FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF TECHNOLOGY

IN

BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM

(2020 -2021)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

KARPAGAM ACADEMY OF HIGHER EDUCATION
(Established Under Section 3 of UGC Act 1956)
COIMBATORE 641 021 INDIA

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(Deemed to be University Established Under Section 3 of UGC Act 1956)

Eachanari Post, Coimbatore – 641 021. INDIA

FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY (B. E. /B. Tech.)

REGULATIONS
(2020)

CHIOCE BASED CREDIT SYSTEM

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KARPAGAM ACADEMY OF HIGHER EDUCATION
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Eachanari, Coimbatore-641 021. INDIA

FACULTY OF ENGINEERING
DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY
REGULAR PROGRAMME

REGULATIONS 2020
CHOICE BASED CREDIT SYSTEM

These regulations are effective from the academic year 2020 – 2021 and applicable to the candidates admitted to B. E. / B. Tech. during 2020 - 2021 and onwards.

1. ADMISSION

1.1 Candidates seeking admission to the first semester of the eight semesters B. E./B.Tech Degree Programme:

Should have passed the Higher Secondary Examination (10+2) (Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III or any similar Examination of any other University or authority accepted by the Karpagam Academy of Higher Education as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

1.2 Candidates seeking admission to the first semester of the eight semesters B. Tech. (Bio-Technology) Degree Programme:

Should have passed the Higher Secondary Examination (10+2) (Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics and Chemistry (or) Physics, Chemistry and Biology as three of the four subjects (or) Physics, Chemistry, Botany and Zoology as subjects of study under Part-III or any similar Examination conducted by any other authority accepted by the Karpagam Academy of Higher Education as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

1.3 Lateral Entry Admission

Candidates who possess Diploma in Engineering / Technology (10+3 or 10+2+2) awarded by the Directorate of Technical Education, Tamil Nadu or its equivalent and candidates who possess a Bachelor Degree in Science (10+2+3) with Mathematics as one of the subjects, awarded by any University or its equivalent are eligible to apply for admission to the third semester of B. E./B. Tech.. Such candidates shall undergo two additional engineering subjects in the 3rd and 4th semester as prescribed by the University.

Eligibility criteria for admission in the first semester is given in the table below

S. No.	Programme	Eligibility criteria
1.	B. E.Automobile Engineering	Diploma in Automobile Engg./ Mechanical Engg / Metallurgy/ Mechanical and Rural Engg. / Machine Tool Maintenance and Repairs / Machine Design and Drafting / Refrigeration and Air-conditioning / Production Engg. / Tool and Die Design.
2	B.E Bio Medical Engineering	Diploma in Electrical & Electronics Engg. / Electronics & Communication Engg./ Computer Science Engg/ Mechatronics Engg/Computer Technology/Instrumentation Technology
3.	B. E. Civil Engineering	Diploma in Civil Engg./ Sanitary Engg. / Civil and Rural Engg.
4.	B. E. Computer Science and Engineering	Diploma in Computer Engg. / Electrical Engg./ Electronics Engg. / Electrical & Electronics Engg. / Electronics & Communication Engg. / Electronics & Telecommunication Engg./ Information Technology/ Computer Science / Instrumentation & Control Engg. / Electronics & Instrumentation.
5.	B. E. Electrical and Electronics Engineering	Diploma in Electrical Engg./ Electronics Engg. / Electrical & Electronics Engg. / Electronics & Communication Engg. / Electronics & Telecommunication Engg./ Information Technology/ Computer Science / Instrumentation & Control Engg. / Electronics & Instrumentation.
6.	B. E. Electronics and Communications Engineering	Diploma in Electronics Engg. / Electronics & Communication Engg. / Electrical Engg. / Instrument Technology / Electronics with specialization in Instrumentation / Electrical & Electronics Engg. / Information Technology/ Computer Science / Instrumentation & Control Engg./ Electronics & Telecommunication Engg.
7.	B. E.Mechanical Engineering	Diploma in Mechanical Engg./ Metallurgy/Automobile Engg./ Mechanical and Rural Engg. / Machine Tool Maintenance and Repairs / Machine Design and Drafting / Refrigeration and Air-conditioning / Production Engg. / Tool and Die Design
8.	B. Tech Biotechnology	Diploma in Chemical Engineering / Leather Technology / Diploma in Petrochemical Engg.

9.	B. Tech Chemical Engineering	Diploma in Chemical Engineering /Petrochemical Engg./ Chemical Technology/ Petroleum Engg/ Polymer Technology/ Plastic Technology/Sugar Technology/Pulp & Paper Technology/ Petro-Chemical Engg
10.	B. Tech Food Technology	Diploma in Food Technology/Chemical Engineering / Leather Technology / Diploma in Petrochemical Engg.

1.4 Migration from other University

Candidates who have completed their first to sixth semesters of B. E./B. Tech. study in any University are eligible to apply for admission to their next semester of B. E./B. Tech. in the branch corresponding to their branch of study. The student will be exempted from appearing for Examination of the equivalent courses passed in the earlier programme and will have to appear for courses which he/she has not done during the period of his/her earlier programme. Along with the request letter and mark sheets, he/she has to submit a copy of syllabus of the programme duly attested by the Registrar,Competent authority,he/she has undergone. Equivalence Certificate shall be provided by the "Students' Affairs Committee" of Karpagam Academy of Higher Education. Students' Affairs Committee comprises all the Heads of the Departments and Dean of the Faculty of Engineering and a nominee of the Registrar.

2 . PROGRAMMES OFFERED

A candidate may undergo a programme in any one of the branches of study approved by the University as given below.

List of B. E. and B. Tech. Degree Programmes

1. B. E. Automobile Engineering
2. B.E Bio Medical Engineering
3. B. E. Civil Engineering
4. B. E. Computer Science and Engineering
5. B. E. Electrical and Electronics Engineering
6. B. E. Electronics and Communications Engineering
7. B. E. Mechanical Engineering
8. B. Tech. Bio-Technology
9. B. Tech Chemical Engineering
10. B. Tech Food Technology

3. MODE OF STUDY

3.1 Full-Time:

In this mode of study, the candidates are required to attend classes regularly on the specified working days of the University.

3.2 Conversion from full time mode of study to part time is not permitted.

3.3 Change from one programme to another is not permitted.

4. STRUCTURE OF PROGRAMMES

4.1 Every programme will have a curriculum with syllabus consisting of theory and practical courses such as:

(i) General core courses comprising Mathematics, Basic Sciences, Engineering Sciences and Humanities.

(ii) Core courses of Engineering/Technology.

(iii) Elective courses for specialization in related fields.

(iv) Workshop practice, computer practice, engineering graphics,laboratory work, in-plant training, seminar presentation, projectwork, industrial visits, camps, etc.

Every student is encouraged to participate in at least any one of the following programmes

- NSS / Sports/Physical exercise/NCC/YRC/Red Ribbon club/Environment club and Energy club
- Other Co-Curricular and Extra Curricular activities

(V) Choice Based Credit System

CBCS is introduced for students admitted in the academic year 2017-18. As per AICTE guidelines, CBCS is an approach in which students opt for courses of their choice. CBCS provides greater flexibility with multiple courses and enable students to undergo additional courses. CBCS is applicable to Full Time Undergraduate & Post Graduate Programmes of study. It provides a choice for students to select from the prescribed courses(Professional soft core, Professional Hard core, Professional Electives, Open Electives, Value added courses, Humanity Sciences, Basic sciences & Engineering sciences). A course designated as hard core for a particular programme of study must invariably be completed by the student to receive the degree in the programme. The Hardcore courses cannot be substituted by another courses. Students can exercise their choice among a set of Soft core courses from the list of Soft core courses specified for each Programme of study.The student should meet the criteria for prerequisites to become eligible to register for that course.The student should request for the course for every semester within the first week of semester. Maximum no of students to be registered in each course shall depend on availablility of physical facilities, classroom availability and lab capacity. Registration of already requested courses by students in previous semester is not allowed.

4.2 Each course is normally assigned certain number of credits.

No. of credits per lecture period per week : 1

No. of credits per tutorial period per week : 1

No. of credits for 3 periods of laboratory course per week : 2
No. of credits for 3 periods of project work per week : 2
No. of credits for 2 periods of Value added course per week: 1
No. of credits for 3 weeks of in-plant training during semester vacations : 1

4.3 Inevery semester, the curriculumshall normally have a blend of theory courses not exceeding6and practicalcourses not exceeding 3. However, the total number of courses per semester shall not exceed 8.

4.4 The prescribed credits required for the award of the degree shallbe within the limits specified below.

PROGRAMME	PRESCRIBED CREDIT RANGE
B. E./B. Tech.	160– 165

4.5 The medium of instruction for all Courses, Examinations, Seminar presentations and Project/Thesis reports is English.

4.6 Value Added Course

Besides core courses and elective courses, value added course is introduced. The blend of different courses is so designed that the student would be trained not only in his / her relevant professional field but also as a socially conscious human being.

4.7 Evaluation in the courses comprises two parts, one is the Continuous Internal Assessment (CIA) and the other one is the End Semester Examination (ESE). Evaluation in few courses may be by Internal Assessment only.

5. DURATION OF THE PROGRAMME

5.1 The prescribed duration of the programme shall be

Programme	Min. No. of semesters	Max. No. of semesters
B. E./B. Tech. (H. Sc. Candidates)	8	14
B. E./B. Tech. (Lateral Entry Candidates)	6	12

5.2 Each semester shall normally consist of 90 working days or 540 hours.

5.3 Additional classes for improvement, conduct of model test, etc., over and above the specified periods shall be arranged, if required. But for the purpose of calculation of attendance requirement for eligibility to appear for the end semester Examinations (as per Clause 11) by the students, 540 hours conducted within the specified academic schedule alone shall be taken into account and the overall percentage of attendance shall be calculated accordingly.

6. REQUIREMENTS FOR COMPLETION OF THE SEMESTER

6.1 Ideally every student is expected to attend all classes and secure 100% attendance. However, in order to allow for certain unavoidable circumstances, the student is expected to attend at least 75% of the classesand the conduct of the candidate has been satisfactory during the course.

6.2 A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization / Accident / Specific Illness) or due to participation in University / District / State / National / International level sports or due to participation in Seminar / Conference / Workshop / Training Programme / Voluntary Service / Extension activities or similar programmeswith prior permission from the Registrar shall be given exemption from prescribed attendance requirements and shall be permitted to appear for the Examination on the recommendation of the Head of the Department concerned and Dean to condone the lack of attendance. The Head of the Department has to verify and certify the genuineness of the case before recommending to the Dean. However, the candidate has to pay prescribed condonation fees.

6.3 Candidates who are not recommended for condonation and those who have less than 65% attendance will not be permitted to proceed to the next semester and have to redo the course. However, they are permitted to write the arrear Examinations, if any.

7. CLASS ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a teacher of the Department who shall function as Class Advisor for those students throughout their period of study. Such Class Advisors shall advise the students and monitor the courses undergone by the students, check the attendance and progress of the students and counsel them periodically. If necessary, the Class Advisor may display the cumulative attendance particulars in the Department notice board and also discuss with or inform the Parents/Guardian about the progress of the students. Each student shall be provided with course plan for each course at the beginning of each semester.

8. CLASS COMMITTEE

8.1. Every class shall have a class committee consisting of teachers of the class concerned, Maximum of six student representatives [boys and girls] and the concerned Head of the Department. It is like the 'Quality Circle' with the overall goal of improving the teaching-learning process. The functions of the class committee include

- Clarifying the regulations of the degree programme and the details of rules therein particularly Clause 4 and 5 which should be displayed on Department Notice-Board.
- Informing the student representatives the details of Regulations regarding weight age used for each assessment. In the case of practical courses (laboratory / drawing / project work / seminar, etc.) the breakup of marks for each experiment / exercise /module of work, should be clearly discussed in the class committee meeting and informed to the students.
- Solving problems experienced by students in the class room and in the laboratories.
- Informing the student representatives the academic schedule, including the dates of assessments and the syllabus coverage for each assessment.

- Analyzing the performance of the students of the class after each test and finding the ways and means of solving problems, if any.
- Identifying the weak students, if any and requesting the teachers concerned to provide some additional academic support.

8.2 The class committee for a class under a particular branch is normally constituted by the Head of the Department. However, if the students of different branches are mixed in a class (like the first semester which is generally common to all branches), the class committee is to be constituted by the Dean.

8.3 The class committee shall be constituted within the first week of each semester.

8.4 The Chairperson of the Class Committee may convene the meeting of the class committee.

8.5 The Dean may participate in any Class Committee of the Faculty.

8.6 The Chairperson is required to prepare the minutes of every meeting, submit the same to Dean through the HOD within two days of the meeting and arrange to circulate it among the students and teachers concerned. If there are some points in the minutes requiring action by the Management, the same shall be brought to the notice of the Registrar by the HOD through Dean.

8.7 The first meeting of the Class Committee shall be held within one week from the date of commencement of the semester, in order to inform the students about the nature and weightage of assessments within the framework of the regulations. Two subsequent meetings may be held in a semester at suitable intervals. During these meetings the student members representing the entire class, shall meaningfully interact and express their opinions and suggestions of the other students of the class in order to improve the effectiveness of the teaching-learning process.

9. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or group, shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as Course Coordinator. The nomination of the Course Coordinator shall be made by the Dean depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The 'Course Committee' shall meet to arrive at a common scheme of evaluation for the test and shall ensure a uniform evaluation of the tests. Where ever feasible, the Course Committee may also prepare a common question paper for the Internal Assessment test(s).

10. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

10.1 Every teacher is required to maintain an 'ATTENDANCE AND ASSESSMENT RECORD' (Log book) which consists of attendance marked in each theory or practical or project work class, the test marks and the record of class work (topic covered), separately for each course.

10.2 Continuous Internal Assessment (CIA): The performance of students in each subject will be continuously assessed by the respective teachers as per the guidelines given below:

THEORY COURSES:

S. No.	CATEGORY	MAXIMUM MARKS
1.	Assignment	5
2.	Seminar *	5
3.	Attendance	5
4.	Test – I	8
5.	Test – II	8
6.	Test – III	9
Continuous Internal Assessment : TOTAL		40

*Evaluation shall be made by a committee.

PATTERN OF TEST QUESTION PAPER (Test I & II)

INSTRUCTION	REMARKS
Maximum Marks	60
Duration	2 Hours
Part- A	1 to 9 Two Mark Questions, uniformly covering the two units of the syllabus. All the 9 Questions are to be answered. (**9 x 2 =18Marks)**.
Part- B	Question 10 to 12 will be of either or type, covering two units of the syllabus. Each Question may have subdivision. (**3 x 14 =42 Marks)**.

PATTERN OF TEST QUESTION PAPER(Test III)

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part - A	Part A will be online Examination. 20 Objective type Questions, Covering all the 5 units. **(20 x 1= 20 Marks) (Online Examination).**
Part- B	21 to 25 Two Mark Questions, uniformly covering the Five units of the syllabus. All the 5 Questions are to be answered. (**5 x 2= 10Marks)**.
Part- C	Question 26 to 30 will be of either or type, covering Five units of the syllabus. Each Question may have subdivision. **(5 x 14=70 Marks).**

PRACTICAL COURSES:

S. No	CATEGORY	MAXIMUM MARKS
1.	Attendance	5
2.	Observation work	5
3.	Record work	5
4.	Model Examination	15
5.	Viva – Voce [Comprehensive]	10
Continuous Internal Assessment: TOTAL		40

Every practical exercise / experiment shall be evaluated based on the conduct of exercise/ experiment and records maintained.

INTEGRATED THEORY AND PRACTICAL COURSES:

The Continous Internal Assessment for Integrated Theory Course is awarded for 40 Marks with mark split up similar to regular theory course.

The external evaluation of integrated practical component from End semester Examinatiion by internal mode is awarded for 50 Marks and later scaled down to 15 Marks and similarly the external evaluation for integrated theory from End semester Examinatiion is awarded for 100 Marks and later scaled down to 45 Marks. Hence the external assessment for Integrated theory and practical components contribute to 60 Marks.

10.3 ATTENDANCE

Attendance carries a maximum of 5 marks and the distribution is as under:

S. No.	Attendance %	Marks
1	91 and above	5.0
2	81-90	4.0
3	76-80	3.0

10.4 PROJECT WORK/ INTERNSHIPS:

Final year project work will be always in-house. However, as a special case, if a student is able to get a project from a government organization or private or public sector company,, the student may be permitted to do his/her project work in reputed institution/research organization/industry. Hence final year students may have commencement of eighth semester classes for 30 days in fast track mode and complete their final semester and are made eligible for undergoing Internships in Industry and also interested students are permitted for doing projects in Industries.

