B.S. Abdur Rahman Crescent Institute of Science & Technology

Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2017

Curriculum and Syllabi

(Amendments updated upto June 2020)

B.Tech.
(Biotechnology)

B.S. Abdur Rahman Crescent Institute of Science & Technology

Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2017

CURRICULUM AND SYLLABI

(Amendments updated upto June 2020)

B.TECH.

BIOTECHNOLOGY

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in 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 Institution
- 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

SCHOOL OF LIFE SCIENCES
VISION AND MISSION

VISION

To attain new heights in biotechnology education and research, shaping life sciences into a premier precision tool for the future for creation of wealth and ensuring social justice-specially for the welfare of the socially weaker group

MISSION

- The mission of the school of life sciences is to maximize the benefits of Biotechnology to the University, the nation, and the globe
- Being an excellent quality, comprehensive, multidisciplinary school that supports, coordinates, and disseminates knowledge to the community
- Apply biotechnology in the areas of social welfare and entrepreneurship

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

B.Tech. (Biotechnology)

PROGRAMME EDUCATIONAL OBJECTIVES

- Provide biotechnological solutions for complex industrial and societal problems
- Pursue advanced studies and research in the biotechnology domain in globally reputed institution
- Excel professionally as socially conscious individuals with a strong foundation in bio-techniques and lifelong learning
- Become entrepreneurs through innovation and management proficiencies

PROGRAMME OUTCOMES:

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

• Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

• Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

• Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.

• Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

• Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

• The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

• Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.

• Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

• Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

• Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

• Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one‘s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

• Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES:

- Apply engineering and applied science knowledge to showcase research aptitude and skills in emerging fields of biotechnology.
- Demonstrate proficiency in Biotechnology to advance the development of processes and products within a global context, ensuring accuracy, precision, safety, ethics, reproducibility, and adherence to standard operating procedures (GMP & GLP).

REGULATIONS - 2017

B.TECH. DEGREE PROGRAMMES

(With Amendments incorporated up to June 2020)
(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS & NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means B.Tech. Degree Programme.

ii) **"Branch"** means specialization or discipline of B.Tech. Degree Programme like Civil Engineering, Mechanical Engineering, etc.,

iii) **"Course"** means a theory or practical subject that is normally studied in asemester, like Mathematics, Physics, Engineering Graphics, Computer Practice, etc.,

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

v) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of B.S.Abdur Rahman Crescent Institute of Science and Technology.

vi) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of B.S.Abdur Rahman Crescent Institute of Science and Technology.

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

2.0 ADMISSION

2.1a) Candidates for admission to the first semester of the eight-semester B.Tech. degree programme shall be required to have passed the Higher Secondary Examination of the (10+2) curriculum (Academic stream) prescribed by the appropriate authority or any other examination of any university or authority accepted by the Institution as equivalent thereto.

2.1b) Candidates for admission to the third semester of the eight-semester B.Tech. programme under lateral entry scheme shall be required to have passed the Diploma examination in Engineering / Technology of the Department of Technical Education, Government of Tamil Nadu or any other examination of any other authority accepted by the Institution as equivalent thereto.

2.2 Notwithstanding the qualifying examination the candidate might have passed, the candidate shall also write an entrance examination prescribed by the Institution

for admission. The entrance examination shall test the proficiency of the candidate in Mathematics, Physics and Chemistry on the standards prescribed for Ten plus Two academic stream.

2.3 The eligibility criteria such as marks, number of attempts and physical fitness shall be as prescribed by the Institution from time to time.

3.0 BRANCHES OF STUDY

3.1 Regulations are applicable to the following B.Tech. degree programmes in various branches of Engineering and Technology, each distributed over eight semesters with two semesters per academic year.

B.TECH. DEGREE PROGRAMMES:

1. Aeronautical Engineering
2. Automobile Engineering
3. Civil Engineering
4. Computer Science and Engineering
5. Electrical and Electronics Engineering
6. Electronics and Communication Engineering
7. Electronics and Instrumentation Engineering
8. Information Technology
9. Manufacturing Engineering
10. Mechanical Engineering
11. Polymer Engineering
12. Biotechnology

4.0 STRUCTURE OF THE PROGRAMME

4.1 Every Programme will have a curriculum with syllabi consisting of theory and practical courses such as,

i) Basic Sciences (BS)

ii) Humanities & Social Sciences (HS)

iii) Management Sciences (MS)

iv) Engineering Sciences Fundamentals (ESF)

v) Engineering Core Courses (EC)

vi) Professional Electives (PE)

vii) General Electives (GE)

viii) Workshop practice, laboratory work, industrial training, seminar presentation, project work, etc.

4.2 Each course is normally assigned certain number of credits:

- one credit per lecture period per week
- one credit per tutorial period per week
- one credit for two to three periods and two credits for four periods of laboratory or practical sessions
- one credit for two periods of seminar / project work per week
- one credit for two weeks of industrial training.

4.3 Each semester curriculum shall normally have a blend of lecture courses, laboratory courses and laboratory integrated theory courses of total not exceeding 26 credits.

4.4 For the award of the degree, a student has to earn a minimum total credit specified in the curriculum of the relevant branch of study. The minimum credits to be earned will be between 174 and 180, depending on the program.

4.5 The medium of instruction, examinations and project report shall be in English, except for courses in languages other than English.

5.0 DURATION OF THE PROGRAMME

5.1 A student is ordinarily expected to complete the B.Tech. programme in eight semesters (six semesters in the case of lateral entry scheme), but in any case, not more than 14 continuous semesters reckoned from the date of first admission (12 semesters in the case of lateral entry student).

5.2 Each semester shall consist of a minimum of 90 working days.

5.3 Semester end examination will normally follow within a week after the last working day of the semester.

6.0 CLASS ADVISOR AND FACULTY ADVISOR

6.1 CLASS ADVISOR

A faculty member will be nominated by the HOD as Class Advisor for the class throughout the period of study except first year.

The Class Advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study. However, for the first and second semester, the class advisors (First year class advisors) will be nominated by the first year coordinator.

6.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general

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

7.0 COURSE COMMITTEE

7.1 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).

8.0 CLASS COMMITTEE

A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted branch-wise and semester-wise

8.1 The composition of class committees for first and second semester will be as follows:

i) The first year coordinator shall be the chairman of the class committee
ii) Faculty members of all individual courses of first / second semester
iii) Six student representatives (male and female) of each class nominated by the first year coordinator
iv) The class advisor and faculty advisors of the class.

8.2 The composition of the class committee for each branch from 3rd to 8th semester will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department
ii) Faculty members of all courses of the semester
iii) Six student representatives (male and female) of each class nominated by

the Head of the Department in consultation with the relevant faculty advisors

iv) All faculty advisors and the class advisors.

v) Head of the Department

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

8.4 During these three meetings the student members representing the entire class, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process.

8.5 The fourth meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

9.0 REGISTRATION AND ENROLMENT

9.1 Except for the first semester, every student shall register for the ensuing semester during a specified week before the semester end examination of the ongoing semester. Every student shall submit a completed registration form indicating the list of courses intended to be enrolled during the ensuing semester. Late registration with the approval of the Dean (Academic Affairs) along with a late fee will be permitted up to the last working day of the current semester.

9.2 From the second year onwards, all students shall pay the prescribed fees for the year on a specific day at the beginning of the semester confirming the registered courses. Late enrolment along with a late fee will be permitted up to two weeks from the date of commencement of classes. If a student does not enroll, his/her name will be removed from rolls.

9.3 The students of first semester shall register and enroll at the time of admission

by paying the prescribed fees.

9.4 A student should have registered for all preceding semesters before registering for a particular semester.

10.0 COURSE CHANGE / WITHDRAWAL

10.1 CHANGE OF A COURSE

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

10.2 WITHDRAWAL FROM A COURSE

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

11.0 TEMPORARY BREAK OF STUDY FROM 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.A student can avail the break of study before the start of first assessment of the ongoing semester. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 5.1).If any student is debarred for want of attendance or suspended due to any act of indiscipline, it will not be considered as break of study. A student who has availed break of study has to rejoin in the same semester only.

12.0 CREDIT LIMIT FOR ENROLMENT & MOVEMENT TO HIGHER SEMESTER

12.1 A student can enroll for a maximum of 32 credits during a semester including Redo /Pre do Courses

12.2 The minimum earned credit required to move to the higher semester shall be

- Not less than 20 credits, to move to the 3rd semester
- Not less than 40 credits, (20 for lateral entry) to move to the 5th semester
- Not less than 60 credits, (40 for lateral entry) to move to the 7th semester

13.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

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

Assessment No.	Course Coverage in Weeks	Duration	Weightage of Marks
Assessment 1	1 to 6	1.5 hours	25%
Assessment 2	7 to 12	1.5 hours	25%
Semester End Exam	Full course	3 hours	50%

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

13.3 Every practical course will have 60% weightage for continuous assessments and 40% for semester end examination. However, a student should have secured a minimum of 50% marks in the semester end practical examination.

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

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

13.6 In the case of Industrial training, the student shall submit a report, which will be evaluated along with an oral examination by a committee of faculty members, constituted by the Head of the Department. A progress report from the industry will also be considered for evaluation. The weightage for report shall be 60% and 40% for Viva Voce examination.

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

approved by the Controller of Examinations, will be included. The weightage for periodic review will be 50%. Of the remaining 50%, 20% will be for the project report and 30% for the Viva Voce examination.

13.8 Assessment of seminars and comprehension will be carried out by a committee of faculty members constituted by the Head of the Department.

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

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

14.0 SUBSTITUTE EXAMINATIONS

14.1 A student who has missed, for genuine reasons, a maximum of one of the two continuous assessments of a course may be permitted to write a substitute examination paying the prescribed substitute examination fees. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Dean of School for that purpose. However, there is no Substitute Examination for Semester End examination.

14.2 A student who misses any continuous assessment test in a course shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of missed assessment test. However, the Substitute Examination will be conducted after the last working day of the semester and before Semester End Examination.

15.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

15.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% (for genuine reasons such as medical grounds or representing the Institution in approved events etc.) to become eligible to appear for the semester-end examination in that course, failing which

the student shall be awarded “I” grade in that course. The cases in which the student is awarded “I” grade, shall register and repeat the course when it is offered next.

15.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in that course to the Class Advisor. The Class Advisor will consolidate and furnish the list of students who have earned less that 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department/ Dean of School. Thereupon, the Dean (Academic Affairs) shall announce the names of such students prevented from writing the semester end examination in each course.

15.3 A student who has obtained ‘I’ grade in all the courses in a semester is not permitted to move to next higher semester. Such student shall repeat all the courses of the semester in the subsequent academic year.

15.4 A student should register to re-do a core course wherein “I” or “W” grade is awarded. If the student is awarded, “I” or “W” grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of Head of the Department / Dean of School.

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

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

16.0 REDO COURSES

16.1 A student can register for a maximum of two redo courses per semester in the evening after regular college hours, if such courses are offered by the concerned

department. Students may also opt to redo the courses offered during regular semesters.

16.2 The Head of the Department with the approval of Dean Academic Affairs may arrange for the conduct of a few courses during the evening, depending on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

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

17.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

17.1 All assessments of a course will be made on absolute marks basis. However, the Class Committee without the student members shall meet within 5 days after the semester-end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

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

"W" denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevention from semester-end examination

"U" denotes unsuccessful performance in the course.

"AB" denotes absence for the semester-end examination.

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

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

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

17.5 After results are declared, grade sheets shall be issued to each student, which will contain the following details. The list of courses enrolled during the semester including redo courses, if any, and the grade scored, the Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards. GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If Ci, is the number of credits assigned for the i^{th} course and GPi is the Grade Point in the i^{th} course

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

Where n = number of courses

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

"I" and "W" grades will be excluded for calculating GPA .

"U", "I", "AB" and **"W"** grades will be excluded for calculating CGPA.

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

Percentage Equivalent of Marks = CGPA X 10

17.6 After successful completion of the programme, the Degree will be awarded with the following classifications based on CGPA.

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

However, to be eligible for First Class with Distinction, a student should not have obtained 'U' or 'I' grade in any course during his/her study and should have completed the U.G. programme within a minimum period (except break of study). To be eligible for First Class, a student should have passed the examination in all the courses within the specified minimum number of semesters reckoned from his/her commencement of study. 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.

18.0 ELECTIVE CHOICE:

18.1 Apart from the various elective courses listed in the curriculum for each branch of specialization, the student can choose a maximum of two electives from any other specialization under any department, during the entire period of study, with the approval of the Head of the parent department and the Head of the other department offering the course.

18.2 ONLINE / SELF STUDY COURSES

Students are permitted to undergo department approved online/ self-study courses not exceeding a total of six credits with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. In case of credits earned through online mode ratified by the respective Board of Studies, the credits may be transferred following the due approval procedures. The students shall undergo self-study courses on their own with the mentoring of a member of the faculty. The online/ self-study courses can be considered in lieu of elective courses.

19.0 SUPPLEMENTARY EXAMINATION

Final Year students can apply for supplementary examination for a maximum of two courses thus providing an opportunity to complete their degree programme. Likewise, students with less credits can also apply for supplementary examination for a maximum of two courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results.

20.0 PERSONALITY AND CHARACTER DEVELOPMENT

20.1 All students shall enroll, on admission, in any of the personality and character development programmes, NCC / NSS / NSO / YRC / Rotaract and undergo practical training.

- **National Cadet Corps (NCC)** will have to undergo specified number of parades.
- **National Service Scheme (NSS)** will have social service activities in and around Chennai.
- **National Sports Organization (NSO)** will have sports, games, drills and physical exercises.
- **Youth Red Cross (YRC)** will have social service activities in and around Chennai.
- **Rotaract** will have social service activities in and around Chennai.

21.0 DISCIPLINE

21.1 Every student is required to observe disciplined and decorous behavior both inside and outside the campus and not to indulge in any activity which will tend to affect the prestige of the Institution.

21.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean will be referred to a Discipline and Welfare Committee nominated by the Vice-Chancellor, for taking appropriate action.

22.0 ELIGIBILITY FOR THE AWARD OF DEGREE

22.1 A student shall be declared to be eligible for the award of B.Tech. degree provided the student has:

i) successfully completed all the required courses specified in the programme curriculum and earned the number of credits prescribed for the specialization, within a maximum period of 14 semester (12 semesters for lateral entry) from the date of admission, including break of study

ii) no dues to the Institution, Library, Hostels

iii) no disciplinary action pending against him/her.

22.2 The award of the degree must have been approved by the Institution.

23.0 POWER TO MODIFY

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

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

B.TECH. BIOTECHNOLOGY

CURRICULUM & SYLLABUS, REGULATIONS 2017

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	BS	MAC 1182	Mathematics for biotechnology	3	1	0	4	
2.	HS	ENC 1181/	English /					
		ISC 1181/	Arabic /					
		LNC 1181/	Mandarin /	3	0	0	3	
		LNC 1182/	German /					
		LNC 1183	Japanese					
3.	BS	PHC 1181	Physics	3	0	2	4	
4.	BS	CHC 1181	Chemistry	3	0	2	4	
5.	ESF	BTC 1101	Fundamentals in Biotechnology	3	0	0	4	
6.	ESF	GEC 1102	Engineering Design	2	0	0	2	
7.	ESF	BTC 1102	Fundamentals in Biotechnology Laboratory	0	0	2	1	
8.	ESF	GEC 1104	Computer Programming, I	1	0	2	2	**23**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MAC 1282	Biostatistics	3	1	0	4
2.	BS	-	Physics Elective	2	0	2	3
3.	BS	-	Chemistry Elective	2	0	2	3
4.	ESF	BTC1211	Biochemistry	4	0	0	4
5.	ESF	BTC1212	Cell Biology	4	0	0	4
7.	ESF	BTC1213	Microbiology	4	0	0	4
8.	ESF	BTC1214	Biochemistry – Lab	0	0	4	2
9.	ESF	BTC1215	Cell Biology– Lab	0	0	3	1

10.	ESF	BTC1216	Microbiology – Lab	0	0	2	1	**26**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	HS	-	Humanities Elective I	2	0	0	2	
2.	HS	ENC 2181	Oral Communication	0	0	2	1	
3.	EC	BTC2101	Enzyme Technology	4	0	0	4	
4.	EC	BTC2102	Fundamentals of Chemical Engineering	4	0	0	4	
5.	EC	BTC2103	Molecular Biology	4	0	0	4	
6.	EC	BTC2104	Basic Bioanalytical Techniques	3	0	0	3	
7.	EC	BTC2105	Molecular Biology – Lab	0	0	3	1	
8.	EC	BTC2106	Enzyme Technology –Lab	0	0	3	1	
9.	EC	BTC2107	Bioanalytical Techniques – Lab	0	0	3	1	**21**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	HS	-	Humanities Elective I	2	0	0	2	
2.	HS	ENC 2282	Written Communication	0	0	2	1	
3.	EC	BTC2211	Genetic Engineering	4	0	0	4	
4.	EC	BTC2212	Immunotechnology	4	0	0	4	
5.	EC	BTC2213	Chemical and Bio Thermodynamics	4	0	0	4	
6.	EC	BTC2214	Plant and Animal Biotechnology	3	0	0	3	
7.	EC	BTC2215	Genetic Engineering Lab	0	0	3	1	
8.	EC	BTC2216	Immunology Lab	0	0	3	1	
9.	EC	BTC2217	Animal and Plant cell culture Lab	0	0	3	1	**21**

SEMESTER V

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	MS	MSC 3181/ MSC 3182	Leadership and CEO Training/ Social Entrepreneurship	3	0	0	3	
2.	GE	-	General Elective I	3	0	0	3	
3.	HS	ENC3181	Communication & soft skill I	0	0	2	1	
4.	EC	BTC3101	Protein Engineering	4	0	0	4	
6.	EC	BTC3102	Chemical Reaction Engineering	4	0	0	4	
7.	EC	-	Programme Elective I	3	0	0	3	
8.	EC	-	Programme Elective II	3	0	0	3	
9.	EC	BTC3107	Chemical Reaction Engineering Lab	0	0	3	1	
10.	PE	BTC3109	Protein Engineering Lab	0	0	3	1	**23**

SEMESTER VI

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	MS	MSC 3181/ MSC 3182	Leadership and CEO Training/ Social Entrepreneurship	3	0	0	3	
2.	BS	-	Mathematics Elective II	3	0	0	3	
3.	HS	-	Communication & soft skill IV	0	0	2	1	
4.	EC	BTC3211	Structural Biology	3	1	0	4	
5.	EC	BTC3212	Bioprocess Engineering	4	0	0	4	
6.	EC	BTC3213	Bioinformatics	4	0	0	3	
7.	PE	-	Programme Elective III	3	0	0	3	
8.	PE	-	Programme Elective IV	3	0	0	3	
9.	EC	BTC3214	Bioprocess Lab	0	0	3	1	
10.	EC	BTC3215	Bioinformatics- Lab	0	0	3	1	**26**

SEMESTER VII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	EC	BTC4101	Bioreactor Design and Analysis	4	0	0	4	
2.	EC	BTC4102	Fermentation Technology	4	0	0	4	
3.	EC	BTC4103	Nano Biotechnology	4	0	0	4	
4.	EC	-	Programme Elective V	3	0	0	3	
5.	PE	-	Programme Elective VI	3	0	0	3	
6.	PE	-	Programme Elective VII	3	0	0	3	
7.	PE	-	General Elective II	3	0	0	3	
8.	GE	BTC4104	Fermentation- Lab	0	0	3	1	
9.	EC	BTC4105	Bioreactor Design and Drawing laboratory	0	0	3	1	
10.	EC	BTC4106	Internship.	0	0	0	1*	**27**

SEMESTER VIII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	EC	BTC 4211	Project Work	0	0	24	12	**12**

Total credits – 174

*Industrial training will be undertaken during Third year summer vacation. The credit will be awarded in the 7th Semester.

PROGRAMME ELECTIVES

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	BTCX01	Biophysics	3	0	0	3
2.	PE	BTCX02	Industrial Biotechnology	3	0	0	3
3.	PE	BTCX03	Bio-Organic Chemistry	3	0	0	3
4.	PE	BTCX04	Molecular Pathology	3	0	0	3
5.	PE	BTCX05	Food Biotechnology	3	0	0	3
6.	PE	BTCX06	Cancer Biology	3	0	0	3
7.	PE	BTCX07	Tissue Engineering	3	0	0	3
8.	PE	BTCX08	Developmental Biology	3	0	0	3
9.	PE	BTCX09	Bioseparation Technology	3	0	0	3
10	PE	BTCX10	Proteomics & Genomics	3	0	0	3
11	PE	BTCX11	Biomedical Instrumentation	3	0	0	3
12	PE	BTCX12	Pharmaceutical Biotechnology	3	0	0	3
13	PE	BTCX13	Medical Biotechnology	3	0	0	3
14	PE	BTCX14	Drug Design and Development	3	0	0	3
15	PE	BTCX15	Intellectual Property Rights	3	0	0	3
16	PE	BTCX16	Recombinant DNA Technology	3	0	0	3
17	PE	BTCX17	Material science	3	0	0	3
18	PE	BTCX18	Molecular & Cellular Diagnostics	3	0	0	3
19	PE	BTCX19	Biomedical Engineering	3	0	0	3
20	PE	BTCX20	Biosafety and Bioethics	3	0	0	3
21	PE	BTCX21	Healthcare Biotechnology	3	0	0	3

22	PE	BTCX22	Molecular Farming	3	0	0	3
23	PE	BTCX23	Stem Cells in Health Care	3	0	0	3
24	PE	BTCX24	Transport phenomena in Bioprocess	3	0	0	3

Physics Elective Courses

(to be offered in II Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	PHCX 01	Fundamentals of Engineering Materials	2	0	2	3
2.	PHCX 02	Heat and Thermodynamics	2	0	2	3
3.	PHCX 03	Introduction to Nanoscience and Technology	2	0	2	3
4.	PHCX 04	Lasers and their applications	2	0	2	3
5.	PHCX 05	Materials Science	2	0	2	3
6.	PHCX 06	Non-Destructive Testing	2	0	2	3
7.	PHCX 07	Properties of Matter and Acoustics	2	0	2	3
8.	PHCX 08	Properties of Matter and Nondestructive Testing	2	0	2	3
9.	PHCX 09	Semiconductor Physics and Optoelectronics	2	0	2	3

Chemistry Elective Courses

(to be offered in II Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CHCX01	Analytical Instrumentation	2	0	2	3
2.	CHCX02	Corrosion and its Control	2	0	2	3
3.	CHCX03	Electrical Materials and Batteries	2	0	2	3
4.	CHCX04	Engineering Materials	2	0	2	3
5.	CHCX05	Fuels and Combustion	2	0	2	3

6.	CHCX06	Fundamentals of Physical Chemistry	2	0	2	3
7.	CHCX07	Green Technology	2	0	2	3
8.	CHCX08	Organic Chemistry of Biomolecules	2	0	2	3
9.	CHCX09	Polymer Science and Technology	2	0	2	3

Humanities Elective I

(to be offered in III Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	SSCX01	Fundamentals of Economics	2	0	0	2
2.	SSCX02	Principles of Sociology	2	0	0	2
3.	SSCX03	Sociology of Indian Society	2	0	0	2

Humanities Elective II

(to be offered in IV Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	SSCX04	Economics of Sustainable Development	2	0	0	2
2.	SSCX05	Industrial Sociology	2	0	0	2
3.	SSCX06	Law for Engineers	2	0	0	2

General Elective

Group I Courses

(To be offered in V semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX101	Disaster Management	Civil
2.	GECX102	Total Quality Management	Mechanical
3.	GECX103	Energy Studies	Mechanical
4.	GECX104	Robotics	Mechanical
5.	GECX105	Transport Management	Automobile
6.	GECX106	Control Systems	EEE
7.	GECX107	Introduction to VLSI Design	ECE
8.	GECX108	Plant Engineering	EIE
9.	GECX109	Network Security	CSE
10.	GECX110	Knowledge management	CSE
11.	GECX111	Cyber security	IT
12.	GECX112	Genetic Engineering	LS
13.	GECX113	Fundamentals of Project Management	CBS
14.	GECX114	Operations Research	Mathematics
15.	GECX115	Nano Technology	Physics / Chemistry
16.	GECX116	Vehicle Maintenance	Automobile
17.	GECX117	Fundamentals of Digital Image Processing	ECE

Group II Courses

(To be offered in VII semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX201	Green Design and Sustainability	Civil
2.	GECX202	Appropriate Technology	Civil / Mechanical
3.	GECX203	Engineering System Modelling and Simulation	Mechanical
4.	GECX204	Value Analysis and Engineering	Mechanical
5.	GECX205	Industrial Safety	Mechanical
6.	GECX206	Advanced Optimization Techniques	Mechanical
7.	GECX207	Mat Lab Simulation	EEE
8.	GECX208	Embedded Systems and its Applications	ECE
9.	GECX209	Usability Engineering	CSE
10.	GECX210	Supply Chain Management	CBS
11.	GECX211	System Analysis and Design	CA
12.	GECX212	Advanced Materials	Physics & Chemistry
13.	GECX213	National Service Scheme	School of Humanities
14.	GECX214	Automotive Pollution and Control	Automobile
15.	GECX215	Motor Vehicle Act, Insurance and Policy	Automobile
16.	GECX216	Principles of Communication Systems	ECE
17.	GECX217	Lean Management	Civil
18.	GECX218	Spatial Data Modeling & Analysis	Civil

SEMESTER I

		L	T	P	C
MAC 1182	**MATHEMATICS FOR BIOTECHNOLOGY**	**3**	**1**	**0**	**4**

OBJECTIVES:

The course is aimed to develop the skills in the areas of Biotechnology, necessary to become a successful biologist. The topics introduced will serve as basic tools for specialized studies in biological fields.

MODULE I MATRICES 10

Rank of a Matrix - Gauss Elimination method - Gauss Jordan method - Eigenvalues and eigenvectors of a real matrix - Properties of eigenvalues and eigenvectors – Applications.

MODULE II DIFFERENTIAL CALCULUS 10

Derivatives of simple functions – Successive Differentiation – Various forms of Algebraic, Trigonometric, Exponential and Logarithmic functions – Simple problems.

MODULE III INTEGRAL CALCULUS 10

Various types of Integration – Reduction formulae (without Proof) for $e^{ax}\,x^n,\ sin^n x,\ cos^n x$ – Simple Problems

MODULE IV FIRST ORDER ORDINARY DIFFERENTIAL EQUATION 10

Variable separable, homogenous and nonhomogenous of first degree, exact, linear and Bernoulli's Equations - problems

MODULE V ORDINARY DIFFERENTIAL EQUATIONS OF SECOND ORDER 10

Second order linear differential equation with constant coefficients, variable coefficients (Legendre and Cauchy).

MODULE VI APPLICATIONS 10

Role of Pattern is Biology- Reaction Differential Relation-Microbial Population Models- Interpretation of Analytical and Numerical Solutions.

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

1. Ramana, B.V, "Higher Engineering Mathematics" Tata McGraw Hill Publishing Co. New Delhi, 2006.

2. Grewal B.S., “Higher Engineering Mathematics” (43rd edition), Khanna Publishers, New Delhi, 2012.
3. John W. Cell “Engineering Problems Illustrating Mathematics” Mc Graw Hill Publishing Co., New York 1943.

REFERENCES:

1. Veerarajan.T., “Engineering Mathematics” (5th edition) Tata Mc Graw Hill Publishing Co. New Delhi, 2012
2. Kreyszig, E., “Advanced Engineering Mathematics”, 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
3. Peter V. O'Neil, “Advanced Engineering Mathematics”, 7th edition, Cengage Learning, 2011.
4. Dennis G. Zill, Warren S. Wright, “Advanced Engineering Mathematics”, 4th edition, Jones and Bartlett publishers, Sudbury, 2011.
5. Alan Jeffrey, “Advanced Engineering Mathematics”, Academic Press, USA, 2002.
6. Venkataraman, M.K., “Engineering Mathematics”, Volume I, 2nd edition, National Publishing Co., Chennai, 2003.
7. James Stewart “Calculus” (7th edition),Brooks/Cole cengage learning,UK

OUTCOMES:

After completing the course, student will be able to

- Understand the matrix techniques and compute eigen values and eigenvectors of a given matrix.
- Do the problems based on three dimensional analytic geometry.
- Apply differential calculus in engineering problems.
- Differentiate more than one variable and their applications.
- Solve the differential equations with constant coefficient and variable coefficient.
- Form and solve differential equations.

ENC 1181	ENGLISH	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To train students to use appropriate vocabulary in academic and technical contexts.
- To facilitate students to speak effectively while exchanging ideas and making presentations.
- To develop students' listening skill for comprehending and analyzing information.
- To develop their reading skill through sub skills like skimming , scanning and critical reading of a text.
- To sharpen their academic writing skills.
- To expose them to the correct usage of language and help them to apply that knowledge appropriately.

MODULE I **8**

L: Listening for general information
S : Self Introduction, Introducing one another.
R: Predicting the content
W: Paragraph Writing
Language Focus: Affixes, Simple Present tense, Connective & Prepositions.

MODULE II **8**

L: Listening for specific information (from dialogues)
S: Exchanging opinion.
R: Skimming technical Passages
W: Argumentative Writing (using the concept of Flipped Learning), Letter to the Editor.
Language Focus: Idioms, use of Modals, Simple Past tense & use of "Wh" and question tags.

MODULE III **7**

L: Learning the ways of describing images and presenting specific information (focusing on note making)

S: Making Presentations using visuals.

R : Scanning short texts for gist of information

W: Letter of Invitation, Expository Writing

Language Focus: Homophones, Homographs, Simple Future & Collocations.

MODULE IV **7**

L: Understanding prepared presentation techniques through videos

S: Short Presentations.

R: Reading for coherence and cohesion

W: Letter seeking permission for Industrial Visit

Language Focus: S-V agreement, Euphemism

MODULE V **8**

L : Understanding Non- Verbal Communications while listening to narration of incidents.

S: Narrating an expereince

R: Inferential Reading

W: Process Description – Transcoding a Flow chart.

Language Focus: Interchange of Active & passive voice, Impersonal Passive voice.

MODULE VI **7**

L: Learning Story telling techniques (stories & visuals) through audio files

S: Discussion in groups

R: Reading for critical appreciation

W: Developing an idea, Slogan writing, Interpreting a Bar Chart.

Language Focus: If clause and phrasal verbs.

TOTAL HOURS :45

REFERENCES:

1. Carol Rosenblun perry(2011). The Fine Art of Technical Writing. Create Space Independent Publishing Platform, New Delhi.
2. Dutt, P.K. Rajeevan. G and Prakash , C.L.N. (2007) A course in Communication Skills. Cambridge Univesity Press, India.

3. Kala, Abdul & Arun Tiwari (2004) . Wings of Fire : An Autobiography(Simplified and Abridged by Mukul Chowdhri). Hyderabad Univeristy Press.
4. Sen, Leena. (2004) Communication Skills. Prentice Hall, New Delhi.
5. Matt Firth, Chris Sowton et.al. (2012). Academic English: An Integrated Skills Course for EAP. Cambridge University Press, Cambridge.

OUTCOMES:

After completion of the course, students will have the ability to

- Demonstrate their range of vocabulary in academic and technical contexts
- Exchange ideas and make presentations
- Comprehend and respond appropriately to listening tasks.
- Read a text efficiently and process information.
- Create and draft different kinds of academic documents
- Communicate effectively using grammatically correct expressions.

ISC1181	ARABIC	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To read and write in Arabic language.
- To learn vocabulary of different fields
- To develop situational communication skills.

MODULE I PREPARATORY ARABIC 7

Introducing Arabic Alphabets.
Listening and Reading.
Audio & Video aided listening, Tajweed listening,
Writing Arabic Alphabets (connected & unconnected).
Introducing words.
Reading simple sentences.
Learning names of the things in and around the class room.
Exercises.

MODULE II FUNCTIONAL ARABIC 7

Listening Arabic texts, stories and action verbs
Communicating Simple sentences.
Jumla' Ismiyya and Jumla' Fi'liyya
Situational Conversation:
Greetings, Introduction.
Classroom, College, Picnic.
Dining and Kitchen.
Reading skills.
Exercises

MODULE III FUNCTIONAL ARABIC 8

Implication of effective listening.
Audio aids.
Writing Simple sentences.
Communicating ordinal and cardinal numbers.
Situational communication:
Playground, library.

Forms of plural – Sample sentences.
Introduction to tenses.
Exercises.

MODULE IV FUNCTIONAL ARABIC 8

Communication:
Family, travel
Market, Prayer hall
Writing skills:
Note making.
Sequencing of sentences.
Developing answers from the questions.
Exercises.

MODULE V TECHNICAL ARABIC 8

Importance of technical communication.
Reading and writing skills.
Audio & Video aided listening.
Introduction to Arabic terms related to administration.
Situation communication:
Air travel, Office administration, passport, visa.
Exercises

MODULE VI TECHNICAL ARABIC 7

Situation communication:
Contractual work, machineries and equipments..
Computer, internet browsing.
Banking,
Exercises.

