMISTRY L T P C
2 0 3 3

OBJECTIVES:

To make the student

- appreciate the chemistry by learning it's formidable role in living systems.
- learn the metabolisms in the shadow of organic chemistry.

MODULE I ENZYMES AND COENZYMES 8

Enzymes: Nomenclature, enzymes-kinetics and mechanism of action, mechanism of inhibition of enzymes and isoenzymes in chemical diagnosis.

Co-enzymes: Vitamins as co-enzymes and their significance - Metals as co-enzymes and their significance.

MODULE II CARBOHYDRATE METABOLISM 8

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

MODULE III LIPID METABOLISM AND BIOLOGICAL OXIDATION 8

Lipid metabolism: 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.

Biological Oxidation: The respiratory chain, its role in energy capture and control, energetics of oxidative phosphorylation, mechanism of oxidative phosphorylation.

MODULE IV BIOCHEMISTRY OF AMINOACIDS 8

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 **8**

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

PRACTICAL **20**

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 a and ß-amylase.
8. Effects of temperature on the activity of a- 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.

Total Hours:60

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 will be familiar with the

- Different types of textile materials
- Dye chemistry
- Printing on fabrics

CHBY29 CHLOR-ALKALI TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To make the student to learn about the

- Electrode materials
- Membrane cells
- Process control and instrumentation

MODULE I ELECTODES 9

Anodes, cathodes and separators for chlor-alkali production: graphite, metal anodes, steel cathodes, coated cathodes, asbestos diaphragms, Improved diaphragms, cation exchange membranes - different types - preparation-characteristics.

MODULE II DIAPHRAGM CELL PROCESS 9

Diaphragm cell process, different cell designs, deposition of diaphragm, mercury cell process - different cell designs, reasons for hydrogen evolution in the primary cells, denuder vertical and horizontal types, design aspects.

MODULE III MEMBRANE CELL PROCESS 9

Membrane cell process, different designs of membrane cell, monopolar and bipolar cells - conversion of mercury and diaphragm cells to membrane cells - factors affecting the performance of the membrane cells.

MODULE IV UNIT OPERATIONS 9

Unit operations in chlor-alkali industry, salt washing, saturation - brine dechlorination - primary brine purification - secondary brine purification, caustic concentration - separation of salt from diaphragm cell liquor, handling of hydrogen, chlorine and caustic, chlorine liquefaction.

MODULE V ENERGY CONSERVATION IN CHLOR-ALKALI INDUSTRY 9

Energy conservation in chlor-alkali industry, chlorine utilization - materials of construction - electrode protection devices - environmental pollution and its control - analytical techniques - process control and instrumentation - safety aspects.

Total Hours: 45

REFERENCES:

1. Ullmann's Encyclopedia of Industrial Chemistry, Volume 6, 1986.
2. Krik and Othmer, Encyclopedia of Chemical Technology, 4th Edition, 1991.
3. N.M. Prout and J.S. Moorhouse, Modern Chlor-Alkali Technology, Volume IV, Elsevier Applied Science, London, 1990.
4. T. Wellington, Modern Chlor-Alkali Technology, Volume V, Elsevier Science, Essex, 1992.

OUTCOMES:

The students will be familiar with the

- anode, cathode and membrane cells
- Unit operations in chlor-alakli industry and instrumentation

CHBY30 UNIT OPERATIONS AND UNIT PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVES:

To make the student conversant with

- Chemical engineering concepts
- Fouriers law and HETP concepts
- Laws of crushing and types of Crushers

MODULE I BASIC CONCEPTS **9**

Stoichiometric principle – material and energy balances - Combustion, Theoretical air for combustion, Flue gas analysis - water treatment - environmental protection.

MODULE II HEAT AND MASS TRANSFER **9**

Modes of Heat Transfer - Fourier's law – simple numerical problems on conduction – natural and forced convection – heat transfer equipment – Drying, Distillation – vapour-liquid equilibria – distillation methods – continuous rectification of binary systems.

MODULE III MASS TRANSFER OPERATIONS **9**

Adsorption and adsorption principle – equilibrium relationships – methods of calculation – various types of equipment - Extraction and Leaching – liquid extraction – ternary diagram – selection of solvent and equipment – method of calculation of co-current and counter-current extraction operations - Crystallization – types of crystallization equipment – material and energy balances.

MODULE IV MECHANICAL OPERATIONS **9**

Laws of crushing – closed and open circuit grinding – various types of crushers and grinders – settling, floatation and filtration concepts.

MODULE V UNIT PROCESSES **9**

Nitration, sulphonation, halogenation, esterification, amination, saponification

and hydrogenation – role of the above unit processes in such industries as petroleum, drugs, pharmaceuticals and organic synthesis.

Total Hours: 45

REFERENCES:

1. Groggins P.H., Unit Processes in Organic Synthesis, McGraw Hill Book Co., Kogakusha, 5th Edition, 2007.
2. McCabe W.L., Smith J.C. and Harriot P., Unit Operations of Chemical Engineering, 6th Edition, McGraw Hill Book Co. 2001.
3. Perry J.H., Handbook of Chemical Engineers, McGraw Hill Book Co., 2006.
4. Badger W.I. and Banchero I.T., Introduction to Chemical Engineering, McGraw Hill Book Co. Inc., Kogakusha, 1988.

OUTCOME:

- The students will be familiar with Bernoullis equation & its applications and demonstrate the role of unit processes in various industries.