10.5 CERTIFICATION COURSES :

Students have to undergo a minimum of one value added course beyond curriculum as a certified course per semester for duration not less than 30 hours**.**

11. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION(ESE)

A candidate shall normally be permitted to appear for the ESE of any semester commencing from I semester if he/she has satisfied the semester completion requirements (Subject to Clause 5) and has registered for Examination in all courses of the semester. Registration is mandatory for Semester Examinations as well as arrearExaminations failing which the candidate will not be permitted to attend the next semester. A candidate already appeared for a subject in a semester and passed the Examination is not entitled to reappear in the same subject of the semester for improvement of grade.

12. END SEMESTER EXAMINATION

ESE will be held at the end of each semester for each subject, for 100 marks, later scaled down to 60 marks.

PATTERN OF ESE QUESTION PAPER:

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part - A	Part A will be online Examination. 20 Objective type Questions. Covering all the 5 units. **20*1= 20 Marks (Online Examination)**
Part- B	21 to 25 Two Mark Questions, uniformly covering the Five units of the syllabus. All the 5 Questions are to be answered. (**5 *2= 10Marks)**.
Part- C	Question 26 to 30 will be of either or type, covering Five units of the syllabus. Each Question may have subdivision. **(5*14=70 Marks)**

13. PASSING REQUIREMENTS

13.1 Passing minimum: The passing minimum for CIA is 20 (i.e. out of 40 marks). The passing minimum for ESE is 30 (i.e. out of 60 marks). The overall passing minimum for theory/laboratory course is 50 (Sum of his/her score in CIA and ESE) out of 100 marks.

13.1.1 The passing minimum for value added course is 50 marks out of 100marks. Therewill be two tests, the first covering 50% of syllabus for 50 marks and the other for 50 marks.

13.2 If the candidate fails to secure a pass in a particular course ESE, itis mandatory that candidate shall register and reappear for the Examination in that course during the subsequent semester when Examination is conducted in that course. Further the candidate should continue to register and

reappear for the Examination till a pass is secured in such supplementary Examination within the stipulated maximum duration of the programme (Clause 5.1).

The CIA marks obtained by the candidate in his/her first or subsequent appearance where he/she secures a pass shall be retained by the office of the Controller of Examinations and considered valid for all remaining attempts till the candidate secures a pass in his/her ESE.

13.3 If the candidate fails to secure a pass in a particular course in CIA, it is mandatory that candidate shall register and reappear for the CIA in that course during the subsequent semester when CIA is conducted in that course by the faculty member assigned for that particular course during that semester by the concerned HOD. Further, the candidate should continue to register and reappear for the CIA till a pass is secured in such subsequent Examination within the stipulated maximum duration of the programme (Clause 5.1).

13.3.1 If a candidate fails to secure a pass in value added course, he/she has to appear for the testswhen course is conducted subsequently.

13.4 ONLINE COURSE(MOOC) COORDINATOR

To help students in planning their online courses and for general advice on online courses, the HOD shall nominate a MOOC coordinator for the online courses. The Online course MOOC coordinator shall identify the courses which students can select for their programme from the available online courses offered by the different agencies periodically and inform the same to the students. Further, the coordinator shall advice the students regarding the online courses and monitor their course.

13.4.1 Student Shall study atleast one online course from Sawayam/NPTEL in anyone of the first seven semesters for which examination shall be conducted at the end of the course by the respective organization.body. The student can register to the course which are approved by the department. The student shall produce a pass certificate from the respective body befiorethe end of the seventh semester.

14. AWARD OF LETTER GRADES

14.1 All assessments of a course will be done on absolute mark basis. However, for the purpose of reporting the performance of a candidate letter grades, each carrying certain number of points will be awarded as per the range of total marks (out of 100) obtained by the candidate in each subject as detailed below:

Letter grade	Marks Range	Grade Point	Description
O	91 - 100	10	OUTSTANDING
A+	81- 90	9	EXCELLENT
A	71-80	8	VERY GOOD
B+	66- 70	7	GOOD
B	61 – 65	6	ABOVE AVERAGE
C	55 - 60	5	AVERAGE
D	50 - 54	4	PASS

RA	<50	-	REAPPEARANCE
AB		0	ABSENT

14.2 GRADE SHEET

After results are declared, Grade sheet will be issued to each student which will contain the following details:

i. The list of courses enrolled during the semester and the grade scored,

ii. The Grade Point Average (**GPA**) for the semester and

iii. 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 (**C**) of courses enrolled and the Grade Points (**GP**) 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.

$$GPA = \frac{\text{Sum of } [C*GP]}{\text{Sum of } C}$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from First semester. **RA** grade and value added course will be excluded for calculating **GPA** and **CGPA**.

14.3REVALUATION

Revaluation and Re-totaling is allowed on representation. A candidate can apply for revaluation of his/her semester Examination answer paper in a theory course, within 2 weeks from the declaration of results, on payment of a prescribed fee through proper application to the Controller of Examinations through the Head of the Department and Dean. A candidate can apply for revaluation of answer scripts for not exceeding 5 subjects at a time. The Controller of Examinations will arrange for the revaluation and the results will be intimated to the candidate through the Head of the Department and Dean. Revaluation is not permitted for Supplementary Examinations, Practical Examinations, Technical Seminars, In-plant Training and Project Work.

14.4 TRANSPARENCY AND GRIEVANCE COMMITTEE

A student may get the Photostat copy of the answer script on payment of prescribed fee, if he/she wishes. The students can represent the grievance, if any, to the Grievance Committee, which consists of Dean of the Faculty, (if Dean is HOD, the Dean of another Faculty nominated by the University), HOD of the Department concerned, the faculty of the course and Dean from other discipline nominated by the University and the COE. If the Committee feels that the grievance is genuine, the script may be sent for external valuation; the marks awarded by the External Examiner will be final. The student has to pay prescribed fee for the same.

15. ELIGIBILITY FOR AWARD OF DEGREE

A student shall be declared to be eligible for award of Degree if he/she has

- Successfully gained the required number of total credits as specified in the curriculum corresponding to his/her programme within the stipulated time.

- No disciplinary action is pending against him/her.

The award of the degree must be approved by the Board of Management of Karpagam Academy of Higher Education.

16. CLASSIFICATION OF THE DEGREE AWARDED

16.1 A candidate who qualifies for the award of the Degree (vide Clause 15) having passed the Examination in all the courses in his/her first appearance within the specified minimum number of semesters (vide Clause 5.1) securing a CGPA of not less than **8** shall be declared to have passed the Examination in First Class with Distinction.

16.2 A regular candidate or a lateral entrant is eligible to register for BE(Honors),B.Tech(Honors). If, he / she has passed all the courses in the first appearance and holds / maintains a CGPA of 7.5 at VI Semester. He / she has to take an additional 20 credits by studying online courses through Swayam/NPTEL . Such a candidate is eligible for the award of BE (Honor),B.Tech(Honor). However, is he / she fails in securing 20 additional credits butmaintains CGPA of 7.5 and above is not eligible for Honors degree but eligible for First class with Distinction.

16.3 A candidate who qualifies for the award of the Degree (vide Clause 15) having passed the Examination in all the courses within the specified minimum number of semesters (vide Clause 5.1) plus one year (two semesters), securing CGPA of not less than **6.5** shall be declared to have passed the Examination in First Class.

16.3 All other candidates (not covered in Clauses 17.1 and 17.2) who qualify for the award of the degree (vide Clause 15) shall be declared to have passed the Examination in Second Class.

17. PROVISION FOR WITHDRAWAL FROM END-SEMESTER EXAMINATION

17.1 A candidate may for valid reasons and on prior application, be granted permission to Withdraw from appearing for the examination of any one course or consecutive examinations of more than one course in a semester examination. .

17.2 Such withdrawal shall be permitted only once during the entire duration of the degree programme. Withdrawal application shall be valid only if the candidate is otherwise eligible to write the Examination

.17.3 Withdrawal application is valid only if it is made within 10 days prior to the commencementof the Examination in that course or courses and recommended by the Head of the Department, Dean and approved by the Registrar.

17.3.1 Notwithstanding the requirement of mandatory TEN daysnotice,applications forwithdrawal for special cases under extraordinary conditions may be considered on the merit of the case.

17.4 Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction. This provision is not applicable to those who seek withdrawal during III semester.

17.5 Withdrawal from the ESE is NOTapplicable to arrearExaminations.

17.6 The candidate shall reappear for the withdrawn courses during the Examination conducted in the subsequent semester.

18. PROVISION FOR AUTHORISED BREAK OF STUDY

18.1 Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme.However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for break of study. If a candidate intends to temporarily discontinue the programme in the middle of the semester for valid reasons and to rejoin the programme in a subsequent year, permission may be granted based on the merits of the case provided he/she applies to the Registrar, through the Head of the Department and Dean stating reasons thereof and the probable date of rejoining the programme.

18.2 The total number of semesters for completion of the programme from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum no. of semesters specified in Clause 5.1 irrespective of the period of break of study (vide Clause 18) in order that he/she may be eligible for the award of the degree (vide Clause 15). The candidate thus permitted to rejoin the programme at the commencement of the semester after the break shall be governed by the curriculum and regulations in force at the time of rejoining. Such candidates may have to do additional courses as per the curriculum and regulations in force at that period of time.

18.3 The authorized break of study (for a maximum of one year) will not be counted for the duration specified for passing all the courses for the purpose of classification (vide Clause17). However, additional break of study granted will be counted for the purpose of classification.

18.4 The total period for completion of the programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in Clause 5.1 irrespective of the period of break of study (vide Clause 18.3) in order that he/she may be eligible for the award of the degree.

18.5 If any student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted 'Withdrawal' or 'Break of Study' (Clause18 and 18 respectively).

19. SUPPLEMENTARY ESE: After the publication of VIII semester results,if a student has **ONE** arrear in any theory course of the entire programme, he/she will be permitted to apply within 15 days of the publication of results, and appear for supplementary Examination.

20. INDUSTRIAL VISIT

Every student is required to undergo one industrial visit for every semester, starting from the third semester of the programme.

21. DISCIPLINE

Every student is required to observe discipline and decorous behavior both inside and outside the University and not to indulge in any activity which will tend to bring down the prestige of the University. The erring student will be referred to the Disciplinary Committee constituted by

the University, to enquire into acts of indiscipline and recommend to the University about the disciplinary action to be taken.

If a student indulges in malpractice in any of the ESE/CIA he/she shall be liable for punitive action as prescribed by the University from time to time.

22. REVISION OF REGULATION AND CURRICULUM

The University may from time to time revise, amend or change the Regulations, Scheme of Examinations and syllabi, if found necessary on the recommendations of Board of Studies, Academic Council and Board of Management of Karpagam Academy of Higher Education.

VALUE ADDED COURSES (VAC)

Value added courses are being offered from different areas for a period of 30 hours. Upon successful completion of VAC, certificates will be provided.

TECHNOLOGY BUSINESS INCUBATOR (TBI)

To encourage and motivate students to become an entrepreneur, Technology Business Incubator (TBI) are being initiated and operated to help the students to start their own startups in thrust areas related to their discipline.

Department of Biotechnology (B.Tech)

B.TECH BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. To prepare the graduates with strong knowledge and practical skills in their professional career.
2. To prepare the graduates to function effectively in teams by upholding their code of bioethical principles.
3. To prepare the graduates to pursue lifelong learning to address the societal issues for progressive development.

PROGRAM OUTCOME (PO)

The graduates of Biotechnology (B.Tech) will be able to

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

b. 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.

c. 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

d. 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

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

f. 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

g. 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.

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

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

j. 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.

k. 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.

l. 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 (PSO)

At the end of the B.Tech Biotechnology program, the graduates will be able to

1. Demonstrate the knowledge in fundamental sciences and engineering that are essential to understand the complex biological system
2. Demonstrate a working knowledge to apply for advanced biological sciences and technologies.

PEO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	✓	✓	✓	✓	✓	✓	✓					
PEO2							✓	✓	✓	✓	✓	
PEO3		✓	✓			✓	✓					✓

PEO-PSO Mapping

	PSO1	PSO2
PEO1	✓	✓
PEO2		✓
PEO3	✓	✓

KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University Established Under Section 3 of UGC Act 1956)
FACULTY OF ENGINEERING
B.Tech (BIOTECHNOLOGY)
COURSE OF STUDY AND SCHEME OF EXAMINATION
(2020 BATCH ONWARDS)

SEMESTER I

Course Code	Course Title	Category	Objectives & Outcomes		Instruction hours/week			Credits	Maximum Marks			Page No
			PEO	PO	L	T	P		CIA	ESE	Total	
									40	60	100	
20BTCC101	English	HS	1,2,3	h,i,k,l	2	0	2	3	40	60	100	27
20BTCC102	Mathematics-I	BS	2,3	a,b,e,h,i	3	1	0	4	40	60	100	29
20BTCC141	Engineering Physics	BS	2,3	a,b,c,e, h,i,k	3	1	2	5	40	60	100	31
20BTCC142	Basic Electrical and Electronics Engineering	ES	2,3	a,b,c,e,i,k	3	1	2	5	40	60	100	34
20BTCC143	Python Programming	ES	1	a,b,d	2	0	2	3	40	60	100	37
TOTAL					13	3	8	20	200	300	500	

SEMESTER II

Course Code	Course Title	Category	Objectives & Outcomes		Instruction hours/week			Credits	Maximum Marks			Page No
			PEO	PO	L	T	P		CIA	ESE	Total	
									40	60	100	
20BTCC201	Communicative English	HS	1,2,3	h,i,k,l	2	0	2	3	40	60	100	40
20BTCC202	Mathematics – II	BS	2,3	a,b,e,h ,i	3	1	0	4	40	60	100	42
20BTCC203	Biophysics	BS	1,3	a,b,c,d	2	0	0	2	40	60	100	45
20BTBT204	Environmental Studies	MC	1,3	f,g,h,l	3	0	0	3	40	60	100	48
20BTCC241	Engineering Chemistry	BS	2,3	a,b,c,d, e,f,i,k	3	0	4	5	40	60	100	50
20BTCC211	Workshop Practices	ES	1	a,d,e	0	0	4	2	40	60	100	53
20BTCC212	Engineering Graphics	ES	1	a,d,e	1	0	4	3	40	60	100	55
TOTAL					14	1	14	22	280	420	700	

Internship/Inplant Training – During Summer Vacation – Non Credit Course- Evaluation in next semester

SEMESTER III												
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No**
			PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
20BTBT301	Principles of Chemical Engineering	ES	1,3	a,b,d	3	1	0	4	40	60	100	57
20BTBT302	Molecular Biology & Genetics	PC	1,3	a,b,c,d ,e,f	3	0	0	3	40	60	100	59
20BTBT341	Biochemistry	PC	1,2,3	a,b,c,e	3	0	2	4	40	60	100	61
20BTBT342	Microbiology	PC	1,3	a,b,c, g,i	3	0	2	4	40	60	100	64
20BTBT343	Cell Biology	PC	1,3	a,b,d	3	0	2	4	40	60	100	67
20BTBT351	Technical Seminar	MC	1,2,3	i,j,k,l	0	0	2	0	100	-	100	70
20BTBT352	Synthesis of Organic Molecules	MC	1,3	a,b,c,f	0	0	1	-	100	-	100	71
20BTBT391	Internship	MC	1,2,3	i,j,k,l	0	0	1	-	100	-	100	72
TOTAL					15	1	10	19	500	300	800	

SEMESTER IV												
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No**
			PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
20BTBT401	Probability and Statistics	BS	1,3	a,b	3	1	0	4	40	60	100	73
20BTBT402	Chemical Thermodynamics	ES	1,3	a,b,c, d	3	1	0	4	40	60	100	75
20BTBT403	Basics of Industrial Biotechnology	PC	1,2,3	a,b,c,f,g	3	0	0	3	40	60	100	77
20BTBT404	Enzymology & Enzyme technology	PC	1,3	a,b,c,d,f	3	0	0	3	40	60	100	79
20BTBT441	Analytical Techniques	PC	1,3	a,b,c,d	3	0	2	4	40	60	100	81
20BTBT442	Genetic Engineering	PC	1,2,3	a,b,c,d,e,f	3	0	2	4	40	60	100	84
20BTBT451	Introduction to reactors	MC	1,2,3	a,b,c,d,f	0	0	1	-	100	-	100	87
	TOTAL				18	2	5	22	340	360	700	
	Summer Internship/ Mini Project – During Summer Vacation – Credit Course – Evaluation in next semester											

SEMESTER V

Course Code	Course Title	Category	Objectives & Outcomes		Instruction hours/week			Credits	Maximum Marks			Page No
			PEO	PO	L	T	P		CIA	ESE	Total	
									40	60	100	
20BTBT501	Structural Biology	PC	1,3	a,b,c,d	3	0	0	3	40	60	100	88
20BTBT541	Bioprocess Engineering	PC	1,2,3	a,b,c,d,e,f	3	1	2	5	40	60	100	90
20BTBT542	Immunology	PC	1,3	a,b,c,d	3	0	2	4	40	60	100	93
20BTBT543	Bioinformatics & Computational Biology	PC	1,3	a,b,c,d,e	3	1	2	5	40	60	100	96
20BTBT5E__	Professional Elective I	PE	-	-	3	0	0	3	40	60	100	-
20BTBT551	Constitution of India	MC	1,2	h,l	2	0	0	0	100	-	100	99
20BTBT552	Production of commercially valuable bioproducts	MC	1,3	a,f,g	0	0	1	-	100	-	100	102
20BTBT591	Summer Internship - I	PW	1,2,3	i,j,k,l	0	0	4	2	100	-	100	103
TOTAL					17	2	11	22	500	300	800	