TOTAL HOURS :45

TEXT BOOKS:

1. Arabic for professionals and employees, Kilakarai Bukhari Aalim Arabic College, Chennai, India, 2013.

REFERENCES:

1. Arabic Reader for Non Arabs (Ummul Qura University, Makkah),

Kilakarai Bukhari Aalim Arabic College, 2005.

OUTCOMES:

On successful completion of the course, the student will be able to:

- Write correct sentences in Arabic.
- Communicate in Arabic at primary level in working situations in the fields of engineering and administration.

LNC1181	MANDARIN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To improve the proficiency of students in Mandarin language.
- To develop their knowledge of vocabulary.
- To train them in using appropriate grammatical forms during communications.
- To empower them for successful communication in social and academic contexts.
- To make them appreciate the language usage in real life situations.

MODULE I **8**

· General Introduction to Chinese • Pinyin and Tones • Introduction to the Writing System: basic strokes and stroke order · Numbers 1-100, song · Days of the Week · Months of the Year

MODULE II **8**

· Chinese names and related culture · Chinese family structures and values · Greetings
· Introducing Yourself · Family members · Occupations

MODULE III **7**

· Languages and Nationalities · Daily Routine · Chinese breakfast · Negative Sentences and Interrogative Sentences · Asking for Personal Information · The Verb *shi* and Basic Sentence Structures

MODULE IV **7**

· Answering an Affirmative-negative Question · Food and drinks · Transportation · Likes and dislikes · Adverbs *bu*, *jiu* and *dou* · Verb-absent Sentences

MODULE V **8**

·*Jisui* and *duoda* Questions · S+V+O Construction · Routines and Daily Activities ·*Haishi* Questions · Modal Verbs · Hobbies and Habits

MODULE VI **7**

· Making Suggestions with *haoma* ·Colors · Clothing · Body parts · Talking about Likes and Dislikes · Measurement Words in Chinese

TOTAL HOURS :45

TEXT BOOKS:

1.Ma, Yanmin, and Li, Xinying. *Easy Steps to Chinese, Vol*. *1 Textbook*. Beijing: Beijing Language and Culture University Press, 2006. Print.

2. Ma, Yanmin, and Li, Xinying. *Easy Steps to Chinese, Vol. 1 Workbook*. Beijing: Beijing Language and Culture University Press, 2006. Print.

OUTCOMES:

On completion of the course, students will be able to

- Exhibit proficiency in Chinese Language.
- Use vocabulary in appropriate contexts.
- Use appropriate grammatical forms effectively.
- Use the language in social and academic contexts.
- Appreciate the use of language forms.

LNC1182	GERMAN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To improve the proficiency of students in German language.
- To create awareness of using vocabulary among students.
- To expose them to correct grammatical forms of the language.
- To empower them for successful communication in social and academic contexts.

MODULE I **8**

Introduction to German alphabets, phonetics and pronunciation- Introducing themselves and others using simple sentences and answer to some basic personal questions-: Introduction to different types of articles and verbs, Nouns

MODULE II **8**

Understanding and responding to everyday queries like instruction, questions, - number & gender, pronouns, present and past tense.

MODULE III **7**

Short telephone messages, requests etc., if spoken slowly and clearly-- Detailed overview of articles, adjectives with/without articles, Prepositions

MODULE IV **7**

Ask and giving directions using simple prepositions- Ability to fill basic information on forms while registering for courses / classes.

MODULE V **8**

Ability to extract and understand relevant information in a public announcement, broadcast, newspaper, radio etc-- dative & accusative

MODULE VI **7**

Ability to describe about people, work, immediate environment, education and other topics related to personal needs in a concise manner--

Understanding of matters that are familiar and are encountered regularly like instances at school, work, at public places, places of leisure etc.

TOTAL HOURS :45

TEXT BOOKS:

1. Course book : Tangram aktuell 1 – Lektion 1–4 (Kursbuch + Arbeitsbuch mit Audio-CD zum Arbeitsbuch), Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Publisher, ISBN 978-3-19-001801-7
2. Practice book: Tangram aktuell 1 – Lektion 1–4 (Kursbuch + Arbeitsbuch mit Audio-CD zum Arbeitsbuch), Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Publisher, ISBN 978-3-19-001801-7.

REFERENCES:

1. NETZWERK A1 TEXTBOOK, Deutsch als Fremdsprache,Stefanie Dengler,Paul Rusch, Helen Schmitz, Tanja Sieber, Langenscheidt and Klett, ISBN : 9788183076968
2. STUDIO D A1 (SET OF 3 BOOKS + CD), Hermann Funk. Cornelsen, ISBN: 9788183073509
3. Willkommen! Beginner's course. Paul Coggle, Heiner Schenke. 2nd edition. (chapter 1 - 6) ISBN: 9781444165159 –
4. Willkommen! Beginner's course. Paul Coggle, Heiner Schenke. ISBN: 978-1-444-16518-0
5. An Introduction to the German Language and Culture for Communication, Updated Edition Lovik, Thomas A., J. Douglas Guy & Monika Chavez. Vorsprung -. New York, Houghton Mifflin Company, 1997/2002. ISBN 0-618-14249-5.

OUTCOMES:

On completion of the course, students will be able to

- Show their proficiency in German Language.
- Use appropriate vocabulary in real life contexts.
- Use appropriate grammatical forms while communicating with people.
- Effectively use the language in social and academic contexts.

LNC1183	JAPANESE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To train students to use appropriate vocabulary in academic and technical contexts.
- To facilitate students to speak effectively while exchanging ideas and making presentations.
- To develop their reading skill through sub skills like skimming, scanning and critical reading of a text.
- To sharpen their academic writing skills.
- To expose them to the correct usage of language and help them to apply that knowledge appropriately.

MODULE I **7**

Introduction of the Japanese writing system, i.e. *Hiragana*, *Katakana* and *Kanji*, word-building, writing foreign names and loan words in Katakana.

MODULE II **8**

Oral practice of pronunciation and intonation of Japanese sounds, Japanese greetings, self introduction, identifying things, time of the day, calendar; counting using Japanese numerical classifiers; describing things;

MODULE III **7**

Making comparisons; talking of daily activities, kinship terms used for address and reference, seasons, giving and receiving, shopping; making requests, talking of one’s likes and dislikes.

MODULE IV **8**

Extensive practice of basic patterns at the lower intermediate level through drills and exercises.

MODULE V **7**

Comprehension of passages in simple Japanese and writing of composition in Japanese applying lower intermediate grammatical patterns.

MODULE VI **8**

Diverse texts based on Japanese culture, customs, history, food habits, and science etc, for the development of communicative competence of students; skimming, scanning of texts with emphasis on advanced sentence patterns, grammatical structures and idiomatic phrases, reading and writing of approximately

TOTAL HOURS :45

REFERENCES:

1. Nihongo I, Kokusaigakuyukai, and other supplementary material
2. Exersice book 1of Nihongo 1, and other supplementary material
3. Nippon, the Land and its People & Encyclopedia of Contemporary Japanese
4. Japani: Japanese Conversation for Improving Spoken Proficiency, By P.A. George, Inoue Yoriko and Itsuko Nandi, Books Plus.
5. Chukyu Nihongo, Tokyo Gaikokugo Daigaku; Nihongo II, Kokusaigakuyukai, and other supplementary material.

OUTCOMES:

After completion of the course, students will have the ability to

- Demonstrate their range of vocabulary in academic and technical contexts
- Exchange ideas and make presentations
- Comprehend and respond appropriately to listening tasks.
- Read a text efficiently and process information.
- Create and draft different kinds of academic documents
- Communicate effectively using grammatically correct expressions.

PHC 1181	PHYSICS	L	T	P	C
		3	0	2	4

OBJECTIVES:

To make students conversant with the

- basic concepts of crystal physics and its structures
- production and applications of ultrasonic waves
- study of thermal conductivities of good and bad conductors
- phenomenon of wave optics and its applications
- principle of fibre optic communication and its applications to sensors
- wave mechanics principle and its applications in electron microscopy
- green energy physics and its environmental impacts to society

MODULE I CRYSTAL PHYSICS **8**

Crystalline and amorphous solids – Unit Cell – Seven Crystal Systems – Bravais Lattice – Miller Indices – Interplanar Spacing – Characteristics of Unit Cell - Calculation of Number of atoms per unit cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP and Diamond structures –Defects in crystals-Point defects –Edge and screw dislocations and their significance - Surface Defects.

MODULE II ULTRASONICS AND THERMAL PHYSICS **8**

Introduction to Ultrasonics - Properties - Production methods - Magnetostriction Oscillator method- Piezoelectric Oscillator method – Detection of Ultrasonics – Thermal method – Piezoelectric method – Kundt's tube method – Applications of Ultrasonics – Acoustic Grating – SONAR – Depth of sea – Velocity of blood flow, Ultrasonic Flaw detector (qualitative). Transmission of heat – Conduction, Convection and Radiation – Thermal Conductivity of good Conductor – Forbe's method- Thermal Conductivity of bad Conductor – Lee's Disc method.

MODULE III APPLIED OPTICS **8**

Interference – Air Wedge – Michelson's Interferometer – Determination of wavelength of light and thickness of thin transparent sheet.

Introduction to Laser – Characteristics of Laser – Spontaneous and Stimulated Emissions – Einstein's Coefficients - Population inversion – Pumping Mechanism – Laser Action – Types of Laser: He-Ne laser, CO2 laser and Nd:YAG laser - Applications : Laser Materials Processing .

MODULE IV FIBRE OPTICS 7

Optical fibre – Principle and propagation of light in optical fibre – Numerical aperture and acceptance angle – Types of optical fibres – Attenuation – Absorption, Scattering losses, Bending losses and Dispersion in Optical fibres – Fiber Connectors and Couplers - Applications – Fibre optic communication system (block diagram only)- Fibre optic sensors - displacement and pressure sensors (qualitative) - Medical endoscope.

MODULE V QUANTUM MECHANICS 7

Black body radiation – Planck's theory of radiation – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory –Dual nature of matter – de Broglie's wavelength- Physical significance of wave function – Schrodinger wave equation – Time independent and time dependent wave equation – Particle in one dimensional box – Harmonic oscillator(qualitative).

MODULE VI RENEWABLE ENERGY SOURCES 7

Present Energy sources and sustainability - Solar energy - Solar photovoltaics - Solar cells – Bioenergy - Biomass – production of liquid fuels from biomass – Wind energy – Wind turbines – energy and power from wind turbines - Geothermal energy - Ocean energy: Wave energy – Wave energy conversion devices – Tidal energy – Tidal power basics – power generation –Tidal energy potential – Environmental benefits and impacts of renewable energy sources

PRACTICALS

1. Determination of Velocity of Ultrasonic waves in a given liquid using Ultrasonic Interferometer.
2. Determination of wavelength of ultrasonic waves using Kundt's tube method.

3. Determination of thickness of a thin wire using Air Wedge method.
4. Determination of wavelength of light using spectrometer diffraction grating.
5. Determination of angle of divergence of a laser beam using He-Ne laser.
6. Determination of particle size of lycopodium powder using semiconductor laser.
7. Determination of wavelength of laser light using semiconductor laser diffraction.
8. Determination of Acceptance angle and Numerical Aperture using fiber optic cable.
9. Determination of thermal conductivity of a good conductor by Forbe's method.
10. Determination of thermal conductivity of a bad conductor by Lee's disc method.
11. Determination of solar cell characteristics.

L – 45; P – 30; TOTAL HOURS – 75

REFERENCES :

1. Gaur R.K. and Gupta S.L., "Engineering Physics'', 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.
2. Palanisamy P.K., Physics for Engineers, Vol1 & Vol2, 2nd Edition, Scitech Publications, 2003.
3. Serway R.A. and Jewett, J.W. "Physics for Scientists and Engineers with Modern Physics". Brooks/cole Publishing Co., 2010.
4. Tipler P.A. and Mosca, G.P., "Physics for Scientists and Engineers with Modern Physics", W.H. Freeman, 2007.
5. Markert J.T., Ohanian. H. and Ohanian, M. "Physics for Engineers and Scientists". W.W. Norton & Co. 2007.
6. Godfrey Boyle, "Renewable Energy: Power for sustainable future", 2nd edition, Oxford University Press, UK, 2009.

OUTCOMES:

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

- understand the different types of crystal structures
- apply the concept of ultrasonic principle in engineering and medical field

- calculate thermal conductivities of good and bad conductors
- differentiate the various laser systems and its applications in engineering and medical field
- apply the principle of fibre optics for communication and sensor applications
- formulate wave mechanics principle for applications in electron microscopy
- Correlate the different renewable energy sources for societal needs.
- To complement the knowledge acquired in the theory class.
- To correlate the experimental results for application.

CHC1181	CHEMISTRY	L	T	P	C
		3	0	2	4

OBJECTIVES:

The students should be conversant with

- the basic problems like hardness, alkalinity, dissolved oxygen associated with the water used for domestic and industrial purpose and treatment process involved.
- the synthesis, properties and applications of nanomaterials.
- the importance of renewable energy sources like solar, wind, biogas, biomass, geothermal, ocean and their limitations.
- the basic analytical techniques like UV-Visible, FT-IR, NMR, AAS, AES, Circular Dichroism and XRD etc.
- photochemistry concepts related to physical processes and chemical reactions induced by photon absorption and their applications.
- basic principles of electrochemistry, cell construction and evaluation and to understand general methodologies for construction & design of electrochemical cell

MODULE I WATER TECHNOLOGY 9

Impurities present in water, hardness : types of hardness, demerits of hard water in boilers, estimation of hardness by EDTA method (problems) – alkalinity : estimation of alkalinity (problems) – dissolved oxygen: estimation of dissolved oxygen – conditioning methods : external treatment method: – lime soda and zeolite process (principle only), Ion exchange process – Internal treatment : colloidal, carbonate, phosphate and calgon methods – drinking water: standards (BIS), treatment of domestic water {screening, sedimentation, coagulation, filtration, disinfection }– desalination: electrodialysis, reverse osmosis.

MODULE II NANOCHEMISTRY 6

Introduction – distinction between molecules, bulk materials and nanoparticles – classification based on dimension with examples – synthesis (top-down and bottom-up approach} : sol-gel, thermolysis (hydrothermal and solvothermal), electrodeposition, chemical vapour deposition, laser ablation

– properties and applications (electronic, magnetic and catalytic) – risk factors and future perspectives.

MODULE III ENERGY SOURCES 8

Energy: past, today, and future – a brief history of energy consumption – present energy scenario of conventional and renewable energy sources – renewable energy : needs of renewable energy, advantages and limitations of renewable energy – solar energy: basics, solar energy in the past , photovoltaic, advantages and disadvantages – bioenergy: conversion, bio degradation, biogas generation, biomass gasifier, factors affecting biogas generation, advantages and disadvantages – geothermal energy: geothermal resources (hot dry rock and magma resources, natural and artificial), advantages and disadvantages – wind energy: wind resources, wind turbines, advantages and disadvantages – ocean energy: wave energy, wave energy conversion devices, ocean thermal energy, advantages and disadvantages.

MODULE IV PHOTOCHEMISTRY 7

Introduction: absorption and emission, chromophores, auxochromes – laws of photochemistry : Grotthus-Draper law, Stark Einstein law – quantum yield (problems) –photo physical processes : fluorescence and phosphorescence - Jablonski diagram (electronic states and transitions) – quenching, annihilation – photosensitization: principle and applications – chemiluminescence, bioluminescence.

MODULE V ANALYTICAL TECHNIQUES 7

Spectroscopy: electromagnetic radiation and spectrum – types of transitions – types of spectra (atomic and molecular with their chemical usefulness) – Beer-Lamberts law (problems) – principles, instrumentation and applications of: Colourimetry – UV-Vis spectrophotometer – atomic absorption spectroscopy – atomic emission spectroscopy – principles and applications of: IR, NMR, mass and X-ray diffraction analysis.

MODULE VI ELECTROCHEMISTRY 8

Electrochemistry - types of electrodes (principle and working) : gas (SHE), metal/metal ion electrode, metal-metal insoluble salt (calomel electrode),

ion-selective (glass electrode and fluoride ion selective electrode) – Electrolytic and galvanic cells, construction of cell, EMF measurement and applications (problems), standard cell (Weston-cadmium), reversible and irreversible cell, concentration cell. Determination of fluoride ion using fluoride ion selective electrode – Chemically modified electrodes (CMEs) : concept, approaches and applications.

PRACTICALS

1. Estimation of hardness in given water sample.
2. Estimation of the alkalinity of the given water sample.
3. Estimation of strong acid by conductometry.
4. Estimation of Fe^{2+} present in the given sample by potentiometry.
5. Verification of Beer-Lamberts law and estimation of Cu^{2+} present in unknown sample.
6. Estimation of sodium and potassium present in the given sample by flame photometry.
7. Determination of molecular weight and degree of polymerisation of a polymer by viscosity method.
8. Synthesis of thermosetting polymer.

L – 45; P – 30; TOTAL HOURS – 75

REFERENCES:

1. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India Ltd., New Delhi, 2011.
2. G.A. Ozin and A.C. Arsenault, “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, Thomas Graham House, Cambridge, 2005.
3. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
4. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand& Company Ltd, New Delhi, 2014.
5. G.D.Rai, “Non conventional energy sources,” Khanna Publishers, New Delhi, 2011.
6. John Twidell and Tony Weir, “Renewable Energy Resources, Taylor & Francis Ltd, London, United Kingdom, 2005

7. Principles of molecular photochemistry: An introduction, Nicholas J. Turro, V.Ramamurthy and Juan C. Scaiano, University Science Books, Sausalito, CA, 2009.

OUTCOMES:

The students will be able to

- solve problems related to hardness, alkalinity, dissolved oxygen associated with the water and describe the treatment processes.
- classify nanomaterials and apply the nanochemistry approach to synthesize the nanomaterials.
- explain the principle and enumerate the advantages and disadvantages of various renewable energy sources.
- state the principle and illustrate the instrumentation of various analytical techniques.
- apply the concepts of photochemistry to elaborate various photo-physical and photochemical reactions.
- construct a electrochemical cell and describe the various types of electrodes and determine the fluoride content.

BTC 1101	FUNDAMENTALS IN BIOTECHNOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- Provide a breadth of knowledge of basic principles and concepts. Provide a broad background in the biological sciences.
- Provide knowledge content across the full range of biology.
- Demonstrate knowledge of form, function, mechanism, organization, scale, hierarchy, diversity and evolution.
- Students will learn the microbial-related diseases and biofilm formation.
- Students will learn the handling of the fermenter

MODULE I INTRODUCTION TO BIOTECHNOLOGY 9

Introduction -Biotechnology: an interdisciplinary pursuit -Biotechnology: a three-component central core Product safety -Public perception of biotechnology -Biotechnology and the developing world.

MODULE II GENERAL PHYSIOLOGY AND CELL BIOLOGY 7

General Physiology: The gastrointestinal System- The circulatory System- The respiratory System- Nervous system- The Endocrine System.

Cell Biology: Cell structure and function of cell organelles - Eukaryotic and prokaryotic cells - Cell division, Mitosis, Meiosis.

MODULE III BIOCHEMISTRY 11

Introduction to Carbohydrates, fats, proteins, nucleic acids, vitamins-structure and classification. Enzyme nomenclature, Classification of Enzymes, enzymes specificity, mechanisms of enzyme action.

MODULE IV GENETICS 12

Mendelian Inheritance-Mendelism and Mendel's experiments, Laws of Segregation and Independent Assortment- Genetic disorders in man-Sexlinked traits hemophilia and colour blindness in man. Sex limited and sex influenced traits DNA Structure, Transcription of DNA to RNA, Translation of RNA to Protein. Epigentics, Genetic Engineering - Application of Genetic engineering.

MODULE V MICROBIOLOGY 9

Microbiology –Microbial diversity –Major types of micro-organisms - Sterilization techniques - Phases of microbial growth, Microbial growth curve, Cell growth kinetics, -Batch and continuous growth, Kinetics of batch and continuous culture - microorganism and Biofilm - Microorganism in Food,

medicine and industry – Microbes associated human diseases - Communicable and non-communicable diseases

MODULE VI FERMENTATION TECHNOLOGY 12

Fermentation- Types of media and media components- Fermentors and their accessories - Types of Fermentors, Airlift fermentor, Tower fermentor, Continuous stirred tank fermentor. Downstream Process – introduction - stages in downstream operations- Cell disruption, solid liqid separations, Concentration-purification, formulation.

TOTAL HOURS – 60

TEXT BOOKS:

1. Text Book of Microbiology by Michael J Pelczar, Mc Graw Hill Education
2. Text Book of Biochemistry for Medical Students by D M Vasudevan
3. Text Book of Medical Physiology by Guyton and Hall

REFERENCES:

1. Principles of Fermentation Technology by P.F.Stanbury and A.Whitaker
2. Biotechnology by John. E.Smith, Cambridge University Press

OUTCOMES:

At the end of the course students will be able to

- Awareness on the importance of biotechnology in the developing world and public acceptance of biotechnology.
- Deep knowledge on basic concepts of cell biology, function and features of cell organelle.
- Familiar with the biochemical reactions of carbohydrates, proteins, nucleic acids.
- Comprehend the system of genetic inheritance with examples
- Understanding the world of microbes to correlate with industrial and clinical applications and also implications on human health.
- Exposure to the technology of fermentation which is regarded as the most advantageous application of biotechnology.

GEC 1102	ENGINEERING DESIGN	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To understand the role of design in Engineering
- To understand the basic design concepts
- To understand the role of innovation in design

MODULE I DESIGN AS A CENTRAL ACTIVITY IN ENGINEERING **08**

Product design – products and processes – product design methodology Design of systems; Software design

MODULE II NEED ANALYSIS AND CONCEPT DEVELOPMENT **07**

Voice of customers – product specification - need analysis Bench marking Product architecture – concept generation and evaluation;

MODULE III CASE STUDIES IN ENGINEERING DESIGN **08**

Product design – process design; system design; software design - Ergonomics – usability

MODULE IV INNOVATION AND DESIGN **07**

Role of innovation in Engineering – incremental changes and systemic changes; scientific approach to driving innovation – case studies.

TOTAL HOURS – 30

REFERENCES:

1. Clive L. Dym and David C. Brown,“Engineering Design: Representation and Reasoning”, 2nd Edition, Cambridge University Press, New Delhi, 2011.
2. Daniel G. Dorner, G. E. Gorman and Philip J. Calvert, “Information Needs Analysis: Principles and practice in information organizations”, Published by Faced Publishing, London. 2015.
3. Cliff Matthews, “Case Studies in Engineering Design”, John Wiley & Sons Pvt. Ltd, New York, 1998.

4. Bengt-Arne Vedin, “The Design-Inspired Innovation Workbook”, World Scientific, 2011.
5. Navi Radjou, Jaideep Prabhu and Simone Ahuja, “Jugaad Innovation”, Published by Random House India, 2012.

OUTCOMES:

The students will be able to

- Apply the basic knowledge of design in engineering products / process / service.
- Analyze the problems and give innovative solutions.
- Correlate the basic knowledge of design in the real-world problems.
- Apply innovative approaches to engineering design.

BTC 1102	FUNDAMENTALS IN BIOTECHNOLOGY LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

- Provide a breadth of knowledge of basic principles and concepts. Provide a broad background in the biological sciences.
- Provide knowledge content across the full range of biology.
- Demonstrate knowledge of form, function, mechanism, organization, scale, hierarchy, diversity and evolution.

Experiments

1. Lab safety procedure
2. Lab instrumentation
3. Visualization of Bacteria and its structure in the microscope
4. Visualization of fungi and its structure in the microscope
5. Visualization of protozoa and its structure in the microscope
6. Visualization of algae and its structure in the microscope
7. Visualization of other organism and its structure in the microscope
8. Simple test for carbohydrates,
9. Simple test for lipids
10. Simple test for proteins
11. View of the structure of chromosome
12. Spotter: Gastrointestinal system (liver)
13. Spotter: circulatory system (heart)
14. Spotter: respiratory system (lungs)
15. Spotter: nervous system (brain)

TOTAL HOURS – 30

OUTCOMES:

At the end of the course students will be able to

- Understand the good laboratory practices and lab safety protocols.
- Apply the knowledge to understand the principles behind the available instruments in the laboratory.
- Examine the structure, shape, size and morphology of both eukaryotic and prokaryotic cells under the microscopes
- Demonstrate the simple tests to estimate the concentration of different biomolecules.
- Models for understanding the physiology and anatomy of vital organs.
- Summarize the importance of the scientific method to understanding natural phenomena.

GEC 1104 COMPUTER PROGRAMMING I

L	T	P	C
1	0	2	2

OBJECTIVES:

- To identify the hardware and software components of the computer.
- To know the basic concept of operating system and get knowledge about different operating systems.
- To learn various database concepts and operations
- To develop efficient algorithms for solving a problem.
- To implement the algorithms in C language.
- To use arrays in solving problems.

MODULE I COMPUTER FUNDAMENTALS **7**

Introduction -. Number System - Planning the computer program - Computer Software - Basic operating system concepts - Database Operations

MODULE II PROGRAMMING IN C **8**

Introduction to C Programming Language – Operators - Control statements -Iterative statements - Arrays.

LIST OF EXPERIMENTS:

1. Computer organization –Hardware in a typical computer Identification – Booting- error messages and what it means
2. Types of Operating systems – Windows and Linux
3. Structure of a basic program - Hello world program – Debugging it
4. Data types: Type conversions
5. Input / Output: Formatted functions – Unformatted functions – Library functions
6. Properties of operators – Priority of operators – Arithmetic relational logical and bitwise operators
7. If – if else- nested if else- goto- switch case – nested switch case – for loops

– nested for loops – while loop – do-while loop – break and continue statement

8. Arrays – Operation with arrays
9. Sorting and searching.

L – 15; P – 30; TOTAL HOURS – 45

REFERENCES:

1. Ashok N Kamthane, “Computer Programming”, Pearson Education, 2nd Edition, ISBN 13: 9788131704370, 2012
2. Paul J. Deitel, Deitel & Associates, “C How to Program”, Pearson Education, 7th Edition, ISBN-13: 978-0132990448, 2012

OUTCOMES:

Students who complete this course will be able to

- Recognize Modular design, logic flow, data abstraction
- Analyze the working of the programming constructs, functions, and I/O.
- Write down programs for sorting and searching algorithms
- Write down programs developing cycle for different applications
- Debug the programs and solve some practical problems in programming
- Develop programs using arrays.

SEMESTER II

MAC1282	BIOSTATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

This course aims to provide students with fundamental knowledge of the design and analysis of clinical trials and epidemiological studies of statistical problems arising in biomedical research and Bio-statistical data including data from microarray experiments.

The course is aimed to

- make informed decisions based on data
- correctly apply a variety of statistical procedures and tests.
- know the uses, capabilities and limitations of various statistical procedures.
- interpret the results of statistical procedures and tests.

MODULE I INTRODUCTION TO STATISTICS **10**

Exploratory Data Analysis - Motivation, Population vs Sample, ”Scientific Method” - Definitions, Examples, Medical Study Designs – Graphical Displays: Dot plots, Stem plots, Pie chart, Histograms - Summary Statistics: Measures of Central tendency.

MODULE II MEASURES OF DISPERSION **10**

Range, Quartile deviation, Mean deviation, Standard deviation, Variance , Coefficient of Dispersion: coefficient of variation, Moments: Relationship between raw and central moments , Effect of change of Orgin and Scale, Pearson beta and gamma cofficiencts,Skewness: Measures of Skewness , Kurtosois.

MODULE III CORRELATION AND REGRESSION **10**

Bi-variate data – Correlation and Regression coefficients and their relation, properties - Effect of change of origin and scale on correlation coefficient, Linear regression, Association and Independence of attributes.

MODULE IV PROBABILITY AND ITS DISTRIBUTIONS **10**

Events - exhaustive, mutually exclusive and equally likely - Baye’s theorem (without proof) - Binomial, Poisson, Exponential and Normal distributions - Simple properties of the above distributions (without derivation).

MODULE V SAMPLING TECHNIQUES 10

Concept of population and sample, Random sample, Methods of taking a simple random sample, Tests of Significance: Sampling distribution of mean and standard error, Large sample tests (test for an assumed mean and equality of two population means with known S.D.); small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, t-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit.

MODULE VI EXPERIMENTAL DESIGNS 10

Analysis of variance (ANOVA) - Principles of experimental designs, Completely randomized, Randomized block and Latin square designs.

TOTAL HOURS – 60

TEXT BOOKS:

1. Gupta .S.C and V.K.Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons ,NewDelhi 2002.

REFERENCES:

2. Norman T J Bailey, ”Statistical Methods in Biology “ (3rd Edition), Cambridge University Press 1995
3. Gerald van Belle, L.D.Fisher, P.J.Heagerty, and T.Lumney, “Introduction to Biostatistics” Second Edition, John Wiley & Sons, New Jersey 2004
4. Wong Limsoon, ”Essence of biostatistics” , NUS Lecture Notes Series 2003.
5. Gupta .S.C and V.K.Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons ,NewDelhi 2002.
6. Gupta.S.C.,”Fundamentals of Applied Statistics”, Sultan Chand & Sons ,NewDelhi 2014.
7. Ross,S.M.,”Probabilty and Statistics for Engineers and Scientists” John Wiley & Sons, New Jersey 2007

OUTCOMES:

At the end of the course the students will be able to

- represent the data in pictorial form.
- make decision based on statistical data.
- correlate the real time data.
- apply Baye's theorem and probability distributions
- interpret the results of hypothesis tests
- make an informed decision, based on the results of inferential procedures.

BTC1211	BIOCHEMISTRY	L	T	P	C
		4	0	0	4

OBJECTIVES:

The course aims

- The course provide students with understanding the nature of weak interactions and its influence in the behavior and properties of biological molecules and earn the principles behind weak acids and weak bases
- To explore the diverse roles of carbohydrates in living organisms, including energy storage and structural support.
- To provide students with a solid foundation in the principles and applications of metabolism, glycolysis, and their implications in various physiological and disease contexts.
- To provide students with a comprehensive understanding of the processes and regulation of gluconeogenesis and glycogen metabolism, highlighting their importance in energy homeostasis and their implications in various physiological contexts.
- To provide students with a comprehensive understanding of the processes, regulation, and interplay of the citric acid cycle and related metabolic pathways.
- To provide students with a understanding of the processes and mechanisms involved in cellular energy production

MODULE I AMINO ACIDS, CARBOHYDRATES AND LIPIDS 10

Structure, Function, Methods of Characterization, Separation Techniques based on the structure and properties of amino acids, Classification, Structure, Function, Separation and Characterization Techniques of mono and polysaccharides and lipids.

MODULE II NUCLEIC ACIDS AND VITAMINS 9

Nucleic Acids and Polynucleotides, Classification, Structure, Function,Separation and Characterization Techniques, Clinical Significance.Vitamins: classification, Structure, Function,Separation and Characterization Techniques, Clinical Significance.

MODULE III METABOLISM OF AMINO ACIDS 9

Nitrogen metabolism and urea cycle – Biosynthesis of amino acids (Gly, Ser, Cys, Met, Thr, Lys, Ile, Val and Leu) – Regulation of branched chain amino acids (concerted inhibition, allosteric regulation and enzyme multiplicity, sequential feed back) from oxaloacetate and pyruvate – Biosynthesis of

aromatic amino acids – Metabolic disorders associated with branched chain and aromatic amino acid degradation – Important molecules derived from amino acids (auxins, DOPA, Serotonian, porphyrins, T3, T4, Adrenaline, Noradrenaline, histamine, GABA, polyamines).

MODULE IV METABOLISM – NUCLEIC ACIDS, POLYSACCHARIDES AND LIPIDS **09**

Biosynthesis of nucleotides – *de novo* and salvage pathways for purines and pyrimidines – Regulatory mechanisms – Degradation of nucleic acid by exo and endo nucleases – Biosynthesis and degradation of starch and glycogen – Biosynthesis and degradation of Lipids –Fatty acid synthesis and oxidative degradation – Triacylglycerol and phospholipid biosynthesis and degradation – Cholesterol biosynthesis and regulation and targets and action of cholesterol lowering drugs.

MODULE V BIOMEMBRANE, TRANSPORT AND ELECTRICAL CONDUCTIVITY **12**

Micelles – Lipid bi-layer structure of membranes – Membrane proteins – Passive – Careermediated and active transport – Ion-selective channels – Trans-membrane potential coupled ATP generation – Receptors – Acetylcholine receptor as a ligand gated ion-channel – Neuronal sodium channel as voltage-gated ion channel – Neurotransmitters and their mechanism of action – Action potential – Depolarization and nerve conduction – Ion-channel agonists and antagonists as drugs – Ion channel defects (Cystic Fibrosis)

MODULE VI BIOCHEMICAL ENERGETICS **11**

Energy Yielding and Energy Requiring Reactions, Calculations of Equilibrium Concentrations, Oxidation-Reduction Reactions, Metabolism and ATP Yield. Photosynthetic Phosphorylation, Active Transport, Second Law of Thermodynamics, Enthalpy and Entropy, Activation Energy.