SEMESTER VI

Course Code	Course Title	Category	Objectives & Outcomes		Instruction hours/week			Credits	Maximum Marks			Page No
			PEO	PO	L	T	P		CIA	ESE	Total	
									40	60	100	
20BTBT601	Heat and Mass Transfer	PC	1,2,3	a,b,c,d	3	1	0	4	40	60	100	104
20BTBT602	Intellectual Property Rights (IPR) & Regulatory	PC	1,2,3	f,g,h ,i	3	0	0	3	40	60	100	106
20BTBT641	Animal & Plant Biotechnology	PC	1,2,3	a,b,c,d,f	3	0	2	4	40	60	100	108
20BTBT642	Cheminformatics & Medicinal Chemistry	PC	1,2,3	a,b,c,d,e,f	3	1	2	5	40	60	100	111
20BTBT6E__	Professional Elective II	PE	-	-	3	0	0	3	40	60	100	-
20__6E__	Open Elective I	OE	-	-	3	0	0	3	40	60	100	-
20BTBT651	Separation of Bioactive compounds from plant material	MC	1,2	a,f,g	0	0	1	-	100	-	100	114
TOTAL					18	2	5	22	340	360	700	

Summer Internship/ Mini project– During Summer Vacation – Credit Course – Evaluation in next semester

	SEMESTER VII											
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No**
			PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
20BTBT701	Entrepreneurship and Startups	PC	1,2,3	f,g,h,i,j,k,l	3	0	0	3	40	60	100	115
20BTBT702	Economics for Engineers	HS	1,3	a,h,k,l	3	0	0	3	40	60	100	117
20BTBT741	Bioseparation Engineering	PC	1,2,3	a,b,c, d,e,f	3	0	2	4	40	60	100	119
20BTBT7E_	Professional Elective III	PE	-	-	3	0	0	3	40	60	100	-
20BTBT7E_	Professional Elective IV	PE	-	-	3	0	0	3	40	60	100	-
20__7E__	Open Elective II	OE	-	-	3	0	0	3	40	60	100	-
20BTBT791	Project-I	PW	1,2,3	i,j,k,l	0	0	4	2	40	60	100	122
20BTBT792	Summer Internship - II	PW	1,2,3	i,j,k,l	0	0	6	3	40	60	100	123
TOTAL					18	0	12	24	320	480	800	

SEMESTER VIII												
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No**
			PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
20BTBT891	Project-II	PW	1,2,3	i,j,k,l	0	0	18	9	120	180	300	124
TOTAL					0	0	18	9	120	180	300	

Total Credits	**160**

LIST OF ELECTIVES

Professional Elective - I

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER - V											
20BTBT5E01	Environmental Biotechnology	1,3	a,b,f, g	3	0	0	3	40	60	100	125
20BTBT5E02	Good Manufacturing and Laboratory Practice	1,2, 3	f,g,h	3	0	0	3	40	60	100	127
20BTBT5E03	Synthetic & Systems Biology	1,2, 3	a,b,c, d	3	0	0	3	40	60	100	129
20BTBT5E04	Biosimilars Technology	1,2, 3	a,b,c,d	3	0	0	3	40	60	100	131
20BTBT5E05	Genome Editing	1,3	a,b,c,d, e	3	0	0	3	40	60	100	133

Professional Elective - II

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER - VI											
20BTBT6E01	Big Data Analytics	1,3	a,b,c	3	0	0	3	40	60	100	135
20BTBT6E02	Waste Management & Upcycling	1,3	a.b.c,f, g	3	0	0	3	40	60	100	137
20BTBT6E03	Nano Biotechnology	1,3	a,b	3	0	0	3	40	60	100	139
20BTBT6E04	Immunotechnology	1,3	a,b,c ,d	3	0	0	3	40	60	100	141
20BTBT6E05	Genomics and Proteomics	1,3	a,b,c d,e	3	0	0	3	40	60	100	143

Professional Elective - III

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER - VII											
20BTBT7E01	Gene Expression and Transgenics	1,3	a,b,c	3	0	0	3	40	60	100	145
20BTBT7E02	Machine Learning	1,3	a,b,c,d, e	3	0	0	3	40	60	100	147
20BTBT7E03	Rational Drug Discovery	1,3	a,b,c,d, e	3	0	0	3	40	60	100	149
20BTBT7E04	Stem-Cell Technology	1,2,3	a,b,c, d,e,f	3	0	0	3	40	60	100	151
20BTBT7E05	Molecular Modeling	1,3	a,b,c, d,e	3	0	0	3	40	60	100	153

Professional Elective - IV

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER - VII											
20BTBT7E06	Precision Medicine & Wellness	1,3	a,b,c,d, e,f	3	0	0	3	40	60	100	155
20BTBT7E07	Tissue Engineering	1,2, 3	a,b,c, d,e,f	3	0	0	3	40	60	100	157
20BTBT7E08	Clinical Trial and management	1,2, 3	a,b,f,g ,h,i	3	0	0	3	40	60	100	159
20BTBT7E09	Bioimaging	1,3	a,b,c,d, e,f	3	0	0	3	40	60	100	161
20BTBT7E10	Data analysis and simulations	1,3	a,b,c,d, e	3	0	0	3	40	60	100	163

Open Electives (Offered by Biotechnology)

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
Open electives											
20BTBTOE01	Bioreactor Design	-	-	3	0	0	3	40	60	100	165
20BTBTOE02	Food Processing and Preservation	-	-	3	0	0	3	40	60	100	167
20BTBTOE03	Basic Bioinformatics	-	-	3	0	0	3	40	60	100	169
20BTBTOE04	Fundamentals of Nanobiotechnology	-	-	3	0	0	3	40	60	100	171

LIST OF OPEN ELECTIVES (COURSES PREFERRED BY BIOTECHNOLOGY)

SUB. CODE	TITLE OF THE COURSE	L	T	P	C	CIA	ESE	TOTAL	Page No
SCIENCE AND HUMANITIES									
20BTSHOE02	Green Chemistry	3	0	0	3	40	60	100	174
CHEMICAL ENGINEERING									
20BTCEOE04	Solid and hazardous waste management	3	0	0	3	40	60	100	176
FOOD TECHNOLOGY									
20BTFTOE04	Agricultural Waste and Byproducts Utilization	3	0	0	3	40	60	100	178
BIOMEDICAL ENGINEERING									
20BEBMEOE02	Artificial Organs And Implants	3	0	0	3	40	60	100	180

S.No.	Course work-subject area	Credits/ Semester								Credits Total	Percentage
		I	II	III	IV	V	VI	VII	VIII		
1.	Humanities and Social Sciences (HS)	3	3					3		9	5.6 %
2.	Basic Sciences (BS)	9	11		4					24	15.0 %
3.	Engineering Sciences-Common(ES)	8	5	4	4					21	13.1 %
4.	Professional Subjects-Professional Core (PC)			15	14	17	16	7		69	43.1 %
5.	Professional Electives (PE)					3	3	6		12	7.5 %
6.	Open Electives (OE)						3	3		6	3.8 %
7.	Mandatory Courses (MC)		3							3	1.9 %
8.	Project Work, Seminar, Internship (PW)					2		5	9	16	10.0 %
Total Credits										160	**100** %

SEMESTER I

B.Tech Biotechnology		**2020-2021**
		Semester-I
20BTCC101	**English**	**4H-3C**

Instruction Hours/week: L:2 T:0 P:2 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To enable students to attain fluency and accuracy to inculcate proficiency in professional communication to meet the growing demand in the field of Global communication.
- To help students acquire their ability to speak effectively in real life situations.
- To inculcate the habit of reading and to develop their effective reading skills.
- To ensure that students use dictionary to improve their active and passive vocabulary.
- To enable students to improve their lexical, grammatical and communicative competence.

Course Outcomes

Upon successful completion of the course, students will be able to

1 Use English language for communication: verbal & non –verbal.
2 Enrich comprehension and acquisition of speaking & writing ability.
3 Gain confidence in using English language in real life situations.
4 Improve word power: lexical, grammatical and communication competence.
5 To guide the students to write business letters and other forms of technical writing.
6 To enable students to prepare for oral communication in formal contexts.

Unit: I - **Basic Writing Skills**

Sentence Structures - Use of phrases and clauses in sentences - Importance of proper punctuation - Creating coherence- Organizing principles of paragraphs in documents - Techniques for writing precisely

Unit: 1I - Vocabulary Building

The concept of Word Formation - Root words from foreign languages and their use in English - Acquaintance, with prefixes and suffixes from foreign languages in English to form derivatives. - Synonyms, antonyms, and standard abbreviations.

Unit: III - Grammar and Usage

Subject-verb agreement - Noun-pronoun agreement - Misplaced modifiers – Articles – Prepositions – Redundancies - Clichés

Unit: IV - Listening and Reading Skills

Note taking- viewing model interviews – listening to informal conversations – improving listening / reading comprehension – reading model prose / poems – reading exercise

Unit: V.-**Writing Practices**

Comprehension - Précis Writing - Essay Writing Listening Comprehension - Common Everyday Situations: Conversations and Dialogues - Communication at Workplace – Interviews - Formal Presentations

Note: Students shall have hands on training in improving listening skill in the language laboratory @ 2 periods per each unit.

SUGGESTED READINGS

1. Sangeeta Sharma , Meenakshi Raman, .(2015),Technical Communication: Principles And Practice, 2nd Edition, OUP, New Delhi.
2. Sanjay Kumar and PushpLata, (2011), Communication Skills ,Oxford University Press.
3. Liz Hamp - Lyons and Ben Heasly, (2006), Study Writing, Cambridge University Press
4. F.T. Wood., (2007), Remedial English Grammar, Macmillan.
5. Michael Swan, (1995). Practical English Usage, OUP.

Semester-I

20BTCC102	**Mathematics I**	**4H-4C**

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for the students

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To understand geometrical aspects of curvature and elegant application of differential calculus which are needed in Engineering applications.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model Engineering problems.
- To familiarize the student with functions of several variables which is the foundation for many branches of Engineering.
- To introduce sequence and series which is central to many applications in Engineering.

Course Outcomes

Upon completion of this course the students will be able

1. To solve the rank, Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices and the students will be able to use matrix algebra techniques for practical applications.
2. To equip the students to have basic knowledge and understanding in one field of materials, differential calculus
3. To solve simple standard examples using the ideas of differential equations.
4. To apply various techniques to solve Partial Differential Equations
5. To develop the tool of power series for learning advanced Engineering Mathematics.
6. To apply the knowledge acquired to solve various Engineering problems.

UNIT I - Matrices

Introduction - Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction to canonical form through orthogonal reduction. Simple problems using Scilab.

UNIT II – Differential Calculus

Overview of Derivatives - Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes- Evolutes as Envelope of normals

UNIT III - Differential Equations

Linear Differential equations of second and higher order with constant coefficients – Homogeneous equation of Euler’s and Legendre’s type – Method of variation parameters.

UNIT IV –Functions of Several Variables

Partial derivatives- Homogeneous functions and Euler's theorem - Total derivative - Differentiation of implicit functions - Jacobians -Partial differentiation of implicit functions- Taylor's series for functions of two variables- Errors and approximations - Maxima and minima of functions of two variables- Lagrange's method of undetermined multipliers.

UNIT V - Sequences and series

Sequences: Definition and examples – **Series:** Types and Convergence – Series of positive terms – Tests of convergence: Comparision test, Integral test and D'Alembert's ratio test – Alternating series – Leibnitz's test – Series of positive and negative terms – Absolute and conditional convergence.

Total : 60

Suggested Readings:

1. Grewal B.S., (2014), Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi.
2. Erwin Kreyszig, (2016), Advanced Engineering Mathematics, 10th Edition, John Wiley, India.
3. BaliN.P. and Manish Goyal, (2014), A text book of Engineering Mathematics, Laxmi Publications, New Delhi, India.
4. Veerarajan T**,** (2008), Engineering Mathematics for first year,Tata McGraw-Hill, New Delhi,.
5. Ramana B.V**,** (2010), Higher Engineering Mathematics, 11th Reprint, Tata McGraw Hill New Delhi.
6. Hemamalini. P.T**,** (2014), Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
7. ThomasG.B and. FinneyR.L**,** (2002), Calculus and Analytic geometry, 9th Edition,Pearson**,**.
8. Michale D. Greenberg, (2011),Advanced Engineering Mathematics, 2nd Edition, Books Pearson Education, First Indian reprint.
9. Peter V. O'Neil,(2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning.
10. Gilbert Strang, (2009), Introduction to Linear Algebra, 4th Edition, Wellesley-Cambridge Press.

Websites :

1. www.efunda.com
2. www.mathcentre.ac.uk
3. www.intmath.com/matrices-determinants
4. www. Intmath.com/calculus/calculus-intro.php

Semester-I

20BTCC141	**Engineering Physics (Theory & Lab)**	**7H-5C**

Instruction Hours/week: L:3 T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

(i)Theory

Course Objectives

The Goal of this course is for students to

- Inculcate the basics of properties of matter, sound and its applications.
- Basics of laser and optical fiber with appropriate applications.
- Disseminate the fundamentals of thermal physics and their applications.
- Introduce the concepts of quantum mechanics for diverse applications.
- Impart the basic knowledge of crystal and its various crystal structures.

Course Outcomes

Upon completion of this course, the students will be able to

- Understand the elastic nature of materials.
- Infer the characteristics of laser for various engineering applications.
- Extend the knowledge on optical fiber for communication purposes.
- Illustrate the thermal properties of materials through various methods.
- Develop the idea of quantum mechanics through applications.
- Identify the different atomic arrangements of crystals and its defects.

UNIT I – PROPERTIES OF MATTER AND SOUND 9

Elasticity – basic definitions, stress - strain diagram - factors affecting elastic modulus and tensile strength – Poisson's ratio – Twisting couple - Torsion pendulum- bending of beams – bending moment – young's modulus – cantilever method, uniform and non-uniform bending – I-shaped girders.

Loudness, decibel, echo, reverberation, Sabine's formula, Ultrasonic – Production, Industrial and medical applications.

UNIT II – LIGHT, LASER AND FIBER OPTICS 9

Light – interference – reflection, refraction – Air wedge - LASER- Principle – characteristics - emission and absorption process - Einstein's coefficients derivation. Types of LASER - Nd:YAG, CO_2, Semiconductor LASER- Applications of LASER in industry and medicine.

Fiber optics: Total internal reflection – modes of propagation of light in optical fibers – numerical aperture and acceptance angle – types of optical fibers (Material, refractive index and mode) – fiber optical communication system (block diagram) - Fiber optic sensors: pressure and displacement.

UNIT III – THERMAL PHYSICS 9

Introduction– thermal expansion of solids and liquids – expansion joints – bimetallic strips – Mode of heat transfer - heat conductions in solids – thermal conductivity – derivation, Phonons - Forbe's and Lee's disc method: theory and experiment – conduction through compound media

(series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV – QUANTUM PHYSICS **9**

Merits of quantum theory, Demerits of classical theory – Black body radiation, Photo electric effect – Compton scattering: experimental description, dual nature of matter and radiation – de Broglie wavelength, uncertainty principle – Schrödinger's wave equation – time dependent and time independent equations – particle in one dimensional box- physical significance of wave function, Scanning Electron Microscope, Transmission Electron Microscope.

UNIT V – CRYSTAL PHYSICS **9**

Crystalline materials – types - unit cell, primitive cell, intercepts, interfacial angle - crystal systems, Bravais lattices, Miller indices – determination of inter-planar distances - Coordination number and packing factor for SC, BCC, FCC, HCP structures-crystal imperfections: point defect, line defect, surface and volume defect. Crystal growth techniques: Czochralski and Bridgman method.

SUGGESTED READINGS

1. Bhattacharya D.K. & Poonam T., Engineering Physics, Oxford University Press, 2015.
2. Gaur R.K. and Gupta S.L, Engineering Physics, Dhanpat Rai Publications, 2012.
3. Pandey .B.K. & Chaturvedi .S, Engineering Physics, Cengage Learning India, 2012.
4. Halliday.D., Resnick R. & Walker. J, Principles of Physics, Wiley, 2015.
5. Charles Kittel, Kittel's Introduction to Solid State Physics, Wiley India Edition, 2019.
6. P.M. Mathews, K.Venkatesan, A text book of Quantum Mechanics, 2/e, Mc Graw Hill Education, 2017.
7. Laser Fundamentals, William T Silfvast, Cambridge Univ Press. 2012.
8. Fiber Optics and Optoelectronics, R P Khare, Oxford, 2012.
9. Daniel V.Schroeder, An Introduction to Thermal Physics, Pearson, 2014.
10. D.S. Mathur, Elements of properties of matter, S.Chand, 2010.

JOURNALS

1. Nature Physics.
2. Journal of Applied Mechanics (ASME).
3. Ultrasonics and sonochemistry (Elsevier).
4. Journal of Light wave Technology (IEEE).
5. Optics and Laser Technology (Elsevier).
6. Applied Thermal Engineering (Elsevier).
7. Physical Review B (American Physical Society).

WEBLINKS

1. https://nptel.ac.in/courses/122/103/122103011/
2. https://nptel.ac.in/courses/113/104/113104081/
3. http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/lascon.html

(ii)Laboratory

Course Objective:

- To learn the basic concepts in physics relevant to different branches of Engineering and Technology.

Course Outcome:

- To familiarize the properties of material and basic concepts in physics.

LIST OF EXPERIMENTS – PHYSICS (Any 10 Experiments)

1. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of disc
2. Uniform bending (or) Non-uniform Bending – Determination of young's modulus.
3. Viscosity of liquids-Determination of co-efficient of viscosity of a liquid by Poiseuille's flow .
4. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.
5. Laser- Determination of the wave length of the laser using grating, Acceptance angle of optical fiber.
6. Spectrometer- Determination of wavelength using grating.
7. Air wedge – Determination of thickness of a thin sheet/wire.
8. Lee's disc – Determination of thermal conductivity.
9. Determination of Band gap of a semiconductor.
10. Potentiometer – Determination of thermo emf of a thermo couple.
11. Characteristics of photo diode.
12. Particle size determination using LASER.

20BTCC142 **Basic Electrical and Electronics Engineering** **6H-5C**

Instruction Hours/week: L:3 T:1 P:2 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

- To impart the basic knowledge about the Electric circuits.
- To understand the concept of Electrical Machines and Transformers.
- To understand the working of Semiconductor devices and Digital Circuits.
- To impart the basic knowledge of Measuring Instruments and Electrical Installation.

Course Outcomes

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

1. Attributing the electric circuits with DC and AC excitation by applying various circuit laws.
2. Attributing the electrical machines and transformer.
3. Evaluate the various digital circuits in real time applications.
4. Analysis various semiconductor devices in real time applications.
5. Reproduce the Measuring Instruments and Electrical Installation.

UNIT I - DC Circuits **(9)**

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

UNIT II - AC Circuits **(9)**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III - Electrical Machines And Transformer **(9)**

Construction and working of a three-phase and Single-phase induction motor. Construction, working and speed control of DC motor. Magnetic materials, BH characteristics, Construction and working principle of ideal and practical transformer.

UNIT IV- Semiconductor Devices And Digital Electronics **(9)**

Bipolar Junction Transistor – Characteristics. Introduction to operational Amplifier – Model–Applications. Number systems – binary codes - logic gates - Boolean algebra, laws & theorems

UNIT V- Measuring Instruments And Electrical Installation (9)

Principle, construction, and operation of moving coil and moving iron meters- Measurement of Power. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, RCCB, MCCB. Earthing. Types of Batteries and its application in Electric Vehicle, Important Characteristics for Batteries. Elementary calculations for energy consumption and battery back up

TEXT BOOK

1. S.K.Bhattacharya, "Basic Electrical Engineering", Pearson, 2019.
2. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.

REFERENCES

1. VN Mittle and Arvind Mittal,(2006) ,Basic Electrical Engineeering, McGraw Hill.
2. A.Sudhaka and Shyammohan S Palli,(2013), Circuits and Networks, McGraw Hill.
3. R.Muthusubramanian and S.Salivahanan,(2014),Basic Electrical and Electronics Engineering, McGraw Hill.

WEBSITES:

1. www. nptel.ac.in.
2. encyclopedia-magnetica.com/doku.php/coenergy.
3. https://en.wikibooks.org/wiki/electronics/measuring instruments.

ii) Laboratory

Course Objective

- To impart the basic knowledge about the DC and AC Electric circuits.
- To understand the working of DC Machines and Energy Meter.
- To impart the knowledge of Logical digital circuits and their differences.

Course Outcomes (Cos)

At the end of this course, students will be able

1. To understand and analyze basic electric and magnetic circuits.
2. To understand and analyze the working principles of DC Machines and Energy Meter.
3. To verify the truth table of Logic Gates.

List of Experiments

1. Experimental verification of electrical circuit problems using Ohms law
2. Experimental verification of electrical circuit problems using Kirchoff's Voltage law.
3. Experimental verification of electrical circuit problems using Kirchoff's Current law.
4. Measurement of electrical quantities – voltage, current, power & power factor in R load.
5. Measurement of energy using single phase energy meter.
6. Speed control of DC Shunt Motor.
7. Verification of truth table of Logic Gates.

Semester-I

20BTCC143 **Python Programming** **4H-3C**

Instruction Hours/week: L:2 T:0 P:2 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

(i) Theory

COURSE OBJECTIVES:

Students undergoing this course are exposed to:

- Describe the core syntax and semantics of Python programming language.
- Discover the need for working with the strings and functions.
- Illustrate the process of structuring the data using lists, dictionaries, tuples and sets.
- Indicate the use of regular expressions and built-in functions to navigate the file system.
- Infer the Object-oriented Programming concepts in Python.
- Students will solve problems, explore real-world software development challenges, and create practical and contemporary applications.

COURSE OUTCOMES:

Upon Completion of this course, the student will be able to:

- Explain various operators used in python.
- Apply the string handling functions to solve the given problem
- Describe Object oriented concepts with python
- Use image processing techniques in python programming to solve a given problem
- Discuss the functions of networking in python
- Solve a given analogy

UNIT I INTRODUCTION (9)

Installing Python; basic syntax, interactive shell, editing, saving, and running a script variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages;

UNIT II CONDITIONAL STATEMENT & STRING HANDLING (9)

Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation – Manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers.

UNIT III OBJECT ORIENTED PROGRAMMING WITH PYTHON (9)

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects – OOP, continued: inheritance, polymorphism, operator overloading; abstract classes; exception handling, try block

UNIT IV IMAGE PROCESSINGWITH PYTHON (9)

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Program structure and design. Recursive functions Simple Graphics and Image Processing: "turtle" module; simple 2d drawing – colors, shapes; digital images, image file formats, image processing Simple image manipulations with 'image' module (convert to b/w, rayscale, blur, etc).

UNIT V NETWORKINGWITH PYTHON (9)

Multithreading, Networks, and Client/Server Programming; introduction to HTML, interacting with remote HTML server, running html-based queries, downloading pages; CGI programming, programming a simple CGI form.

Total Hours : 45

TEXT BOOK:

1. Shroff ,"Learning Python: Powerful Object-Oriented Programming: 5th Edition, Fifth edition (24 July 2013)
2. Timothy A. Budd 'Exploring Python' – TATA McGRAW-HILL Edition - 2011
3. Vamsi Kurama , "Python Programming: A Modern Approach", Pearson Education, 2018.

REFERENCE BOOKS :

1. "Python Essential Reference". Addison-Wesley Professional; 4 edition (July 19, 2009) by David M.Baezly
2. "Python Cookbook" O'Reilly Media; 3rd edition (June 1, 2013) by David M. Baezly.
3. Guido Van Rossum, Fred . L. Drake 'Introduction to Python' – Network Theory Limited – March 2011
4. Alex Martelli 'Python in a Nutshell' - O'Reilly - 2nd Edition, 2006

WEBSITES:

1. https://www.codecademy.com/learn/python
2. www.learnpython.org/

(ii) Laboratory

PYTHON PROGRAMMING

COURSE OBJECTIVES:

Students undergoing this course are exposed to:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, and dictionaries.
- Read and write data from/to files in Python.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

LIST OF EXPERIMENTS:

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball in Pygame

SEMESTER II

B.Tech Biotechnology		**2020-2021**
		Semester-II
20BTCC201	**Communicative English**	**4H-3C**

Instruction Hours/week: L:2 T:0 P:2 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To help students acquire their ability to speak effectively in real life situations.
- To enable students to communicate in effective way without any barriers.
- To inculcate the habit of listening and to develop their effective listening skills.
- To ensure that students use different aids in order to attain effective communication.
- To enable students to improve their group behavior and presentation skill.

Course Outcomes

Students undergoing this course will be able to

1 Enrich comprehension and acquisition of listening, speaking & writing ability.
2 Gain confidence in using English language and develop leadership qualities.
3 To guide the students to effectively manage the team as a team player.
4 To develop the students Interpersonal and Interview skills.
5 Use English language for communication: verbal & non –verbal
6 To enable students to prepare for oral communication in formal contexts.

Unit: I - Communication Skills:

Communication Skills: Introduction, Definition, The Importance of Communication

The Communication Process – Source, Message, Encoding, Channel, Decoding Receiver, Feedback, Context

Barriers to Communication: Physiological Barriers, Physical Barriers, Cultural Barriers, Language Barriers, Gender Barriers, Interpersonal Barriers, Psychological Barriers, Emotional Barriers

Perspectives in Communication: Introduction, Visual Perception, Language, Other factors affecting our perspective-Past Experiences, Prejudices, Feelings, Environment

Unit:1I - Elements of Communication Introduction, Face to Face Communication- Tone of Voice, Body Language (Non-verbal communication), Verbal Communication, Physical Communication.

Communication Styles: Introduction, The Communication Styles Matrix with example for each -Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style.

Unit: III - Basic Listening Skills

Introduction, Self-Awareness, Active Listening, Becoming anActive Listener, Listening in Difficult Situations.

Effective Written Communication: Introduction, When and When Not to Use Written Communication-Complexity of the Topic, Amount of Discussion's Required, Shades of Meaning, Formal Communication.

Writing Effectively: Subject Lines, Put the Main Point First, Know Your Audience

Organization of the Message.

Unit: IV - Interview Skills and Giving Presentations

Purpose of an interview, Do's and Don'ts of an interview- Dealing with Fears, planning your Presentation, Structuring YourPresentation, Delivering Your Presentation, Techniques of Delivery.

Unit: V.-Writing Practices

Group Discussion: Introduction, Communication skills in group discussion, Do's and Don'ts of group discussion

Note: Students shall have hands on training in improving Speaking skill in the language laboratory @ 2 periods per each unit.

SUGGESTED READINGS

1. SanjayKumar,Pushpalata, (2011),Communicationskills,1st EditionOxfordPress.
2. Konarnira, (2011), Communication Skills forprofessionals,2nd EditionNew arrivals.
3. JohnAdair,4th Edition, (2009), . Effectivecommunication, 1st Edition CengageLearning
4. Indiapvt.ltd
5. ButterField, (2011), Softskillforeveryone, Macmillan.
6. Stephen.P.Robbins, (2013).Communicationskills, OxfordPress

Semester-II

20BTCC202	**Mathematics – II**	**4H-4C**

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

Course Objectives:

The goal of this course is for the students

- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.
- To calculate and establish identities connecting these quantities, to evaluate line, surface and volume integrals in simple coordinate systems and to use Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.
- To enable the students to apply the knowledge of Mathematics in various Engineering fields by making them to identify the functions in engineering problems as analytic function and their study as a function of a complex variables.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, to specify some difficult integration that appear in applications can be solved by complex integration in application areas such as fluid dynamics and flow of the electric current.
- To use Laplace transforms efficiently for solving the problems that occur in various branches of engineering disciplines.

Course Outcomes:

Upon completion of this course the students will be able

1. To apply integration to compute multiple integrals, area, volume, integrals in polar and Cartesian coordinates, in addition to change of order and vector integration.
2. To acquaint the student with the concepts of vector calculus, needed for problems in all Engineering disciplines
3. To find the Analytic functions using the Cauchy Riemann equations and they will learn mapping properties of elementary functions and mapping properties of some special transcendental functions.
4. To understand relations between conformal mappings and quadratic differentials and how geometric structures are changing under conformal mappings.
5. To evaluate complex integrals using the Cauchy integral formula and the residue Theorem and to appreciate how complex methods can be used to prove some important theoretical results.
6. To evaluate Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients

UNITI - Multiple Integrals

Double integral – Cartesian coordinates – Polar coordinates – Area as double integrals - Change of order of integration – Triple integration in Cartesian co-ordinates

UNITII- Vector Calculus

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem, Gauss divergence theorem and Stoke's theorems (Statement Only)- Surfaces : hemisphere and rectangular parallelopipeds.

UNITIII-Analytic Functions

Analytic functions - Cauchy-Riemann equations in Cartesian and polar forms – Sufficient condition for an analytic function (Statement Only) - Properties of analytic functions – Constructions of an analytic function - Conformal mapping: w = z+a, az, 1/z and bilinear transformation.

UNITIV-Complex Integration

Complex Integration - Cauchy's integral theorem and integral formula (Statement Only) – Taylor series and Laurent series - Residues – Cauchy's residue theorem (Statement Only) - Applications of Residue theorem to evaluate real integrals around unit circle and semi circle (excluding poles on the real axis).

UNITV-Laplace Transform

Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and final value theorems. Inverse Laplace transforms – Convolution theorem (statement only) – Solution of Ordinary Differential Equations with constant coefficients using Laplace transforms – Transform of periodic functions.

Total : 60

Suggested Readings:

1. Grewal, B.S., (2014), Higher Engineering Mathematics Khanna Publishers, New Delhi, 43rd Edition.
2. Kreyszig Erwin, (2016), Advanced Engineering Mathematics , John Wiley and Sons, 10th Edition, New Delhi.
3. Bali N. P and Manish Goyal, (2011), A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd.
4. Ramana B.V, (2008), Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, New Delhi.
5. Kandasamy. P, Thilagavathy. K, Gunavathy. K.,(2008), Engineering Mathematics, S Chand & Co. Ltd, New Delhi.
6. Hemamalini. P.T**,** (2014), Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
7. Venkataraman, M. K.,(2005), Engineering Mathematics, The National Publishing Company, Chennai.
8. Dass, H.K., and Er. Rajnish Verma,(2011), Higher Engineering Mathematics, S. Chand Private Ltd.
9. Glyn James,(2012), Advanced Modern Engineering Mathematics, 3rd Edition, Pearson Education,
10. Peter V. O'Neil,(2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning.
11. Sastry.S.S,(2014), Engineering Mathematics''. Vol.I&II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi.

12. Wylie, R.C. and Barrett. L.C., (2012), Advanced Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi.
13. Narayanan. S, Manicavachagampillay.T.K and Ramaniah, (2002),Advanced Mathematics for Engineering Students, Viswanathan S.(Printers and Publishers) Pvt. Ltd. Chennai.

Websites:

1. www.intmath.com
2. www.efunda.com
3. www.mathcentre.ac.uk
4. www.sosmath.com/diffeq/laplace/basic/basic.html

20BTCC203 **Environmental Studies** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Create the awareness about environmental problems among people.
- Develop an attitude of concern for the environment.
- Motivate public to participate in environment protection and improvement.

Course Outcomes (COs)

Upon completion of the course the students will be able to

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
7. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

Unit I – INTRODUCTION - ENVIRONMENTAL STUDIES & ECOSYSTEMS

Environment Definition, Scope and importance; Ecosystem, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Classification of ecosystem. Forest ecosystem, GrasslandEcosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit II - NATURAL RESOURCES - RENEWABLE AND NON-RENEWABLE RESOURCES

Natural resources - Renewable and Non – Renewable resources. Land resources and land use change, Land degradation, soil erosion and desertification. Forest resources -Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water resources- Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water.Use of alternate energy sources, growing energy needs, case

studies.Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit III - BIODIVERSITY AND ITS CONSERVATION

Levels of biological diversity - genetic, species and ecosystem diversity.Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Bio-geographical classification of India. Biodiversity patterns (global, National and local levels). Hot-spots of biodiversity. India as a mega-diversity nation. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit IV - ENVIRONMENTAL POLLUTION

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution.Nuclear hazards and human health risks. Solid waste management and control measures of urban, industrial and e-wastes. Role of an individual in prevention of pollution. Case studies.

Unit V - SOCIAL ISSUES AND THE ENVIRONMENT

Concept of sustainability and sustainable development. Water conservation -Rain water harvesting, watershed management.Climate change, global warming, ozone layer depletion,acid rain andits impacts on human communities and agriculture. Environment Laws (Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act). International agreements (Montreal and Kyoto protocols).Resettlement and rehabilitation of projectaffected persons.Disaster management (floods, earthquake, cyclones and landslides).EnvironmentalMovements (Chipko, Silent valley, Bishnois of Rajasthan). Environmental ethics: Roleof Indianand other religions and cultures in environmental conservation. Environmental communication and public awareness,case studies (e.g., CNG vehicles in Delhi).Human population growth: Impacts on environment, human health and welfare.