TOTAL HOURS – 60

REFERENCES:

1. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
2. Biochemistry by Lehninger. McMillan publishers
3. Biochemistry by Zubey. Wm. C. Brown publishers

OUTCOMES:

At the end of the course students will be able to

- Acquire a solid foundation of knowledge and understanding of the fundamental principles and concepts in biochemistry such as the structure and function of biological macromolecules, metabolic pathways, enzymology, cellular respiration, and molecular genetics.

- Develop critical thinking skills to analyze and solve complex biochemical problems.
- Integrate their knowledge of biochemistry with other areas of biology and chemistry with molecular biology, genetics, physiology, pharmacology, and other related fields.
- Gain an understanding of the ethical implications of biochemistry and develop ethical decision-making skills within the field.
- Apply their knowledge of biochemistry to real-world situations and problems such as biochemical basis of diseases, drug mechanisms, and the development of biotechnological applications.
- Develop the skills to stay updated with the latest advancements in biochemistry and related fields throughout their careers.

BTC1212	CELL BIOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To get overview of classes of cells and structural and function aspects of plasma membrane.
- To obtain knowledge of various cell organelles.
- To develop skill to understand molecular aspects of cell cycle and cell division.
- To get familiar with transcription and translation in details
- To understand the architecture of cytoskeleton

MODULE I **INTRODUCTION TO CELL** **15**

Discovery of cells-a brief history: Cell Theory; Basic properties of cell, Different classes of cell: Prokaryotic and eukaryotic cell; Chemical basis of life, Water, inorganic and organic constituents, covalent and non covalent bonds, basic composition of cells-biomolecules.

MODULE II **CELL MEMBRANE** **15**

Structure and function of plasma membrane, Transport of substances through cell membrane- osmosis, diffusion and its types, Active transport (sodium pump) and passive transport; membrane potential, measuring membrane potential, ion channels- Na^+ and K^+ channels, action potential and nerve impulse.

MODULE III **CELL ORGANELLE** **15**

Nucleus-structure and function, concept of chromosomes; Mitochondria, Chloroplast- photosynthesis, Endoplasmic reticulum, Golgi apparatus, lysosome, Membrane transport- exocytosis and endocytosis.

MODULE IV **CYTOSKELETON** **15**

Eukaryotic cytoskeleton structures- intermediate filaments and their role in organelle movements, microtubules- tubulin, centrosome structure, actin filaments, muscle contraction. Prokaryotic cytoskeleton - FtsZ - MreB- ParM - Crescentin.

TOTAL HOURS – 60

TEXT BOOKS:

1. Lodish H. F.Cell and Molecular Biology. W.H. Freeman & Co Ltd, 2000.

2. Cooper G. M. Cell: a Molecular Approach.Sinauerassociates,USA, 2000.
3. Lewin B. Gene VIII. Prentice Hall, USA 2003.

REFERENCES:

1. Molecular Biology of Cell by Alberts et.al. John Wiley & Sons, 6th Ed, 2015.
2. Cell and Molecular Biology by Karp. John Wiley & Sons, 7th Ed, 2013.

OUTCOMES:

At the end of the course the students will be able to

- Describe the fundamental principles cellular biology
- Apply the knowledge to current biological questions of today
- Develop a deeper understanding of cell structure, functions and how it relates to other cellular components
- Understand the regulatory mechanisms that enable diversity and dynamics of cellular components and how it is accomplished
- Analyze how cells grow, divide, and die and how these important processes are being regulated.
- Discriminate molecular mechanisms and signaling molecules between the organelles

BTC1213	MICROBIOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- Describe how microorganisms are used as model systems to study basic biology, genetics, metabolism, and ecology.
- Identify ways microorganisms play an integral role in disease and microbial and immunological methodologies are used in disease treatment and prevention.
- To provide an introduction to the science of microbiology, particularly medical microbiology, to the student with both limited background in the biological sciences and limited interest in pursuing this field further.
- To provide concepts of microbial metabolism, growth, and control of microbes.
- Describe the opportunity available in applied & industrial microbiology through the different applications.
- To instill practical skills about methods of isolation, characterization, and control of
- Microbes and familiarize with the fundamental aspect of the cellular characteristics.

MODULE I **MICROBES AND FUNCTIONAL ANATOMY** **12**

Types of microorganisms. Brief history of microbiology. Microbes& human warfare. Microbes & human disease, Classification of microorganism and methods of classifying and identification of microorganism. Size, shape, and arrangement of bacterial cells. Structures external to cell wall, structures internal to cell wall.

MODULE II **OBSERVING MICROORGANISMS THROUGH A MICROSCOPE** **8**

Types of Microscopy - Light Microscopy,Two-Photon Microscopy, Scanning Acoustic Microscopy, Electron Microscopy, Confocal Microscopy, Scanned-Probe Microscopy; Preparation of Specimens for Light Microscopy-Preparing Smears for Staining, Simple Stains, Differential Stains, Special Stains

MODULE III **VIRUSES, VIROIDS AND PRIONS** **10**

General Characteristics of Viruses -Host Range, Viral Size; Viral Structure - Nucleic Acid, Capsid and Envelope, General Morphology, Isolation, Cultivation, and Identification of Viruses - Growing Bacteriophages in the Laboratory, Growing Animal Viruses in the Laboratory, Viral Identification;

Viral Multiplication- Multiplication of Bacteriophages, Multiplication of Animal Viruses; Prions- Plant Viruses and Viroids.

MODULE IV **MICROBIAL METABOLISM, GROWTH AND CONTROL** **10**

Microbial metabolism and Biochemical Tests and Bacterial Identification; Growth requirements, culture media, obtaining pure cultures and preservation of cultures, growth of bacterial cultures, Control of Microbial Growth, Action of microbial control agents, physical and chemical methods of microbial control.

MODULE V **APPLIED & INDUSTRIAL MICROBIOLOGY** **10**

Food Microbiology- Foods and Disease, Industrial Food Canning, Aseptic Packaging, Radiation and Industrial Food Preservation, High-Pressure Food Preservation, The Role of Microorganisms in Food Production; Industrial Microbiology Fermentation Technology, Industrial Products, Alternative Energy Sources Using Microorganisms, Biofuels, Industrial Microbiology and the Future.

MODULE VI **MICROBIAL GENETICS** **10**

Recent advances in molecular genetics of viruses and bacteria. The Regulation of Bacterial Gene Expression-Pre-transcriptional Control and Post-transcriptional Control; Genetic Transfer and Recombination-Transformation in Bacteria, Conjugation in Bacteria, Transduction in Bacteria, Plasmids and Transposons.

TOTAL HOURS – 60

TEXT BOOKS:

1. Microbiology: An Introduction: Tortora, Funke & Case. 7th edition, 2001
2. Microbiology: Davis, Dulbecco, Eisen and Ginsburg.
3. Introduction to Microbiology: Ross
4. General Microbiology: Stainier, Adelberq and Ingraham

OUTCOMES:

At the end of the course the students will be able to

- Demonstrate a broad understanding of the diversity and range of microorganisms, the interactions between humans and microorganisms, the role of microorganisms in industrial and environmental processes, and their role in the development of the techniques that underpin modern molecular biology
- Demonstrate proficiency in a set of core microbiological and molecular biological technical methods, including both an understanding of the principles of the methods and their utilisation in laboratory settings

- Demonstrate familiarity with the risk assessment process, and use this information to operate safely in the laboratory environment
- Collect, organise, analyse, evaluate and interpret experimental data using appropriate quantitative, technological and critical thinking skills
- Critically evaluate relevant scientific data and literature and comprehend the nature and scope of the scientific literature in microbiology and related areas
- Communicate microbiological principles and information effectively to diverse audiences, using a variety of formats

BTC1214	BIOCHEMISTRY – LAB	L	T	P	C
		0	0	4	2

OBJECTIVES:

The students should be able to understand and develop their skills in

- Accuracy and Precession of analysis
- Qualitative testing of Carbohydrates
- Identification of amino acids and proteins
- Quantitative analysis of nucleic acids and enzymes.

LIST OF EXPERIMENTS

1. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
2. pH measurements and preparation of buffers.
3. Determination of Wavelength maximum and concentration of a given solution.
2. Qualitative tests for Carbohydrates.
3. Quantitative estimation of reducing sugars.
4. Estimation of proteins by Lowry's method.
5. Estimation of cholesterol by Zak's method.
6. Estimation of Urea by DAM Method.
7. Determination of saponification number of lipids.
8. Estimation of Amino acids.
9. Separation of amino acids - thin layer chromatography.
10. Separation of sugars - Paper chromatography
11. Biochemical estimation of DNA /RNA using Spectrophotometer

TOTAL HOURS – 30

BOOKS:

Laboratory Manual

OUTCOMES

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

- Understand the properties of biomolecules and their importance in biological systems
- Develop competence in handing various spectrometric techniques and apply them to characterizing different biological molecules.
- Demonstrate the concepts in preparation of solutions and buffers
- Analyze the error, repeatability, precision, and accuracy in biomolecules analysis
- Design a strategy on biochemical techniques for the wellbeing of human
- Apply the knowledge in biochemistry to learn latest advanced techniques for the growth of their career.

BTC1215	CELL BIOLOGY LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- Provides an opportunity to experimentally verify the theoretical concepts already studied.
- It also helps in understanding the theoretical principles in a more explicit and concentrated manner.
- The students should be able to understand explicitly the concepts
- Develop their skills in the preparation and identification of cell structures and their functions.

LIST OF EXPERIMENTS

1. Microscope and its working principle
2. Microscopic study of cell diversity
3. Osmosis in onion
4. Fixation and Staining of blood cells: Blood cell morphology
5. Buccal smearing and Barr body identification
6. Mitosis in onion root tips
7. Isolation of Mitochondria
8. Nuclear staining

Total Hours-30

REFERENCE BOOK

Laboratory Manual

OUTCOMES

On the completion of the above objectives' the student will be able to perform

- Understand the basic lab protocol, instruments including microscopes.
- Apply the knowledge to realize the structure and physiology of cells
- Relate the mitotic division and osmosis using various models
- Demonstrate the isolation protocol for mitochondria and nucleus
- Plan a staining protocol for sub-cellular organelles.
- Apply the techniques to study the structure and functions of cells and other biological systems.

BTC1216 MICROBIOLOGY LABORATORY

L	T	P	C
0	0	3	1

OBJECTIVES:

OBJECTIVES

The students should be able to

1. Understand explicitly the concepts
2. Develop their skills in the preparation, identification, and quantification of microorganisms

LIST OF EXPERIMENTS

1. Sterilization techniques
2. Media preparation (solid and liquid)
3. Isolation, enumeration, and purification of microbes from a given sample
4. Staining Techniques (Gram staining, spore staining)
5. Motility test by Hanging drop method
6. Biochemical Characterization of Bacteria Oxidation/Fermentation Test
7. Biochemical Characterization of Bacteria Catalase, Oxidase and Urease Tests
8. Biochemical Characterization of Bacteria- IMViC test
9. Biochemical Characterization of Bacteria- Hydrogen Sulfide Test
10. Biochemical Characterization of Bacteria - Nitrate Reduction Test.
11. Biochemical Characterization of Bacteria - Casein and Starch Hydrolysis
12. Antibiotic Assay - Antimicrobial Sensitivity Test (Disc Diffusion Method)
13. Growth Kinetics (Bacterial Growth Curve)
14. Isolation of antibiotics producing bacteria
15. Isolation and characterization of plant microbes

TOTAL HOURS – 30

REFERENCE BOOK

1. Laboratory Exercises in Microbiology, Fifth Edition by Harley−Prescott, The McGraw−Hill Companies, 2002
2. Lab manual

OUTCOME

Students will learn about

- Basic methods in microbiology
- Characterization and isolation of bacteria isolated from various sources
- Growth kinetics of Bacteria

- Antimicrobial assays
- Isolation and characterization of plant microbes
- Media preparation

SEMESTER III

		L	T	P	C
BTC2101	**ENZYME TECHNOLOGY**	**4**	**0**	**0**	**4**

OBJECTIVES:

- To understand structure and basic concepts related to enzymes.
- To understand the enzyme functional activity.
- To understand the diverse nature of enzyme based on mechanism of catalysis.
- To learn the strategies needed to purify enzymes for industrial use
- To gain knowledge for use of enzymes for welfare of society
- To gain knowledge about instrumentation used in enzymology.

MODULE I INTRODUCTION TO ENZYMES 12

The Enzyme- Introduction-- Distinct features of Enzymes, Characteristics of Enzyme Catalysis, Specificity of Enzyme action- The active site-General features and regulation, Hypothesis and Models for Enzyme Substrate action. Enzyme classification and Nomenclature

MODULE II ENZYME KINETICS 12

Enzyme kinetics-Michaelis-Menten equation- Brigg's-Haldane steady state hypothesis & estimation of constants using graphical technique, Lineweaver Burk Plot-Kinetics for reversible reactions-basics of enzymatic reaction-collision theory and transition state theory and role of entropy in catalysis- Enzyme inhibition-Competitive, Uncompetitive and Mixed. Effect of pH and temperature on Enzyme action, Bisubstrate reactions

MODULE III CHEMICAL NATURE OF ENZYME CATALYSIS 08

Mechanisms of catalysis- Acid base catalysis- Electrostatic catalysis- Covalent catalysis- Proximity and Orientation effects, Enzyme catalysis- Mechanisms of reactions catalyzed by enzymes without cofactors- Metal activated enzymes and metalloenzymes. Mechanism of Reactions catalyzed by Ribonuclease, carbonic anhydrase, Lysozyme, Triose phosphate Isomerase and Lactate dehydrogenase, Involvement of Coenzymes in enzyme catalyzed reactions.

MODULE IV EXTRACTION OF ENZYMES AND ASSAY 08

The extraction of soluble enzymes, Membrane bound Enzymes, nature of extraction medium. Purification of Enzymes by analytical techniques, Criteria of Purity, Determination of Molecular Weight of Enzymes. Enzyme assay- Introduction, Enzyme assay by kinetic determination of catalytic activity, Coupled kinetic assays, Radioimmunoassay (RIA) of enzymes, Investigation of sub-cellular compartmentation of enzyme, and enzyme histochemistry

MODULE V APPLICATIONS OF ENZYMATIC CATALYSIS 10

Applications in Medicine- Assay of Plasma Enzymes, Enzymes in Inborn errors in metabolism, Application of enzymes in food industry, Forensic Science and others Large-scale production and purification of enzymes, Synthesis of artificial enzymes, Immobilization of enzymes, its preparation, properties and applications.

MODULE VI INSTRUMENTAL TECHNIQUES USED IN ENZYME CATALYSIS 10

Principles of – Manometry – Spectrophotometry – Spectro fluorimetry – Electrochemical methods – Enthalpimetry – Radio chemical methods – Automation in enzymatic analysis.

TOTAL HOURS – 60

TEXT BOOKS:

1.Trevor Palmer , Enzymes IInd Horwood Publishing Ltd

2. Enzymes by Robert A. Copeland, 2nd edition.

REFERENCES:

1. Biochemical Engineering by Harwey W. Blanch and Douglas S. Clark

2. Wiseman, Enzyme Biotechnology, Ellis Horwood Pub.

OUTCOMES:

- Understand the fundamentals of enzyme properties and distinguish based on reaction mechanism
- Apply biochemical calculation and plot graphs for enzyme kinetics
- Compare methods for production, purification, characterization, and immobilization of enzymes
- Understand various application of enzymes that can benefit human life

- Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.
- Understand the basic principles and concepts related to instrumentation in enzyme catalysis

BTC2102	FUNDAMENTALS OF CHEMICAL ENGINEERING	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To refresh and strengthen the concept of units used in chemical engineering and conversion from one system of units to another.
- To provide insight on the behavior of ideal gas behavior and applications of gas laws.
- To introduce the concept of material flow in an industry.
- To emphasize the significance of energy, energy flow and its significance in industries.
- To highlight the types of fluid and its behavior
- To introduce basic calculations involved in chemical reactions.

MODULE I BASIC CHEMICAL CALCULATIONS 12

Units and dimensions, Systems of Unit, Conversion from one unit system to another, basic/fundamental units, multiple units, derived units, Dimensional Homogeneity, Significant figures, concept of mass, volume and concentration, composition of mixtures and solutions- solids, liquids and gases - mass fraction, mole fraction, mass %, mole %, density, specific gravity, ppm ,molarity, molarity and normality, flow rate –mass, volumetric and molal, Determination of molecular mass of a mixture, Pressure measurements- atmospheric pressure, absolute pressure, gauge pressure, temperature scale- conversion from one temperature scale to another scale.

MODULE II BASIC CONCEPTS OF GASES AND GASEOUS MIXTURE 12

Ideal gas, Ideal gas equation, mixture of ideal gases- partial pressure- Dalton's law, Amagat's law, average molecular weight of gaseous mixtures, real gases, van der Waals equation, compressibility factor, vapour pressure, Vapour liquid equilibria, Humidity, Humidity chart, Psychrometer.

MODULE III MATERIAL BALANCE 12

Unit operations and process, Classification and Types of system, Conservation of mass/material, Concept of Degree of freedom, Concept of material balance in different systems, Chemical reactions, Stoichiometry, material balance with chemical reactions, yield, selectivity, percent conversion, specificity, recycle , bypass and purge operations.

MODULE IV ENERGY BALANCE 12

Law of conservation of energy, components of energy balance equation- Heat, work, kinetic, potential energy, enthalpy, internal energy, heat capacity, steam tables and its application, concept of heat associated with physical process-Hess's

law, heat associated with chemical reactions, applications of energy balance in bioprocess.

MODULE V FLUID AND ITS PROPERTIES 06

Fluids, fluid flow, concept of viscosity, Newtonian and non-Newtonian fluid, Fluid flow in pipes- laminar, transient and turbulent, flow measurement-applications and devices, Transport of fluids- pumps and its types.

MODULE VI BASICS OF CHEMICAL REACTION KINETICS 06

Rate of a reaction, rate equation, order of a reaction, factors that affect rate of a reaction, methods to determine the rate equation, homogeneous and heterogeneous reactions, chemical reaction equilibrium, introduction to biochemical reactions and bioreactors.

Total Hours –60

TEXT BOOKS:

1. Stoichiometry and process calculations by KV Narayanan and B. Lakshmikutty, 2nd Edition,PHI Learning Pvt Ltd.

2. Basic principles & Calculations in Chemical engineering by David Himmelblau, 6th edition, PHI Learning Pvt Ltd.

3. Elementary Principles of Chemical Processes by Richard Felder, 3rd Edition, John Wiley & Sons, Inc.

REFERENCES:

1. Unit operations of chemical engineering, McCabe WL and JC Sonith and P Harriot, 6th edition, McGraw Hill 2001.

2. Transport process and Separation process principles, Geankoplis, 4th edition, PHI Learning Pvt Ltd.

OUTCOMES:

- To perform simple calculations using different unit systems, concentration, humidity, pressure and temperature
- To differentiate ideal gas and non-ideal gas behavior.
- To apply material balance calculations on simple systems
- To apply energy balance and can demonstrate the direction of flow of energy
- To identify and categorize the different types of fluid
- To determine the order and the rate of a chemical reaction.

BTC2103	MOLECULAR BIOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To develop an in-depth knowledge about the DNA replication process
- To conceptualize the types of DNA mutation and DNA damage repairing process
- To get a detailed idea about the transcription process
- To understand the protein synthesis by ribosomes
- To develop concepts about the Gene regulation mechanisms in prokaryotes and eukaryotes
- To get an overview of the basic molecular biology techniques

MODULE I **DNA REPLICATION** **10**

Prokaryotic and eukaryotic DNA replication, models of DNA replication – semi-conservative replication, mechanism of DNA polymerase, Semi-discontinuous replication, replication fork-DNA synthesis at replication fork, initiation, elongation and termination of replication, telomere, end replication problem and telomerase enzyme

MODULE II **MUTATION AND DNA REPAIR** **10**

Molecular basis of mutations, sources of mutation- replication error and chemical damage, transition and transversion, mutational hotspots, hydrolysis and deamination DNA repair mechanisms, light dependent repair, excision repair, mismatch repair, double strand break repair; homologous recombination and non-homologous end joining mechanism of DSB repair.

MODULE III **TRANSCRIPTION** **10**

RNA polymerases in prokaryote and eukaryote, types and function. Initiation, elongation and termination of transcription, promoters in prokaryotes and eukaryotes; Transcription of mRNA in Prokaryote and eukaryote – initiation, elongation and termination models. Post transcriptional processing of mRNA – G-capping, poly-A tail, RNA splicing (including different types).

MODULE IV **TRANSLATION** **10**

Genetic code and Wobble hypothesis. Translation in prokaryote and eukaryote. Translation- codons, ribosomal assembly, initiation, elongation and termination, ribosomal cycle, Post translational modifications.

MODULE V **REGULATION OF GENE EXPRESSION** **10**

Operon system, Constitutive and non-constitutive, Inducible operon, Positive and negative regulation, regulation of inducible system, regulation of repressible system, Lac operon,operator, inducer and catabolite repression, cAMP regulation, regulation in Eukaryotes; Trp Operon, repression and attenuation, organization of trp operon

MODULE VI **TOOLS IN MOLECULAR BIOLOGY** **10**

Isolation of nucleic acids- gel electrophoresis, restriction endonucleases-properties, restriction mapping, Nucleic acid hybridization, Southern blot, Northern blot, microarray, DNA fingerprinting, DNA sequencing and Physical mapping-Sanger sequencing, automated DNA sequencing, High-through sequencing

Total Hours – 60

TEXT BOOKS:

Molecular Biology of the Gene. James D Watson, 7Ed. Cold Spring Harbor Laboratory Press. 2014

Molecular Biology. Robert F Weaver, 5Ed, McGraw Hill, 2013

REFERENCES:

Molecular Biotechnology. Glick and Pasternak, 4Ed, ASM Press, 2010

OUTCOMES:

- The students should be able to understand the replication machinery
- To explore the DNA mutation and the repair mechanism in understanding diseases
- To explore the mechanism and functions of different enzymes and proteins involved in transcription
- To understand the mechanism of translation and post-translational events
- To understand the mechanisms of gene expression regulation
- To understand and apply the basic molecular biology techniques

BTC2104	BASIC BIOANALYTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand structure and basic concepts of spectroscopic techniques.
- To understand the process of different electrophoresis techniques.
- To understand the different ways of chromatography process.
- To learn the strategies needed to centrifugation techniques.
- To gain knowledge for use of different types of microscopes.
- To gain knowledge about basics about the radioisotope techniques.

MODULE I **CALORIMETRY AND SPECTROSCOPY** **8**

Properties of electromagnetic radiations, interaction with matter. Ultraviolet and visible light spectroscopy: beer lamberts law, chromophore, principles, Instrumentation. Spectroflourometry, principles and instrumentation, applications, circular dischroism spectroscopy, principles instrumentation and applications.

MODULE II **ELECTROPHORESIS** **8**

General principle, support media.Agarose gels, polyacrylamide gelsSDS PAGE. Electrophoresis of proteins, native gels, gradient gels, isoelectric focusing gels, 2D PAGE, protein (western) blotting, Electrophoresis of nucleic acid

MODULE III **CHROMATOGRAPHY** **8**

Introduction: Chromatography theory and practice. Paper chromatography. Thin layer chromatography. Ion exchange chromatography.Affinity chromatography. Gel filtration chromatography. Adsorption chromatography.Introduction to gas chromatography and HPLC.Permeation.

MODULE IV **CENTRIFUGATION** **7**

Principle of centrifugation, different types of centrifuges, small bench centrifuges, large capacity bench centrifuges, large capacity refrigerated centrifuges, high speed refrigerated centrifuges, continuous flow centrifuges, preparative ultracentrifuges, analytical centrifuges, different types of rotors.

MODULE V **MICROSCOPY** **7**

Simple theory of microscopy, parts of microscope, adjusting a microscope, dark-filed microscopy, phase contrast microscopy, fluorescence microscopy, electron microscopy, methods of preparing samples.

MODULE VI **RADIOISOTOPE TECHNIQUES** **7**

Study of radioisotopes in biological samples, proportional and GM counter, scintillation counters, autoradiography, radio –immunoassay

Total Hours –45

TEXT BOOKS:

1. Pierre C. ORD and CD in chemistry and biochemistry: An Introduction. Academic Press, 1972.
2. Paddock S. W. Confocal Microscopy methods & protocols.1st Ed., Human Press, 1999.

REFERENCES:

Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st Ed., Wiley-Liss, 2001.

OUTCOMES:

- Understand the fundamentals of spectroscopic techniques to study different properties of biomolecules.
- Apply methods for purification to find out the purity and size of biomolecules.
- Compare different methods for identification and purification of the biomolecules.
- Understand various application of separating biomolecules on the basis of size and density.
- Discover the current and future trends of different microscopic techniques.
- Understand the basic principles and concepts related to radioisotope techniques.

BTC2105	MOLECULAR BIOLOGY LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To acquire basic understanding for the isolation of DNA from bacterial cell
- To learn techniques for the isolation of Plasmid DNA from bacterial cell
- To acquire basic understanding of techniques for the Quantification of nucleic acid by using the spectrophotometric method
- To learn techniques for the isolation of RNA from bacterial cell
- To study and to differentiate the electrochemical properties of nucleic acids

MODULE I

Agarose gel electrophoresis of chromosomal & plasmid DNA

Extraction of genomic DNA from bacteria

Extraction of plasmid DNA from bacteria

Extraction of genomic DNA from yeast cells

Isolation of RNA from bacteria

Isolation of DNA fragment from agarose gel

Total Hours –30

TEXT BOOKS AND REFERENCES:

1. Michel R. G and Sambrook J. Molecular Coning- A laboratory manual. Cold spring harbor laboratory press, 2012.

OUTCOMES:

On completion of the course students will able to

- Understand the fundamental principles of genomic DNA isolation and demonstrate their practical applications
- Demonstrate the fundamental principles of plasmid DNA isolation and their practical applications
- Analyze the quality of the nucleic acid
- Criticize the RNA isolation techniques
- Analyze the quantity of the nucleic acid
- Develop project management skills, ensure good coordination and consider various environmental factors, adhere to molecular biology ethics, and address monetary issues

BTC2106	ENZYME TECHNOLOGY LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To understand the basics of the enzyme, its function, and the factors which affect its kinetic properties
- To know the steps involved in the calculation of enzyme kinetics parameters.
- Students will develop their skills to classify their knowledge about the classification of enzymes and their role
- Carry out enzyme immobilization.

MODULE I

1. Isolation and Screening of amylase producing microorganisms from soil and saliva
2. Construction of Protein standard curve by Folin's Lowry method and Determination of specific activity of enzyme.
3. Effect of substrate concentration on Enzyme kinetics and determination of Km and Vmax
4. Effect of temperature on Enzyme kinetics
5. Effect of time on Enzyme kinetics
6. Effect of pH on Enzyme kinetics

Total Hours –30

TEXT BOOKS AND REFERENCES

1. Bioctalaysis and Enzyme Technology by Klaus Buchholz, Volker Kasche, and Uwe T. Bornscheuer.

OUTCOMES:

- Students will be able to understand the fundamentals of enzymes and their role.
- Students will be familiar with the techniques involved in factors affecting enzyme kinetics.
- Insight into details of enzyme kinetics
- Students will be familiar with immobilization techniques and its application.
- Give an account of important enzymatic industrial processes
- Familiarize with enzyme immobilization techniques

BTC2107	BIOANALYTICAL TECHNIQUES LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To expose the students to various biological techniques and their applications
- To develop the skills to understand the theory and practice of bio analytical techniques
- To provide scientific understanding of analytical techniques and detail interpretation of results.
- To bridge the gap between academics, research and industry

MODULE I

1. Preparation of buffers (acetate and PBS buffer).
2. To check the purity of proteins using SDS PAGE.
3. To find out the concentration of unknown protein using absorption techniques.
4. To see the effect of different denaturant in protein by absorption spectroscopy.
5. purification of proteins using affinity chromatography.
6. purification of carbohydrates by paper chromatography.
7. Purification of amino acids using Thin layer chromatography.

Total Hours –30

TEXT BOOKS:

1. Lab Manual

OUTCOMES:

At the end of this course students will be able to

- Understand the basic principles of different bioanalytical techniques
- Apply introductory analytical techniques for quantifying chemical concentrations
- Apply the analytical methods in biotechnology industries
- Understand the strengths, limitations and creative use of techniques for problem-solving.
- Make a strategy on molecular techniques for the improvement in any trait or its wellbeing based on the techniques
- Practice the knowledge for designing research project and execute it.

SEMESTER IV

BTC2211	GENETIC ENGINEERING	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To learn about the classical mendelian genetics and basic principles related to genetics.
- To know about the applications of mendelian genetics
- To acquire basic understanding of techniques in genetic engineering.
- To acquire basic understanding of applications of genetic engineering in human health and disease.
- To acquire basic understanding of creation of transgenic animals and plants
- To acquire basic understanding of transposable genetic elements.

MODULE I **MENDELIAN GENETICS** **14**

Introduction to genetics, Mendel's experiment-monohybrid and dihybrid cross, Test cross and back cross, Concept of alleles and allelic variation-incomplete dominance and codominance, ABO blood group system, chromosomal theory of inheritance, sex linkage, non disjunction, hemophilia, colour-blindness

MODULE II **APPLICATIONS OF MENDELIAN GENETICS** **14**

Punnett square method and Fork line method of gene heritance, Probablity method of gene heritance, Multiplicative and additive rule, Pedigree analysis, Mendelian segregation in human, Genetic counseling

MODULE III **BASIC TECHNIQUES IN GENETIC ENGINEERING** **10**

Polymerase Chain Reaction – its applications; Molecular cloning, vectors - plasmid, viral and artificial chromosomes, Human genome project.

MODULE IV **APPLICATION OF MOLECULAR GENETICS** **12**

Diagnosis of Huntigton's disease, Diagnosis of Sickle cell anemia, Gene therapy- somatic cell gene therapy, Vectors for gene therapy, Retroviral, Lentiviral and adenoviral vectors Reverse Genetics-Gene knockouts, RNA interference (RNAi) - miRNA, siRNA

MODULE V **TRANSGENIC ANIMALS AND PLANTS** **08**

Generation of transgenic mouse models – microinjection method and transfection to Embryonic cells method, applications of transgenic animal

models; generation of transgenic plants, Agrobacterium mediated transgenic plants, Ti plasmid, T DNA, Vir gene, applications of transgenic plants

MODULE VI TRANSPOSABLE GENETIC ELEMENT 04

Introduction, Transposable element in bacteria, IS elements, Composite transpososns, Tn3 elements, Transposons in eukaryotes, Drosophila P elements, hybrid dysgenesis, applications in drosophila genetics, Retrotransposons, Transposable element in humans

Total Hours –60

REFERENCES:

1. Concepts of Genetics, Klug & Cummings, Prientice Hall.
2. Molecular Cloning, Moniatisetal, Cold Spring Harbor Laboratory

OUTCOMES:

On completion of the course

- The students will acquire knowledge on the concepts and terminology in classical and non-classical genetics.
- The students will be familiar with basics of inheritance pattern in individuals, pedigree analysis, etc.
- The students will be familiar with various cloning strategies in prokaryotes as well as in eukaryotes.
- The students will learn various techniques in genetic engineering, especially PCR.
- They will also get awareness about the social and ethical issues concerning cloning by genetic engineering by gene therapy, transgenic plants, and animals.
- They will acquire knowledge about the mobile genetic elements and its consequences in animals and plants.

BTC2212 **IMMUNOTECHNOLOGY** **L T P C**
4 0 0 4

OBJECTIVES:

- An understanding of immunity types, inflammatory and compliment pathways.
- To acquire knowledge on the immune organs and immune cells of the immune system.
- An understanding of essential features of antigens and antibodies and their types.
- To provide knowledge on antibody production and their applications.
- Gain Knowledge on the concepts of hypersensitivity, auto immunity, transplantation immunology and cancer immunology.
- To provide knowledge on immune deficiencies and several immunological techniques.

MODULE I **INTRODUCTION TO IMMUNE SYSTEM** **10**

General concepts of the immune system, Innate and acquired immunity, active and passive immunity, humoral and cell mediated immunity, Inflammation-basic concept, components, functions and properties. Complement System.

MODULE II **CELLS & TISSUES OF IMMUNE SYSTEM** **10**

Hematopoeisis, T and B-lymphocytes, antigen presenting cells, Natural killer cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils, Mast Cells, Dendritic Cell, Organs of the Immune System, Bone marrow, Thymus, Lymph node, Spleen, CALT, MALT.

MODULE III **ANTIGEN AND ANTIBODY** **10**

Antigens:Different characteristics of antigens (foreignness, molecular size, heterogeneity), epitope, Hapten,immunogen,,adjuvants. Antibody:Molecular structure of antibody, Classification, Isotypes, Synthesis assembly and expression of immunoglobulin molecules, Antigen-antibody interaction.