Suggested Readings

1. Anonymous. 2004. A text book for Environmental Studies, University Grants Commission and Bharat Vidypeeth Institute of Environmental Education Research, New Delhi.
2. Anubha Kaushik., and Kaushik, C.P. 2004. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, New Delhi.
3. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.
4. Daniel, B. Botkin., and Edward, A. Keller. 1995. Environmental Science John Wiley and Sons, Inc., New York.
5. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S.Chand& CompanyPvt. Ltd., New Delhi.
6. Odum,E.P., Odum, H.T. and Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

7. Rajagopalan, R. 2016.Environmental Studies: From Crisis to Cure, Oxford University Press**.**
8. Sing, J.S., Sing. S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Publishing Company, New Delhi.
9. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources.Daya Publishing House, New Delhi.
10. Tripathy. S.N., andSunakar Panda. (2004). Fundamentals of Environmental Studies (2nd ed.). Vrianda Publications Private Ltd, New Delhi.
11. Verma, P.S., and Agarwal V.K. 2001. Environmental Biology (Principles of Ecology).S.Chand and Company Ltd, New Delhi.
12. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, New Delhi.

20BTBT243 **Semester-II**

Biophysics **3H-2C**

(Theory)

Instruction Hours/week: L:4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The Goal of this course is for students to

- Introduce the Students to the fundamental concepts of physics applicable in biological systems.
- Study the concepts of thermodynamics and entropy in biological processes.
- Inculcate the dynamics of biomolecules interms of Physical concepts.
- Disseminate the basics of electrical signals and source on nerve system.
- Introduce the fundamentals of molecular motor in human health.

Course Outcomes

Upon completion of this course, the students will be able to

- Evaluate appropriate physical scale (length, force, time, energy, etc.) that is applicable in living systems.
- Apply laws of thermodynamics in biological processes like protein folding, metabolism, DNA melting, phase transitions in membrane, etc.
- Apply discrete and continuous distributions in biological systems.
- Understand the significance of low Reynold numbers in biological systems and their role in transport phenomenon in living systems.
- Draw electrical network equivalence of nerve signals.
- Understand the complete principles and concepts behind in the working of human hniological systems.

Unit -1 Biological aspects in terms of Physics

Life and its physical basis, length force and time scales in living systems, Chemical Bonds in Biochemistry, forces and energies at nanometer scale: Intermolecular interactions, electrostatic screening, chemical composition of living systems, Biomolecules, Conformational Changes in DNA Molecules, From DNA to RNA, The Biophysics of RNA.

Unit- 2 Thermodynamics and entropy in biology

Heat, temperature, thermodynamic equilibrium, types of energies and laws of thermodynamics: Applications: Brownian motion, protein stability and folding, metabolism in animals. Entropy, Entropic forces, Applications: Electrostatics in water, melting of DNA, phase transitions in membranes, Diffusion and its applications in biological systems.

Unit - 3 Dynamics of biomolecules

Friction in fluids, viscosity, surface tension, Reynold number, significance of low Reynolds numbers, The time reversal properties of a dynamical law, osmosis Applications: Swimming and pumping - Bacterial motion, vascular networks.

Unit - 4 Nerve impulses

Electrical phenomena in excitable cells, electrically excitable cells, electrical signals of nerve cells, the ionic hypothesis and rules of ionic electricity.

Unit -5 Molecular motors

Kinesin, dynein and myosin, and intracellular movement, microtubule structure. Mechanobiology and its importance in human health.

Reference:

1. P. Nelson, Biological Physics: Energy, information, life, Freeman, 1st edition (2013).
2. Rodney M.J. Cotterill, Biophysics: An Introduction, Wiley, Ist Edition (2002).
3. R. Glaser, Biophysics: An introduction, Springer, 2nd Edition (2012).
4. Mae-Wan Ho, The rainbow and the worm: The physics of organisms, World scientific publishing, 3rd edition (2008).
5. Neuroscience. 2nd edition. Purves D, Augustine GJ, Fitzpatrick D, et al., editors. Sunderland (MA): Sinauer Associates; (2001).
6. Biochemistry. 5th edition. Berg JM, Tymoczko JL, Stryer L.New York: W H Freeman; (2002).

Journals:

1. Medical Physics and Biophysics (IOP).
2. European Biophysics Journal (Springer).
3. Biochemical and Biophysical Research Communications. (Elsevier).
4. Biophysical Reviews and Letters. (World Scientific Press).
5. Journal of Biophysics (Hindawi).

Weblinks:

1. https://nptel.ac.in/courses/104102009/.
2. https://nptel.ac.in/content/syllabus_pdf/104102009.pdf.

		Semester-II
20BTCC241	**Engineering Chemistry (Theory & Lab)**	**7H-5C**

Instruction Hours/week: L:3 T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

(i) Theory

Course Objective

The goal of this course is for students to

- Study the basics of Periodic properties, Intermolecular forces
- Understand the terminologies of electrochemistry and to study about energy storage devies
- Understand the concept of corrosion and its prevention
- Comprehend the basic water technology and its purification.
- Study about spectroscopic technique

Course Outcomes

Upon completion of the course the students will be able to

1. Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
2. Analyse the mechanism of different energy storage devices.
3. Rationalise different types of corrosion and its prevention.
4. List the various methods in the purification of water.
5. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
6. Integrate the chemical principles in the projects undertaken in field of engineering and technology

UNIT I - Periodic properties, Intermolecular forces

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers. Ionic, dipolar and van Der Waals interactions.

UNIT II – Electrochemistry and Storage Devices

Thermodynamic functions. Free energy and emf. Cell potentials, the Nernst equation and applications. Types of electrodes Standard Hydrogen Electrode (SHE) & Calomel. Energy storage devices Primary and secondary cells leclanche cell, Lead Acid Battery, Nickel Cadmium Battery, Lithium Battery Charging and discarging reactions.

UNIT III – Corrosion and its control

Chemical and Electrochemical corrosion - Galvanic corrosion - Differential aeration corrosion - Corrosion control - Sacrificial anode and Impressed current cathodic methods - Corrosion inhibitors - Protective coatings – Organic coatings-Paints - Constituents and functions –Inorganic coatings- Metallic coatings - Electroplating (Au) and Electro less plating (Ni) - Surface conversion coating - Hot dipping

UNIT IV – Water Technology

Sources-Characteristics – Specification for drinking water, BIS &WHO-Alkalinity – Types of alkalinity and determination – Hardness – Types and estimation by EDTA method - Domestic water treatment – Disinfection methods (Chlorination, Ozonation. UV treatment) – Boiler feed water – Requirements – Disadvantages of using hard water in boilers – Internal conditioning (Phosphate, Calgon and Carbonate conditioning methods) – External conditioning – Demineralization process – Desalination - Reverse osmosis.

UNIT V - Spectroscopic techniques and applications

Spectroscopy (Principles and Instrumentation only).Electronic spectroscopy.Vibrational and rotational spectroscopy. Applications. Surface characterization techniques Scanning electron microscope (SEM) and Transmission electron microscopy (TEM). Fluorescence and its applications in medicine.

.

SUGGESTED READINGS

1. B. H. Mahan, (2010).University chemistry, Pearson Education,
2. M. J. Sienko and R. A. Plane, Chemistry: Principles and Applications.
3. C. N. Banwell, (2001)Fundamentals of Molecular Spectroscopy, McGraw-Hill,.
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web-book)
5. P. W. Atkins, (2009).Physical Chemistry, Oxford University Press,
6. K. P. C. Volhardt and N. E. Schore, (2014).5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman,
7. P C Jain & Monica Jain, (2015).Engineering Chemistry, DhanpatRai Publishing Company,

(ii) Chemistry Laboratory

Course Objectives

The goal of this course is for students to

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

Course Outcomes

Upon completion of the course the students will be able to

1. The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:
2. Estimate rate constants of reactions from concentration of reactants/products as a function of time
3. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc

Choice of 10 experiments from the following:

1. Determination of surface tension and viscosity
2. Determination of Sodium Carbonate and Sodium Hydrogen Carbonate in a mixure using volumetric titration
3. Determination of Ca / Mg using complexometric titration
4. Thin layer chromatography
5. Determination of chloride content of water
6. Determination of the rate constant of a reaction
7. Conductometry - Determination of cell constant and conductance of solutions
8. pH Metry – Determination of Acid / Base
9. Potentiometry - determination of redox potentials and emfs
10. Saponification/acid value of an oil
11. Determination of the partition coefficient of a substance between two immiscible liquids
12. Adsorption of acetic acid by charcoal
13. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

20BTCC211 **Workshop Practices** **4H-2C**

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- to prepare the students to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare the students to communicate effectively and to use the techniques, skills, and modern engineering tools necessary for engineering practice

COURSE OUTCOMES

1. Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
2. Students will be able to fabricate components with their own hands.
3. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
4. By assembling different components, they will be able to produce small devices of their interest.

(i) Lectures & videos:

Detailed contents

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical &Electronics
5. Carpentry
6. Plastic molding, glass cutting
7. Metal casting
8. Welding

(ii) Workshop Practice:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop
6. Casting
7. Plumbing Exercises

SUGGESTED READINGS

1. Gowri S, Jeyapoovan, T.,Engineering Practices Lab Manual, 5th edition, Vikas Publishing House Pvt. Ltd, Chennai. 2017.
2. Bawa, H.S, Workshop Practice, 2nd edition, Tata McGraw – Hill Publishing Company Limited, New Delhi, 2009.
3. Choudhry S K, Elements of workshop technology, Vol 2, 13th edition, Indian book distributing company, Kolkatta, 2010.

4. D K Singh, Manufacturing Technology, 2nd edition, Pearson Education, 2008.
5. Kalpakjian S., Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition,Pearson Education India Edition, 2001.
6. Roy A. Lindberg, Processes and Materials of Manufacture, 4th edition, Prentice Hall India, 1997.
7. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, 4th edition, Tata McGrawHill House, 2018.

20BTCC212 **Engineering Graphics** **5H-3C**

Instruction Hours/week: L:1T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

Course Objectives

- To prepare the students to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- To prepare the students to communicate effectively and to use the techniques, skills, and modern engineering tools necessary for engineering practice

Course Outcomes

On completion of this course, students will be able to

1. Understand the engineering drawing and its place in society.
2. Expose the visualization of engineering drawing and engineering graphics standards.
3. Expose the engineering communication.

UNIT I INTRODUCTION

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Bureau of Indian Standards (BIS), Layout of drawing sheets, sizes of drawing sheets, different types of lines used in drawing practice geometric constructions, principles of dimensioning– linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension. Reducing Scale, Enlarging Scale, Plain Scale, Diagonal Scale and Vernier Scale. Conic sections including the Ellipse, Parabola and Hyperbola (eccentricity method only); Cycloid, Epicycloid, Hypocycloid and Involute.

UNIT II INTRODUCTION TO COMPUTER GRAPHICS – 2D

Overview of Computer Graphics, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars, Drawing Area, Dialog boxes and windows, Shortcut menus ,The Command Line (where applicable), Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Annotations, layering & other functions.

UNIT III PROJECTION OF POINTS, LINES AND PLANE SURFACES

Projection of points and straight lines located in the first quadrant inclined to both planes– Determination of true lengths and true inclinations. Projection of polygonal surface and circular lamina inclined to both reference planes.

UNIT IV COMPUTER GRAPHICS – 3D

Introduction to3D modeling packages. Drafting practices - modeling of simple engineering components, sections and extraction of 2D drawings.

UNIT V ISOMETRIC PROJECTIONS

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple solids, truncated prisms, pyramids, cylinders and cones; Conversion of Isometric Views to Orthographic Views and Vice-versa

SUGGESTED READINGS

1. Venugopal K and Prabhu Raja V, (2015), Engineering Graphics, New Age International Publishers.
2. C M Agrawal and Basant Agrawal, (2012), Engineering Graphics, Tata McGraw Hill, New Delhi.
3. James D. Bethune, (2019), Engineering Graphics with AutoCAD , Macromedia Press.
4. Narayana, K.L. & P Kannaiah, (2010), Text book on Engineering Drawing, Scitech Publishers.
5. Shah, M.B. & Rana B.C., (2010), Engineering Drawing and Computer Graphics, Pearson Education.
6. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House.

SEMESTER III

B.Tech Biotechnology		2020-2021
		Semester-III
20BTBT301	Principles of Chemical Engineering	4H-4C

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To understand the basic laws and concepts of chemical calculations.
- To explain the first and second laws of thermodymics.
- To explain the overall material balances of chemical reactions and its basic calculations.
- To discuss the fluid flow mechanics and its concepts.
- To understand the fluid transportation.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Outline the basic chemical calculations and the basic laws governing it.
2. Illustrate basic laws of thermodynamics.
3. Infer the overall material balances of chemical reactions and its basic calculations.
4. Outline the application of fluid flow mechanics in chemical engineering.
5. Discuss the fluid flow and its measurements.
6. Understand the basic principles of chemical calculations and measurements.

UNIT I - BASIC CHEMICAL CALCULATIONS

SI units, stoichiometry, basic chemical calculations: mole, atomic mass and molar mass, equivalent mass, conversion of mass function to mole fraction, molarity, normality, density, specific gravity. Ideal gas law- Ideal mixtures and solutions – Dalton's law of additive volumes, Henry's law, Raoult's law, Concepts of Simpson's rule and their applications to different systems.

UNIT II - MATERIAL BALANCES

Overall and component balances, material balances without and with chemical reactions, degrees of freedom, steady and unsteady state, unit operations, recycle and by pass humidity calculations.

UNIT III – UNIT OPERATION

Units and dimension, dimensional analysis, Filtration-types, filter media, selection of medium, filter aids-filter theory, settling and sedimentation; centrifugation, Modes of heat transfer, principles of conduction, Fourier's Law of heat conduction, thermal conductivity, steady state conduction, unsteady state conduction, forced and natural convection - Dimensional analysis, Heat exchanger- types, Equipments.

UNIT IV - FLUID MECHANICS

Fluids; fluid statics and applications in chemical engineering; fluid flow; laminar; Turbulent pressure drops; compressible fluid flow concepts; multiphase flow concepts.

UNIT V - TRANSPORTATION OF FLUIDS

Pumps- Types, Working principle, Characteristics, Suction and Cavitation; Measurements of flowing fluids; Fluidization and flow through Packed Bed Column

SUGGESTED READINGS:

1. Bhatt. B.I. and Vora. S.M. (2004). Stoichiometry. 4th Edition. Tata McGraw-Hill Education.
2. McCabe. W., Smith. J., and Harriott. P. (2004). Unit Operations of Chemical Engineering. 7th Edition. Tata McGraw Hill Education.
3. Geankoplis C.J. (2016). Transport Processes and separation process principles. (Includes unit operations). 4th Edition, Pearson.
4. Smith. J.M., Van Ness H.C. and Abbot. M.M. (2001). Chemical Engineering Thermodynamics. McGraw-Hill.
5. Narayanan. K.V. (2001). A Text Book of Chemical Engineering Thermodynamics. Prentice Hall India.
6. Sandler. S.I. (1989). Chemical and Engineering Thermodynamics. John Wiley.
7. Stockar. U.V., Luuk A.M. and Wielen V.D. (2013). Biothermodynamics: The Role of Thermodynamics in Biochemical Engineering. EPFL Press.

Semester-III

20BTBT302 **Molecular Biology and Genetics** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To outline the classical genetics concepts of eukaryotes and prokaryotes.
- To explain the structure of nucleic acids and DNA replication.
- To understand the molecular process of transcription.
- To understand the basic machinery of translation and its mechanisms.
- To understand the regulation of gene expression and various types of mutation .

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Course outcomes

Upon successful completion of the course, students will be able to

1. Discuss the concepts related to eukaryotic and prokaryotic genetics.
2. Identify the structure of nucleic acids, DNA replication and chromosome organization.
3. Illustrate the prokaryotic and eukaryotic transcription, and its post transcriptional modifications.
4. Outline the concept of genetic code, translation process and post translational modifications.
5. Interpret the process of regulation of gene expression and its importance.
6. Identify the different types of mutation and DNA repair mechanisms.

UNIT I - CLASSICAL GENETICS

Eukaryotic genetics - Mendelian genetics, linkage, crossing over, classical experiments – Hershey and Chase, Avery McLeod & McCarty. Prokaryotic genetics - Bacterial conjugation, transduction and transformation.

UNIT II - STRUCTURE OF NUCLEIC ACIDS AND DNA REPLICATION

Conformation of DNA, Types of RNA, Replication in prokaryotes, D-loop and rolling circle mode of replication, replication of linear viral DNA. Organisation of eukaryotic chromosome – cot value, replication of telomeres in eukaryotes

UNIT III - TRANSCRIPTION

Conformation of RNA- Prokaryotic and Eukaryotic transcription, RNA polymerase, Transcription signals, transcription factors, Features of promoters and enhancers, ribozymes. Post

transcriptional modification – 5' capping, adenylation, splicing, processing of rRNA and tRNA, RNA editing.