MODULE IV **INTRODUCTION TO ANTIBODY ENGINEERING** **10**

Definitions of chimeric and hybrid monoclonal antibodies, Hybridoma technology: - Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their application.

MODULE V **IMMUNE SYSTEM IN HEALTH AND DISEASE** **10**

Autoimmunity, hypersensitivity,Transplantation immunology: Types of grafts, immunologic basis of graft rejection, properties and types of rejection, immunosuppressive therapy and transplants to immunologically privileged sites, Tumor immunity- tumor antigens (TSTA and TAA), immune response to tumors. Tumor evasion of the immune system.Immunotherapy for tumors.Synthetic vaccines.

MODULE VI **IMMUNOLOGICAL TECHNIQUES** **10**

Immunological principles of various reactions and techniques: Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, rocket immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, ELISPOT assay), DOT ELISA, immunoblotting, immunofluorescence, flow cytometry and fluorescence, and immunoelectron microscopy.

Total Hours –60

TEXT BOOKS

1. Immunology – an Introduction by Tizard, Thomson.
2. Immunology by J Kuby, WH Freeman.
3. Immunology & Immunotechnology by Ashim K Chakravarthy, Oxford University Press.
4. Immundiagnostics by S C Rastogi, New Age International

REFERENCES:

1. Essential Immunology by Roitt I. Blackwell Scientific Publications, Oxford.
2. Molecular Immunology By Benjamini E.
3. Immunology a short course by Benjamini E. and Leskowitz S. Wiley Liss.
4. The Immune System by Peter Parham, Garland Science.
5. Understanding Immunology by Peter Wood, Pearson Education.

OUTCOMES:

- Understand various components of immune system, compare the key mechanism of innate and adaptive immunity.
- Compare various cellular and soluble components of the immune syste
- Develop knowledge of different types of antigens, antibodies and their specificity.

- Apply knowledge on antibody production and their biological applicatior diagnostic and in medicine.

- Understand various immune disorders and their complications.

- Apply knowledge of immunological techniques to identify and character unknown antigen in disease diagnosis.

BTC2213	CHEMICAL AND BIOTHERMODYNAMICS	L	T	P	C
		4	0	0	4

OBJECTIVES:

The course aims at making the students understand the fundamental principles and concepts of chemical and bio thermodynamics.

MODULE I THERMODYNAMIC PROPERTIES OF FLUIDS 10

Volumetric properties of fluids exhibiting non ideal behavior – Residual properties – Estimation of thermodynamic properties using equations of state – Calculations involving actual property exchanges – Maxwell's relations and applications.

MODULE II SOLUTION THERMODYNAMICS 10

Partial molar properties – Concepts of chemical potential and fugacity – Ideal and non-ideal solutions – Concepts and applications of excess properties of mixtures – Activity coefficient – Composition models – Gibbs Duhem equation.

MODULE III PHASE EQUILIBRIA 10

Criteria for phase equilibria – VLE calculations for binary and multi component systems – Liquid-liquid equilibria (LLE) and solid-solid equilibria (SLE).

MODULE IV CHEMICAL REACTION EQUILIBRIA 10

Equilibrium criteria for homogeneous chemical reactions – Evaluation of equilibrium constant – Effect of temperature and pressure on equilibrium constant – Calculation of equilibrium conversion and yields for single and multiple reactions.

MODULE V THERMODYNAMIC ANALYSIS OF PROCESSES 10

Concept of lost work – Entropy generation – Calculation of real irreversible processes – Power cycle – Liquefaction.

MODULE VI BIOCHEMICAL THERMODYNAMICS 10

Energetics of metabolic pathways energy coupling (ATP and NADH), stoichiometric and energetic analysis of cell growth and product formationelemental balances, degree of reduction concepts-available – electron balance, yield coefficients, oxygen consumption and heat evolution in aerobic cultures, thermodynamics efficiency of growth.

Total Hours –60

TEXT BOOKS:

1. Smith, J.M., Van Ness H.C. and Abbott M., “Introduction to Chemical Engineering Thermodynamics”, 6th Edition, Tata McGraw- Hill, 2001.

2. Narayanan, K.V., “A Text Book of Chemical Engineering Thermodynamics”, Prentice Hall India, 2001.

3. Sandler, S.I., “Chemical, Biochemical and Engineering Thermodynamics”, 4th Edition, John Wiley and Sons Inc., 2006.

4. Haynie, D.T., “Biological Thermodynamics”, 2nd Edition, Cambridge University Press, 2008.

5. Nicholls, D.G. and Ferquson, S.J., “Bioenergetics 3”, 2nd Edition, Elsevier Science Ltd., 2002.

OUTCOMES:

At the end of the course the students will

- Understand the thermodynamic properties of fluids
- Apply the concept of solution thermodynamics to solve problems
- Understand the criteria for attaining phase equilibria
- Understand the criteria for criteria for homogeneous chemical reactions

- Develop analysis of thermodynamic process
- Understand biochemical thermodynamics

BTC2214	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The purpose of the course is to provide training in the science behind
- plant biotechnology
- Students can learn the techniques in manipulating the plant cells
- An appreciation of the current scope and limits to its industrial application, and the implications of modern methods of genetic modification for plant industries
- Students learnt the methods of preserving the germplasm.
- Learn the basics of animal cell culture and in the culture the cells in the laboratory
- Also, the main mechanism of cell, tissues, organs and apparatus
- functionality and the current methods of animal cell culture and its application in research

MODULE I **INTRODUCTION TO PLANT TISSUE CULTURE** **06**

Introduction, History, Applications of Plant tissue culture, Laboratory facilities and operations, Nutrition medium composition and preparation, Sterilization Techniques and Types of culture.

MODULE II **MICROPROPAGATION, INVITRO PRODUCTION OF HAPLOIDS AND SOMATIC HYBRIDIZATION** **08**

Micro propagation techniques- different methods, advantages and disadvantages. Haploid plants -generation, significance, method, advantage disadvantage. Protoplast preparation, isolation, purification, viability and culturing, somatic hybridization- techniques, methods to screen, methods of verification/ characterisation. Advantage and disadvantage; Somatic hybridization Applications.

MODULE III **TRANSGENICS FOR CROP IMPROVEMENT AND METABOLITE PRODUCTION** **09**

Transgenic plant generation, Agrobacterium infection-Ti and Ri plasmid, plant vectors, methods of gene transfer, selection and screening, transgenics in crop improvement, terminator seed technology, transgenics in molecular farming, Cell suspension culture, secondary metabolite production, selection of high yielding line, Molecular farming.

MODULE IV **SOMACLONAL VARIATION, GERMPLASM STRORAGE AND CRYOPRESERVATION** **06**

Somaclonal variation - method, applications, advantages and disadvantage, causes; germ plasm storage- in situ and ex situ, cryopreservation, slow growth method.

MODULE V **08**

INTRODUCTION TO ANIMAL TISSUE CULTURE, MEDIA AND CRYOPRESERVATION OF ANIMAL CELLS

Background, Advantages, Limitations, Application, Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation. Planning, Construction, Layout, Essential Equipment's, Aseptic Technique, Objectives, Elements, Sterile Handling. Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum Free media, Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance. Need of Cryopreservation, Preservation, Cell banks, In Vitro Fertilization and Embryo Transfer: Composition of IVF media, Steps involved in IVF

MODULE VI **08**

TRANSGENIC ANIMALS AND GENE THERAPY

Methodology, Embryonic Stem Cell method, Microinjection method, Retroviral vector method, Applications of transgenic animals. Ex-vivo gene therapy, In vivo gene therapy, Viral gene delivery system, Retrovirus vector system, Adenovirus vector system, Adeno-Associated virus vector system, Herpex simplex virus vector system, Non-viral gene delivery system, Prodrug activation therapy, Nucleic acid therapeutic agents.

Total Hours –45

TEXT BOOKS:

An Introduction to Plant Biotechnology by H C Chawla Oxford and IBH 2002

Animal Cell Culture by John R.W. Masters Oxford University Press

OUTCOMES:

At the end of the course the students will acquire:

- An appreciation of the issues associated with growing and using transgenic plants as food crops.
- An understanding of the aims and needs of industrial enterprises using plant biotechnology techniques to develop new products.
- Apply biotechnological methods for basic research
- Apply bimolecular methods to veterinary pharmacology, to the design, correct use and traceability of medicines
- Apply reproduction methods with particular reference to gamete and embryo manipulation techniques, production of transgenic animals and cloning
- A capacity to undertake research in plant biotechnology and animal biotechnology

BTC2215	GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To learn the basic concepts for recombinant DNA preparation
- To gain practical knowledge of transformation of cells
- To learn differentiation of electrochemical properties of nucleic acids
- To gain practical knowledge to carry out nucleic acid digestion
- To gain practical knowledge of mutational analysis

List of Experiments

1. Preparation of competent cells
2. Transformation of bacterial cells using foreign DNA
3. Formaldehyde gel electrophoresis of nucleic acid
4. Restriction digestion of nucleic acid
5. UV mutation analysis

Total Hours –30

TEXT BOOKS:

Michel R. G and Sambrook J. Molecular Coning- A laboratory manual. Cold spring harbor laboratory press, 2012.

OUTCOMES:

- Understand the principles and basics of genetic engineering.
- Understand the basics of gene transfer methods and identify suitable hosts for cloning.
- Acquiring theoretical knowledge in the techniques, tools, application, and safety measures of genetic engineering.
- Describes the genome mapping and sequencing and methods for gene therapy.
- Acquire knowledge about DNA digestion techniques.
- Acquire knowledge of mutagenesis and its significance.

BTC2216 **IMMUNOLOGY LABORATORY** **L T P C**
0 0 3 1

OBJECTIVES:

- To develop a practical understanding of the components and functioning immune system.
- To introduce the students to immunological techniques.
- To provide students training in basic to advanced immunology techniques routinely applicable in clinical, laboratory or industrial settings.
- To develop the necessary skills to experimentally evaluate innate, humoral or cell mediated immune responses.
- To enable students to independently design and establish assays, using peripheral blood cells, cell lines or mouse-derived cells.
- To acquire skills for the interpretation of immunoassay and will be able to evaluate the usefulness of immunology in different clinical settings

List of Experiments

1. Blood grouping
2. Immunodiffusion, Immunoelectrophoresis.
3. Antigen-antibody reaction-Haemagglutination, precipitation-Widal and VDRL
4. Affinity chromatography for antibody purification.
5. ELISA-DOT and plate ELISA
6. Western blotting

Total Hours –30

REFERENCES:

1. Rose et al., Manual of Clinical laboratory Immunology, 6th Ed ASM

Publications, 2002.

2. Lefkovis and Pernis. Immunological methods. Academic Press, 1978.

3. Hudson L. and Hay F.C. Practical Immunology. Black Well publishers, 1989

OUTCOMES:

The students will

- Develop a practical understanding of the components and functioning immune system.
- Understanding of the principles to immunological techniques.
- Trained in basic to advanced immunology techniques routinely applicable in clinical, laboratory or industrial settings.
- develop the necessary skills to experimentally evaluate innate, humoral or cell mediated immune responses.
- Be enable to independently design and establish assays, using peripheral blood cells, cell lines or mouse-derived cells.
- Be able to acquire skills for the interpretation of immunoassay and will be able to evaluate the usefulness of immunology in different clinical settings

BTC2217	ANIMAL AND PLANT CELL CULTURE LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To introduce the students to the principles and applications of plant tissue culture and animal cell culture
- To design cell culture-based experiments and maintain cell lines
- To optimize the media based on the experiments
- To gain knowledge on the troubleshoots of cell culture methods
- To understand the advantages and disadvantages of cell culture as an *in vitro* mode

Experiments:

1. Introduction to animal cell culture lab
2. Animal cell culture media preparation
3. Subculturing of animal cells
4. Cell counting by hemocytometer
5. Cell viability study (trypan blue)
6. Cell viability study (mtt assay)
7. Plant tissue culture lab introduction
8. Tissue culture media preparation (liquid and solid)
9. Effect of sugar on the growth of root explant
10. Callus culture
11. Establishment of suspension culture

Total Hours –30

TEXT BOOKS:

1. Ian Freshney (2010) Culture of Animal Cells. J Wiley Publishers

2. Tarek Capiel. CELL AND TISSUE CULTURE Lab manual

OUTCOMES:

Upon completion of this course students should be able to

- Demonstrate knowledge of basic cells culture
- Optimize media specifically based on experiments
- Maintain cell lines with good viability and minimal contamination

- Design cell culture-based experiments and evaluate its constraints and possibilities as an *in vitro* model
- Define the various stages of micro-propagation, including morphogenesis
- Recognize and troubleshoot problems common to routine cell culture

SEMESTER V

		L	T	P	C
BTC3101	**PROTEIN ENGINEERING**	**4**	**0**	**0**	**4**

OBJECTIVES:

- To understand structure of proteins and their stability.
- To understand different types of post translational modification and their functions.
- To understand the protein production in different sources.
- To learn the techniques of different types of purification of proteins.
- To gain knowledge about the mutagenesis and their application.
- To gain knowledge about different enzymes and proteins used for industrial purpose.

MODULE I PROTEIN STRUCTURE AND ENGINEERING 10

Introduction, Overview of protein structure, Higher level structure, protein classification on the basis of structure, Protein structural stability, higher order structure prediction, protein folding, intrinsically disordered protein

MODULE II POST-TRANSLATIONAL MODIFICATION 10

Introduction: post translational modification, types of post translational derivatives, types of post translational reactions, chaperones involved post translational modification, biological functions of post translational modification: regulation, cross links, covalent cofactors, membrane anchors, other functions.

MODULE III PROTEIN SOURCES 10

Recombinant versus non-recombinant production, Heterologous protein production in E.coli, bacteria other than E.coli, yeast and fungi, proteins from plants, animal tissue as protein source, Heterologous protein production in transgenic animals, Heterologous protein production in using cell culture.

MODULE IV PROTEIN PURIFICATION AND CHARACTERIZATION 10

Protein detection and quantification, Initial recovery of protein, removal of whole cells and cell debris, Concentration, chromatographic purification, Protein inactivation and stabilization, protein characterization.

MODULE V DIRECTED MUTAGENESIS 10

Site-directed mutagenesis by traditional PCR, Site-directed mutagenesis by primer extension, Site-directed mutagenesis by inverse PCR, applications

MODULE VI **INDUSTRIAL ENZYMES AND THERAPEUTIC PROTEINS** **10**

Sources and engineering, environmental benefits, immobilized enzymes, extremophiles, enzymes in organic solvents, industrial enzymes: future use. Blood products, anticoagulants, thrombolytic agents, additional blood-related products, vaccine technology therapeutic enzymes.

Total Hours –60

TEXT BOOKS:

1. Proteins: Biochemistry and Biotechnology by Gary Walsh. (2002): John Wiley & Sons Ltd.
2. Proteins Analysis and Design. Ruth Hogue Angeletti, Albert Einstein College of Medicine of Yeshiva University Bronx, New York.

REFERENCES:

1. Protein Engineering in Industrial Biotechnology, Lilia Alberghina, harwood academic publishers.

OUTCOMES:

- Apply the knowledge of protein structure to predict the three-dimensional structure of protein.
- Apply the concept of protein modification to know their biological functions.
- Compare different methods to produce proteins in different organism.
- Analyze the purity and activity of the purified proteins.
- Understand the different function of mutagenesis in protein engineering.
- Understand the applications of therapeutic proteins and vaccine technology.

BTC3102	CHEMICAL REACTION ENGINEERING	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To impart knowledge to design different types of chemical reactors. Students gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

MODULE I REACTION KINETICS 10

Rate equation, elementary, non-elementary reactions, theories of reaction rate andtemperature dependency; Design equation for constant and variable volume batch reactors,analysis of experimental kinetics data, integral and differential analysis.

MODULE II DESIGN OF CONTINUOUS REACTORS 10

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors,combination of reactors, size comparison of reactors.

MODULE III MULTIPLE REACTIONS 9

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factorsaffecting choice, optimum yield and conversion, selectivity, reactivity and yield.

MODULE IV KINETICS OF COMPLEX REACTIONS 11

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchangesfor different reactors, design for constant rate input and constant heat transfer coefficient,operation of batch and continuous reactors, optimum temperature progression.

MODULE V RESIDENCE TIME DISTRIBUTION 10

The residence time distribution as a factor of performance; residence time functions andrelationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors.

MODULE VI CHEMICAL REACTOR DESIGN 10

Transient and steady state analysis, Optimal design of reactors, Multiphasereactors: fixed, fluidized, trickle bed, slurry etc, Non-ideal continuous flow reactors.

Total Hours – 60

TEXT BOOKS and REFERENCES:

1. Levenspiel O, “Chemical Reaction Engineering”, Wiley Eastern Ltd., IInd Edition, 2000.
2. Smith, J.M, “Chemical Engineering Kinetics”, McGraw Hill, IIIrd Edition, 1981.
3. Fogler.H.S., “Elements of Chemical Reaction Engineering”, Prentice Hall of India Ltd.,IIIrd Edition, 2000.
4. Froment. G.F. & K.B.Bischoff, “Chemical Reactor Analysis and Design”,John Wiley andSons, 1979

OUTCOMES:

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

- Develop rate laws for use in reactor design based on reaction data from a reactor or set of reactors.
- Make comparisons of ideal reactor types (batch, plug flow, mixed flow, etc.) and be able to determine the best choice for simple objectives when using a single reactor or a set of reactors.
- Predict reactor performance in situations where a reacting gas has a significantly changing density, including the case of variable pressure within an ideal plug flow reactor.
- Determine optimal ideal reactor design for multiple reactions for yield or selectivity.
- Predict reactor performance for reactors when the temperature is not uniform within the reactor.
- Predict reactor performance in situations where the observed reaction rate is significantly influenced by internal mass transfer in porous heterogeneous catalysis (the iso-thermal effectiveness factor).

BTC3107	CHEMCIAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- This laboratory course will reinforce the students' understanding of basic concepts pertaining to analyze kinetics for complex reactions using differential and integral methods.
- Batch reactor will be employed to analyze rate kinetics for isothermal and exothermic reactions. The tracer dynamics in reactors will be studied using Residence Time Distribution.
- Familiarize with suitable measurement techniques and devices to measure concentration and temperatureb. learn to employ various methods to determine the kinetics of reactionsc. quantify the effect of non-ideality of flow in chemical reactorsd. calculate the effects of mass transfer on chemical reactionse. predict errors in experimentation and compare experimental data with models

Experiments

1. Solvent extraction of Iodine using Hexane / Dichloromethane
2. Solvent extraction of iodine using Chloroform / Toulene
3. Separate acetone from the mixture of acetone and water by distillation
4. Retrieve ethanol, methanol, and water from its mixture by distillation. Confirm using iodoform and boric acid test.
5. Hydrolysis of ester (Ethylacetate)
6. Estimation and removal of hardness of water

Total Hours –30

TEXT BOOKS:

1. Lab Manual

OUTCOMES:

At the end of the course the students should:

- Understanding of basic concepts pertaining to analyze kinetics for complex reactions using differential and integral methods.
- Analyze rate kinetics for isothermal and exothermic reactions. The tracer dynamics in reactors will be studied using Residence Time Distribution.
- Compare with suitable measurement techniques and devices to measure concentration and temperature.
- Quantify the effect of non-ideality of flow in chemical reactors
- Calculate the effects of mass transfer on chemical reactions.
- Inspect errors in experimentation and compare experimental data with models.

BTC3109	PROTEIN ENGINEERING LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To understand the hydrolysis of proteins by different methods.
- To understand the presence of sulfhydryl groups in proteins.
- To understand the presence of cross linkers in proteins.
- To learn the techniques of proteins modifications.
- To gain knowledge about the cleavage of protein molecule with chemicals.
- To gain knowledge about protein digestion with enzymes

Experiments

1. To study the Acid hydrolysis of protein
2. To study Alkaline hydrolysis of Protein
3. Procedure for Quantitating Sulfhydryl Groups Using a Cysteine Standard using Ellmans reagent
4. Procedure for Quantitating Sulfhydryl Groups Based on Molar Absorptivity
5. Isolation of Proteins Cross-linked to DNA by Formaldehyde.
6. Modification of Arginine Side Chains with p-Hydroxyphenylglyoxal.
7. Chemical Cleavage of Proteins at Methionyl-X Peptide Bonds.
8. Enzymatic Digestion of Proteins in Solution and in SDS Polyacrylamide gel.

Total Hours –30

TEXT BOOKS:

1. Lab Manual

OUTCOMES:

Student will be able to:

- Apply the knowledge of protein hydrolysis to study the effects of different factors.
- Apply the concept disulphide bond present in the proteins and its application.
- Apply the knowledge of cross linker in protein to study the protein stability.
- Analyze the protein modification for different applications in engineering protein.
- Understand the method of protein cleavage using chemicals.
- Understand the applications of various enzymes which can digest proteins

SEMESTER VI

BTC3211	**STRUCTURAL BIOLOGY**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To understand the secondary structure of proteins.
- To understand the quaternary structure of proteins and their aggregates.
- To understand crystallographic techniques and to learn the basics of NMR.
- To learn the properties of crystal and the solutions of NMR techniques.
- To gain knowledge about oxygenation of hemoglobin and water network in crystal.
- To learn about different DNA binding domain and their structures.

MODULE I **STRUCTURAL STATES OF PROTEINS-I** **10**

chemical nature of polypeptide chains,Secondary structure,beta structure, collagen triple helix, higher structure determination, prediction of secondary structure, Domains and super secondary structures.

MODULE II **STRUCTURAL STATES OF PROTEINS -II** **10**

Association of protein subunits, helical or continuous protein polymers.thequaternary structure of closed aggregates,-oligomeric enzymes, biological implication of quaternary structure, surface accessibility.

MODULE III **CRYSTALLOGRAPHY** **10**

Diffraction methods, X-ray crystallography, crystallization, resolution, temperature factors, electron density maps, NMR methods for protein structure determination

MODULE IV **PROPERTIES OF MACROMOLECULES IN CRYSTALLINE STATE** **10**

Protein crystal, physical properties, chemistry of crystalline proteins, chemical reactivity, enzymatic and biological activities, crystal versus solution NMR studies, Crystallographic temperature factors, structural heterogeneity in protein crystals

MODULE V **Conformational States in Crystal and Nuclear MagneticResonance Structures** **10**

Comparison of two conformational states, Oxygenation of hemoglobin: two crystals conformation, Hydrogen Bonds and Water Molecules in Crystalline Proteins- hydrogen bonding positions in proteins, water molecules observed in crystalline proteins, the distribution of protein bound water, water network in crystalline proteins.

MODULE VI PROTEIN COMPLEXES 10

Structural data describing DNA, interaction between DNA and site-specific proteins, DNA-binding motifs, helix-turn-helix, leucine zipper. Functional reason for metal ion binding metalloproteins, membrane protein structure by electron microscopy and X ray methods

Total Hours –60

TEXT BOOKS:

1. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)

2. Foundations of Structural Biology by Leonard J. Banaszak (2000) Academic Press.

OUTCOMES:

At the end of this course, students will be able to

- Understand the way to predict the protein structure by the help of secondary structure information.
- Apply the concept of oligomers to find out the association between the units.
- Understand the process of crystallization and can analyze the NMR spectra to know the structure of biomolecules.
- Understand the different nature of proteins in different states, ie., crystal and solution.
- Understand various factors which affect oxygenation and deoxygenation of hemoglobin.
- Understand the role of different binding domains and their role in regulation of DNA.

BTC3212	BIOPROCESS ENGINEERING	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To provide the theoretical basis of bioprocess principles
- To introduce the student to the various mass and energy balances in bioprocess operations.
- To provide the integration of biochemistry, microbiology, cell biology and process engineering.
- To bring out the important and modern methods of bioprocess
- To exploit the potential of microorganisms and cells for various industrial applications.

MODULE I **INTRODUCTION TO ENGINEERING CALCULATION, PRESENTATIONS AND ANALYSIS OF DATA** **10**

Physical variables, dimensions, Modules, errors in data and calculations, testing mathematical models, process flow diagram

MODULE II **MATERIAL & ENERGY BALANCES** **10**

Thermodynamics Law of conservation of mass, types of material balance products, electron balances, biomass yield, General Energy balance equations, Enthalpy calculations, Enthalpy changes in non-reactive processes, Types of heat reactions, problems

MODULE III **UNSTEADY STATE MATERIAL AND ENERGY BALANCES** **10**

Material balance equation for CSTR, Energy balance equations, solving differential equations, solving mass balances, solving energy balances, problems.

MODULE IV **FLUID FLOW AND MIXING** **10**

Classification of fluids, Reynolds number, Momentum transfer, Non – Newtonian fluids, Two-Parameter models, rheological properties of fermentation broths, mixing, power requirements for mixing, scale-up of mixing systems, role of shear in stirred fermentors, problems.

MODULE V **HEAT& MASS TRANSFER** **10**

Equipments, mechanism of heat transfer, conduction, heat transfer between fluids, design equation for heat transfer systems, applications of design equations, problems, Mass transfer: Molecular diffusion, role of

diffusion in bio-processing, film theory, convective mass transfer, oxygen uptake and transfer in cell cultures, kLa determination, problems

MODULE VI REACTOR ENGINEERING 10

Bioreactor configurations, practical considerations for bioreactor construction, monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor, case studies of production process.

Total Hours –60

TEXT BOOKS:

1. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press 1995.
2. Bioprocess Engineering - Basic concepts by M. L. Schuler & F. Kargi, Entice Hall 1992

REFERENCES:

1. Fermentation & Biochemical Engineering Hand Book (1983), Principles, Process

OUTCOMES:

At the end of the course the students will be able to

- Understand the basic role of engineering in bio-processing applications
- Utilize material balances to evaluate cell growth and substrate/product utilization in bioreactors
- Understand and model enzyme kinetics and apply the models for analysis of immobilized enzymatic bioreactors.
- Design bioreactors to achieve desired results (i.e., specified cell concentration, production rates, etc.).
- Understand and apply scale-up methods for designing bioreactors.
- Differentiate the ideal and non-ideal reactor operations for various bioprocess applications

BTC3213	BIOINFORMATICS	L	T	P	C
		4	0	0	3

OBJECTIVES:

The course aims to provide the students with an

- experimental and computational knowledge to embrace a systems biology approach and experience authentic systems genetics research by designing and conducting independent research projects.

MODULE I INTRODUCTION TO BIOINFORMATICS AND RESOURCES-I **7**

History and Scope of Bioinformatics, Central Dogma-biological information, Biological Databases, Primary and Secondary, Nucleotide-Protein Sequence and Structure databases, Data- formats, Accession, Submission,Retrieval, NCBI Data Model, GenBank,PDB

MODULE II SEQUENCE ALIGNMENT AND DATABASE SEARCHING -II **8**

Introduction, Evolutionary basis of sequence alignment, Optimal alignment methods, Substitution scores & gap penalties, Statistical significance of alignments, Database similarity searching, FASTA, BLAST, Low complexity regions, Repetitive elements, Multiple Sequence Alignment: Progressive alignment methods, Motifs and patterns

MODULE III PHYLOGENETIC ANALYSIS **8**

Elements of phylogenetic models, data analysis: Alignment, substitution model building, tree building and tree evaluation, building methods, searching for trees, hooting trees, Evaluating trees and data, phylogenetic software Some simple practical consideration

MODULE IV PREDICTIVE METHODS **8**

Gene structure Genome-types,Gene Prediction tools, Genome Browsers,Genome Annotation pipeline Codon Bias Detection, Protein identity based on composition, Propsearch, Physical properties based on sequences, secondary structure features prediction, Tertiary structure, homology modeling, ab initio methods threading

MODULE V ADVANCED BIOINFORMATICS-I **7**

Drug Discovery overview, Computational Drug Designing- Structure Based, Protein target identification, Molecular Docking, Scoring, MD Simulations, Ligand Based, ligand databases, virtual HTS, MOlecular Similarity, QSAR, Pharmacophore

MODULE VI ADVANCED BIOINFORMATICS-II 7

Machine Learning-Supervised vs Unsupervised, Genomics, Proteomics Analysis, Data Classification-Bioinformatics Pipelines, R, Python- Basics and Applications

Total Hours –45

TEXT BOOKS:

1. Bioinformatics: A practical guide to the analysis of genes and proteins A.D. Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons.

2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, 2001, Cold Spring Harbor Laboratory Press.

REFERENCES:

Latest Research and Review articles

OUTCOMES:

At the end of the course students will be

- Classify different types of biological databases available will learn how to effectively search and retrieve data from biological databases using various query systems and their applications.
- Compare various search tools, query languages, and retrieval methods to extract relevant information from the databases.
- Analyze and interpret evolutionary relationships and contribute to phylogenetics by employing bioinformatics tools.
- Apply computational algorithms for prediction and decision-making in biological research, particularly genes, and proteins.
- Demonstrate computational methods in the discovery and optimization of potential drug molecules for therapeutic interventions.
- Experiment with real-world bioinformatics problems to extend the knowledge on genomics, proteomics, structural biology, and systems biology.

BTC3214	BIOPROCESS LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- Enables the student to develop their skills in the field of enzyme isolation, its assays, and microbial fermentation**.**
- Develop their practical skills in enzyme isolation and purification.
- Evaluate enzyme kinetics
- Carry out enzyme immobilized reaction and microbial culture
- Develop practical skill in submerged and solid-state fermentation

Experiments

1. Isolation of proteolytic organism from soil sample
2. Glucose assay by DNS method
3. Evaluations of enzyme kinetic parameters
4. Enzyme activity calculation
5. Determination of optimum pH for enzyme
6. Determination of optimum temperature for an enzyme
7. Enzyme immobilized by alginate gel method
8. Hydrolysis of starch by immobilized method
9. Effect of substrate concentration on biomass yield
10. Solvent extraction techniques for product recovery

Total Hours – 30

TEXT BOOKS:

1. Lab Manual

OUTCOMES:

- Understand the fundamentals of bioprocess techniques
- Students will be familiar with the techniques involved in upstream and downstream processes.
- Give an account of the design and operations of various bioreactors and downstream processes

- Calculate yield and production rates in a biological production process, and also interpret data
- Give an account of important microbial/enzymatic industrial processes.
- study the stoichiometry and energetics of cell growth and product formation

BTC3215	BIOINFORMATICS LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To gain knowledge on bioinformatics internet resources and algorithms
- To understand the sequence of protein and nucleic acids
- To understand the structural prediction of protein primary secondary, tertiary and quaternary structures.
- To learn basics of Python language and to apply in bioinformatics problems

Experiments

1. Study of internet resources in Bioinformatics
2. Similarity search using BLAST
3. Similarity search using FASTA
4. Algorithm used in bioinformatics
5. Multiple sequence alignment
6. DNA Prediction Methods
7. Protein Prediction Methods
8. Phylogenetic analysis
9. Python basic syntax
10. Python programming

Total Hours –30

REFERENCES:

1. Laboratory Manual

OUTCOMES:

On the completion of the above objectives' the student will be able to perform

- Find the different available databases for biological Sciences
- Interpret the difference between global versus local alignment using different tools and softwares
- Understand the algorithms used for annotation, comparing the sequences.
- Compare the primary, secondary, tertiary and quaternary structures of proteins.
- Develop a phylogenetic tree using multiple sequences.
- Understand the programming languages, R and Python.

SEMESTER VII

		L	T	P	C
BTC4101	**BIOREACTOR DESIGN AND ANALYSIS**	**4**	**0**	**0**	**4**

OBJECTIVES:

The course imparts

- advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology.
- familiarize the concepts of multiple metabolic reactions in reactor conditions,
- understand bioreactor instrumentation and control,
- methods and strategies for fermentation in bioreactor.
- modelling and simulation of fermentation processes and Plant and animal cell bioreactors.

MODULE I REACTION KINETICS 10

Definitions of rate constant, reaction order - Elementary and nonelementary reactions - Mechanisms and kinetics - Reactions with constant volume and variable volume-Conversion yield - Kinetics of chemical reactions - Elementary and non - elementary reactions, nth order kinetics - Rate equations with multiple rate constants, shifting - Order kinetics, interpretation of batch reactor data for simple and complex reactions, dependence of reaction rate on environmental conditions – Arrheniu's equation

MODULE II IDEAL REACTORS BIOREACTORS 10

Introduction to ideal reactors - Performance equations for ideal reactors and non-isothermal reactors - Rate data analysis – Multiple reactors and multiple reactions -Polymerization reactions, enzymatic reactions, microbial growth and

MODULE III NON-IDEALITY IN REACTORS 10

RTD studies - Dispersion effects, models for non-ideal reactors – Non isothermal reactors - External diffusion effects on heterogeneous reactions Diffusion and reaction in porous catalysts.