UNIT IV - TRANSLATION

Genetic code, Salient features - Wobble hypothesis, basic machinery of translation and its mechanism,codon usage, Post translational modifications, protein targeting.

UNIT V - REGULATION OF GENE EXPRESSION

Regulation of genes – replication, transcription & translation factors, Lac operon, ara operon and trp operon, phage life cycle,Mutation – transition, transversion, artificial & natural mutation, suppressor mutation and repair of DNA.

SUGGESTED READINGS:

1. David. F. (2008). Molecular Biology. Narosa Pubilcation.
2. Benjamin. L. (2004). Gene VIII. Pearson Education.
3. Watson. J.D., Baker Bell, Gann, Levine and Losick. (2004). Molecular Biology of the Gene. Pearson Education.
4. Weaver. R.F. (2005). Molecular Biology. Mc Graw Hill.

Semester-III

20BTBT341	**Biochemistry (Theory & Lab)**	**5H-4C**

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Outline the basics of biochemistry.
- Explain the structure and properties of carbohydrates and lipids.
- Illustrate the structure and properties of amino acids, proteins and nucleic acids.
- Discuss the metabolism of carbohydrates and lipids & its associated genetic disorders.
- Summarize the amino acid and nucleic acid metabolism and its associated genetic disorders.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Recall the basics of biochemistry and solve the basic calculations.
2. Categorize the different forms of carbohydrates & lipids and its properties.
3. Analyse the structure and properties of biomolecules – amino acids and nucleic acid.
4. Review the carbohydrate and lipid metabolism and its associated genetic disorders.
5. Illustrate the synthesis of amino acids and nucleic acid and its degradation pathways.
6. Relate the metabolic disorders with its associated human diseases.

UNIT I INTRODUCTION TO BIOCHEMISTRY

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson – Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes.

UNIT II STRUCTURE AND PROPERTIES OF BIOMOLECULES- CARBOHYDRATES AND LIPIDS

Carbohydrates: Monosaccharides: aldose, ketose, epimers, pyronoses, furanoses, anomers, Haworth formula, conformation of pyranoses, sugars as reducing agents, Disaccharides: Glycosidic bonds, hydrolysis, Polysaccharides: starch, glycogen, dextrans, homopolysaccharides, chitin. Glyconjugates: Glycoproteins, proteoglycan, and glycolipids. Sugar code, methods of carbohydrate analysis

Lipids: Fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins. structural lipids in membrane, lipid extraction.

UNIT III STRUCTURE AND PROPERTIES OF BIOMOLECULES - PROTEINS AND NUCLEIC ACID

Protein: General structure of amino acid, properties, conventions of amino acids, classification of aminoacids by R group, uncommon amino acids, Zwitterion. Peptides: Peptide bond, polypeptides, oligomers, protomers. Proteins: hierarchy, four levels of structure in protein, steps in sequencing of a polypepide, locating di sulfide bond. Chemical synthesis of peptides, Enzymes – Types.

Nucleic acids: Nucleotides and nucleic acid nomenclature, Phosphodiesterase Linkage, structure of purine and pyrimidine, nucleoside, RNA, DNA-Watson-Crick structure of DNA.

UNIT IV - METABOLISM OF CARBOHYDRATES AND LIPIDS

Major pathways of glucose utilization: glycolysis, gluconeogenesis, Pentose phosphate pathway; TCA cycle: Reactions and regulations, genetic disorders affecting carbohydrate metabolism. Electron transport chain. Biosynthesis of fatty acid, Tricylglycerol and cholesterol. The β-oxidation pathway. Oxidation of monounsaturated and polyunsaturated fatty acid. Genetic defects in fatty Acyl–CoA dehydrogenases causing serious diseases, Biochemical basis of human diseases (Eg: Diabetes, Cardiovascular disease- atherosclerosis).

UNIT V - METABOLISM OF AMINO ACIDS AND NUCLEIC ACIDS

Biosynthesis of amino acids from acetyl CoA, Biosynthesis of essential amino acids (Met, Thr, Lys, Ile, Val, Leu, Phe, Trp, Tyr), Urea cycle, haemoglobin synthesis. Pathways of degradation of aromatic, glucogenic and ketogenic amino acids. Inborn errors of amino acid metabolism. Biosynthesis of nucleotides, *de novo* and salvage pathways for purines and pyrimidines, regulatory mechanisms; catabolism of purine & pyrimidine; Metabolic disorders associated with nucleic acid metabolism.

ii) Laboratory

Course Objectives

The goal of this course is for students to

- Explain the principles behind the qualitative and quantitative analysis of biomolecules such as carbohydrates, lipids, nucleic acids and proteins.
- Analyse the enzymatic activity of lysozyme
- Carry out the quantification of sugars

Course Outcomes

Upon successful completion of the course, students will be able to

- Demonstrate the quantification of biomolecules such as carbohydrates, lipids, nucleic acids and proteins
- Interpret the enzyme activity of lysozyme
- Perform the quantification of sugars

LABORATORY COMPONENT

1. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
2. Quantification of lipids (Zak's method)
3. Estimation of DNA (DPA method)
4. Estimation of RNA (Orcinol method)
5. Quantification of proteins (Lowry' s and Bradford's method)
6. Estimate lysozyme enzymatic activity
7. Quantification of sugars (Anthrone method)

SUGGESTED READINGS:

1. Nelson. D.L., Cox. M., and Cox. M.M. (2017). Lehninger Principles of Biochemistry. 7th Edition Freeman W.H. & Company, New York.
2. Zubay. G.L. (2017). Principles of Biochemistry. Medtech.
3. Berg JM, Tymoczko JL, Stryer L. (2002). Biochemistry. 5th edition. Freeman W.H. & Company, New York.
4. Varki A, Cummings RD, Esko JD, et al., editors. Essentials of Glycobiology [Internet]. 3rd edition. Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press; 2015- 2017.
5. Siegel GJ, Agranoff BW, Albers RW, et al, editors. (1999). Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 6th edition. Philadelphia: Lippincott-Raven.
6. Murray. R.K., Granner. B.K., Mayes. P.A. and Rodwell. V.W. (2018). Harper's Illustrated Biochemistry, 31st edition, McGraw-Hill Education.
7. Voet. G. and Voet. A. (2018). Fundamentals of Biochemistry. 2nd Edition. John Wiley & Sons, Inc.

Semester-III

20BTBT342 **Microbiology** **5H-4C**

(Theory & Lab)

Instruction Hours/week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Illustrate the basic concepts of microbiology and different microbial identification techniques.
- Interpret the microbial growth and its metabolism.
- Explain the microbial genetics in molecular level.
- Infer the major groups of interactions and ecological diversity.
- Outline the mechanism for the control of microorganisms.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Outline the history of microbiology and microbial staining techniques.
2. Infer the basic requirements for microbial growth towards the biosynthesis of important molecules.
3. Explain the molecular genetics of microorganisms.
4. Discuss the controlling mechanism of microorganisms.
5. Illustrate the production of various metabolites and its applications.
6. Recall with a conceptual and experimental background.

UNIT I INTRODUCTION TO MICROBIOLOGY

History and Scope of Microbiology, Taxonomy and classification of microorganisms, Role of microbes, Organization of Prokaryotic and Eukaryotic cell structure and Function, Diversity of microbial world, Microscopy - Light, dark field, phase contrast, Fluorescence and Electron Microscopes. Different staining techniques.

UNIT II MICROBIAL NUTRITION AND GROWTH

Types of growth media, Different phases of growth curve, Culture methods, preservation methods; Microbial metabolism - Aerobic & anaerobic respiration, fermentation, Entner Duodruffs pathway, Photosynthesis, Nitrogen fixation, bioenergetics, utilization of energy, biosynthesis of important molecules.

UNIT III MICROBIAL MOLECULAR BIOLOGY AND GENETICS

Genome and gene structure, Replication, Expression, Regulation of gene expression (Operon System), Transformation, Conjugation and Transduction; Applications-Microbial bioremediation by superbugs.

UNIT IV MICROBIAL ECOLOGY AND INTERACTION

Microbes from marine, freshwater and terrestrial environments, Various microbial interactions – Symbiotic, Non-symbiotic and pathogenic microbes, Biogeochemical cycles-Water cycle, Carbon cycle, Nitrogen cycle, Sulphur cycle.

UNIT V CONTROL OF MICROOGANISMS

Physical and chemical control of microorganisms, Effect of heat, Sterilization, disinfectants, therapeutic agents, antimicrobial resistance, host-microbe interactions, antibacterial, anti-fungal, anti-viral agents, mode of action, resistance to antibiotics, clinically important microorganisms.

SUGGESTED READINGS:

1. Talaro. K.P. and Chess. B. (2017). Foundations in microbiology. 10th Edition. Tata McGraw-Hill Education.
2. Pelczar. M. J. Chan. E.C.S. and Kreig N.R. (2015). Microbiology. 5th Edition. Tata McGraw-Hill Education.
3. Willey. J.M., Sherwood. L.M. and Woolverton C.J. (2011). Prescott's Microbiology, 8th Edition, McGraw-Hill International
4. Kolwzan. B., Adamiak. W., Grabas K. and Pawelczyk. A. (2006). Introduction to Environmental Microbiology, ebook.

ii) Laboratory

Course objectives

The goal of this course is for students to

- Characterize the nature of the cells present in the biological sample through microscope.
- Explain the different staining techniques.
- Experiment the stages of mitosis and different types of blood cells.
- Illustrate the chloroplast isolation from leaves.
- Demonstrate the culturing, growth and control of microorganisms.

Course outcomes

Upon successful completion of the course, students will be able to

1. Illustrate the handling of microscope and categorize the cells present in the biological sample.
2. Interpret the various staining techniques to identify the cell.

3. Outline the stages of mitosis.
4. Remember the growth of organism and the parameters that influence their stability to grow.
5. Acquire the knowledge about the chemicals that controls the bacterial growth.
6. Recall the growth curve and the control of microorganisms.

LIST OF EXPERIMENTS

1. Microbial Good Lab Practices and Biosafety
2. Media preparation, sterilization and disinfection
3. Microscopic examination of different groups of microorganisms
4. Total count and viable count determination
5. Microbial simple and differential staining methods
6. Isolation of pure culture and its preservation
7. Microbial Growth Curve Determination
8. Effect of physical and chemical environment on growth
9. Biochemical tests for microbial identification
10. Antibiotic Sensitivity of Microorganisms

SUGGESTED READINGS

1. Willey. J.M., Sherwood. L.M. and Woolverton C.J. (2011). Prescott's Microbiology, 8th Edition, McGraw-Hill International.
2. Pelczar. M. J. Chan. E.C.S. and Kreig N.R. (2015). Microbiology. 5th Edition. Tata McGraw-Hill Education.
3. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1978). General microbiology 5th edition, Cambridge University Press.
4. Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J. (2003). *Brock biology of microorganisms*. Upper Saddle River (NJ): Prentice-Hall.

Semester-III

20BTBT343 **Cell Biology** **5H-4C**

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- To explain the cell structure of Prokaryotes and Eukaryotes
- To understand how cells undergo mitosis
- To outline the views on transport across the cell membranes.
- To explain the signaling process involved in the cell.
- To illustrate the function of mitochondria and chloroplast.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the structure and function of cell components
2. Understand the role of the cytoskeletal proteins and link it with cell cycle.
3. Illustrate the transport process across the cell membrane.
4. Outline the basic ideas on signaling process through the receptors.
5. Explain the electron transfer in mitochondria.
6. Relate the importance of cell signaling process to understand diseases.

UNIT-I CELL STRUCTURE AND CELL ORGANELLES

History of cell biology, comparison of eukaryotic and prokaryotic cells, membrane organisation, theories, components; Structure of prokaryotic cells - cilia, flagella, cell wall; Structure of eukaryotic cell organelles: cytoplasm, endoplasmic reticulum, mitochondria, chloroplast, peroxisomes, nucleus, Microscopic techniques for viewing cell organelles.

UNIT-II CYTOSKELETAL PROTEINS & CELL DIVISION

Cytoskeletal proteins - Types, contractile proteins - actin & myosin, cell adhesion proteins; extracellular matrix; Types of cell division: mitosis & meiosis, Cell cycle and molecules that control cell cycle

UNIT-III TRANSPORT ACROSS CELL MEMBRANES

Passive & active transport, permeases, sodium potassium pump, Ca_2^+ ATPase pumps, lysosomal and vacuolar membrane ATP dependent proton pumps, co-transport symport,

antiport, active group translocation; endocytosis and exocytosis; Entry of viruses and toxins into cells.

UNIT-IV RECEPTORS AND CELL SIGNALLING

Cytosolic, nuclear and membrane bound receptors, examples of receptors, identify cation and purification of cell surface receptors, secondary messangers, autocrine, paracrine and endocrine modes of action

UNIT- V FUNCTION OF MITOCHONDRIA AND CHLOROPLAST

Chloroplast: photosynthetic stages and light-absorbing pigments, Mitochondria: Electron transport chain, Reduction Potentials of Electron Carriers, Electron transfer from reduced cytochrome c to O_2, ATP synthesis.

SUGGESTED READINGS:

1. Lodish. H., Berk A., Zipurursky S.L., Matsudaria P., Baltimore D. and Darnell. J. (2000). Molecular Cell Biology. 4th Edition. Freeman press.
2. Alberts. B., Johnson. A., Lewis. J., Raff. M., Roberts K., and Walter. P. (2002). Molecular Biology of the Cell, Garland PUB.
3. Rastogi. S.C. (2004). Cell Biology. New Age International Pub. Ltd.
4. De Robertis. E.D.P. and De Robertis E.M.F. (2005). Cell and Molecular biology. B.I publications Pvt Ltd.

ii) Laboratory

Course objective:

The goal of this course is for students

- To understand the nature of the cells present in the biological sample through microscope.
- To explain the different staining techniques.
- To understand the stages of mitosis and different types of blood cells.
- To understand the chloroplast isolation from leaves.

Course outcomes:

Upon successful completion of the course, students will be able to

1. Illustrate the handling of microscope and categorize the cells present in the biological sample.
2. Interpret the various staining techniques to identify the cell.
3. Outline the stages of mitosis.

LIST OF EXPERIMENTS

Laboratory Safety and Aseptic Techniques

1. Identification of given plant, animal and bacterial cells and theirs components by microscopy.
2. Staining Techniques: (i) Leishmann staining (ii) Giemsa staining.
3. Staining for different stages of mitosis in *Allium cepa* (Onion).
4. Identification of different types of blood cells
5. Isolation of chloroplasts from spinach leaves.

SUGGESTED READINGS:

1. Benjamin. A. pierce.(2016).Genetics a conceptual approach., Published by W. H. Freeman.
2. Venkata. R., Prakash.D. (2015). Key Notes on Genetics and Plant Breeding. Astral International publishers.
3. De Robertis. E.D.P. and De Robertis E.M.F. (2005). Cell and Molecular biology. B.I publications Pvt Ltd.
4. James. D. W., Baker .T., Bell Stephen.P., Gann Alexander., Levine Michael., and Losick Richard.(2004) Molecular Biology of the Gene.

Semester-III

20BTBT351 **Technical Seminar** **2H-0C**

Instruction Hours/ week: L: 0 T: 0 P: 2 **Marks:** Internal**: 100** External**: 0** Total**: 100**

End Semester Exam: 3 Hours

Course Objective

The goal of this course is for students to

- Develop an ability to understand and present a seminar on the latest scientific and technological developments in the field of engineering and technology

Course Outcome

Upon successful completion of the course, students will be able to

1. Reproduce their writing as well as oral communication skills.

Guidance / Remarks:

- Seminar in-charges shall highlight the significance of technical seminar in the first two sessions and enlighten the students on the utility of these seminars.
- The student has to identify the related topic.
- The slots, titles shall be decided upfront and seminar in charge shall take signatures.
- The same sheet shall be affixed in the respective classrooms and seminar register
- If any student fails to present his/her seminar on the given slot, to genuine reasons, they may be asked to present in the subsequent slot/week.
- Progress of the seminars need to be reviewed by the concerned HOD once in 15 days.
- The evaluation for technical seminars has to be informed to students and displayed in the classrooms.

Semester-III

20BTBT352 **Synthesis of Organic molecules** **1H-0C**

Instruction Hours/ week: L: 0 T: 0 P: 1 **Marks:** Internal**: 100** External**: 0** Total**: 100**

End Semester Exam: 3 Hours

Course Objective

The goal of this course is for students to

- Perform the synthesis of organic molecules

Course Outcome

Upon successful completion of the course, students will be able to

- Demonstrate the synthesis of organic molecules

LIST OF EXPERIMENTS

1. Synthesis of Aspirin.
2. Synthesis of p-nitroacetanilide.
3. Preparation of Acetanilide from Aniline.
4. Extraction of Lycopene
5. Preparation of alpha D-glucopyranose penta acetate.
6. Preparation of 1,2:5,6- dicyclohexylidine- alpha-D glucofuranose.