MODULE IV BIOREACTOR 10

Definition of bioreactor, basic principles of bioreactor – Interaction of heat and mass transfer in the microbial processes – Classification of bioreactors and their configurations - Analysis of batch, continuous, fed batch and semicontinuous bioreactors, non-ideal effects, mechanical design of bioreactors and its components

MODULE V BIOREACTOR SCALE – UP 10

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors - Microbial oxygen demands, methods for the determination of mass transfer coefficients, mass transfer correlations - Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed**.**

MODULE VI SIMULATION AND OPTIMIZATION OF BIOPROCESSES 10

Simulation techniques (Numerical Methods): Programs based on numerical methods like algebraic equations, Newton-Raphson method for algebraic convergence, interpolation, arbitrary function generation (FUN1, FUN2 subroutines). Programs based on solution of differential equations: Euler method for 1st and 2nd order integration, subroutines INT and INTI; Fourth order Runga –Kutta method: stability of numerical integration variable slip size method. Case studies, Numerical problems

Total Hours –60

TEXT BOOKS:

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Easter Ltd, New York, 5th Edition, 1999

2. Fogler, H. S., Elements of Chemical Reaction Engineering, Prentice Hall Pvt Ltd, 4th Edition, 2006

REFERENCES:

1. Smith, J.M., Van Ness, H.C., Abbott, M. M., Introduction to Chemical Engineering Thermodynamics , McGraw Hill, New York, 6th Edition, 2001

OUTCOMES:

At the end of the course students will be able to

- Apply the concepts of reaction kinetics for bioreactor design
- Correlate the metabolic multiple reactions in bioreactors

- Optimize the performance of bioreactors based upon the biochemical reactions involved in cellular metabolism
- Design reactors with mass transfer between two ideally mixed fluid phases, for continuous, fed-batch, batch operation.
- Specify reactor systems including instrumentation and control components for industrial bioprocesses
- Develop mathematical models and analyze the bioreactor behaviour at dynamic conditions.

BTC4102	FERMENTATION TECHNOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To educate the students about microorganisms, development of media, and anaerobic digesters
- To make the students understand the fermentation process using these tools and its combination of bioprocess engineering

MODULE I **PILOT PLANT FERMENTATION** **10**

Microbial fermentation, Mammalian cell culture system, Plant cell tissue and organ cultures

MODULE II **FERMENTATION DESIGN** **11**

Fermentation department, equipment and space requirements, the design of large fermenters (based on aeration), Statistical Methods for Fermentation Optimization.

MODULE III **ENVIRONMENTAL CONCERNS ABOUT FERMENTATION** **13**

Environmental regulations and technology, laws and regulations, Technology (waste water), Waste water treatment strategy, Air (emissions of concerns), Selecting a Control Technology, Inorganics, and volatile Organic Compound Emission Control.

MODULE IV **ANAEROBIC DIGESTERS** **12**

An overview of aerobic and anaerobic fermentation. Substrates, Products and Biogas, Operational Conditions, Types of anaerobic digesters.

MODULE V **PLANT CELL CULTURE** **14**

Biochemical Engineering of the Production of Plant – specific Secondary metabolites by Cell Suspension Cultures, Gas Concentration Effects on Secondary Metabolite Production by Plant Cell Cultures, Integrated

Bioprocessing for Plant Cell Cultures and Large – Scale plant micro propagation.

Total Hours –60

TEXT BOOKS:

1. Fermentation and biochemical engineering handbook by Henry C. Ogal, 2nd edition, Noyes Publications.

2. Advances in Biochemical Engineering Biotechnology by T. Sceper and J.J Zhong; Springer Publication.

3. The Microbiology of anaerobic digesters by Michael H. Gerardi, A John Wiley & Sons, Inc., Publication, 2003.

OUTCOMES:

- Describe current knowledge in biological and biochemical technology, with a focus on fundamentals of fermentation technology.
- Outline the application of biological and engineering principles to problems involving microbial, mammalian, and biological/biochemical systems.
- Practice the knowledge on current environmental laws and regulation and protection acts, zero emission and waste water treatment strategies
- Analyze the bioprocess paradigm: Scale-down, bioprocess simulation and economics, sterilization, and bioburden in biological manufacturing.
- Distinguish bioreactor operations and types in bacteria and mammalian cell systems, oxygen transfer and shear in bioreactors, strain improvement for bio- product production.
- Apply the knowledge on plant based secondary metabolites from pilot to large scale production.

BTC4103	NANO BIOTECHNOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- The course aims at introducing the underlying principles and applications of the emerging field of nanotechnology and nanoscience intended for a multidisciplinary audience with a variety of backgrounds. Introduces tools and principles relevant at the nanoscale dimension and discusses current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics and energy.

MODULE I INTRODUCTION 10

Technological impact of nano-scale systems, Micro and nano-systems and technologies - Overview of nano-devices and techniques

MODULE II NANOSCALE MATERIALS 10

Strategies for nano architecture (top down and bottom up approaches) - Fabrication technologies and characterizations – Selfassembly systems, some aspects of nanofluidics- Surfactants, polymers, emulsions and colloids.

MODULE III INORGANIC NANOSCALE SYSTEMS FOR BIOSYSTEMS 10

Nano-structured materials, fullerenes - Properties and characteristics, carbon nanotubes - Characteristics and applications quantum dots and wires, gold nanoparticles and nanopores.

MODULE IV APPLICATIONS OF NANO-MOLECULES IN BIOSYSTEMS 10

Molecules of life - Proteins, lipids, RNA and DNA – Nanoscale elements for delivery of materials into cells, peptides coupled nanoparticles - DNA based artificial nanostructure proteins as components in nanodevices.

MODULE V APPLICATION OF NANO-BIOTECHNOLOGY IN DRUG DELIVERY 10

Nanoscale devices for drug discovery Micelles for drug delivery protein targeting - Small molecule - Protein interactions, microarray and genome chips.

MODULE VI NANOTECHNOLOGY FOR CANCER DIAGNOSIS 10

Nanobiosensors and nanobiochips, Nanomedicines, Drug targeting, Nanotechnology for cancer diagnosis and treatment – tumour targeted drug delivery system –nanotechnology for imaging and detection .Nanotechnology for cell destruction

Total Hours –60

TEXT BOOKS and REFERENCES:

Mick Wilson, Kamali Kannangra, Geoff Smith., Nanotechnology, Oversees Press India Private Ltd, New Delhi, 2nd Edition, 2005.

2. Jain, K.K., Nanobiomolecular Diagnostics: Current Techniques and Application, Taylor and Fransis Publishers, New York, 1st Edition, 2006.

3. Kimball Nill., Glossary of Biotech and Nanobioterms, CRC Publisher, California, 4th Edition, 2005.

OUTCOMES:

At the end of the course students will be able to

- Apply the knowledge of nano science and mathematics to: Follow protocols, conduct science or engineering procedures, fabricate products, make conclusions about results, Troubleshoot, Discover
- Understand the laboratory environment using complex instrumentation machinery and protocols
- Analyze innovations in the rapidly changing field of nanotechnology
- Analyze and compile data and draw conclusions at the nano level.
- Design, implement and document experiments • Collaborate and communicate effectively in a high-tech environment
- Design applications of nanotechnology for cancer therapeutics

BTC4104	FERMENTATION LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- Provides an opportunity to experimentally verify the theoretical concepts already studied. It also helps in understanding the theoretical principles in a more explicit and concentrated manner. The students will be able to
- Develop the skills of large-scale production of secondary metabolites.
- Identify the growth factors
- Study the batch and continuous culture growth • Evaluate the temperature effect on culture growth

LIST OF EXPERIMENTS:

1. Temperature effect on growth-estimation of energy of activation and Arrhenius constant for microorganisms. Batch, fed batch and continuous cultures a) Estimation of Monod parameters b) Pure and mixed cultures.
2. Production of secondary metabolite by plant cells in a photobioreactor. Production of secondary metabolites in synthetic and complex industrial media.
3. Production of wine by yeast.
4. Production of Aminoacid.
5. Screening of process variables single dimensional search, Plackett Burman design, design expert etc.
6. Study of rheology of fermentation broth and power determination.

Total Hours –30

REFERENCES:

Laboratory manual

OUTCOMES:

On the completion of the above objectives' the student will be able to perform

- Production and analysis of fermented products
- Screening of different strain for commercial production
- Design fermentation experiments

- Apply scientific methodology to the study of life and natural phenomena.
- **I**nterpreting the growth kinetic studies on microbes for fermented products
- Apply biological concepts to societal issues. Finally, students will learn the economics of fermentation for the total cost of production

BTC4105	BIOREACTOR DESIGN AND DRAWING LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

The course imparts

- Basic concepts of engineering drawing and reactor design
- advanced knowledge on applying the requirements of various bioprocess for bioreactor design
- develop the skills to establish multiple metabolic reactions in reactor conditions,
- design bioreactor instrumentation and control for different industrial applications,
- inculcate the three-dimensional designs and drawings of different bioreactors with advanced features.
- design bioreactors on miniature scale.

LIST OF EXPERIMENTS:

1. Draw neat labelled diagram of simple stirred tank bioreactor.
2. Draw labelled sketch of sparged-stirred tank bioreactor
3. Tank reactor with Draft tube configuration
4. Sequencing batch reactor
5. Membrane Bioreactor
6. Design of Vascular Graft Bioreactors
7. Design of miniaturized bioreactor

Total Hours –30

REFERENCES:

Laboratory manual

OUTCOMES:

At the end of the course students will be able to

- Apply the concepts of engineering drawing for bioreactor design
- Detail about the components of bioreactors.
- Design bioreactor for various bio-based industries
- Apply the chemical engineering principles to design effective bioreactor
- Implement the bioethics and biosafety concepts in reactor designs
- Consider energy requirements in designing the industrial process flow sheets

BTC 4106	INTERNSHIP	L	T	P	C
		0	0	0	1

OBJECTIVES:

- To assist the student to transform from student life to embark on their professional journey as a biotechnician.
- To apply the academic and technical competencies learned in the classroom to real world problems.
- To develop the employability skills that will assist the students in their chosen field.
- To make the most exciting time experience by culminating the many hours of hard work as a student and beginning of many years of satisfying work experience.

GENERAL GUIDELINES

- The Internship programme duration is of ten days and it should be carried out in (VI and VII semester) Vacation.
- The internship can be carried out in any industry/R&D Organization/ Research Institute/Reputed Educational Institute. The students are permitted to carry out the internship anywhere in India or abroad.
- At the end of industrial internship, the students should submit a complete report and attendance certificates to the Department.
- Examination, conducted internally by a Departmental Committee constituted by the Dean of the School of Life Sciences
- The evaluation will be done accordingly: 50 marks for CIE (Internship report: 50) and 50 marks for Viva – Voce conducted during SEE.
- The minimum requirement of marks shall be 50% of the maximum marks.

COURSE OUTCOMES:

On successful completion of the course students will be able to:

- Understand the Organizational Assembly of a company.
- Student is able to test the theoretical learning in practical situations by accomplishing the tasks assigned during the internship period.
- Develop work habits and attitudes necessary for job success (technical competence, professional attitude, organization skills etc.)
- Develop written communication and technical report writing skills.
- Ability to communicate efficiently with the coworkers.
- Develop an awareness for the need and applications of standards in the industry.

SEMESTER VIII

		L	T	P	C
BTC 4211	**PROJECT WORK**	**0**	**0**	**24**	**12**

OBJECTIVES:

The students should prepare and perform a project on any literary topic to solve the problem within the context of legal, global, and environmental constraints. A Viva Voce exam will be conducted following the project submission, during which the student will be tested on both the project and the general information they have acquired from their undergraduate curriculum.

GENERAL GUIDELINES:

This course will be conducted largely as an individual project under the supervision of a department faculty. The project topic undertaken will reflect the interests and expertise of the student and the supervisor.

Students will be required to

- Perform a literature search to review current knowledge and developments in the chosen technical area
- Undertake detailed technical work in the chosen area
- Produce progress reports to establish completed, and to schedule additional work within the time frame specified for the project
- Deliver a seminar on the general area of work being undertaken and specific contributions to that field
- Prepare a formal report describing the work undertaken and results obtained so far
- Present the work in a forum of expert team

COURSE OUTCOMES:

On successful completion of the course students will be able to:

- Identify the research gap and complex problems in context of legal, global, and environmental constraints.
- Formulate engineering solutions for societal issues.
- Plan, monitor, and manage project schedule to ensure timely completion.
- Defend performance of the implemented project and understand the Implication of the solution
- Interpret the results and summarize the work in written and oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer and manage any disputes and conflicts.

PROGRAMME ELECTIVES

BTCX01	BIOPHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- students will learn the detailed structure of biomolecules.
- they will understand the importance of structures in the field of biotechnology.
- they will learn some techniques which help to elucidate the structures.

MODULE I **MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS** **7**

Interaction of Biomolecules – Covalent and Ionic bond, co-ordinate-covalent bond, non-covalent bond, hydrophobic interaction, hydrogen bonds, water structure, examples of bonds present in biomolecules, stereochemistry, chirality and isomerism.

MODULE II **CONFORMATION OF NUCLEIC ACIDS** **8**

Primary structure –Bases, sugars, phosphodiester bonds – Double helical structure, A, B and Z forms of DNA, properties of circular DNA – Topology – Polymorphism and flexibility of DNA, Structure of ribonucleic acids, Thermodynamics of DNA denaturation and Tm values.

MODULE III **CONFORMATION OF PROTEINS** **7**

Conformation of the peptide bond – Secondary structures, – Ramachandran's plots, alpha-helices and factors stabilizing the alpha helix, beta turns, random coils, torsion angles, dihedral angles, hydration of proteins, Tertiary structure-types of interaction present in tertiary structure, hydropathy plots.

MODULE IV **STRUCTURE DETERMINATION OF MACROMOLECLUES** **9**

Ultraviolet/Visible Absorption Spectroscopy, Applications of Absorption Spectroscopy, Fluorescence Spectroscopy, Applications of Fluorescence, Spectroscopic Techniques Using Plane-Polarized Light, CD of Biopolymers, Crystallization of biomacromolecules, X-ray diffraction by crystals, structure determination by NMR

MODULE V **MEMBRANE BIOLOGY** **7**

Phospholipids-major class of membrane lipids, lipid bilayer-noncovalent and cooperative structures, liposome- its significance, molecular structure of membranes-fluid mosaic model, carbohydrate and proteins molecules

associated with membrane, lipid movement in membranes, membrane channels and their motifs, hydrophobicity plots.

MODULE VI **BIOCALORIMETRY** **7**

Thermodynamic parameters, activation energy of reactions, enthalpy, entropy, free enrgy, Isothermal titration calorimetry, changes in heat capacity by isothermal titration calorimetry, differential scanning calorimetry, equilibrium constant.

Total Hours –45

TEXT BOOKS:

1. Cantor, C.R. and Schimmel, P.R., Biophysical Chemistry, W.H Freeman and Company, Press, New York, 4th Edition, 1999.
2. Sheehan. D. Physical biochemistry, principles and Applications, Second Edition
3. Crieghton, T.E, Biophysical Chemistry

REFERENCES:

- Biophysical and Structural Aspects of Bioenergetics by Mårten Wikström (Editor) (RSC Publishing)

COURSE OUTCOMES:

The students will be able to

- Understand the chemistry of the structures of biomolecules.
- Understand the structure of nucleic acid involved in propagation of life.
- Demonstrate the structure of protein
- Design the protocol to study the structure of macromolecules
- Explain models of biological systems and models dealing with statistical mechanics and transport phenomena.
- Apply thermodynamics in cellular & biochemical processes.

BTCX02	INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The students will acquire basic knowledge of industrial and traditional fermentation process and products obtained through them
- The students will acquire knowledge of the basic metabolic pathways and their application in bioprocess
- The students will acquire knowledge about the process of production of various metabolites on industrial scale
- The students will acquire knowledge about the various techniques used in bioprocess industry
- To update students' knowledge of new developments in bioprocess industry relevant to diagnostics, forestry, its socio-economic impact on society
- To update students' knowledge of new developments in biology of industrial relevance.

MODULE I **INTRODUCTION TO INDUSTRIAL BIOPROCESS** **07**

Overview of industrial fermentation process – traditional and modern biotechnology. A brief survey of organisms, processes, products relating to modern biotechnology. Biotechnology and the developing world.

MODULE II **METABOLIC STRATEGIES** **08**

General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis, Bioprocess/fermentation technology: Bioreactor, Scale-up, Media design, Technology for microbial, mammalian and plant cell culture, Downstream processing.

MODULE III **PRODUCTION OF PRIMARY AND SECONDARY METABOLITES** **08**

A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, lactic acid, acetic acid etc.,); amino acids (glutamic acid, phenylalanine, aspartic acid etc.,) and alcohols (ethanol, butanol etc.) Study of production processes for various classes of secondary metabolites.

MODULE IV **ENZYME TECHNOLOGY & BIOPHARMACEUTICALS** **08**

Nature, Application, Genetic engineering & protein engineering, Immobilised enzymes and Technology of enzyme production, Introduction to genetic engineering, Antibiotics, Therapeutic proteins, Vaccines & monoclonal antibodies, Gene therapy.

MODULE V **APPLICATIONS** **07**

Introduction, Fermentation, Food processing, Sweeteners, Food wastes, Rapid diagnostics, Public acceptance & safety, Plant biotechnology, Forestry, Biological control, Animal biotechnology, Diagnostics in agriculture, Bioremediation. IPR, Safety, Social, moral and ethical aspects of Biotechnology.

MODULE VI **PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS** **07**

Production of recombinant proteins having therapeutic and diagnostic applications, production of vaccines. Production of monoclonal antibodies. Products of plant and animal cell culture.

Total Hours –45

REFERENCES:

1. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
2. Biochemistry by Zubey. Wm. C. Brown publishers
3. Biotechnology, John E. Smith
4. Bioprocess Engineering Principles, Pauline M. Doran
5. Prescott, Dunn, “Industrial Microbiology”, Agrobios (India)

COURSE OUTCOMES:

- The facts, concepts, principles, and theories relevant to the broad area of bioprocess technology
- The metabolic strategies to be employed for bioreactor design, scale-up and downstream process.
- The professional and ethical responsibilities of the biotechnologist.
- Current themes and/or insights, at/or informed by, the forefront of the Biotechnology Industry and its related disciplines.
- The techniques applicable to the area of Biotechnology.
- Processes which facilitate the production of therapeutic and industrial bioprocess products.

BTCX03	BIO-ORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The course aims to develop skills of Students in the area of Organic Chemistry and its applications in Biology.

MODULE I **Introduction to Bioorganic Chemistry** **7**

Overview of Bioorganic Chemistry- Historical Connection Between Organic and Biological Chemistry; Weak Interactions in Organic and Biological World; Proximity Effect in Organic Chemistry; Molecular Adaptation; Molecular Recognition; Chemistry of the Living Cells; Analogy Between Biochemical and Organic Reaction

MODULE II **Bioorganic Chemistry of Amino Acids and Polypeptides** **7**

Chemistry of the Living Cells; Analogy Between Organic Reactions and Biochemical; Chemistry of the Peptide Bond; Nonribosomal Peptide Bond Formation; Asymmetric Synthesis of a-Amino Acids; Asymmetric Synthesis with Chiral Organometallic Catalysts; Transition State Analogs; Antibodies as Enzymes; Chemical Mutations; Molecular Recognition and Drug Design

MODULE III **Enzyme Chemistry** **7**

Introduction to Catalysis; Introduction to Enzymes; Multifunctional Catalysis and Simple Models; a-Chymotrypsin; Other Hydrolytic Enzymes; Stereoelectronic Control in Hydrolytic Reactions; Immobilized Enzymes and Enzyme Technology; Enzymes in Synthetic Organic Chemistry; Enzyme-Analog-Built Polymers; Design of Molecular Clefts

MODULE IV **Enzyme Models** **10**

Host-Guest Complexation: Chemistry New Developments in Crown Ether Chemistry; Membrane Chemistry and Micelles; Polymers; Cyclodextrins; Enzyme Design Using Steroid Template; Remote Functionalization Reactions; Biomimetic Polyene Cyclizations

MODULE V **Bioorganic Chemistry of Nucleic Acids** **7**

History, Sugars and bases; Conformation of sugar-phosphate backbone; hydrogen bonding by bases; the double helix; A, B, and Z double helices; Stability of Double Helix ; DNA intercalators; Chemical synthesis of DNA

MODULE VI **Protein Folding** **7**

Fundamentals of cellular protein folding, mechanism of in vitro protein folding and unfolding, basics of protein misfolding and aggregation process, protein misfolding disorders, Basics of Molecular and chemical Chaperones, Molecular and chemical chaperone as potential therapeutic agents, Applications of molecular chaperones in cellular system.

Total Hours –45

TEXT BOOKS:

1. Structure and Mechanism In Protein Science: A Guide To Enzyme Catalysis and Protein Folding; A. R. Fersht, W.H. Freeman, 1999.
2. Bioorganic Chemistry; H. Dugas, Springer Verlag, 1999.

OUTCOMES:

At the end of this course students will be able to:

- Understand correlations between the structure of organic molecules and their properties/reactivity
- Understand about biomolecules such as carbohydrates, polysaccharides, amino acids, their structure and chemical properties.
- Understand enzyme actions and kinetics
- Understand the properties, composition and biosynthesis of the natural compound classes terpenoids, polyketides, phenylpropanoids and alkaloids.
- Understand about the proteins, nucleic acids, DNA/RNA and lipids structure and properties
- Understand the mechanisms of protein folding

BTCX04	MOLECULAR PATHOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

students shall know about

1. introduction to cellular and molecular basis of diseases
2. molecular biology and genetics of disease and human genome and techniques
3. principle of molecular pathology
4. molecular basis of human diseases
5. molecular therapeutics

MODULE I **INTRODUCTION TO MOLECULAR BASIS OF DISEASE** **9**

Mechanisms of cell death, apoptosis, necrosis, pathways to apoptosis, acute and chronic inflammation, infection and host response, neoplasia

MODULE II **MOLECULAR BIOLOGY AND GENETICS** **9**

Structure and organization of human genome, human genome project, genetic diseases, gene expression profiling- microarray, SAGE, RNA-seq, genetics of Acute myeloid leukemia and cystic fibrosis

MODULE III **PRINCIPLES OF MOLECULAR PATHOLOGY** **8**

History of approaches to disease, current practice and future prospect, role of computer in disease diagnosis, pathogenesis of Hepatitis C, HIV, Dengue

MODULE IV **MOLECULAR BASIS OF HUMAN DISEASES** **12**

Cardiovascular diseases-atherosclerosis, ischemic heart diseases, cardiomyopathies; Cancer-genetic basis, major types, pathology of breast and colon cancer, leukemia; diseases of immune system- types, pulmonary diseases-Asthma, COPD, diseases of gastrointestinal tract, neuropathological disorders-ALS, Alzheimers, Huntington’s

MODULE V **MOLECULAR THERAPEUTICS** **7**

Pharmacogenetics, SNPs, cytochrome P450 system, High throughput, screening techniques, Gene therapy- emphasis to CRISPR-Cas system, Immunotherapy, recombinant drugs, embryonic stem cells

Total Hours –45

TEXT BOOKS:

Coleman and Tsongalis (Eds.). Essential Concepts in Molecular Pathology. elsevier

REFERENCES:

Related research papers

OUTCOMES:

Students Shall Be Able To

- Understand basic cellular and molecular processes in cell that cause disease
- Understand the structure of human genome, expression techniques and diseases with gene mutation
- Understand principle of molecular pathology and infectious disease
- Explain fundamentals of different types of diseases
- Define the different types of molecular therapeutics
- Apply various techniques in the diagnosis of diseases

BTCX05	FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims to

- Provide a programme of education which can enable its graduates to enter a career in the food industry as technologists capable of ensuring the production and marketing of safe and quality foods.
- Provide a broadly based technological education whose graduates can also enter into employment in other sectors of the food chain, or related technical sectors, where they can apply their technological skills.
- Allow individuals to develop their capacity to undertake research into problems relating to the production and marketing of safe and quality foods.

MODULE I **INTRODUCTION** **8**

History of Microorganisms in food, Historical Developments, Taxonomy, role and significance of microorganisms in foods. Intrinsic and Extrinsic Parameters of Foods that affect microbial growth, Microorganisms in fresh meats and poultry, processed meats, seafood's, fermented and fermented dairy products and miscellaneous food products, Starter cultures, cheeses, beer, wine and distilled spirits, SCP, medical foods, probiotics and health benefits of fermented milk and foods products.

MODULE II **PRIMARY & SECONDARY FERMENTATION** **8**

Brewing malting, mashing, hops, primary & secondary fermentation: Biotechnological improvements: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl. Beer, wine and distilled spirits.

MODULE III **FOOD QUALITY PARAMETERS** **8**

Emerging processing and preservation technologies for milk and dairy product, Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods

MODULE IV **FOOD PRESERVATION** **7**

Food Preservation Using Irradiation, Characteristics of Radiations of Interest, in Food Preservation. Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents

MODULE V **STORAGE** **7**

Stability Food Preservation with Low Temperatures, Food Preservation with HighTemperatures, Preservation of Foods by Drying, Indicator and Food-borne Pathogens, Other Proven and Suspected Food-borne Pathogens.

MODULE VI **FOOD QUALITY AND CONTROL** **7**

Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Microbial safety of food products, Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination.

Total Hours – 45

TEXT BOOKS:

1. Modern Food Micro-Biology by James M. Jay, (2000), 6th edition, An Aspen Publication, Maryland, USA.
2. Food Microbiology: Fundamentals and frontiers by M.P. Doyle, L.R. Beuchat and Thoma J. Montville, (2001), 2nd edition, ASM press, USA.
3. Food Science and Food Biotechnology by G.F.G. Lopez & G.V.B. Canovas (2003), CRCPress, Florida, USA

OUTCOMES:

At the end of the course students will be able to

- Adapt the basic knowledge of food and its microbiological aspects in term of quality and spoilage activity along with structural composition, nutrient value and biological value and their mechanisms.
- Understand the application of fermentation and their importance in the development of fermented food along with the biological and nutritive value
- Identify the most important quality parameters and spoilage agents in foods
- Discuss the effect of radiation in food preservation
- Understand the concept of food storage in various conditions
- Apply and communicate technological knowledge to meet the needs of industry and the consumer for the production and marketing of safe and quality foods.

BTCX06	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The origins of cancer and the genetic and cellular basis for cancer**.**
- It will examine the factors that have been implicated in triggering cancers.
- The intercellular interactions involved in cancer proliferation.
- Current treatments for cancer and how these are designed.
- Future research and treatment directions for cancer therapy.
- Current methods employed in diagnosing cancer.

MODULE I FUNDAMENTALS OF CANCER BIOLOGY 08

The six hallmarks of cancer, characteristic properties of cancers and cancer cells, benign tumors, classification of cancers, causes of cancer, regulation of cell cycle, cyclin dependent protein kinase, cell cycle check points, mutations, DNA damage and DNA repair.

MODULE II TUMOR MICROENVIRONMENT 08

Physiological parameters- hypoxia, gene expression and metastatsis, Malignant cells-aberrant DNA methylation, vascular and stroma, immune mediated cells, extracellular matrix, secreted ptoteins.

MODULE III CANCER GENETICS 07

Cancer genes, Oncogenes-retroviral oncogenes, approaches to the identification of human oncogenes, Tumor suppressor genes in hereditary cancers, TP53 as a different kind of tumor suppressor, cancer epigenetics.

MODULE IV CANCER SIGNALING 07

Cancer gene pathways, individual biochemical reactions, multistep pathways and network, signal from cell surface: protein tyrosine kinase, the ras pathways, The PI3K/AKT pathways, The WNT/APC pathways, TGF-Beta/SMAD signaling.

MODULE V TUMOR IMMUNOLOGY 08

Historical perspectives, Tumor Antigen, Mechanism to immune response to cancer, role of gene rearrangement in tumor response, Heat shock protein as the regulator for immune response, Inflammation and cancer, Immunotherapy, Adoptive immunotherapy.

MODULE VI CANCER DIAGNOSTIC 07

Categories of Tumor markers, Nucleic Acid based marker, Gene expression microarrays in breast cancer, lung cancer and colorectal cancer, Proteomics methods for cancer detection, molecular imaging, importance of Pharmacogenomics in Cancer.

Total Hours –45

REFERENCES:

1. Dimmock, N., Keith., Introduction to Modern Virology, Blackwell Scientific Publications, Oxford, 6th Edition,2007
2. Maly, B.W.J., Virology a Practical Approach, IRL Press, Oxford, 2nd Edition, 1995

COURSE OUTCOMES:

- Differentiate between carcinoma, sarcoma, leukemia, and lymphoma and how these terms are used to name cancer types.
- Outline how cancer starts and how it spreads.
- List the genes involved in cancer proliferation.
- Overview the impact of cell signaling in cancer.
- Discuss the effect of immune response in cancer
- Apply the various tools in diagnosis of cancer.

BTCX07	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

Students shall know about

- Basic concept of types of tissues, cell migration and therapeutic importance of tissue engineering
- Different aspects of cell culture and 3 dimensional cell culture
- Importance of growth factors, hormones and signalling method
- Scaffold synthesis and its application in tissue engineering
- Case studies and regulatory issues

MODULE I INTRODUCTION 9

Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

MODULE II CELL-CELL COMMUNICATION and IN VITRO CULTURE 9

Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization,3-D cell culture, Bioreactors.

MODULE III MOLECULAR BIOLOGY ASPECTS 9

Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

MODULE IV SCAFFOLD AND TRANSPLANT- SYNTHESIS and APPLICATION 9

Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hematopoiesis.

MODULE V CASE STUDY AND REGULATORY ISSUES 9

Case study of multiple approaches: cell transplantation for liver, cardiovascular, neural, fetal tissue engineering and artificial womb, prosthetics. Ethical, FDA and regulatory issues of tissue engineering.

Total Hours –45

TEXT BOOKS:

- Robert Lanza, Robert Langer, Joseph Vacanti, Principles of Tissue Engineering, Third Edition, 2007, Elsevier Academic Press
- Minoth, Strehl, Schumacher. Introduction to Tissue engineering. Wiley VCH.

REFERENCES:

- Robert A Brown, Extreme Tissue Engineering: Concepts and Strategies for Tissue Fabrication, 2013, Wiley Blackwell

OUTCOMES:

After the completion of this course, students shall be able to

- Understand fundamentals of tissue engineering
- Understand cell-cell communication and cell culture techniques
- Understand how cell signaling molecules help in cell proliferation
- Understand and apply the knowledge of scaffold synthesis and tissue engineering application
- Apply to concept to different tissue engineering applications
- Understand the ethical and regulatory issue in clinical applications

BTCX08	DEVELOPMENTAL BIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide insight on the history, formulation of theories and the processes associated with embryonic development in humans.
- To enlighten on the molecular intricacies of the organ formation.
- To highlight the types, significance, advantages and disadvantages of model organisms.
- To introduce the different molecular techniques employed to decipher the molecules/ process/ signalling mechanism of developmental processes.
- To provide an understanding of post embryonic development and its need.
- To impart the application of developmental biology in other fields of life science.

MODULE I BASIC CONCEPTS IN DEVELOPMENTAL BIOLOGY AND STAGES OF DEVELOPMENT **8**

Theories in Developmental Biology, Stages of development, Gametogenesis, Egg types, Cell division or cleavage- types, purpose, laws,regulation. Cell specification and determination, Different types of cell specification (autonomous and conditional) - organiser, morphogen, gradient theory. Gastrulation- different modes, molecular mechanism and process.

MODULE II ORGANOGENESIS: NEURULATION, SOMITOGENESIS, LIMB DEVELOPMENT, HEART FORMATION **8**

Neurulation- different stages, Hensen's node, primitive streak, Neural crest, neural tube, notochord, Molecular mechanism, Neuronal cell proliferation- vertical and horizontal, neuronal birthday. Somitogenesis- Stages, Molecular mechanism- clock and wave model of somite formation, Hox genes (master genes) Limb formation- Stages, Molecular details- specification and coordination of different axes. Heart formation- Heart field, Heart tube formation , cardiac looping and chamber heart formation , left and right specification.

MODULE III MODEL ORGANISM IN DEVELOPMENTAL BIOLOGY **8**

Ideal characteristics of model organisms, Genetic and Non genetic model organism, Genetic model- Bacteria, Fungi, Slime mold, Nematode, Fruit fly, Mice. Non Genetic Model- Chick, Frog, Rat. Life cycle, Applications, advantages and disadvantages of model organisms. Importance of unicellular organisms, Drosophila a genetic work horse- segmentation genes, C.elegans-cell number constancy (defined number of cells), Dictyostelium- unicellular and multicellular, Mice-Mammalian model.

MODULE IV MOLCEULAR TECHNIQUES TO DECIPHER DEVELOPMENTAL PROGRAM 8

Forward genetics- approaches- chemical, physical and genetic- genetic screens(random mutant library)-REMI- Random mutagenesis, Reverse Genetics- Knock out, homologous recombination, traditional and conditional knock out. Knock in, Gene Silencing/knock downv- importance and different strategies- RNAi , RNA morpholino. Advantages and disadvantages. Differential Screening- Transcriptomics and Proteomics Approaches

MODULE V POST EMBRYONIC DEVELOPMENT 7

Different types of post embryonic development- Growth, Metamorphosis, aging and regeneration. Growth- different modes-hyperplasia, hypertrophy and accretion- regulation by hormones, Metamorphosis- types of metamorphosis, universal set of events.Amphibian and insect -stages and molecular details , Regeneration- 4 Types with example, Aging- Mechanisms.