Semester-III

20BTBT391 **Internship** **1H-0C**

Instruction Hours/ week: L: 0 T: 0 P: 1 **Marks:** Internal**: 100** External**: 0** Total**: 100**

End Semester Exam: 3 Hours

Minimum of six weeks in an Industry preferably in the area of Biotechnology. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: AICTE Internship Policy available on AICTE's website may be referred for more information regarding Internship.

Guidance/Remarks:

Internship needs to be done in Summer Break after Semester - II and will be considered for evaluation in Semester - III.

SEMESTER IV

B.Tech Biotechnology		2020-2021
		Semester-III
20BTBT401	Probability and Statistics	4H-4C

Instruction Hours/ week: L: 3 T: 1 P: 0 **Marks:** Internal**: 100** External**: 0** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives:

The goal of this course is for the students

- This course aims at providing the required skill to apply the statistical tools in Engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two-dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

Course Outcomes:

Upon Completion of this course the students will be ableto:

1. Explain the fundamental concepts of probability and standard distributions which can describe real life phenomenon.
2. Explain the basic concepts of one- and two-dimensional random variables and their applications in engineering.
3. Apply the concept of testing of hypothesis for small and large samples in real life problems.
4. Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
5. Discuss the notion of sampling distributions and statistical techniques used in engineering and management problems.
6. Discuss about the techniques in quality control that model engineering problems.

UNIT I –Probability and Random Variables

Probability – The axioms of probability – Conditional probability – Baye‘s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II –Two - Dimensional Random Variables

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression using SPSS tool– Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III –Testing Of Hypothesis

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chisquare and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV –Design of Experiments

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design using SPSS tool.

UNIT V –Statistical Quality Control

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

Total: 60

Suggested Readings:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
4. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
5. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
6. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum‘s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
7. Walpole. R.E., Myers. R.H., Myers.S.L. and Ye.K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.
8. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
9. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
10. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Websites:

1. www.cut-theknot.org/probability.shtml
2. www.mathworld. Wolfram.com
3. www.mathcentre.ac.uk

Semester-IV

20BTBT402 **Chemical Thermodynamics** **3H-4C**

Instruction Hours/ week: L: 3 T: 1 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To explain the thermodynamic properties of fluids and its calculations.
- To discuss the basic concepts of solution properties.
- To illustrate the phase equilibria concepts for various systems.
- To outline the equilibrium criteria for various chemical reactions.
- To infer the knowledge on general thermodynamic processes.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Discuss the various properties of the fluids and its calculations.
2. Explain the concept of solution thermodynamics and composition models.
3. Analyze the criteria of phase equilibria for different component system.
4. Apply the concept of chemical reaction equilibria and equilibrium conversion.
5. Analyze the thermodynamic flow process.
6. Illustrate the working principles and the process involved in the refrigeration and Liquefaction system.

UNIT-I THERMODYNAMIC PROPERTIES OF FLUIDS

Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties - equations of state; Actual property exchanges - Calculations; Maxwell's relations and applications.

UNIT- II SOLUTION THERMODYNAMICS

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.

UNIT- III PHASE EQUILIBRIA

Criteria - phase equilibria; V-L-E calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

UNIT- IV CHEMICAL REACTION EQUILIBRIA

Equilibrium criteria - 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.

UNIT- V THERMODYNAMIC ANALYSIS OF PROCESSES

Thermodynamics of flow processes, Concept of lost work; entropy generation; power cycle (rankine, regenerative, reheat); liquefaction and refrigeration

SUGGESTED READINGS:

1. Smith. J.M., Van Ness H.C. and Abbot. M.M. (2001). Chemical Engineering Thermodynamics. McGraw-Hill.
2. Narayanan. K.V. (2001). A Text Book of Chemical Engineering Thermodynamics. Prentice Hall India.
3. Sandler. S.I. (1989). Chemical and Engineering Thermodynamics. John Wiley.
4. Stockar. U.V., Luuk A.M. and Wielen V.D. (2013). Biothermodynamics: The Role of Thermodynamics in Biochemical Engineering. EPFL Press.

Semester-IV

20BTBT403 Basics of Industrial Biotechnology 3H-3C

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To explain the basic idea on scope of biotechnology and its commercial production in modern biotechnology.
- To discuss the process of primary metabolite production in different industries.
- To discuss the process of secondary metabolite production.
- To explain the basic procedures for production of bioproducts.
- To illustrate the various methods for the production of recombinant products.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Outline the scope of biotechnology and its commercial potential.
2. Interpret the modern biotechnological processing techniques for the production of commercial bioproducts.
3. Illustrate the production methods of primary metabolites.
4. Illustrate the production methods of secondary metabolites.
5. Infer the knowledge on commercial enzyme and bioproduct production.
6. Explain the production of various commercially available products using recombinant technology.

UNIT I- INTRODUCTION TO INDUSTRIAL BIOPROCESS

Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Traditional and modern biotechnology. Products relating to modern biotechnology, industrially important organisms, fermentation processes – modes of operation.

UNIT II - PRODUCTION OF PRIMARY METABOLITES

Production of commercially important organic acids - citric acid, lactic acid, acetic acid, amino acids - glutamic acid, phenyalanine, aspartic acid , alcohols - ethanol, butanol.

UNIT III- PRODUCTION OF SECONDARY METABOLITES

Secondary metabolites: antibiotics: beta-lactams (penicillin, cephalosporin), aminoglycosides (streptomycin) macrolides (erythromycin), vitamins (B12) and steroids (progesterone).

UNIT IV- PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS

Production of industrial enzymes - proteases, amylases, lipases, cellulases etc., Production of biopesticides, biofertilizers, biopreservatives (Nisin), cheese, biopolymers (xanthan gum, PHB), single cell protein.

UNIT V-PRODUCTION OF RECOMBINANT DNA PRODUCTS

Production of recombinant proteins - therapeutic and diagnostic applications, production of vaccines (hepatitis B vaccine), hormones (insulin). Production of monoclonal antibodies-commercial scale, products of plant (human growth hormone) and animal cell culture (interferons).

SUGGESTED READINGS:

1. Casida Jr. L.E. (2006). Industrial Microbiology. 2nd Edition. New Age International.
2. Reed G. (2004). Prescott & Dunn's Industrial Microbiology. 4th Edition. CBS Publishers & Distributors.
3. Dubey. R.C. (2014). Text book of Biotechnology. 5th Edition. S Chand Publishers.
4. Cruger. W. (2017). Crueger's Biotechnology: A Textbook of Industrial Microbiology. 3rd Edition. Medtech.

Semester-IV

20BTBT404 **Enzymology & Enzyme technology** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To understand the knowledge on enzyme mechanism of action.
- To explain the production & purification of enzymes.
- To explain about the kinetics of single substrate enzyme action
- To understand the kinetics of multi substrate enzyme action
- To illustrate on immobilization and applications.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Discuss the overview of enzyme mechanism of action.
2. Outline the knowledge on extraction, purification and characterization of enzymes.
3. Understand the kinetics of multisubstrate enzyme action.
4. Interpret the various enzyme immobilization techniques and its application in bioreactor.
5. Summarize the basics of enzyme engineering.
6. Explain the features of enzyme biosensors and its application.

UNIT-I INTRODUCTION TO ENZYMES

Chemical nature, apoenzyme, coenzyme, cofactor, prosthetic group. Nomenclature– IUB system of classification -Six main classes with examples. Mechanisms of enzyme-action; Specificity, type of enzyme specificity, Active site, Models of enzyme action –Lock and key, induced fit, transition state theory. metal ion catalysis, proximity & orientation. metal-activated enzyme and metalloenzyme.

UNIT- II EXTRACTION, PURIFICATION AND CHARACTERIZATION OF ENZYMES

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays.

UNIT-III KINETICS OF MULTISUBSTRATE-ENZYME ACTION

Kinetics of Single substrate reaction – estimation of Michaelis- Menten parameters and Multisubstrate reactions mechanisms; Turnover number; types of inhibition Allosteric regulation of enzymes, Monod - Changeux -Wyman model, pH and temperature effect on enzymes & deactivation kinetics

UNIT- IV ENZYME IMMOBILIZATION

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment,encapsulation, cross-linking, covalent binding etc., - examples, applications, advantages and disadvantages. applications. Immobilised enzyme bioreactors.

UNIT- V ENZYME ENGINEERING AND BIOSENSORS

Chemical and genetic methods, Property alteration, Prediction of enzyme structure, design and construction of novel enzymes; Enzyme Biosensor – Classification, Design, Application - industry, healthcare, food and environment.

SUGGESTED READINGS:

1. Palmer. T. (2007). Enzymes. Affiliated East West Press Pvt Ltd.
2. Wiseman. (1995). Enzyme Biotechnology. Ellis Horwood Publishers.
3. Chaplin and Bucke. (1990). Enzyme technology. Cambridge University Press.
4. Price and Stevens. (2002). Fundamentals of Enzymology. Oxford University Press.
5. Blanch. H.W. and Clark. D.S. (1996). Biochemical engineering. Marcel Dekker Inc.
6. Bailey J.E. and Ollis D.F. (1986). Biochemical Engineering Fundamentals. McGraw Hill.
7. Pye E.K. and Wingard L.B. (1974). Enzyme Engineering II. Plenum Press.

B.Tech Biotechnology		2020-2021
		Semester-IV
20BTBT441	Analytical Techniques (Theory & Lab)	5H-4C

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Paraphrase the basic concepts of wave properties and radiation sources
- Outline the different separation techniques for product purification
- Describe the concepts and instrumentation of modern microscopic techniques.
- Explain the theory and instrumentation of analytical spectroscopy.
- Illustrate the real time analytical techniques for genome sequencing.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the basic concepts of wave properties and radiation sources
2. Identify the separation techniques for product purification.
3. Illustrate the basic working of modern microscopic techniques.
4. Outline the basic ideas on spectroscopy and NMR techniques.
5. Tell the working mechanism of modern microscopic techniques.
6. Relate the importance of real time analytical techniques for genome sequencing.

UNIT-I FUNDAMENTALS OF ANALYTICAL TECHNIQUES

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – chemical analysis, tools for quantitative chemical analysis, quality assurance.

UNIT-II SEPARATION TECHNIQUES

General description and classification of Chromatography - Theory, instrumentation and Applications of the following chromatographic techniques: Ion-Exchange, Affinity, Hydrophobic, Size exclusion, FPLC, HPLC, GC; Ultracentrifugation, Electrophoresis; Applications.

UNIT-III MICROSCOPY TECHNIQUES

Introduction to optics, principles of image formation, principles of fluorescence, digital imaging, Light spectroscopy and Microscopy-Absorption, IR, Scattering (Raman and

Rayleigh), Resonance Raman, Fluorescence (steady-state and time resolved), confocal microscopy, Multi-photon microscopy, Atomic Force Microscopy

UNIT-IV SPECTROSCOPY AND NMR

Introduction, Theory of UV-Visible Spectroscopy & Calorimetry, Beer Lambert law, Deviation from Beer Lambert law. Mass spectroscopy- Basic principles & brief outline of instrumentation, Ion formation, molecular ion, meta stable ion, fragmentation process in relation to molecular structure & functional groups; MALDI, LC-MS, GC-MS, MS-MS, MALDI-Mass imaging; Solution- and solid-state NMR spectroscopy: Introduction, Theory & Instrumentation, chemical shift concept, spinspin coupling, isotopic nuclei, reference standards & solvents, applications., X-ray crystallography.

UNIT- V REAL TIME ANALYTICAL TECHNIQUES

Introduction of real time analytical techniques - Proteomics, MS and NMR based Metabolomics, DNA and RNA sequencing for genomics, PCR for transcriptomic, Real time PCR, Droplet PCR, Surface Plasmon Resonance (SPR), Bio-layer interferometry (BLI), High content screening.

(ii) Laboratory

Course Objectives

The goal of this course is for students to

- To provide students with practical knowledge of quantitative analysis of materials by traditional and modern analytical techniques
- Develop experimental skills in building technical competence through instrumental methods.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Perform the qualitative and quantitative analysis experiments using spectroscopy.
2. Estimate the compound purification through chromatography techniques.
3. Hypothesize the genomics data analysis.

LABORATORY COMPONENT

1. Measurement of IR and Raman spectra of small molecules
2. Measurement of excitation and emission spectra of a fluorophore and their wavelengths for maximum excitation and emission
3. Purification of a compound from a mixture using HPLC
4. Protein purification using affinity, ion-exchange and gel filtration chromatography
5. Analysis of NMR spectra and structure determination of a bio-active compound like cyclosporine.

6. Analysis of SPR and ITC data and calculation of binding affinities.
7. Demonstration of analysis of genomics data

SUGGESTED READINGS:

1. Charles R. Canter and Paul R. Shimmel, 1980, Biophysical Chemistry, Vol II, W. H. Freeman.
2. Robert K. Scopes (Narosa), 1994, Protein Purification: Principles and Practice, Springer-Verlag New York.
3. Joseph R. Lakowicz , 2006, Principles of Fluorescence Spectroscopy, Springer US.
4. Barbar Stuart, 2004, Infrared Spectroscopy Fundamentals and Applications, Wiley online library.
5. Richard L. McCreery, 2000, Raman Spectroscopy for Chemical Analysis, Wiley online library.
6. Harald Gunther, 2013, NMR spectroscopy, 3rd Edition, Wiley.
7. Christopher G. Herbert and Robert W. Johnstone, 2002, Mass Spectrometry Basics, 1st Edition, CRC Press.
8. A Braithwaite and F. J. Smith, 1999, Chromatographic methods, 5th Edition, Kluwer Academic Publishers.

Semester-IV

20BTBT442	**Genetic Engineering (Theory & Lab)**	**5H-4C**

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- To understand the basic concepts in rDNA technology.
- To explain the importance of recombinant molecules in rDNA technology.
- To outline the concepts involved in gene library construction and differentiate between different gene libraries.
- To explain about the different types of PCR, the main concept in genetic engineering.
- To understand the vast applications of rDNA technology in diverse fields.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Discuss the knowledge on the basics of rDNA technology.
2. Outline the usage of recombinant molecules in research and development.
3. Understand gene libraries construction and to perform blottings.
4. Interpret the indepth knowledge acquired to perform PCR reactions and their types.
5. Infer the importance of DNA sequencing methods.
6. Summarize the concept of rDNA technology and its importance in cloning, gene therapy and relate its applications.

UNIT I - BASICS OF RECOMBINANT DNA TECHNOLOGY

Role of genes within cells, genetic elements that control gene expression, Isolation and separation of genomic and plasmid DNA; restriction and modifying enzymes, safety guidelines of recombinant DNA research.

UNIT II - CREATION OF RECOMBINANT MOLECULES

Restriction mapping, design of linkers and adaptors, gene editing.Characteristics of plasmid and phage vectors, prokaryotic and eukaryotic expression vectors.Insect, Yeast and Mammalian vectors.

UNIT III - CONSTRUCTION OF LIBRARIES

Construction of cDNA and genomic libraries.Screening of libraries with DNA probes and with antisera.Cloning : Characterization of recombinant clones by southern, Northern, western and

PCR analysis, factors affecting foreign gene expression,over expression and purification of recombinant proteins.

UNIT IV –THEORIES OF rDNA TECHNIQUES

Polymerase chain reaction: Inverse PCR, Nested PCR, Taqman assay, RT - PCR, RACE PCR, RAPD, RFLP, site directed mutagenesis (Kunkel's Method), nucleic acid sequencing- Sangers method, Maxam Gilbert sequencing and automated sequencing method.

UNIT V –APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY

Applications of recombinant DNA Technology: Cloning in plants, Ti plasmid, Methods of producing transgenic animals and their applications, gene silencing, gene therapy.

SUGGESTED READINGS:

1. Primrose. S.B. and Twyman. R.M. (2006). Principles of Gene Manipulation and Genomics. 7th Edition. Blackwell Publishers.
2. Ansubel. F.M., Brent. R., Kingston. R.E. and Moore D.D. (2003). Current Protocols in Molecular Biology. Greene Publishing Associates.

ii) Laboratory

Course Objectives

The goal of this course is for students

- To outline and evaluate the methods for isolation and purification of DNA from plant and animal samples.
- To explain the protocol to run the agarose gel electrophoresis sample analysis.
- To demonstrate the DNA ligation techniques for transformation and screening of rDNA.
- To understand the methods involved in optimization protocol for recombinant protein expression.
- To explain the importance of high throughput screening, SDS PAGE and PCR.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Carry out agarose gel electrophoresis and isolation of DNA samples individually.
2. Develop the knowledge of techniques involved in DNA isolation and purification.
3. Perform the restriction enzyme digestion and ligation of DNA samples.
4. Produce recombinant DNA and implement blue white screening techniques to screen them.

5. Develop methods to produce recombinant proteins and understand their applications and perform SDS PAGE and PCR reactions.
6. Summarize the overall structure of rDNA technology and implement its techniques in research and development.