MODULE VI DEVELOPMENTAL BIOLOGY IN MEDICINE, ECOLOGY AND EVOLUTION 6

Birth defects, teratogens- types and examples, endocrine disruptors, Environmental effects on development- polyphenism- different phenotypes, Evolutionary- Modules of development, Molecular parsimony, tool kit genes, heterochrony, heterotrophy, heterometry, heterotyphy.

Total Hours – 45

TEXT BOOKS:

1. Scott Gilbert and Micheal JF Barresi, Developmental Biology, 11th edition.
2. Jonathan Slack, Essentials of Developmental Biology, 3rd Edition.

REFERENCES:

1. Lewis Wolpert, Principles of development, 4th Edition.

OUTCOMES:

- To design simple experiments and interpret concepts of embryonic development.
- To appreciate and describe the signaling orchestra involved in organogenesis
- To make the right choice of model organism for a problem related to development.
- To strategize a molecular method to tweeze the intricacies of signaling in development.
- To predict the impact of exogenous factors on the development of an organism.
- To apply the concepts of development in the field of medicine, evolution, ecology and systems biology.

BTCX09 BIOSEPARATION TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To understand the process and challenges involved in the recovery, isolation, purification and polishing of biological products on a large scale.

MODULE I Introduction to Bioseparation 7

Definition, Role of bioseparation in Bioprocess technology, challenges in bioseparation, Ideal bioseparation process

MODULE II Removal of solids 8

Principle and types of Filtration, Large scale filtration system, Large scale microfiltration, Large scale centrifugation, Sedimentation centrifugation, Decanter Centrifuges, Disc Stack Centrifuges, Hydrocyclones, Filter Centrifuges, Ultracentrifugation

MODULE III Volume reduction 8

Extraction, Soxhlet extraction, Maceration extraction, Ultrasound assisted extraction, Microwave assisted extraction, supercritical fluid extraction, Aqueous two-phase systems, precipitation, selective precipitation, affinity precipitation

MODULE IV Purification 7

Adsorption, Mixed mode expanded bed adsorption, adsorbents, Nano-based adsorbents, Chromatography, electrophoresis, crystallization

MODULE V Drying and Polishing 8

Drying biological materials,intermittent drying, pulse combustion drying, impinging stream drying, cyclic pressure vacuum drying, spray-freeze-drying, atmospheric freeze-drying, vacuum fluidized bed drying, low-pressure spray drying, superheated steam drying, heat pump drying, inert medium drying, supercritical fluid drying, sorption drying, spouted bed drying, jet spouted bed drying, vibrating fluidized bed drying, pulse fluidized bed drying, high electric field drying, and microwave drying, auxiliary process

MODULE VI Product based bioseparation 7

Desired purity level needed for the specific industrial product, Bioseparation in biopharma industry (Vaccines, Interferons, Interleukins, Monoclonal antibodies, hormones and other additional products)

Total Hours –45

TEXT BOOKS:

1. Industrial Bioseparations: Principles and Practice, Daniel Forciniti, Wiley, 2008
2. Bioseparations Science and Engineering (2nd ed.), Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides

REFERENCES:

1. Bioseparations Downstream Processing for Biotechnology-Paul A Belter and E L Cussler
2. Bioseparations Engineering: Principles, Practice, and Economics-Michael R Ladisch

OUTCOMES:

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

- Apply different technologies involved in the reduction of bulk quantity after the large-scale process in bioreactor and to remove specific impurities
- Define the importance and fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing in solid liquid separation
- Apply the mechanism in finishing operations and formulations
- Make rational decisions to achieve the product specifications and enrich target products
- Apply the components of down-stream equipment in liquid-liquid separation.

BTCX10	PROTEOMICS & GENOMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course offers advanced level training on gene expression and gene therapy by covering topics such as genome mapping, proteomic techniques. To familiarize and expose the students to the Principle of gene expression, Concepts of functional genomics and proteomics in biopharmaceutical industry.
-

MODULE I **OUTLINE ABOUT GENOME** **5**

Genome organization (prokaryotes and Eukaryotes) – Viral genomes, bacterial genomes, fungal genome, worm genome, plant genome and animal genomes. High capacity vectors- cosmid, Fosmid, PAC, P1 derived vectors, BAC, YAC

MODULE II **FUNCTIONAL GENOMICS** **8**

Introduction, Northern blot, Subtractive hybridization, Differential Display reverse transcription PCR (DDRT-PCR), Serial Analysis Gene Expression (SAGE), microarray technology. DNA sequencing methods-chemical degradation, chain termination, next generation sequencing.

MODULE III **Proteomics and the proteomes** **8**

Introduction - Traditional route of protein study, Protein isolation methods-extraction methods, protein separation technique. Branches of proteomics-quantitative proteomics, Characteristics of proteomics.

MODULE IV **Tools of Proteomics** **8**

Two-dimensional gel electrophoresis of proteins- principle, 2D apparatus, sample preparation, first dimensional IEF, equilibration, second dimentional separation by SDS, image analysis, application of 2D PAGE. Mass spectrometry- protein sample preparation. Application of MS proteomics. Peptide Mass fingerprinting

MODULE V **Application of Proteomics** **8**

Mining Proteomes, protein expression profiling, protein-protein interactions and protein complexes, Mapping protein modification, new direction in proteomics.

MODULE VI **Advance Topics** **8**

Metablome network, regulatory networks, methionine synthesis in *E.coli* , Protein- DNA Interactions, Gene Regulation-Lac operon.

Total Hours –45

REFERENCES:

1. Saccone, C., Pesole, G., Hand book of Comparative Genomics – Principles and Methodology, John Wiley and Sons Publication, New Jersey, 1st Edition,2003.

2. Lesk, A.M., Introduction to Protein Science. Architecture, Function and Genomics, Oxford University press, New York, 2nd Edition, 2004.

3. Creighton, T.E., Protein Structure – A Practical Approach, Oxford University Press, New York, 4th Edition, 2004.

4. Brown, T.A., Genomes III, Garland Science, Taylore and Francis Group, New York, 3rd edition, 2007.

OUTCOMES:

- Describe DNA sequencing technologies and recent advances for high throughput genomic sequencing.
- Compare and contrast different methods for functional genomic analysis.
- Provide examples of how genomics technologies have been applied to improve our understanding of biological systems.
- Compare and contrast classical approaches to understanding protein
- Apply proteomics in various process
- Understand the recent advancement in genomics and proteomics

BTCX 11	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

COB1: To provide an acquaintance of the physiology of the heart, lung, blood circulation and respiration.

COB2: To introduce the student to the various sensing and measurement devices of electrical origin.

COB3: To provide the latest ideas on devices of non-electrical devices.

COB4: To bring out the important and modern methods of imaging techniques and to provide latest knowledge of therapeutic equipment.

COB5: To provide awareness of electrical safety of medical equipment.

MODULE I PHYSIOLOGY AND TRANSDUCERS 08

Cell and its structure; Resting and Action Potential Nervous system: Functional organisation of the nervous system Structure of nervous system, neurons - synapse transmitters and neural communication Cardiovascular system respiratory system Basic components of a biomedical system – Transducers selection criteria Piezo electric, ultrasonic transducers Temperature measurements - Fibre optic temperature sensors

MODULE II ELECTRO PHYSIOLOGICAL MEASUREMENTS 10

Electrodes Limb electrodes floating electrodes pregelled disposable electrodes - Micro, needle and surface electrodes Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers Isolation amplifier. ECG, EEG, EMG, ERG Lead systems and recording methods Typical waveforms. Electrical safety in medical environment: shock hazards leakage currentInstruments for checking safety parameters of biomedical equipments.

MODULE III NON-ELECTRICAL PARAMETER MEASUREMENTS 10

Measurement of blood pressure Cardiac output Heart rate Heart sound Pulmonary function measurements spirometer Photo Plethysmography, Body Plethysmography Blood Gas analysers : pH of blood measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements.

MODULE IV MEDICAL IMAGING 09

Radio graphic and fluoroscopic techniques Computer tomography MRI Ultrasonography Endoscopy Thermography Different types of biotelemetry systems and patient monitoring Introduction to Biometric systems.

MODULE V ASSISTING AND THERAPEUTIC EQUIPMENTS 08

Pacemakers Defibrillators Ventilators Nerve and muscle stimulators Diathermy Heart Lung machine Audio meters Dialysers Lithotripsy

Total Hours – 45

REFERENCES:

1. R.S. Khandpur, “Hand Book of Biomedical Instrumentation”, Tata McGraw Hill Publishing Co. Ltd., 2003.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, “Bio-Medical Instrumentation and Measurements”, II Edition, Pearson Education, 2002.

COURSE OUTCOMES:

- Describe the physiology of biomedical system
- Analyze and apply the static and dynamic characteristics of biomedical instrument
- Design and operate various biomedical instrument
- Illustrate the role of electrical, non-electrical, imaging and therapeutic instruments in human health
- Identify and recommend patient safety issues related to biomedical instrumentation.
- Evaluate the output of the imaging instruments

BTCX12	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims to provide the students with the important principles and techniques that are used in the design and analysis of biopharmaceutical engineering processes.

MODULE I INTRODUCTION OF BIOPHARMACEUTICALS 7

Development of drug and pharmaceutical industry – Therapeutic agents, their use and economics Regulatory aspects. current status and future prospects, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals.

MODULE II DRUG METABOLISM AND PHARMACOKINETICS 7

Definition, rationales, absorption, distribution and metabolism pathway. Factors governing, LD50, LC50, ED50, absorption of drug, Pharmacokinetics and Pharmacodynamics, Dose response relationship, interspecies scaling, In vitro studies, In vivo studies. Route of Administration of Drugs, Angle of Injection of drug, Drug Toxicities, Animal Models in Biopharmaceutical Research

MODULE III IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS 8

Bulk drug manufacturers - Type of reactions in bulk drug manufacture and processes - Special requirement for bulk drug manufacture.

MODULE IV MANUFACTURING PROCESSES & THEIR USE 8

Manufacturing Process for Tablets, Dry granulation process, Wet granulation process, Dose conversion from preclinical studies to clinical studies, Route of administration of drugs, angle of injections of drug, different phases of clinical trials of drugs.

MODULE V REGULATORY AGENCIES AND THEIR CONTROL 7

Role of Regulatory agencies in drug development, FDA guidelines for drug development, Patenting process in India, Possible therapeutic intervention against COVID-19, Scheduling process of Drugs, Amphetamines, Cannabinoids,

Benzdizapines, CNS stimulant Drugs, Drug designing against apoptotic mediated diseases

MODULE VI	DRUG MANUFACTURE AND MARKET SPECIFICATIONS	8

Principles of monoclonal antibodies production, design and development of ELISA kit. Monoclonal antibodies in diseases detection and treatment. Role of PCR in microbial, plant and animal cell/ virus detection. manufacture- solutions, suspensions and emulsions. Topical application of ointments, creams, suppositories. Solid dosage forms-powders, granules, capsules, coating of tablets, aerosols. Preservation, packing techniques. Indian pharmacopoeia, Guide to good manufacturing practice.

Total Hours – 45

TEXT BOOKS:

1. Curtis D. Klaassen, Casarett & Doull's Toxicology: The Basic Science of Poisons, 9th edition.

REFERENCES:

1. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, andPatent Issues, CRC Press, 2006.
2. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes intodrugs, 1stEdition, Wiley Liss, 2003.

OUTCOMES:

At the end of the course students will be able to

- Explain the therapeutic mode of action, and understand structural considerations of at least four classes of biopharmaceutical agents.
- Outline the drug manufacturing process including the role of quality control

- Quality assurance in protecting the public, workers, and the environment.
- Give an oral presentation to scientific audience on the biological mechanism of action and proposed evaluation of safety, efficacy and manufacturing controls on a biopharmaceutical age
- Understand the role of regulatory agencies and their importance in drug development
- Apply the concept in drug manufacture and marketing

BTCX13	MEDICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims to build on previous study and, through team-based research, student-led journal clubs and critical evaluation of scientific literature, challenge you to investigate new developments in selected, medical applications of biotechnology**.**

MODULE I **SIMPLE PROTEINS AND THERAPEUTIC AGENTS** **8**

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins Engineering human interferons and human growth hormones Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis.

MODULE II **MONOCLONAL ANTIBODY AS THERAPEUTIC AGENT** **8**

Production of monoclonal antibodies Production of antibodies- Human monoclonal antibodies, its scope and limitations - Hybrid human – Mouse antibodies – in E.coli Approaches for producing HIV therapeutic agents.

MODULE III **HUMAN DISEASES** **8**

Viral and bacterial diseases - Diseases caused by protozoan and parasitic worms (helminths) - Emerging infectious diseases – Active and passive immunity – Autoimmunity- Rational of immunization - Diseases controllable by vaccination – Vaccines, designing vaccines adjuvants - Whole organisms vaccines - Attenuated viruses and bacteria - Inactivation of pathogenic organisms by heat and chemical treatment

MODULE IV **VACCINES** **7**

Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution

MODULE V **APPLICATION OF GENETIC ENGINEERING IN HEALTH CARE** **7**

Production of Recombinant Proteins having therapeutic and diagnostic applications, Recombinant vaccine.

MODULE VI **DIAGNOSIS AND KIT DEVELOPMENT** **7**

Use of enzymes in clinical diagnosis - Use of biosensors for rapid clinical analysis - Diagnostic kit development for microanalysis

Total Hours –45

TEXT BOOKS:

1. Glick, B.R., Pasternak, J. J., Molecular Biotechnology, Principles and Application of Recombinant DNA, ASM press, Washington, 2nd Edition, 1998
2. Ratledge, C., Kristiansen, B., Basic Biotechnology, Cambridge University Press, USA, 2nd Edition, 2001.
3. David, E., Technology and Future of health care, Preparing for the Next 30 years, Jhon Wiley, Singapore, 2nd Edition, 2000.

OUTCOMES:

At the end of the course students will be able to

- Evaluate the theoretical basis and practical application of selected medical biotechnologies
- Demonstrate knowledge and understanding of selected medical biotechnologies
- Describe in detail essential facts and theory in molecular biology and biotechnology when applied to medicine
- Describe and critically evaluate aspects of current research in the biosciences with reference to reviews and research articles
- Apply established techniques of analysis and enquiry within the biosciences.
- Understand the principles behind the production of Vaccines

BTCX14 **DRUG DESIGN AND DEVELOPMENT** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

COB1: To get an overview of drug discovery process

COB2: To obtain knowledge of various drug designing methods.

COB3: To develop skill to understand the computation tools available for drug designing.

COB4: To obtain knowledge about enzyme inhibitors in drug designing

COB5: To learn peptide-based drug designing

COB6: To get familiarized with pre-clinical and clinical trial designs

MODULE I **DRUG DISCOVERY AND DEVELOPMENT** **08**

Organized drug discovery and development – Target identification and validation strategies -Microbial, recombinant - Biochemical and molecular level screening systems and assay development - Alternative strategies in lead identification - Lead optimization.

MODULE II **DRUG DESIGNING** **08**

Rational basis of drug designing, criteria for synthesizing drugs -Drug designing approaches - structure based drug design process - Receptor based design - Drug designing using known receptor structure - Drug design by receptor site fit, active site simulations using PDB structure data and homology modeling-Current research in drug designing, a case study.

MODULE III **COMPUTATION FOR DRUG DESIGNING** **08**

Overview of computer-based tools for drug designing – Ligand Based drug design - Scoring and docking mode-QSAR principles and methods in drug designing - Pharmacophore based drug design. Similarity Principle-Molecular fingerprinting-Tanimoto coefficients- Current research in drug designing, a case study.

MODULE IV **MIMICKING IN DRUG DESIGNING** **07**

Rational design of enzyme inhibitors - Enzyme catalytic principles - Recapitulation affinity labels - Illustrative examples - Principle of suicide inactivation – Design strategies - Scope and limitations. Principles and practice of transition state mimicry – Illustrative examples - HIV protease inhibitors – Collected substrate analog inhibitors and design strategies, illustrative examples.

MODULE V **PEPTIDE BASED DRUG DESIGNING** **07**

Synthetic peptide libraries –Advantages and limitations-venome peptides-Peptide libraries through phage display - Applications in epitope and agretope mapping, synthetic vaccine design - Artificial combinatorial - Peptides, bezodiazepines and other current examples - Selection strategies and screening methodologies .

MODULE VI **DRUG DEVELOPMENT** **07**

Preclinical trials-Pharmacokinetics, pharmacodynamics, toxicity studies, mutagenic tests Clinical trial- Phases and significance-Trial design-randomized control studies - Non-randomized studies-factorial-Hybrid-advantage sand limitations-Role and remit of regulatory authorities-FDA-IND-NDA.

Total Hours –45

REFERENCES:

1. Drug Discovery Glossary, University of Oxford, 2016.
2. David C Young, Computational Drug Design: A guide for Computational and Medicinal Chemists, Wiley Publishers, 2009.

COURSE OUTCOMES

- Obtain overview of drug design and development process.
- Identify and apply the different approaches in drug designing.
- Develop skills to use computational tools, design strategy for drug designing processes
- Be familiar with designing of enzyme inhibitors.
- Compare and contrast the advantages and limitations of peptide - based drug designing.
- Understand the importance of regulatory guidelines in conducting clinical trials.

BTCX15 INTELLECTUAL PROPERTY RIGHTS

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course is aimed at familiarizing researchers with the nuances of Intellectual Property Rights (IPR) so as to help them integrate the IPR process in their research activities.
- To make the students familiar with basics of IPR and their implications in Research, development and commercialization.

MODULE I WTO **8**

As an international agency controlling trade among nations. WTO with reference to biotechnological affairs, TRIPs.

MODULE II GENERAL INTRODUCTION TO PATENT **8**

Patent claims, the legal decision – making process, ownership of tangible and intellectual property. Basic Requirements of Patentability, Patentable subject matter, novelty and the public domain, non-obviousness

MODULE III SPECIAL ISSUES IN BIOTECHNOLOGY PATENTS **8**

Disclosure requirements, Collaborative research, Competitive research, plant,Plant biotechnology Indian patents and Foreign patents, The strategy of protecting plants.

MODULE IV PATENT LITIGATION AND FARMER RIGHTS **8**

Substatritive aspects of patent litigation, Procedural aspects of patent litigation. Farmer rights – PPVFR act – Role and regulations

MODULE V IPR ISSUES IN INDIAN CONTEXT **7**

Role of patent in pharmaceutical industry, computer related innovations, microbiological and biotechnological products

MODULE VI **IPR RELATED CRITICISMS** **6**

Criticisms of Intellectual Property Rights, Politics of Intellectual Property Rights, Third World Criticisms, Marxist Criticisms

Total Hours – 45

TEXT BOOKS:

1. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
2. Intellecutla property rights – Ganguli – Tat McGrawhill
3. Intellectual property right – Wattal – Oxford Publishing House

OUTCOMES:

At the end of the course students will be able to

- Communicate in depth knowledge on selected topics within the area of biotechnology
- Identify current technical problems within the area of biotechnology
- Describe the relationship between patenting and scientific discovery
- Describe the patenting process and how it relates to the international patent authorities and organizations.
- Understand patents as strategic tools in business development
- Understand how intellectual property rights relates to and handles genetic sequences and other biological material

BTCX16 RECOMBINANT DNA TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To establish an understanding of DNA manipulation strategies
- To establish an appreciation of the advantages and disadvantages of novel
- methods for DNA purification, sequencing and mutagenesis
- To be aware of ethical issues associated with DNA engineering and cloning

MODULE I TOOLS OF GENETIC ENGINEERING 7

Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase,Polymerase etc, Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, and virus based vector

MODULE II METHODS OF GENE TRANSFER 7

Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agrobacterium mediated gene transfer, Preparation and application of molecular probes: DNA probes, RNA probes, Radioactive labeling, Non radioactive labeling, use of molecular probes, DNA fingerprinting

MODULE III ANALYSIS AND EXPRESSION OF CLONED GENE IN HOST CELLS 8

Expression vectors, Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins

MODULE IV GENE LIBRARIES 8

cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, Identifying the products of cDNA clones, Isolation, Sequencing and synthesis of gene: Different methods of gene isolation,Techniques of DNA sequencing, Artificial DNA synthesis.

MODULE V MODIFYING GENES 7

Site-directed mutagenesis, Insertion & Deletion Mutagenesis, Polymerase, Chain reaction (PCR): Basic principles, modifications, applications.

MODULE VI APPLICATION OF RDNA TECHNOLOGY 8

Antisense and ribozyme technology, Human genome project and its application, Gene therapy prospect and future, DNA vaccine, Transgenic plants, Current production of rDNA products, Bio-safety measures and regulations for rDNA work.

Total Hours –45

TEXT BOOKS:

- From Genes to Clones by Winnacker. PANIMA
- Molecular Biotechnology by Pasternack and Glick
- From Genes to Genomes: Concepts & Applications of DNA Technology by J.W. Dale & M.V. Schartz
- Gene Cloning & DNA Analysis: An Introduction (4th edition) by T.A. Brown.

REFERENCES:

- Molecular Cloning by Sambrook, et al
- Principles of Gene Cloning by Old and Primrose

OUTCOMES:

- Define recombinant DNA technology and explain how it is used to clone genes
- Compare and contrast different types of vectors and describe practical features of vectors and their applications in molecular biology.
- Discuss how DNA libraries are created and screened to clone a gene of interest.
- Be familiar with RNA interference (RNAi) as a powerful new technique for silencing gene expression
- Understand potential scientific and medical consequences of the Human Genome Project
- Discuss the ethical, legal, and social issues in rDNA technology

BTCX17	MATERIAL SCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce concepts of materials, surface and tissue placement in biomaterial functions
- To understand diverse elements controlling biological responses to materials
- To provide contemporary biomaterial principles

MODULE I INTRODUCTION 8

Fundamentals of biomaterials science. Concept of biocompatibility. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Definition of biomaterials, mechanical properties, surface chemistry of materials, surface modification, Tissue Reaction, Wound Kinetics, Bio Compatibility.

MODULE II METALLIC IMPLANT MATERIALS 8

Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

MODULE III POLYMERIC IMPLANT MATERIALS 8

Polymeric implant materials: Polyolefin’s, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers).Viscoelastic behavior: Importance of molecular structure, hydrophilic and hydrophobic surface properties.

MODULE IV CERAMIC IMPLANT MATERIALS 7

Ceramic implant materials: Definition of bio ceramics. Common types of bio ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).

Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

MODULE V **STERILIZATION OF BIOMATERIALS** **7**

Sterilization techniques: – process and mechanism of action of steam sterilization, radiation sterilization, electron beam sterilization, ethylene oxide, chlorine dioxide and plasma gas sterilization.

MODULE VI **TOXICOLOGICAL SCREENING OF BIOMATERIALS** **7**

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

Total Hours –45

TEXT BOOKS:

1. J.H.U.Brown (Ed), Advances in Bio Medical Engineering, Academic Press 1975.
2. Andrew F.Von Racum, Hand Book of Bio Medical Evaluation, Mc-Millan Publishers, 1980.
3. Jacob Cline, Hand Book of Bio Medical Engineering, Academic Press in Sandiego, 1988.
4. Jonathan Black, Biological Performance of Materials- Fundamentals of bio compatibility, 4th Edition, CRC Press 2005.
5. Larry L. Hench and Julian R.Jones, Biomaterials, Artificial organs and Tissue Engineering, 2005.
6. Buddy D.Ratner,Allan S .Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterial Science; An Introduction to Materials in Medicine,2nd Edition, Elsevier Academic Press,San Diego,2004.

REFERENCES:

1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.

2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.

3. J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.

OUTCOMES:

After completion of this course, students will able to

- Understand the fundamentals of biomaterials science
- Categorize the metallic implant materials
- Elaborate the polymeric implant materials
- Demonstrate the various ceramic implant materials
- Apply the different techniques in sterilization of biomaterials
- Design protocol for various toxicological testing

BTCX18	MOLECULAR AND CELLULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Developing the basic concept of molecular diagnostics
- Understand the techniques involving identification of microorganism
- Understand the techniques of clinical genetics
- Understand immunological diagnostic technique
- understand biosensors activity

MODULE I **INTRODUCTION TO MOLECULAR DIAGNOSTICS** **8**

Collection, preservation and storage of clinical samples, biopsy, Principles, and application of Biological assays used in diagnostics- PCR, ELISA, FISH, Flow cytometry, gene sequencing, microarrays, protein arrays. GLP, SOP and ethics in molecular diagnostics.

MODULE II **DETECTION AND IDENTIFICATION OF MICROORGANISMS** **12**

Specimen Collection, Sample Preparation, Quality Control, Bacterial Targets of Molecular-Based Tests, Molecular Detection of Bacteria, Detection of Respiratory Tract Pathogens, Molecular Testing for Urogenital Tract Pathogens, Mechanism and Molecular Detection of Resistance, Molecular Strain Typing Methods for Epidemiological Studies, Viruses- Human Papillomavirus, HIV-1, Hepatitis C, Dengue, Viral Load Determination

MODULE III **CLINICAL GENETICS** **9**

Overview of Molecular Genetics, Nucleic Acid Amplification, Molecular Detection of Inherited Diseases, Molecular Oncology, Analysis of Human Splicing Defects, Detection of Genomic Duplications and Deletions, Molecular Techniques for DNA Methylation Studies, DNA Microarrays and Genetic Testing, Genetic Counseling, Preimplantation Genetic Diagnosis

MODULE IV **IMMUNODIAGNOSTICS** **8**

Introduction to immunodiagnostics, antigen-antibody reactions, antibody production, antibody markers, CD markers, FACS, Human Leukocyte Antigen (HLA) typing, agglutination (ABO/ Bacterial), immunoprecipitation, immunodiffusion

MODULE V BIOSENSORS 8

Concepts and applications, Biosensors for personal diabetes management, Noninvasive Biosensors in Clinical Analysis, Introduction to Biochips and their application in modern Sciences, Introduction to Nanotechnology.

Total Hours 45

TEXT BOOKS:

1. George P. Patrinos and Wilhelm J. Ansorge (ed.)(2010) Molecular Diagnostics Second Edition, Academic Press

2. Lela Buckingham and Maribeth L. Flaws (2007) Molecular Diagnostics. Fundamentals, Methods, & Clinical Applications. F A Davis Company

OUTCOMES:

On completion of this course, students will able to

- Define function, ethics and basic technique used in molecular diagnostic lab
- Understand different molecular techniques used to identify microbial pathogens
- Understand different molecular biology techniques to identify nucleic acid polymorphisms
- Apply different immunological techniques used in molecular diagnostic lab to identify diseases
- Understand concept of biosensor and its application in diagnostics
- Understand the concept of nanotechnology

BTCX19	BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the application of biomedical instrumentation
- To introduce the student to the various devices of electrical origin and non electrical origin.
- To provide awareness of electrical safety of medical equipments.
- To know the important and modern methods of imaging techniques.

MODULE I **FUNDAMENTALS OF MEDICAL INSTRUMENTATION** **9**

Role of technology in medicine, landmark developments in biomedical instrumentation, physiological systems of the body, sources of biomedical signals, basic medical instrumentation system, performance requirements of medical instrumentation systems, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, Basic components of a biomedical system, Transducers, Piezoelectric, ultrasonic transducers, Temperature measurements, Fibre optic temperature sensors. Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers Isolation amplifier.

MODULE II **THERAPEUTIC EQUIPMENTS AND PATIENT SAFETY** **9**

Audiometers and Hearing Aids, Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart – Lung machine, Dialysers, Lithotripsy, electric shock hazards, leakage currents, safety codes for electromedical equipment, electrical safety analyzer, testing of biomedical equipment.

MODULE III **BIOMEDICAL RECORDER** **9**

Measurement of blood pressure, Heart rate, Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analysers : pH of blood measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements, Electrocardiograph, vectorcardiograph (VCG) , phonocardiograph (PCG),digital stethoscope, electroencephalograph (EEG), electromyography, other biomedical recorders, biofeedback instrumentation.

MODULE IV **CLINICAL INSTRUMENTS AND PATIENT MONITORING SYSTEMS** **9**

Medical diagnosis with chemical tests, spectrophotometry, spectrophotometer type instruments, colorimeters, spectrophotometers, clinical flame photometers, selective-ion electrodes based electrolytes analyser, automated biochemical analysis systems, Radio graphic and fluoroscopic techniques, Computer tomography, MRI, Ultrasonography, X-ray Machines and Digital Radiography, Blood cell counter.

MODULE V **BIOELECTRIC SIGNALS AND ELECTRODES** **9**

Origin of bioelectric signals, recording electrodes, silver-silver chloride electrodes, Electrodes, Limb electrodes, floating electrodes, pregelled disposable electrodes, electrodes for ECG, electrodes for EEG, electrodes for EMG, electrical conductivity of electrode jellies and creams, microelectrodes, Micro, needle and surface electrodes, Typical waveforms, Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters.

Total Hours –45

REFERENCES:

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', McGraw Hill Publishing Co Ltd. 2003
2. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
3. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.
4. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
5. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India)

OUTCOMES:

After the completion of the course

- understand the importance of laboratory safety and standard operating procedures of common laboratory equipment's used in medical sciences
- theoretically trained to with working knowledge of different instruments and be able design experiments
- understand the importance of measurement of blood pressure, ECG and other instruments used as biomedical recorder
- analyze and estimate biomolecules in normal and diseased conditions
- Learn the importance and gain working knowledge of medical test and instruments used in patient monitoring systems
- Understand the principle and working of therapeutic instruments such as hearing aids, vision aids etc and learn about patient safety protocols.

BTCX20	Biosafety and Bioethics	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The aim of this course is to teach biosafety issues, biosafety and biotechnological applications, biosafety in laboratory, waste management, registration, national and international regulations, bio-ethical issues in medicine, environment and genetics, related regulations and laws.

MODULE I **BIOSAFETY** **7**

Introduction to biosafety, biocontaminants, biosecurity and major components, biosafety requirements, bisafety issues, bisafety levels (BSL) -I, II,III, IV, animal biosafety levels (ABSL)-I, II,III, IV, bisafety cabinets and types, types of filters, Safe use of BSC in lab, Biohazards

MODULE II **BIOETHICS** **8**

Introduction of ethics, bioethics, different ethical issues, stem cell technology, its uses and controversies, Biosecurity, Bioterrorism, Biodefense, gene drives, biopiracy, CRISPR, ethical guidelines for biomedical research in human, guidelines for management of cancer, diabetes, retinoblastoma, guidelines for research in transplantation.

MODULE III **GENETICALLY MODIFIED ORGANISM** **9**

Introductions of GMOs, history, advantages and disadvantages, genetic engineering vs traditional breeding, GMO regulation, risk factors, Biosafety : Indian status, traits of GMO, biosafety guidelines in india, GMO uses in food and medicine, Status of GMO today.

MODULE IV **HUMAN CLONING** **8**

Methods of animal cloning, adverse effects and concerns, human cloning, procedure, why human cloning, ethical implications of human cloning, pros and cons of human cloning, future prospect, why no reproductive cloning in humans, legal issues: UK, UN, US, India.

MODULE V **ETHICAL REVIEW AND GUIDELINES** **6**

Specific principles for clinical evaluation of Drugs, devices, diagnostics, vaccines, herbal remedies. specific principles for human genetics and genomic research: pedigree studies, genetic engineering, therapeutic trials including gene therapy.

MODULE VI **LABORATORY ASSOCIATED INFECTION AND BIOSAFETY** **7**

Survey of lab associated infection with various agents, disease transmission and infection, biosafety in microbiology lab, management of laboratory accident, laboratory hazard: chemical, accidental, fire, electrical, noise. Safety organisation and training programs, biotech patenting in india and key issues.

Total Hours – 45

TEXT BOOKS:

Legal Perspectives on Bioethics by Ana S Iltis & Sandra H Johnson & Barbara A Hinze

Genetically Modified Microorganisms Han, Lei

OUTCOMES:

On the completion of course student will be able to know:

- the importance of safety related to biological hazards and how to handle that.
- the ethics related to every field nowadays.
- the good lab practices and the recent status of GMO and human cloning worldwide.
- Understand ethical review and guidelines
- Understand lab protocols
- Understand safety organization and programes

BTCX21 HEALTHCARE BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- This course will enable students to acquire knowledge on the fundamentals of healthcare biotechnology. It enables them to understand emerging and advanced concept in molecular pathogenesis of disease and role of biotechnology in diagnosis, prevention and therapeutics.
- This programme will facilitate the students to acquire knowledge in fields various aspects and molecular tools used in clinical application in alleviation of human disease.
- It will also empower the students to have advanced focus on the molecular basis of diseases and development of advanced therapeutics.

MODULE I Introduction and Therapeutic Biomolecules 7

Molecular basis of disease, Biotechnology in disease prevention, therapeutics and diagnosis, Personalized Medicine; Therapeutic Biomolecules: Introduction, Nucleic acid, protein, carbohydrate and lipids, Role of biomolecules in diseases.

MODULE II Molecular diagnostics and Immunological products 8

Molecular diagnostics: gene based diagnosis, tools for screening of infectious disease, genetic disease; Immunological products: Overview, Vaccines, Cancer immunotherapy, Monoclonal Antibodies in Solid Organ Transplantation Monoclonal Antibodies in Anti-inflammatory Therapy.

MODULE III Oligonucleotides and Oligosaccharides 8

Oligonucleotides: Overview, Gene therapy, Antisense therapy, Ribozyme; Oligosaccharides: Overview, Oligosaccharide synthesis, Heparin, Glycoproteins, Polysaccharide bacterial vaccines, Approaches to carbohydrate based cancer Vaccines

MODULE IV Radiological Agents and Cardiovascular Drugs and endocrine drugs 8

Radiological Agents: Radiosensitizers and Radioprotective agents; Cardiovascular Drugs and endocrine drugs: Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents, Anticoagulants, antithrombotics and Haemostatics, Sex hormones and analogs.

MODULE V Chemotherapeutic Agents 8

Chemotherapeutic Agents: Synthetic antibacterial agents, antifungal, anti protozoal, Antihelminithic agents Antiamoebic agents, Antiviral agents

MODULE VI Drug Targeting 6

Drug Targeting: Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery.

Total Hours –45

REFERENCES:

1. Pharmaceutical Chemistry by Christine M. Bladon. John Wiley & Sons, Ltd.(2002).

2. Burger's Medicinal Chemistry and Drug Discovery (5th edition) by Manfred E.Wolff. A Wiley (2000).

3. Drug Targeting Organ-Specific Strategies by Grietje Molema and Dirk K. F. Meijer. Wiley-VCH. (2002).

4. Medical Biotechnology, by Judit Pongracz, Dr. Habil and Mary Keen. Churchill Livingstone (2008).

5. Healthcare Biotechnology: A Practical Guide 1st Edition by Dimitris Dogramatzis. CRC Press (2010)

6. Biotechnology in Healthcare: An Introduction to Biopharmaceuticals. Gavin Brooks,Pharmaceutical Press, (1998)

7. Biotechnology in Medical Sciences,By Firdos Alam Khan, CRC press, Taylor and Francis, (2014)

OUTCOMES:

The students will be able

- To understand therapeutic biomolecules and their applications
- To get knowledge of molecular diagnostics know the applications of oligonucleotides and oligosaccharides
- Understand principles of chemotherapeutic agents
- Understand drug targeting
- Understand carbohydrate-based cancer therapeutics
- Understand therapeutic molecules

BTCX22	MOLECULAR PHARMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce molecular pharming
- To create complete knowledge about the recombinant protein production.
- To create awareness about the production of pharmaceutical proteins in plants

MODULE I **INTRODUCTION AND FOREIGN PROTEIN EXPRESSION** **8**

Introduction, foreign protein production systems -Plant tissue culture - Suspended cultures. Hairy root cultures, shoot teratoma cultures. Strategies for improving FP production in tissue culture. modifications to existing expression constructs. Secretion of foreign proteins - Foreign protein stability - Stability inside the cells

MODULE II **NOVEL SPROUTING TECHNOLOGY FOR RECOMBINANT PROTEIN PRODUCTION** **8**

Biology of sprouting - Dicotyledonous seeds - Germination, sprout Rubisco synthesis, rubisco promoters- Inhibition of endogenous gene expression - Expression cassette design, sprouting- equipments, conditions - Sterilization, time and temperature, light, inhibition of endogenous gene expression, Growth regulators, nitrogen fertilizer - Seed production, quality and environmental aspects

MODULE III **MONOCOT AND PLANT VIRAL EXPRESSION SYSTEMS** **8**

Technical aspects, cereal transformation, expression construct design - Prodigene and Maize. Recombinant proteins expressed in Rice - Recombinant proteins expressed in Wheat, Barley. Plant RNA viruses as expression vectors- TMV, PVX - Plant RNA viruses as expression vectors- CPMV, AIMV. Biological activity of target molecules. Efficacy of plant virus antigens. Vaccine antigens- particle based

MODULE IV **CHLOROPLAST DERIVED ANTIBODIES, EDIBLE VACCINES** **7**

Introduction, expression of therapeutic and human proteins in plants. Transgenic chloroplast system. Chloroplast derived human antibodies, biopharmaceuticals. Human Serum Albumin. Human insulin like growth

factor-1, Human interferon, Antimicrobial peptides. Chloroplast derived vaccine antigens, *Cholera* toxin B subunit, *Bacillus anthracis* protective antigen. *Yersinia pestis* F1-V fusion antigen, Canine Parvovirus VP2 protein.

MODULE V **DOWNSTREAM PROCESSING OF PLANT DERIVED RECOMBINANT THERAPEUTIC PROTEINS** **7**

Similarities and differences in the processing of pharmaceutical proteins from different sources Process scale. Individual steps of a Downstream process. Initial processing and extraction Chromatographic purification, Regulatory requirements for downstream processing of plant derived products. Regulatory requirements for downstream processing of plant derived products.

MODULE VI **PRODUCT ISSUES** **7**

Biosafety aspects of molecular farming in plants; A top-down view of molecular farming from the pharmaceutical industry: requirements and expectations; The role of science and discourse in the application of the precautionary approach

Total Hours –45

TEXT BOOKS:

1. Molecular Farming, Amita Sarkar, 2019, Discovery Publishing Pvt.Ltd

REFERENCES:

1. Molecular Farming – Plant-made Pharmaceuticals and Technical Proteins, Rainer Fischer and Stefan Schillberg. Wiley.VCH Verlag GmbH and Co. KGaA. 2004

2. Molecular Pharming: Applications, Challenges and Emerging Areas 1st Edition, Allison R. Kermode, Liwen Jiang 2017

OUTCOMES:

After the completion of course, students will able to

- Understand the concepts of foreign proteins
- Understand the novel sprouting technology in rDNA production
- Elaborate the various expression systems
- Design the methodology for vaccine production
- Demonstrate the regulatory measures in therapeutic proteins
- Discuss the various ethical issues in molecular pharming

BTCX23	STEM CELLS IN HEALTH CARE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the underlying principles and applications in the emerging field of Stem Cell Technology
- To analyze the key concepts used in the debate about stem cell research
- To list the properties that define a stem cell and explain hoe stem cells are derived for scientific research
- To list the common and extrapolated potential clinical uses of stem cells

MODULE I INTRODUCTION TO STEM CELLS 7

Stem Cell Biology, Fate Mapping of Stem Cell, Stem Cell Pattern, differentiated parental DNA chain causes stem cell pattern of cell type switching in *Schizosaccharomyces pombe*

MODULE II CELL CYCLE CONTROL 7

Checkpoints, and Stem Cell Biology, Senescence of Dividing Somatic Cells, The Drosophila Ovary, An In Vivo Stem Cell System, Male Germ-line Stem Cells

MODULE III PRIMORDIAL GERM CELLS 8

Primordial Germ Cells as Stem Cells, Embryonic Stem Cells, Embryonal Carcinoma Cells as Embryonic Stem Cells, Trophoblast Stem Cells

MODULE IV HEMATOPOIETIC STEM CELLS 8

Repopulating Patterns of Primitive Hematopoietic Stem Cells,Molecular Diversification and Developmental Interrelationships, Hematopoietic Stem Cells:Lymphopoiesis and the Problem of Commitment Versus Plasticity, Hemangioblast, Mesenchymal Stem Cells of Human Adult Bone Marrow

MODULE V TYPES OF STEM CELLS 7

Stem Cells and Neurogenesis, Epidermal Stem Cells: Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon

MODULE VI APPLICATION OF STEM CELLS 8

Cancer stem cells, neural stem cells for CNS repair, embryonic stem cells for heart diseases, stem cells in treatment of diabetes, stem cells in regenerative medicine, stem cell gene therapy

Total Hours –45

TEXT BOOKS:

Essentials of stem cell biology, Robert Lanza, 2nd Ed, Academic press, 2009

Stem cell biology in health and diseases. Thomas Dittmar and Kurt S. Zänker, Springer, 2009

Stem cell biology and Gene therapy. PETER J. QUESENBERR, Wiley, 2003

REFERENCES:

Developments in stem cell research. Prasad S Koka, Nova biomedical books, 2009

OUTCOMES:

- Search and read current stem cell technology literature applied to a particular problem domain
- Classify tumor stem cells which give rise to metastases and treatment-resistant remnant cells that cause relapse, and
- understand the impacts on the development of future cancer treatment strategies.
- Outline how stem cells are currently being used in the clinic and what kinds of future treatments lie on the horizon. Students will also be exposed to current Norwegian projects lying at the frontier of stem cell research
- To demonstrate an interdisciplinary understanding of central concepts in tissue engineering, biomaterials and stem cell science
- critically evaluate different methods and techniques used

BTCX24	Transport phenomena in Bioprocess	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand various laws in momentum transfer, types of fluids, viscosity & measurement and factors effecting it
- To understand isothermal system, mixing mechanisms and power requirement for Newtonian and Non-Newtonian fluids.
- To demonstrate the mechanisms of heat transfer in stirred tank reactor.
- To understand the requirement and effect of oxygen in the process.
- To understand the diffusional properties and various film theory concepts.

MODULE I **MOMENTUM TRANSPORT-I** **7**

Mechanism of Momentum Transport: Newton's Law of Viscosity, Non- Newtonian fluids, theory of viscosity of liquids, time dependent viscosity, viscosity measurement (cone-and-plate viscometer, coaxial cylinder rotary viscometer, impeller viscometer), use of viscometers with biological reaction fluids, rheological properties of fermentation broth, factors affecting broth viscosity (cell concentration, cell morphology, osmotic pressure, product and substrate concentration), Velocity distribution in laminar flow and turbulent flow

MODULE II **MOMENTUM TRANSPORT-II** **8**

Equation of change for isothermal system (equation of continuity, equation of motion, equation of mechanical energy), interphase transport in isothermal systems (friction factors for flow in tubes and in packed columns) mixing, mixing mechanism, power requirements in ungassed Newtonian and Non Newtonian fluids, gassed fluids, interaction between cell and turbulent Eddies, operating conditions for turbulent shear damage. Macroscopic Balances- mass, momentum and mechanical energy balances.

MODULE III **ENERGY BALANCES** **8**

Shell energy balances, temperature profiles, average temperature, energy fluxes at surfaces, Equations of change (non-isothermal), equation of continuity, equation of motion for forced and free convection, equation of energy (non-isothermal). Shell mass balances, concentration profiles, average concentration, mass flux at surfaces, Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component).

MODULE III **ENERGY TRANSPORT** **7**

Thermal conductivity and the mechanisms of energy transport- measurement of thermal conductivity, Fourier's law, steady state conduction, analogy between heat and momentum transfer. Temperature distribution with more than one independent variables- heating in a semi-infinite and finite slab, temperature distribution in

turbulent flow-reference to stirred tank reactor, relationship between heat transfer, cell concentrations and stirring conditions

MODULE IV MASS TRANSPORT 8

Diffusivity, theory of diffusion, analogy between mass heat and momentum transfer, role of diffusion in bioprocessing, film theory, concentration distribution with more than one independent variable- unsteady diffusion, boundary layer theory, concentration distribution in turbulent flow- Corrosion equation. Definition of binary mass transfer coefficients, transfer coefficients at high mass transfer rates-boundary layer theory, penetration theory. Convective mass transfer, Liquid -solid mass transfer, liquid-liquid mass transfer, gas-liquid mass transfer

MODULE V OXYGEN TRANSPORT 7

Oxygen uptake in cell cultures, Factors affecting cellular oxygen demand, oxygen transfer from gas bubbles to aerobic culture, oxygen transfer in fermenters, bubbles factors affecting oxygen transport- sparging, stirring, medium properties, antifoam agents, temperature, mass transfer correlations, measurements of kLa – oxygen balance method, dynamic method.

Total Hours –45

TEXT BOOKS:

1. R. B. Bird, W. E. Stewart, E. N. Lightfoot, Transport Phenomena, 2ndedition, John Wiley and sons Singapore, 2006.
2. P. M. Doran, Bioprocess Principles, 2nd edition, Academic Press, 2012.
3. Harvey W. Blanch, Douglas S. Clark Biochemical Engineering, Marcecel, Dekker, 2007.
4. Byron, R. B., Stewart, W. E., Lightfoot, E. N., “Transport Phenomena”, John Wiley & Sons, 1960.

REFERENCES:

1. M. L. Shuler and F. Kargi, Bioprocess Engineering: Basic concepts, 2nd edition, Prentice Hall of India, 2003.

OUTCOMES:

- Assessment by ability to differentiate Newtonian and Non-Newtonian fluids.
- Assessment by ability to demonstrate interphase transport in isothermal system and interactions.
- Assessment by ability to demonstrate the effect of heat transfer on cell concentration and stirring conditions in stirred tank reactor.
- Assessment by ability to analyze and demonstrate the diffusion concepts during the transport.
- To understand the requirement and effect of oxygen in the process.

- Understand oxygen transport and balance method

Physics Elective Courses

(to be offered in II Semester)

PHCX 01	FUNDAMENTALS OF ENGINEERING MATERIALS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To help students to acquire the properties and applications of conducting and semiconducting materials.
- To familiarize students with basic ideas about the properties of dielectric and magnetic materials and their applications.
- To familiarize students with basic knowledge of nanomaterials and its electrical, electronic, mechanical and magnetic properties.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I CONDUCTING AND SEMICONDUCTING MATERIALS **7**

Conductors: properties, Fermi distribution function, Fermi energy in metals-density of states- conducting polymers-properties-applications, semiconductors: intrinsic and extrinsic semiconductors-carrier concentration, conductivity and energy band gap, semiconducting polymers-properties- applications.

MODULE II DIELECTRIC MATERIALS **8**

Polarization- dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – Internal field - Clausius Mosotti relation - dielectric loss – dielectric breakdown – applications of dielectric materials (capacitors and transformers) – Pyroelectricity, Piezoelectricity, ferroelectricity and applications in Ferroelectric Random Access Memory (FeRAM) - multiferroic materials and its applications.

MODULE III MAGNETIC MATERIALS **7**

Origin of magnetism-magnetic moment, susceptibility, permeability – Bohr magneton – Dia, Para and Ferro magnetism –Spontaneous magnetization-Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its application - Giant Magneto-resistance effect (GMR) - Magnetic resonance imaging(MRI).

MODULE IV NANOMATERIALS 8

Properties of nanomaterials – size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties – quantum confinement – classification of nanomaterials –quantum well, quantum wire, quantum dot - nanoporous materials - carbon nanotubes, graphene - nanocomposites – applications of nano materials.

PRACTICALS

1. Determination of energy band gap of a semiconductor.
2. Determination of resistivity of metals by four point probe method.
3. Determination of dielectric constant of dielectric material.
4. Determination of time constant of a capacitor using RC circuit.
5. Determination of paramagnetic susceptibility of given liquid.
6. Determination of hysteresis loss in a transformer using BH curve.
7. Analysis of size effect on the absorption spectrum of nanomaterials.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. William D. Callister, “Material Science and Engineering”, Wiley Publications, 2006.
2. Raghavan, V., “Materials Science and Engineering”, 5th edition, Printice Hall of India Pvt Ltd. New Delhi, 2004.
3. Wahab. M.A, “Solid State Physics: Structure and Properties of Materials”, Narosa Publishing House Pvt. Ltd., New Delhi , 2nd Edition, 2010.
4. Pillai, S.O., “Solid State Physics”, New Age International, New Delhi, 2005.
5. Charles P. Poole and Frank J. Owens, ”Introduction to nanotechnology”, Wiley (India), 2009.
6. Pradeep. T., “Textbook of Nanoscience and Nanotechnology”, McGraw Hill Education (India) Private Limited, New York, 2012.

OUTCOMES:

On completion of this course, the student will be able to

- apply the concepts of conducting and semiconducting materials for solid state devices.
- comprehend the significance of properties of dielectric magnetic materials and derive these properties from synthesized materials.
- differentiate between the properties of the nanomaterials compared to bulk materials.
- complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 02	HEAT AND THERMODYNAMICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To familiarize students with basic concepts of heat.
- To help students acquire the fundamentals of heat conduction and radiation.
- To enable students acquaint with the basics of thermodynamic concepts.
- To make students understand the fundamentals of heat based experiments.

MODULE I CONCEPTS OF HEAT **10**

Definition of temperature, thermal and thermodynamic equilibrium - relationship between temperature and kinetic energy - definition of solid, liquid, gas - Introduction to phase transitions, critical and triple points- definition of heat capacity, mechanical equivalent of heat -Joule's calorimeter- latent heat- microscopic model of ideal gas - equation of state, internal energy, equipartition theorem- equation of state for non-ideal gases.

MODULE II CONDUCTION AND RADIATION **10**

Thermal conductivity – rectilinear flow of heat – thermal conductivity of a good conductor – Forbe’s method – thermal conductivity of a bad conductor – Lee’s disc method – conduction of heat through compound media - radiation – Planck’s law of blackbody radiation – Wien’s law – Stefan’s law – Newton’s law of cooling from Stefan’s law – Solar constant – Pyrometry.

MODULE III FUNDAMENTALS OF THERMODYNAMICS **10**

Thermodynamic equilibrium – zeroth law of thermodynamics – first law of thermodynamics – Reversible and irreversible processes – second law of thermodynamics - Heat engine – Carnot’s engine – Carnot’s theorem – Internal combustion engines – petrol and diesel engines (qualitative) – Entropy and available energy – temperature – entropy diagram for Carnot’s cycle - Third Law of thermodynamics (qualitative).

PRACTICALS

1. Determination of mechanical equivalent of heat by Joule's calorimeter.
2. Relation between temperature of a body and time by plotting a cooling curve-Newton's law of cooling.
3. Determination of specific heat capacity of liquid by cooling.
4. Determination of thermal conductivity of a good conductor-Forbe's method
5. Determination of thermal conductivity of a bad conductor-Lee's disc method

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur. D.S, "Heat & Thermodynamics", S.Chand & Co., 2009.
2. Brijlal & Subramaniam, "Heat and Thermodynamics", S.Chand & Co, Delhi, 2010.
3. Gupta. A.B and Roy. H, "Thermal Physics", Books and Allied Ltd., 2002.
4. Sharma. J.K and Sarkar. K.K, "Thermodynamics and statistical Physics", Himalaya Publishing House, 1988.

OUTCOMES:

On completion of this course, the student will be able to

- understand the concepts of heat and its properties.
- comprehend the ideas governing the conduction and radiation processes.
- apply the knowledge of laws of thermodynamics in thermodynamic systems.
- perform heat based experiments and determine its various properties.

PHCX 03	INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To acquire basic knowledge about the nanomaterials and applications.
- To learn about the synthesis and imaging techniques of nanomaterials.
- To gain the basic concepts of fabrication techniques.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I NANOMATERIALS AND APPLICATIONS 10

Properties of nanomaterials – size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties – quantum confinement – classification of nanomaterials – quantum well, quantum wire, quantum dot - nanoporous materials - zeolite, mesoporous materials, carbon nanotubes, grapheme - nanocomposites - applications (qualitative): Molecular electronics-nanoelectronics – nanophotonics - single electron transistor-drug delivery.

MODULE II SYNTHESIS AND IMAGING TECHNIQUES 12

Top-down and bottom up approaches – mechanical alloying and mechanical ball milling - sol-gel approach - hydrothermal method - precipitation method - spray pyrolysis - spin coating-self assembled monolayer (SAM) - Chemical vapour deposition method – Physical vapour deposition method: laser ablation method, sputtering method.

Optical microscopy – Phase contrast and interference microscopy – confocal microscopy - high resolution Scanning electron microscope (HRSEM) - high resolution Transmission electron microscope (HRTEM) - Atomic force microscope - Scanning Tunnelling microscope (STM).

MODULE III NANOFABRICATION 8

Photolithgraphy - electron beam lithography - X-ray and Ion beam lithography - nanoimprint lithography - soft lithograpy - nanoelectromechanical systems (NEMS) - nanoindentation principles.

PRACTICALS

1. Synthesis of nanomaterials by sol-gel method.
2. Synthesis of nanomaterials by hydrothermal method.
3. Synthesis of nanomaterials by solid state reaction method.
4. Synthesis of nanomaterials by chemical bath deposition method.
5. Synthesis of nanomaterials by co-precipitation method.
6. Synthesis of nano thin films by spray pyrolysis method.
7. Synthesis of nano thin films by pulsed laser deposition (PLD) method.
8. Analysis of size effect on the absorption spectrum of nanomaterials.
9. SEM characterization of nanomaterials.
10. AFM characterization of nano thin films.
11. Phase confirmation by XRD.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Charles P.Poole and Frank J. Owens, ”Introduction to nanotechnology”, Wiley (India), 2009.
2. Cao. G., “Nanostructures & Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004.
3. Gaddand. W., Brenner. D., Lysherski. S. and Infrate. G.J., “Handbook of NanoScience Engineering and Technology”, CRC Press, 2002.
4. Pradeep. T., “Textbook of Nanoscience and Nanotechnology”, McGraw Hill Education (India) Private Limited, New York, 2012.
5. Chris Mack, “Fundamental Principles of Optical Lithography: The Science of Microfabrication”, John Wiley & Sons, 2008.
6. Bandyopadhyay A.K., “Nano Materials”, New Age International Publishers, New Delhi, 2008.

OUTCOMES:

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

- understand the importance and basic concepts of the nanomaterials.
- comprehend the imaging techniques for nanomaterials.
- illustrate the various nanofabrication techniques.
- complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 04 LASERS AND THEIR APPLICATIONS L T P C

2 0 2 3

OBJECTIVES:

- To recognize the fundamentals of laser and its characteristics.
- To comprehend and compare the different laser systems.
- To apply lasers in metrology and material processing.
- To understand the working of laser instrumentation.
- To correlate the experimental results for applications.

MODULE I LASER THEORY 8

Spontaneous and stimulated emission - Population inversion – Einstein's A & B coefficients - Threshold condition – super-radiance Laser – Three level and four level laser systems -conditions for CW and pulsed laser action. Q-Switching - experimental methods - cavity dumping - Mode locking - experimental methods - Spatial and Temporal coherence.

MODULE II DIFFERENT LASER SYSTEMS 8

Laser systems – General description - Laser structure - excitation mechanism - Different laser systems- He-Ne laser, Carbon-dioxide laser - Excimer laser – Free electron laser- Alexandrite laser - Ti-Sapphire laser – Semiconductor diode laser - Diode pumped solid state laser - Pulsed-CW dye laser- Fibre laser.

MODULE III METROLOGICAL AND MATERIAL PROCESSING APPLICATIONS 8

CW and Pulsed laser beam characteristics and its measurements - Beam focusing effects - spot size - Power and Energy density Measurements - Distance measurement - Interferometric techniques - LIDARS - different experimental arrangements - Pollution monitoring by remote sensing - Laser gyroscope - Laser welding, drilling, machining and cutting - Laser surface treatment - Laser vapour deposition – Biophotonic applications.

MODULE IV LASER INSTRUMENTATION 7

Laser for measurement of length, current and voltage – Laser Doppler Velocimetry - Holography and speckle in displacement and deformation measurements - Laser for communication with fiber optics as channel.

PRACTICALS

1. Tuning of Dye Laser using DFDL Arrangement
2. Determination of Brewster Angle using He-Ne laser
3. Study of transversely Pumped Dye Lasers
4. Study of longitudinally Pumped Dye Lasers
5. Determination of power and wavelength using Distributed Feedback Dye Laser (DFDL)
6. Determination of fibre optic losses using semiconductor laser.
7. Bandgap determination of a semiconductor diode.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. William T. Silfvast, “Laser Fundamentals”, Cambridge University Press, 2009.
2. Ghatak. A. & Thyagarajan. K. “Optical Electronics”, Cambridge University, 1994.
3. Laud.B.B., “Laser and Non-Linear Optics”, Second Edition, New Age International (p) Limited Publishers, 2011.
4. Nambiar. K.R., “Lasers Principle, Types and Applications”, New Age International (p) Ltd, 2004.
5. Wilson. J. & Hawkes. J.F.B., “Opto Electronics - An Introduction”, Prentice Hall, 1992.
6. William M.Steen, ”Laser Material Processing”, Springer-Verlag, Berlin, Third Edn., 2005.

OUTCOMES:

At the end of the course, the students will be able

- To complement the knowledge acquired in the theory class.
- To work with dye lasers for tunability of laser wavelength.
- To measure the loss of information involved in fibre optic communication.
- To correlate the results for application.

PHCX 05	MATERIALS SCIENCE	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To gain basic knowledge in conducting and semiconducting materials and their properties.
- To provide basic understanding of properties and applications of dielectric materials.
- To impart knowledge on magnetic and optical materials and their properties & applications.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I CONDUCTING AND SEMICONDUCTING MATERIALS **10**

Quantum free electron theory of metals and its importance - Energy distribution of electrons in metals - Fermi distribution function - Density of energy states and carrier concentration in metals - Fermi energy – Classification of solids into conductors, semiconductors and insulators on the basis of Band theory – Introduction to Elemental and Compound semiconductors - Carrier concentration derivation for Intrinsic semiconductors - Density of electrons in conduction band & Density of holes in valence band- intrinsic carrier concentration - Fermi energy & Variation of Fermi energy level with temperature - Mobility and electrical conductivity - Band gap determination.

MODULE II DIELECTRIC MATERIALS **7**

Introduction to dielectric materials & basic definitions – Electronic, Ionic, Orientation & Space charge polarizations - Total polarization – Frequency and temperature dependence of polarization - Internal field in a dielectric material - Deduction of Clausius - Mosotti's relation - dielectric loss & loss tangent – Different types of dielectric breakdown – Applications of dielectric materials : Capacitors and Transformers.

MODULE III MAGNETIC MATERIALS 6

Introduction to magnetic materials & origin of magnetic moment - Different types of magnetic materials and their properties - Ferromagnetism & Domain theory of ferromagnetism - Hysteresis, Soft and Hard magnetic materials - Antiferromagnetic materials - Ferrites and its applications – Applications of magnetic materials : Data storage.

MODULE IV OPTICAL MATERIALS 7

Optical properties of semiconductors - Direct and Indirect bandgap semiconductors – Traps, recombination centre, color center and exciton – Luminescence : Fluorescence and Phosphorescence - Liquid crystal display : twisted nematic crystal display – Applications of Optical materials - Optical Sources : light emitting diode and laser diode - Photo detectors : PIN photodiode and Avalanche Photodiode - Pyroelectric devices - Electro optic effect : Kerr effect and Faraday effect.

PRACTICALS

1. Resistivity measurement of a semiconductor using four point probe method.
2. Determination of band gap of a semiconductor diode.
3. Determination of Hall coefficient of a given semiconductor material.
4. Determination of dielectric constant of a given non-polar liquid.
5. Determination of magnetic susceptibility of a given paramagnetic liquid using Quincke's method.
6. Determination of energy loss of a given transformer core using hysteresis method.
7. To study the I-V characteristics of a photodiode.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Palanisamy P.K., ''Physics II'', Material Science for ECE, Scitech Publications (India) Pvt. Ltd., 2006.
2. Kasap. S.O., ''Principles of Electronic materials and devices'', McGraw Hill Publishers, 3rd Edition, 2007.
3. Arumugam. M, "Physics II'', Material Science for ECE, Anuradha Publishers, 5th Edition, 2005.

4. Sze. S.M., ‘’Semiconductor Devices – Physics and Technology’’, John Wiley, 2nd Edition. 2002.
5. Raghavan. V, ‘’Materials Science and Engineering’’, Prentice Hall of India, 5th Edition, 2004.

OUTCOMES:

On the completion of this course, the students will be able to

- Gain knowledge about fundamentals of conducting and semiconducting materials.
- Understand concepts and applications of Dielectric and Magnetic materials.
- Familiarize Optical materials and their applications in Engineering and Medical fields.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 06 NON-DESTRUCTIVE TESTING L T P C

2 0 2 3

OBJECTIVES:

- To study the process and applications of ultrasonic inspection method.
- To understand the basic concepts of radiographic inspection method.
- To acquire the knowledge about the various surface Non-Destructive Testing (NDT) techniques.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I ULTRASONIC INSPECTION METHOD 10

Ultrasonic Testing - Principle of operations - types of sound waves - types of Transducers - transmission and pulse-echo method - straight beam and angle beam, instrumentation - calibration methods - ultrasonic testing technique- data representation, A Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight. Diffraction - thickness determination - advantages, disadvantages and applications.

MODULE II RADIOGRAPHIC INSPECTION METHOD 10

Radiographic testing – Principle - Interaction of X-ray with matter - X-ray radiography - method of generation-industrial radiography inspection techniques – Equipment - Exposure charts - Types of films – Fluoroscopy - Xero-Radiography – Limitations - Gamma radiography - Equipment, radiation sources - method of generation - film processing - interpretations of radiography - safety in industrial radiography.

MODULE III SURFACE NDT TECHNIQUES 10

Liquid Penetrant Testing – Principles, Characteristics and types of liquid penetrants – developers - advantages and disadvantages of various methods - Inspection Procedure and Interpretation of results. Applications of Liquid Penetrant testing.

Magnetic Particle Testing - Principle-magnetizing technique - procedure – equipment - Interpretation and evaluation of test indications - applications and limitations - demagnetization.

PRACTICALS

1. Inspection of welds using solvent removable visible dye penetrant.
2. Inspection of welds using solvent removable fluorescent dye penetrant.
3. Inspection on non magnetic materials by eddy current method.
4. Inspection on magnetic materials by eddy current method.
5. Inspection of welds by Eddy current Testing.
6. Inspection of welds by Magnetic Particle Testing - Dry method.
7. Inspection of welds by Magnetic Particle Testing - Wet method.
8. Ultrasonic flaw detector - Inspection of defects.
9. Demonstration of Radiographic inspection.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Baldev Raj., Jayakumar T.,Thavasimuthu., “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash., “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook of Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, Volume-17, 2000.
4. Paul E Mix,”Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005.
5. Charles J., Hellier, “Handbook of Nondestructive evaluation”, McGraw Hill, New York, 2001.

OUTCOMES:

Upon completion of this course, the students will be able to

- illustrate the ultrasonic inspection methods of NDT.
- understand the basic concept of radiographic inspection method.
- test the surfaces by the various surface NDT techniques.
- complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 07	PROPERTIES OF MATTER AND ACOUSTICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand principles and properties of elasticity.
- To understand the basic concepts and application of viscosity.
- To analysis acoustic of building.
- To know about photoelasticity and its applications.

MODULE I ELASTICITY **8**

Stress and strain - Hooke's Law of elasticity - Elastic moduli - Stress-Strain Diagram - Poisson's Ratio - Relation between elastic constants - Work done in stretching and twisting a wire - Twisting couple on a cylinder- Expression for bending moment - Cantilever–Expression for depression - Uniform bending and Non-uniform bending of beams (theory & experiment) - I form Girders (qualitative treatment) and applications.

MODULE II VISCOSITY **8**

Viscosity- Newton’s formula for viscous flow - Streamline and turbulent motion - Reynolds number - Poiseuille's formula - Determination of coefficient of viscosity- factors affecting viscosity - capillary flow method - Stoke's formula- viscosity of highly viscous liquids – Stoke’s method - Lubricants and its applications –viscosity measurements - Viscometer - Variation of Viscosity with Temperature.

MODULE III ACOUSTICS OF BUILDING **7**

Basic requirement for the acoustically good halls - Reverberation and time of reverberation – Sabine’s formula for reverberation time - Absorption coefficient and its measurement -Transmission of sound and transmission loss - Factors affecting the architectural acoustics and their remedy-sound absorbing materials - vibration and noise control systems for buildings.

MODULE IV PHOTOELASTICITY **7**

Polarization - double refraction - Theory of Plane, Circularly and Elliptically polarized light - Quarter wave plate and half wave plate - photo elasticity - Theory of photo-elasticity - Stress optic relations - model materials - analysis

techniques - Photo elastic bench - Three dimensional photo elasticity - Digital photo elasticity - Photo elastic coatings.

PRACTICALS

1. Determination of viscosity of liquid by Poiseuille's method.
2. Determination of viscosity of liquid by Stoke's method.
3. Analysis of stress by photo elastic method.
4. Verification of Hooke's law by spring method.
5. Determination of Young's modulus of the cantilever beam.
6. Determination of rigidity modulus by static torsion method.
7. Visit to acoustically good auditorium and identifying the sound absorbing materials in the auditorium.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur D.S., "Elements of Properties of Matter", S.Chand & Co, Delhi, 2009.
2. Gaur R.K., Gupta S.L.,"Engineering Physics", Dhanpat Rai Publishers, 2010.
3. Brijlal and Subramaniam.," Properties of Matter", Eurasia Publishing Co, New Delhi, 2002.
4. Smith C.J.," General Properties of Matter", Orient & Longman,1960.
5. Kenneth G. Budinski and Michel K., Budinski, "Engineering Materials Properties and Selection", Pearson, Singapore, 2002.

OUTCOMES:

Upon completion of this course, the students will be able to

- understand the basic concepts of the elasticity of materials.
- comprehend the concepts of viscosity of liquid and measurement.
- demonstrate the acoustical aspects of building and its importance in construction.
- apply the fundamental concept of photo elasticity for the stress analysis of the object.

PHCX 08	PROPERTIES OF MATTER AND NONDESTRUCTIVE TESTING	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To impart knowledge about the principles and properties of elasticity.
- To learn the laws governing the dynamic of rigid bodies.
- To acquire the knowledge of the various techniques of Non-Destructive Testing (NDT) of materials.
- To understand the principle and basic concept of low temperature applications.

MODULE I ELASTICITY **8**

Stress and strain - Hooke's Law of elasticity - Elastic moduli - Stress-Strain Diagram - Poisson's Ratio - Relation between elastic constants - Work done in stretching and twisting a wire - Twisting couple on a cylinder- Expression for bending moment-Cantilever–Expression for depression - Uniform Bending and Non-uniform bending of beams (theory & experiment) - I form Girders (qualitative treatment) and applications.

MODULE II DYNAMICS OF RIGID BODIES **8**

Rigid bodies - angular acceleration - Torque on a particle - angular momentum - law of conservation of angular momentum - moment of inertia and its significance -Theorem of parallel and perpendicular axis - moment of inertia of a thin uniform bar - moment of inertia of a rectangular lamina - moment of inertia of uniform circular disc - Moment of inertia of hollow and solid cylinders – flywheel
(qualitative) - kinetic energy of rotating body – Routh rule.

MODULE III NDT TECHNIQUES **6**

Ultrasonic Testing- types of Transducers-transmission and pulse-echo method- Radiographic testing- Principle-Interaction of X-ray with matter-X-ray radiography-method of generation-industrial radiography inspection techniques- Liquid Penetrant Testing**-** Inspection Procedure and Interpretation of results.

MODULE IV LOW TEMPERATURE PHYSICS 8

Definition of Refrigeration and Air-Conditioning - Types of Refrigeration Systems-Applications- Comfort Air Conditioning, Industrial Refrigeration, Food processing and food chain - Cryogenic treatment - Low temperature properties of engineering materials: Mechanical properties, Thermal properties, Electrical properties.

PRACTICALS

1. Verification of Hooke's law by spring method.
2. Determination of Young's modulus of the beam by bending method.
3. Inspection of welds using solvent removable visible dye penetrant.
4. Inspection of welds using solvent removable fluorescence dye penetrant.
5. Inspection of welds by Magnetic Particle Testing.
6. Determination of moment of inertia of the disc by torsion pendulum method.
7. Determination of moment of inertia of the disc by static torsion method.
8. Demonstration of working of flywheel.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur D.S.,"Elements of Properties of Matter", S.Chand & Co, Delhi, 2009.
2. Brijlal & Subramaniam," Properties of Matter", Eurasia Publishing Co, Delhi, 2002.
3. Gaur R.K., Gupta S.L., "Engineering Physics" Dhanpat Rai Publishers, 2010.
4. Baldev Raj.,Jayakumar T., Thavasimuthu M.,"Practical Non-Destructive testing", Narosa Publishing House, 2009.
5. Brijlal & Subrahmanyam., "Heat and Thermodynamics" S.Chand & Company Ltd, 2002.
6. Paul E Mix.," Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition, New Jersey, 2005.
7. Charles J., Hellier.," Handbook of Nondestructive evaluation", McGraw Hill, New York, 2001.

OUTCOMES:

Upon completion of this course, the students will be able to

- understand the basic of concept of elasticity of materials.
- comprehend the basic concepts of motion of rigid bodies and its applications.
- demonstrate the various NDT techniques and its importance.
- know the low temperature systems and its applications.

PHCX 09	SEMICONDUCTOR PHYSICS AND OPTOELECTRONICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand the Physics of Semiconductor devices.
- To make the students learn the fundamentals of Photoluminous - semiconductors, Optoelectronic devices, Optical modulators/detectors.
- To make them understand the technology behind latest Display devices like LCD, Plasma and LED Panels.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I PHYSICS OF SEMICONDUCTORS 8

Elemental and compound semiconductors – Drift and diffusion current - Intrinsic semiconductors – Carrier concentration (derivation) – Fermi energy – Variation of Fermi energy level with temperature – Mobility and electrical conductivity – Band gap determination – Extrinsic semiconductors – Carrier concentration in n-type and p-type semiconductor (derivation) – Variation of Fermi level with temperature and impurity concentration – Variation of Electrical conductivity with temperature – Hall effect – Experiment and applications of Hall effect.

MODULE II OPTOELECTRONIC DEVICES 7

Light Emitting Diodes (LED) – power and efficiency - double hetero LED - LED structure - LED characteristics - White LED – Applications. Liquid crystal displays – Dynamic scattering and Twisted nematic display, Semiconductor Lasers, Homojunction and Heterojunction laser diodes - Optical processes in semiconductor lasers.

MODULE III OPTICAL MODULATORS 7

Modulation of light – birefringence –Modulation Techniques - Electro optic effect –Electro optic materials –Types of Electro optic Modulators : Kerr and Pockel modulators –- Magneto optic effect - Magneto optic Modulators – Acousto Optic modulators.

MODULE IV OPTICAL DETECTORS 8

Photo detectors - photodiodes - phototransistors - noise characteristics - PIN diode – Avalanche Photodiode (APD) characteristics - APD design of detector arrays – Charged Couple Device - Solar cells - Materials and design considerations, Thin film solar cells, amorphous silicon solar cells.

PRACTICALS

1. Resistivity measurement of a semiconductor using four point probe method.
2. Determination of band gap of a semiconductor diode.
3. Determination of Hall coefficient of a given semiconductor material.
4. Determination of the wavelength of a given laser source using diffraction grating.
5. Determination of Planck's constant using LED.
6. To study the I-V characteristics of photodiode and phototransistor.
7. To study the characteristics of a solar cell.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Arumugam. M, "Physics II", Anuradha Publishers, 5th Edition, 2005.
2. Sze. S.M., "Semiconductor Devices – Physics and Technology", 2nd edn. John Wiley, 2002.
3. Wilson & J.F.B. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, India, 1996.
4. Bhattacharya, "Semiconductor optoelectronic devices", Second Edn, Pearson Education, 2002.
5. Safa O. Kasap, "Optoelectronics & Photonics:Principles & Practices", Second Edn, Pearson Education,2013.
6. Palanisamy P.K., "Semiconductor physics and optoelectronics" Scitech Publications, 2003.

OUTCOMES:

On completion of this course, the student will be able to

- understand the principles of Physics behind semiconductor devices.
- choose the correct semiconductors for electronic devices and display.
- differentiate the working principle of LED and Diode Laser.

- apply the knowledge of modulation of light for different types of optical modulators.
- select suitable photodetectors for different types of applications.
- complement the knowledge acquired in the theory class and correlate the results for applications.

Chemistry Elective Courses
(to be offered II Semester)

CHCX01	ANALYTICAL INSTRUMENTATION	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make the student conversant with

- principles, instrumentation and applications of different electroanalytical techniques
- different chromatographic techniques
- principles, instrumentation and applications of various types of absorption and emission spectroscopy
- different thermal analytical methods and their applications

MODULE I ELECTROANALYTICAL TECHNIQUES **7**

Principle and applications: conductometric titrations – potentiometrIc titrations, ion-selective electrodes and pH-metry – coulometry – voltammetry - polarography, amperometric titrations.

MODULE II CHROMATOGRAPHY **8**

Basic concepts of chromatography – paper chromatography – column chromatography – thin layer chromatography – gas chromatography – high performance liquid chromatography – gel permeation chromatography.

MODULE III SPECTROSCOPY **8**

Absorptionspectroscopy (principle, instrumentation and applications): Colorimetric analysis – UV-Visible spectroscopy – FTIR spectroscopy - Emission Spectroscopy (principle, instrumentation and applications): fluorescence, phosphorescence and chemiluminescence – Atomic absorption spectroscopy – flame emission spectroscopy.

MODULE IV THERMAL ANALYSIS **7**

Principle, instrumentation and applications: Thermogravimetric analysis – Differential thermal analysis – Differential scanning calorimetry

PRACTICALS

1. Conductometric titrations: acid-base and precipitation titrations
2. Potentiometric titrations
3. Determination of pH of the unknown solution
4. Estimation of alkali metals using flame emission spectroscopy
5. Estimation of metal ions of coloured solutions using colorimetric analysis
6. Separation of compounds using gas chromatography
7. Separation of compounds using high performance liquid chromatography
8. Analysis of the given sample and interpretation of the data using IR, UV-Visible spectroscopy
9. Demonstration of TGA/DTA and DSC and interpretation of data.

L – 30; P – 30; TOTAL HOURS – 60

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. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall, London, 2008.
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

- state the principle and applications of various electro-analytical

techniques

- identify the right separation method for a given sample using different chromatographic techniques
- explain the principle, instrumentation & applications of various spectroscopic methods and also to interpret the data
- elaborate the principle, instrumentation and applications of various thermal analytical techniques and interpret the data.

CHCX02	CORROSION AND ITS CONTROL	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students should be conversant with the

- Basic concepts, principles and factors affecting corrosion
- Types and mechanism of corrosion
- Control measures of corrosion by material selection, proper design and by applying organic coatings
- Control of corrosion by applying inorganic coating

MODULE I BASIC CONCEPTS OF CORROSION 8

Corrosion – causes and impacts of corrosion – mechanism of corrosion: Dry corrosion- oxidation corrosion - corrosion by other gases – Pilling-Bedworth rule- Corrosion by hydrogen: hydrogen blistering, hydrogen embritttlement, decarburization and hydrogen attack – corrosion of silver and copper by sulphur compounds – liquid metal corrosion (embritttlement or cracking) – Wet corrosion : hydrogen evolution – presence and absence of oxygen and absorption of oxygen –difference between dry and wet corrosion-factors influencing corrosion-polarization-passivity-emf series and galvanic series-corrosion current -rate of corrosion.

MODULE II FORMS OF CORROSION 7

Forms of corrosion-conditions for electrochemical corrosion –galvanic corrosion – differential aeration corrosion: pitting, water line, wire fencing, crevice and filiform corrosion – stress corrosion – Intergranular corrosion-erosion corrosion – soil corrosion – microbiological corrosion- fretting corrosion- corrosion in composites.

MODULE III CORROSION CONTROL AND ORGANIC COATINGS 8

Corrosion control – selection of materials and designing- cathodic protection – sacrificial anode and impressed current cathodic protection – corrosion inhibitors: anodic, cathodic and vapour phase inhibitors.

Organic protective coatings – paints: constituents – functions – varnishes : types-constituents – functions – lacquers : constituents – functions – enamels- constituents – functions – special paints : fire retardant, water repellant, heat resistant, temperature indicating and luminous paints.

MODULE IV INORGANIC COATINGS 7

Treatment of metal surface-inorganic coatings- classification- metallic coatings : anodic and cathodic coatings-hot dipping : galvanizing and tinning-electroplating—electroless plating – cementation (diffusion) : sherardizing, calorizing and chromizing – metal cladding-metal spraying – non metallic coatings (chemical conversion coatings) : phosphate, chromate, oxide coatings and anodizing – comparison of anodic and cathodic protection.

PRACTICALS

1. Determination and comparison of rate of corrosion of metals in the presence of acid, base and neutral medium by weight loss method.
2. Determination of rate of corrosion of iron in the presence of various acids by weight loss method.
3. Determination of rate of corrosion of iron in the presence and absence of anodic Inhibitor by weight loss method.
4. Determination of rate of corrosion of iron in the presence and absence of cathodic Inhibitor by weight loss method.
5. Electroplating of base metal with copper.
6. Electrolessplating of base metal with copper
7. Chemical conversion coatings such as chromate and phosphate coatings.
8. Demonstration on the study of rate of corrosion by using cyclic voltametry.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand& Company Ltd, New Delhi, 2014.
3. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill Book

Company, NewYork, 1984.
4. S. Banerjee, A.K. Tyagi, Functional Materials- Preparation, Processing and Applications, ELSEVIER Publications, London ; Waltham, MA : 2011

OUTCOMES:

Students will be able to

- explain the mechanism, compare and enumerate the factors affecting corrosion
- describe and identify the place and types for a given situation.
- choose and elaborate the suitable organic coating method for a given real time situation.
- apply a suitable metallic coating for a given situation

CHCX03	ELECTRICAL MATERIALS AND BATTERIES	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students should be conversant with

- preparation, properties and applications of plastics used in electrical and electronic applications
- properties and uses of electrical engineering materials
- classification and description of different types of batteries.
- classification and types of fuel cells

MODULE I POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS **8**

Preparation, properties and applications **:** polyethylene, polypropylene, EPDM, Nylon-6,6, PVC, PTFE, polycarbonates, ABS, phenol formaldehyde, urea formaldehyde, epoxy resins – polymer blends and alloys.

MODULE II ELECTRICAL ENGINEERING MATERIALS **7**

Conductors: Silver, Copper, Gold, Aluminum – Semiconductors: Germanium, Silicon, Gallium Arsenic – Insulating Materials: Rubbers, Mica, Plastics, Ceramics, Insulating papers – Magnetic Materials: ferromagnetic materials, paramagnetic materials, diamagnetic materials, antiferromagnetic materials, ferrites

MODULE III BATTERIES **7**

Electrochemical and electrolytic cell – batteries: types (primary, secondary and flow cell) – primary batteries: dry cells, alkaline batteries – secondary batteries: nickel-cadmium cell – lead acid storage cell, lithium battery: primary and secondary type – solar cell – dye sensitized solar cell.

MODULE IV FUEL CELLS **8**

Difference between batteries and fuel cells - chemistry of fuel cells - types of fuel cell (based on temperature and electrolyte) – principle, characteristic features, advantages, disadvantages and applications of 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).

PRACTICALS

1. Free radical polymerization of styrene.
2. Free radical polymerization of PMMA.
3. Preparation of phenol-formaldehyde.
4. Preparation of urea-formaldehyde.
5. Synthesis of epoxy resin.
6. Demonstration of mechanical properties of insulating materials using UTM
7. Demonstration of electrical properties of insulating materials
8. Construction of batteries using natural resources
9. Measurement of EMF for different batteries.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Jain P.C. and Renuka Jain, Engineering Chemistry, Dhanpat Rai Publication Co. (P) Ltd., New Delhi, 2013.
2. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
3. H.F. Mark and N. Gaylord, Encyclopedia of Polymer Science and Technology, Vol. 1 to XIV Interscience, 2nd Ed. 1988.
4. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.
5. R.K. Rajput,A Textbook of Electrical Engineering Materials, Firewall Media, 2004
6. Vladimir S. Bagotsky, Fuel Cells: Problems and Solutions, 2nd Edition, John Wiley and Sons, 2012.
7. B. Viswanathan and M. Aulice Scibioh, Fuel Cells: Principles and Applications, Taylor and Francis Group, 2007.

OUTCOMES:

The student will be able to

- summarise the preparation, properties and applications of plastics used in electrical and electronic applications
- enumerate the properties and uses of electrical engineering materials
- illustrate various types of batteries with the aid of a diagram
- classify the fuel cells and elaborate the different types of fuel cells.

CHCX04	ENGINEERING MATERIALS	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students should be conversant with

- properties and uses of different types of refractories and abrasives
- adhesives, cements and lime, setting of cements and their chemical behaviors.
- types, properties and uses of lubricants.
- various types of composite materials.

MODULE I REFRACTORIES AND ABRASIVES **8**

Introduction refractory: -classification - based on chemical nature- characteristic and selection of good refractory - general manufacture of refractory- preparation properties and uses of: silica refractory - magnesite refractory - zirconia refractory, properties of refractories: refractoriness - refractoriness under load - thermal spalling - porosity and dimensional stability, Cermets - super refractory.

Abrasives : introduction - Moh's scale - natural abrasives: diamond – corundum – emery - garnet and quartz, synthetic abrasives: preparation properties and uses: carborundum (silicon carbide)– alundum - boron (norbide) carbide

MODULE II ADHESIVES AND BINDING MATERIALS **7**

Introduction - classification of adhesives –advantage –limitation of adhesive bonding –development of adhesive- factors influencing adhesive action: chemical and physical, application techniques of adhesive – Lime: classification – manufacture - setting and hardening, Gypsum: - Manufacture and properties and uses - Cement : chemical composition- Manufacture – setting and hardening – concrete – weathering of cement and concrete and its prevention- special cements: high alumina cement - sorel cement - white portland cement – water proof cement.

MODULE III LUBRICANTS **7**

Introduction –functions of lubricant- mechanism of lubrication - classification of lubricant – liquid lubricant: vegetable and animal oils – mineral oils, semisolid: grease(calcium, lithium, aluminium) – petroleum jelly, solid

lubricant: graphite - molybdenum disulphide, Properties of lubricant: viscosity - viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue.

MODULE IV COMPOSITE MATERIALS 7

Introduction – advantageous characteristics of composites, applications of composites, main constituent of composites, types and applications of composites: RCC fibre-reinforced plastics (glass , carbon and aramid) - particulate composite - metal matrix composite - layered composites - failures in fibre-reinforced composites, ceramic matrix composites (CMC) – properties and applications.

PRACTICALS

1. Preparation of refractory bricks
2. Preparation of abrasive papers/cloth
3. Preparation of simple adhesives
4. Estimation of alkalinity in cements
5. Determination of cloud point and pour point
6. Determination of flash point and fire point
7. Preparation of fibre-reinforced composite

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. B.Sivasnakar, “Engineering Chemistry”, Tata McGrow-Hill Publication Limited, New Delhi, second reprint 2008.
3. Engineering Chemistry, Wiley India Editorial Team, Willey India Publisher, New Delhi, 2011.
4. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand& Company Ltd, New Delhi, 2014.

OUTCOMES:

The student will be able to

- classify and describe the manufacture the refractories and enumerate the properties and uses of abrasive materials.

- elaborate the manufacture, properties and uses of various adhesives and binding materials.
- classify lubricants and describe the properties and uses of them
- enumerate the properties and uses of various composite materials.

CHCX05	FUELS AND COMBUSTION	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make the students conversant with the

- three types of fuels available and the different processes involved in it.
- analysis of fuel characteristics and manufacture of fuels
- calculations involved in calorific values and minimum air requirement for complete combustion.
- classification, functions, mechanism and properties of lubricants.

MODULE I SOLID FUELS **7**

Characteristics of good fuel. Solid fuel – Wood, Coal – Ranking of coal – selection of coal. Analysis of coal – Proximate analysis. Pulverized coal – Metallurgical coke – Carbonization of coal – types. Manufacture of metallurgical coke – Beehive oven and Otto Hoffman's by-product oven methods.

MODULE II LIQUID AND GASEOUS FUELS **8**

Liquid fuel: Petroleum: Refining of petroleum, Liquid fuels derived from petroleum – Cracking: Thermal (Liquid and Vapour phase) – Catalytic (fixed bed and moving bed cracking – Synthetic petrol: Fischer-Tropsch method– Knocking in petrol and diesel engine: octane number and antiknocking – cetane number and improvement of cetane number – biodiesel (trans-esterification) – Gaseous fuels: Compressed natural gas (CNG) – LPG – oil gas – producer gas – water (blue) gas – biogas.

MODULE III COMBUSTION **8**

Calorific value: Gross and net caloric value – Bomb Calorimeter, Gas calorimeter - Definition of combustion – calculation of minimum requirement of air (problems) – theoretical calculation of calorific values (Dulong's formula), Gross and net calorific values ((problems) – Analysis of flue gas: Orsat's gas analysis method, explosive range, Ignition

temperature. Introduction to air pollution from IC (Internal combustion) engines, photochemical smog, primary and secondary pollutants.

MODULE IV LUBRICANTS 7

Friction and wear – lubricants: definition, functions and mechanism of lubrication (thick film and thin film) –classification: liquid lubricants: animal and vegetable origin, mineral oil, blended oils, lubricating emulsions and silicones – properties of lubricating oils: viscosity and viscosity index; Flash and fire-point, Cloud and pour point, oiliness, emulsification number, volatility, carbon residue, aniline point – semisolid lubricant: greases and waxes – solid lubricant: graphite and molybdenum disulphide –nanolubricants.

PRACTICALS

1. Testing of fuels - proximate analysis (moisture, volatile matter, ash content and fixed carbon present in coal, coke, charcoal etc)
2. Ash content and carbon residue test
3. Biodiesel synthesis by trans-esterification method (from coconut, groundnut, mustard oil, palm oil)
4. Determination of calorific value of a solid fuel using Bomb calorimeter (coal, charcoal, coke etc)
5. Determination of calorific value of a liquid fuel using Bomb calorimeter (petrol, diesel, biodiesel etc)
6. Determination of cloud point and pour point of a lubricant
7. Determination of flash and fire point of diesel.
8. Aniline Point of diesel
9. Viscosity Index of lubricants and Fuels by Viscometer
10. Flue gas analysis by Orsat's gas analysis method – Demonstration
11. Working of internal combustion engine – Demonstration

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi, 2001.
2. Engineering Chemistry, Wiley India Editorial Team, Willey India Publisher, New Delhi, 2011.
3. John Griswold, Fuels Combustion and Furnaces, Mc-Graw Hill Book Company Inc. University of Michigan, 1946.

4. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
5. Bahl B.S., Tuli and Arun Bahl, Essentials of Physical Chemistry, S. Chand and Company Ltd., New Delhi, 2004.

OUTCOMES:

The students will be able to

- compare and contrast the solid, liquid and gaseous fuels and also describe the processes involved in liquid and gaseous fuels.
- analyse the fuel properties such as moisture, votalite matter, ash content, calorific value etc
- calculate minimum air required for complete combustion and calorific values of fuels.
- categorize different lubricants into three types, explain the preparation and determine their properties.

CHCX06	FUNDAMENTALS OF PHYSICAL CHEMISTRY	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students will be conversant with the

- various thermodynamic terms and relate the laws of thermodynamics in chemical processes
- molecularity and order of reaction and derive the rate constant for different order of reactions
- basics of adsorption of different materials and propose mechanisms and surface area measurement
- conditions for equilibrium and learn different components at equilibrium

MODULE I BASIC THERMODYNAMICS **8**

Introduction - Thermodynamic terms - Thermodynamic equilibrium and processes - 1st law of thermodynamics: internal energy, enthalpy, heat capacity, isothermal and adiabatic expansion, Joule-Thomson effect - Zeroth law of thermodynamics: absolute temperature - 2nd law of thermodynamics: - spontaneous and cyclic process, Entropy in isothermal, isobaric and isochoric processes, work and free energy function, Maxwell's relation - 3rd law of thermodynamics

MODULE II CHEMICAL KINETICS **8**

Rate of chemical reaction - order and molecularity of a reaction - Rate constant - kinetics of opposing, parallel and consecutive and chain reactions - isotope effects - effect of temperature on reaction rate - collision theory - absolute reaction rate theory - kinetics in enzyme catalysis

MODULE III SURFACE SCIENCE AND CATALYSIS **8**

Adsorption - adsorption isotherms - uni and bimolecular adsorption reactions - parahydrogen conversion - factors affecting adsorption – Langmuir adsorption isotherm - Hinshelwood mechanism and *Eley-Rideal* mechanism with example - adsorption of gases on solids and surface area measurement

by BET method - Terms in catalysis - homogeneous and heterogeneous and enzyme catalysis with example

MODULE IV PHASE RULE 6

Terms involved - Conditions for equilibrium - application of phase rule to water, lead-silver system, freezing mixtures, thermal analysis: cooling curves.

PRACTICALS

1. Determination of the heat capacity of benzoic acid, internal energy of combustion of camphor using Bomb calorimeter. Calculation of enthalpy of combustion and formation for camphor.
2. Determination of adsorption isotherm of (i) acetic acid on charcoal (ii) oxalic acid on charcoal.
3. *Kineticsoffirst and second order reactions.*
4. Phase rule experiments with organic compounds: (i) naphthalene and p-dichloro benzene (ii) naphthalene and diphenyl (iii) m-dinitrobenzenzene and p-nitro toluene.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Rajaram J. and Kuriacose J.C., Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson Education, India, 2013.
2. Samuel Glasstone, Thermodynamics for Chemists, Read Books, United Kingdom, 2007.
3. James E. House, Principles of Chemical Kinetics, 2nd Edition, Academic Press, United States of America, 2007.
4. Keith J. Laidler, Chemical Kinetics, Pearson Education, India, 1987.
5. Douglas M. Ruthven, Principles of Adsorption and Adsorption Processes, John Wiley & Sons, 1984.
6. Puri B.R., Sharma L.R. and Pathania M.S., Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co. India, 2016.

OUTCOMES:

The student will be able to

- calculate entropy, enthalpy and free energy change for different chemical processes
- calculate the rate constant for any chemical and biochemical processes
- differentiate the adsorption processes and calculate the surface area and predict the suitability of catalysts for different chemical processes
- predict the equilibrium conditions for water, alloys, freezing mixtures and draw the thermal curves for phase transition

CHCX07	GREEN TECHNOLOGY	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make students conversant with the

- basic principles of green chemistry and green technology.
- wastes that causes hazards to human health
- chemicals that harms our environment
- need for green processes in various industries

MODULE I GREEN CHEMISTRY PROTOCOL **7**

Need – Significance – 12 Principles with examples – R4 model – Life cycle analysis – sustainable and cleaner production - Green Technology: definition, examples: CFC free refrigerants, green building, energy, 3D printers, nanotechnology – Awards for Green chemistry – organization promoting green chemistry.

MODULE II WASTE & WASTE MINIMISATION **8**

Source of wastes: domestic, industrial, medical, nuclear, e-waste; problems; prevention – economy of waste disposal – Waste minimization techniques: general waste treatment and recycling – alternate waste water treatment technologies: hybrid process – Green computing: goals, green cloud, green ICT - Pollution statistics from various industries (Industrial case studies).

MODULE III GREEN SYNTHESIS **7**

Introduction - Solvent free reactions - green reagents, green solvents in synthesis - microwave and ultrasound assisted reactions – supercritical fluid extraction – green oxidation and photochemical reactions – catalyst and biocatalysts.

MODULE IV GREEN INDUSTRIAL PROCESSES **8**

Polymer industry: biodegradable polymer - textile industry: greener approaches of dyeing, waste disposal – ecofriendly agrochemicals: biofertilizers, biopesticides – Pharmaceutical industry: atom economy, reduction of toxicity, use of biocatalyst, zero waste disposal – Leather industry: greener process in tanning, crusting, surface coating – ecofriendly batteries & fuel cells.

PRACTICALS

1. Synthesis of an ionic liquids (Ex: imidazolium) and testing the solubility of organic chemicals.
2. Green bromination of stilbene (using pyridine hydrobromide).
3. Green synthesis: Photocatalytic reactions, solvent-free organic reaction – Aldol; green oxidation, green reduction.
4. Microwave assisted chemical reaction. (synthesis of aspirin, pinacol-pinacolone reaction, etc).
5. Comparison of conventional reaction with microwave assisted reactions (atom economy, solvent, etc) [Ex: aldehyde and ketones with hydrazines to give hydrazones].
6. Diels-Alder reaction in eucalyptus oil (green process).

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2001.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, 2006.
3. Paul Anastas, John C.Warner, John Warner Joint; Green Chemistry: Theory & Practice New Ed Edition; Oxford University press, USA, 2000.
4. Rashmi Sanghi, M. M. Srivastava, Green chemistry, Narosa publishers, New Delhi, 2003.

OUTCOMES:

The students will be able to

- outline the principles and implications of green chemistry.
- comprehend the potential risks of waste generated and analyse the threats to human and environment.
- integrate information into design of molecules to avoid/eliminate toxic solvents & reagents or reduce toxic products.
- identify various alternate greener technologies for various industries.

CHCX08	ORGANIC CHEMISTRY OF BIOMOLECULES	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make students conversant with the

- basic concepts in organic chemistry
- types and structure of carbohydrates and lipids
- formation of different structures of proteins from amino acid
- structure of nucleic acids

MODULE I BASIC CONCEPTS IN ORGANIC CHEMISTRY 8

Classification and IUPAC nomenclature of organic compounds – stereochemistry – optical, stereo and geometrical isomerism – types of reagents: electrophiles and nucleophiles – types of reactions: addition, substitution, elimination and rearrangement reactions.

MODULE II CARBOHYDRATES, LIPIDS AND VITAMINS 7

Structure and functions of carbohydrates: mono, di, oligo and polysaccharides – lipids: phospholipids, glycolipids, sphingolipids – cholesterol – steroids – Structure, functions and deficiency disorders of fat soluble vitamins: A, D, E & K - Water soluble vitamins B & C: Thiamine, riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.

MODULE III AMINO ACIDS, PEPTIDES AND PROTEINS 7

Aminoacids: classification, properties - peptides – polypeptides – proteins: primary, secondary, tertiary and quaternary structure – glycoproteins – lipoproteins – Enzymes: classification and functions

MODULE IV NUCLEIC ACIDS 8

Nucleic acids – importance - structure of purines and pyrimidines – nucleotides – polynucleotides - RNA – types & structure - DNA – phosphodiester bonds – chemical, helical structure and functions – DNA replication – gene modification.

PRACTICALS

1. Qualitative tests to identify carbohydrates.
2. Quantitative estimation of carbohydrates.
3. Separation of sugars – TLC and/or paper chromatography.
4. Quantitative estimation of lipids.
5. Separation of amino acids – TLC and/or paper chromatography.
6. Quantitative estimation of proteins by Lowry's method.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. V. K. Ahluwalia, Organic Reaction Mechanism, Narosa Publishers, New Delhi, 2002.
2. Johnson Arthur T., Biology for Engineers, CRC Press, Finland, 2011.
3. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2001.
4. David L. Nelson, Michael M. Cox, Lehninger Principles of biochemistry, Macmillan press, London, 2010

OUTCOMES:

The students will be able to

- classify organic compounds and explain the mechanism of various organic reactions.
- draw the structures and enumerate the functions of carbohydrate, lipids and vitamins.
- correlate the relationship among amino acids, peptides and proteins.
- recognize the role of nucleic acid in the formation of RNA & DNA and differentiate DNA & RNA using their structure and function.

CHCX09	POLYMER SCIENCE AND TECHNOLOGY	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make the student conversant with the

- basic concepts of polymers, classification, types of polymerization and molecular weight & its distribution
- preparation, properties and applications of thermoplastics and introduction to biodegradable polymers
- properties and applications of thermosets, elastomers and FRP
- different types of moulding techniques

MODULE I BASIC CONCEPTS OF POLYMERS **8**

Definitions: monomer, polymer, functionality, degree of polymerization – classification of polymers: source, structure, application, thermal processing behavior (thermoplastics and thermosets), composition and structure (addition and condensation), mechanism (chain growth and step-wise growth) – copolymer: types – Definition –nomenclature of polymers – tacticity – types of polymerization : free radical, cationic and anionic polymerization (concepts only) – average molecular weight of polymer: number, weight – molecular weight distribution (problems)

MODULE II THERMOPLASTICS AND BIODEGRADABLE POLYMERS **8**

Preparation, properties and applications : LDPE, HDPE, polypropylene, PVC, PTFE, PET, polyamides (Nylon-6 and Nylon 6,6) and polycarbonates – polymer blends and alloys – basics of biodegradable polymers.

MODULE III THERMOSET RESINS, ELASTOMERS AND FRP **7**

Thermoset resins : phenolic resins, amino resins (urea and melamine formaldehyde), epoxy resins, unsaturated polyesters – polyurethanes – elastomers : vulcanization of natural rubber, diene based elastomers –fibre reinforced plastics: glass, aramid and carbon.

MODULE IV MOULDING TECHNIQUES 7

Moulding constituents**:** functions – moulding techniques**:** compression, injection, extrusion (single screw), blow moulding, thermoforming, (mechanical and vacuum forming), lamination.

PRACTICALS

1. Determination of molecular weight and degree of polymerization using Oswald's viscometer.
2. Free radical polymerization of styrene.
3. Free radical polymerization of PMMA.
4. Preparation of phenol-formaldehyde.
5. Preparation of urea-formaldehyde.
6. Synthesis of epoxy resin.
7. Synthesis of unsaturated polyester.
8. Preparation of FRP laminates.
9. Demonstration of injection moulding, compression moulding and blow moulding.

L – 30; P – 30; TOTAL HOURS – 60

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. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
4. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, New York, 1998.
5. Encyclopedia of Polymer Science and Technology, Vol. 1 to XIV, H.F. Mark and N. Gaylord, Interscience, 2nd Ed. 1988.
6. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.

OUTCOMES:

The student will be able to

- classify various polymers, name the polymers and types of polymerization reactions, calculate molecular weight of polymers,

- summarise preparation, properties and applications of thermoplastics and give examples of biodegradable polymers
- elaborate the properties and applications of thermosets, elastomers and FRP
- select the appropriate moulding technique for a given polymer, based on the application