LABORATORY COMPONENT

1. Agarose gel electrophoresis
2. Isolation of plasmid & chromosomal DNA from bacterial cell
3. Isolation of plant cell genomic DNA from plant source
4. Isolation of genomic DNA from animal cell
5. Purification of DNA from agarose gel
6. Restriction enzyme digestion and ligation
7. Competent cells preparation ($CaCl_2$ method)
8. Transformation and screening for recombinants
9. Blue and white selection for recombinants
10. Optimization of inducer concentration and time of induction for recombinant protein expression.
11. SDS PAGE
12. PCR

SUGGESTED READINGS:

1. Chaitanya. K.V. (2013). Cell and Molecular Biology, A Lab Manual. Prentice Hall India Learning Private Limited.
2. Vennison. S.J. (2009). Laboratory Manual for Genetic Engineering. Prentice Hall India Learning Private Limited.

Semester-IV

20BTBT451	**Introduction to reactors**	**1H-0C**

Instruction Hours/ week: L: 0 T: 0 P: 1 **Marks:** Internal**: 100** External**: 0** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Describe the chemical engineering principles and its operations.
- Apply the concept of pressure drops in pipes
- Discuss the concept of pressure drops in different reactors.
- Examine the concept of filtration and heat transfer.
- Explain the different separation techniques.

Course outcomes

Upon successful completion of the course, students will be able to

1. Outline the chemical engineering principles and operations.
2. Calculate the flow measurements and pressure drop in pipes and different reactors.
3. Analyze the process of filtration and heat transfer.
4. Perform the distillation and extraction.
5. Demonstrate the process involved in adsorption equilibrium.
6. Demonstrate the process involved in leaching

LIST OF EXPERIMENTS

1. Flow measurement in pipes and Pressure drop in pipes.
2. Pressure drop across Fluidized bed.
3. Pressure drop across packed column
4. Continuous rotary filtration
5. Heat exchanger
6. Liquid-liquid equilibria in extraction
7. Adsorption equilibrium
8. Leaching

SUGGESTED READINGS:

1. Geankoplis. C.J. (2007). Transport Processes and Unit Operations. Prentice Hall of India.
2. McCabe W.L., Smith. J.C. and Harriot P.I. (2004). Unit Operations in Chemical Engineering. 7th Edition. McGraw-Hill Inc.
3. Coulson. M. and Richardson. J.F. (2004). Coulson and Richardsons Chemical Engineering. (Vol. 2). Butterworth Heineman.

SEMESTER V

B.Tech Biotechnology		2020-2021
		Semester-V
20BTBT501	STRUCTURAL BIOLOGY	3H-3C

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**
End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Focus on relating theoretical concepts and experimental approaches to a wide range of potential research problems in the area of structural biology.
- The course aims to provide a solid foundation and breadth of understanding in structural biology that will facilitate application to current and future research problems.
- Understanding of the basic science of Protein Structure, including first principles of the physical interactions that maintain proteins and the mechanisms
- Learn about different techniques and experimental approaches that represent the state-of-the-art and are widely used in the study of proteins.
- Understand the current concepts in structural biology and biochemistry.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Understand the strengths and limitations of various experimental and computational approaches for studying macromolecular structure and function.
2. Judge when the stated scientific conclusions derived from original experimental data are justified, and when they are not justified.
3. Devise alternative scientific approaches to allow more robust conclusions on specific structural biology questions.
4. Develop and present succinct oral presentations describing specific structural biology and biophysics methods papers and their relationship to other work in the field.
5. Understand how cross-talk between proteins and post-translational protein modifications.
6. Understand the key experimental processes required to evaluate protein structure, function and gene expression, and knowledge of how to apply them to solve specific biochemical problems.

UNIT I - FUNDAMENTALS OF PROTEIN STRUCTURE

Fundamentals of protein structure- amino acids fundamental building blocks, Peptide bond, rigid planar peptide unit, *cis* and *trans* configuration. Structural Hierarchy: Primary, Secondary, Tertiary, Quaternary structures. Motifs and domains: α- domain structures, β - domain structures, α/β (alpha/beta) - structures. Principles of nucleic acid structure: Chemical structure of nucleic

acids, Watson and Crick's base-pairings and their implications. Non Watson and Crick pairing schemes - base stacking interactions - DNA polymorphism - structure of ADNA, BDNA and ZDNA - helical transitions.

UNIT II - PROTEIN CRYSTALLIZATION

Protein Crystallization: Principles of protein crystallization, Preparation of crystal for X-ray experiment. Crystallization techniques: Batch method, liquid-liquid diffusion method, vapour diffusion method- hanging drop, sitting drop, dialysis. Seeding Method-macroseeding, microseeding, other seeding methods

UNIT III - ELEMENTARY CRYSTALLOGRAPHY

Introduction: symmetry in crystals, lattices and unit cells, crystal systems, Bravais lattices, Elements of symmetry - rotation axis, mirror planes and center of inversion, proper/ improper axes of rotation, translational symmetry- screw axis and glide planes. Symmetry operation: classes of symmetry operations, classification of symmetry point groups and molecular space groups and equivalent points. X-ray diffraction - Laue equations - Bragg's law - reciprocal lattice and its application to geometrical Crystallography.

UNIT IV - X-RAY SCATTERING

X-ray scattering: Atomic scattering factor - diffraction by a space lattice - structure factor equation - electron density and Fourier series - Fourier Transform and crystal diffraction - Phase Problem – Direct methods, molecular replacement method, Patterson function, heavy atom method.

UNIT V - NUCLEAR MAGNETIC RESONANCE

Nuclear Magnetic Resonance:- Introduction, Nuclear spin, NMR sensitivity, shielding and deshielding effects of NMR, nuclear Over hauser effect. Spectral parameters: chemical shift, spin-spin splitting, coupling, non-equivalent proton. Carbon-13 NMR spectra of protein, FTNMR, spin-spin splitting, proton spin decoupling, off-resonance decoupling, Spin-lattice relaxation time. Multidimensional NMR, COSY, NOSEY, MRI, ESR. Application of NMR to biology- Regulation of DNA transcription, Protein-DNA interaction.

SUGGESTED READINGS:

1. C. Branden and J. Tooze. (1998). Introduction to protein structure. Garland Science. 2nd edition
2. George H. Stout, Lyle H. Jensen. (1989). X-Ray Structure Determination: A Practical Guide. Wiley-Interscience. 2nd Edition.
3. G. E. Schulz. (2009). Principles of Protein Structure. Springer.
4. Philip E. Bourne, Helge Weissig. (2003). Structural Bioinformatics. Wiley Publication.
5. McPherson. (1999). Crystallization of Biological Macromolecules. Cold Spring Harbor Laboratory Press.

20BTBT541 **Bioprocess Engineering** **6H-5C**

Instruction Hours/ week: L: 3 T: 1 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Outline the fundamentals of bioprocess engineering.
- Design the kinetic parameters of microbial growth.
- Illustrate the process design and control of bioreactors.
- Design the r heological parameters and scale up of fermentation process.
- Analyze the simulation and validation program for bioprocess technology.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the general requirements and various types of fermentation process.
2. Outline the growth kinetics of microorganisms.
3. Construct the various designs of bioreactor and its control mechanisms.
4. Characterize the scale up parameters for mixing requirements.
5. Operate the simulation software for the design of bioreactors.
6. Design a bioreactor and study its parameters for biological applications.

UNIT - I - INTRODUCTION OF BIOPROCESS ENGINEERING

Historical development of Bioprocess technology, General requirements and types of fermentation processes - aerobic and anaerobic fermentation process, solid-state and submerged fermentation. Bioreactors - batch, fed-batch and continuous bioreactors, Immobilized cell systems.

UNIT - II - GROWTH KINETICS

Batch growth, balanced growth, effect of substrate concentration - Monod model - determining cell kinetic parameters from batch data - structured and unstructured models - microbial growth kinetics, substrate utilization, and product formation kinetics - stoichiometry - energy balance - principles of enzyme catalysis - enzyme kinetics - immobilized enzymes.

UNIT - III - PROCESS DESIGN AND CONTROL OF BIOREACTORS

Bioreactor design and construction - Reactor Engineering in perspective. Types of Reactors (Batch, Fed, Batch and Continuous) Design of Stirrers and impellers. Principles and Strategies

for Control of Bioreactors (feedback, feed forward, adaptive and statistical control, fuzzy logic control). Bioprocess design for Plant and Animal cell reactor.

UNIT - IV - RHEOLOGY AND SCALE UP OF FERMENTATION

Newtonian and Non Newtonian fluids, Effect of scale on oxygenation, mixing, sterilization, nutrient availability and supply. Bioreactor scale up based on constant power consumption per volume, mixing time, impeller tip speed (shear), Calculation of mass transfer coefficient in fermentation and its role in scale up.

UNIT - V - SIMULATION AND VALIDATION IN BIOPROCESS TECHNOLOGY

Introduction to Process Analytical Technology (PAT) and Quality by Design (QbD). Simulation techniques (Software): Continuous system simulators (CSMP, INT); dynamic process simulators (DYFLO, DYNSIS); steady state material and energy balance programs (PACER, FLOWTRAN, CHESS);.Simulation of batch reactor using MATLAB, SIMULINK for dynamic systems. Application of modelling and simulation in bioprocess industries

ii) Laboratory

Course Objectives

The goal of this course is for students to

- Analyse the concept of growth kinetics
- Optimize the parameters for the microbial growth
- Demonstrate the process of bioconversion
- Perform the product formation kinetics using fermentation process and study its different parameters
- Practice the estimation of volumetric oxygen transfer coefficient

Course Outcomes

Upon successful completion of the course, students will be able to

1. Interpret the growth and inhibition kinetics
2. Perform the bioconversion process using immobilized enzyme
3. Examine the product formation kinetics in fermentation process
4. Infer the bioconversion process under aerobic and anaerobic condition
5. Perform the estimation of volumetric oxygen transfer coefficient

LIST OF EXPERIMENTS

1. Microbial growth kinetics and estimation of cell mass
2. Growth inhibition kinetics
3. Operation of pH control and dissolved oxygen measurement
4. Enzyme immobilization techniques
5. Bioconversion using immobilized enzyme preparation

6. Aerobic and anaerobic bioconversion process
7. Product formation kinetics in a fermentation process
8. Effect of mixing and agitation in bioreactors
9. Mass transfer in immobilized cell
10. Estimation of volumetric oxygen transfer coefficient

SUGGESTED READINGS:

1. Shuler and Kargi. (2017). Bioprocess Engineering Basic concepts. 2nd Edition. Pearson.
2. Stanbury P.F., Hall. S.J. and Whitaker. A. (2017). Principles of Fermentation technology. 3rd Edition. Elsevier.
3. Bailey J.E. and Ollis D.F. (2015). Biochemical Engineering Fundamentals. 2nd Edition. Tata McGraw-Hill.
4. Pauline M. Doran. (2013). Bioprocess Engineering principles. 2nd Edition. Elsevier.
5. Blanch H.W. and Clark D.S. (2012). Biochemical Engineering. 2nd Edition. Marcel Dekker.

Semester-V

20BTBT542	**Immunology (Theory & Lab)**	**5H-4C**

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course objectives:

The goal of this course is for students

- To understand the basic knowledge of cells and organs of Immune system.
- To explain the different cellular responses and its functions.
- To outline the Immune responses to various disease and different immunologic reactions in Human body.
- To explain the organ transplantation and tumor immunology.
- To outline the basics of autoimmunity.

Course outcomes:

Upon successful completion of the course, students will be able to

1. Discuss the cells and components of immune system.
2. Explain the basics of B, T cells, genes and generation of antibody and its functions.
3. Infer the basic views on monoclonal antibodies and antigen- antibody interactions.
4. Discuss the concept of immunity and various immunological responses to infections.
5. Discuss the basics of Transplantation and tumor therapies.
6. To illustrate the current trends in treatment of auto immune disease.

UNIT-I INTRODUCTION

Cells of immune system, innate and acquired immunity, primary and secondary lymphoid organs, Components of immune system: antibodies, antigens, haptens, adjuvants, types of immune responses, theory of clonal selection.

UNIT-II CELLULAR RESPONSES

Development, maturation, activation and differentiation of T-cells and B-cells: TCR, antibodies, structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions; monoclonal antibodies: principles and applications; antigen presenting cells; major histocompatibility complex; antigen processing and presentation; regulation of T-cell and B-cell responses.

UNIT-III INFECTION AND IMMUNITY

Injury and inflammation; immune responses to infections: immunity to viruses, bacteria, fungi and parasites, cytokines, complement, immunosuppression, tolerance, allergy and hypersensitivity, resistance and immunization: Vaccines.

UNIT-IV TRANSPLANTATION AND TUMOR IMMUNOLOGY

Transplantation: genetics of transplantation, laws of transplantation, problems in transplantation: Basis of Graft rejection, specificity and memory of graft rejection; Role of cell mediated response in graft rejection, Transplantation antigens, Mechanisms involved in Graft rejections, tumor immunology-immune therapy.

UNIT-V AUTOIMMUNITY

Autoimmunity, Auto immune diseases and diagnosis, proposed mechanisms for induction of Autoimmunity, Treatment of Autoimmune diseases; current therapies, monoclonal antibody and diagnosis, treatment.

ii) Laboratory

Course Objectives

The goal of this course is for students

- To discuss the handling techniques of animals and immunization.
- To understand the isolation and identification of cells and blood group.
- To explain the methods for the detection of anitigen-antibody.
- To outline the techniques for antigen identification.
- To understand the techniques of T-cell rossetting and Western blotting.

Course Outcomes:

Upon successful completion of the course, students will be able to

1. Infer the basic handling techniques for animal studies.
2. Outline the basics of isolation and identification of cells and blood group.
3. Illustrate the Immuno electrophoresis and Immuno diffusion for determination of antibody.
4. Understand the knowledge about ELISA and western blotting for identification of various diseases.
5. Explain the identification of typhoid antigens by Widal test.
6. Discuss principles of T-cell rossetting.

LIST OF EXPERIMENTS

1. Handling of animals, immunization and raising antisera
2. Identification of cells in a blood smear

3. Identification of blood group
4. Immuno diffusion
5. Immuno electrophoresis
6. Testing for typhoid antigens by Widal test
7. Enzyme Linked Immuno Sorbent Assay (ELISA)
8. Isolation of peripheral blood mononuclear cells
9. Identification of T cells by T-cell rossetting using sheep RBC.
10. Western blotting

SUGGESTED READINGS:

1. Roitt I. Male and Brostoff. (2012). Immunology. 8th Edition. Mosby publications.
2. Judy Owen, Jenni Punt and Sharon Stranford. (2013). Kuby Immunology. 7th Edition. W. H. Freeman.
3. David W. Mount. (2004). Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press, U.S.
4. Chakravarty. A.K.. (2006). Immunology and Immunotechnology. 1st Edition. Oxford University Press.

Semester-IV

20BTBT543	**Bioinformatics & Computational Biology (Theory & Lab)**	**6H-5C**

Instruction Hours/ week: L: 3 T: 1 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Understand the principles of analyzing biological data, building models and testing hypothesis using computer science algorithms.
- Understand the basic tools in biological sequence analysis.
- Outline the principle of phylogenetic methods.
- Summarize genome sequence technologies.
- Illustrate the basic concept of machine learning and its application in the analysis of biological data.

Course outcomes:

Upon successful completion of the course, students will be able to

- Understand the concepts of bioinformatics and computational biology.
- Distinguish and relate various sequence analyze methods.
- Able to perform different types of phylogenetic methods.
- Execute computational methods to help biological research by analyzing the biological problems.
- Explain the latest machine learning and deep learning techniques.
- Apply computational analyze methods to biological problems.

UNIT I INTRODUCTION

Bioinformatics and its applications; Biological databases- sequence databases, structure databases, Protein sequence, structural and functional databases; in silico tools for rDNA technology, Database searching.

UNIT II SEQUENCE ANALYSIS

Sequence Analysis, Pair wise alignment, Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST and its types, FASTA and its types.

UNIT III PHYLOGENETIC METHODS

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, transcription factor regulation and motif finding.

UNIT IV COMPUTATIONAL GENOMICS

Genome sequencing technologies and analysis, Genomic variations and its associations: Linking genes, variations and diseases, Genome-wide association studies of human diseases, Genome editing tools and applications to human diseases.

UNIT V MACHINE LEARNING

Artificial Neural Network – Perceptron, Characteristics of neural networks, models of neuron, Single and multi-layer ANN perceptron, back propagation, learning, input – hidden and output layer computation, Application of ANN, application of Bigdata in biology.

ii) Laboratory

Course Objectives

The goal of this course is for students to

- Understand and perform the different biological database
- Analyze the genome sequences and carry out the sequence alignment
- Examine and interpret phylogenetic analysis

Course Outcomes

Upon successful completion of the course, students will be able to

1. Explain the purpose of various biological databases
2. Examine the motifs and patterns in the genomes
3. Perform the sequence alignment and carry out phylogenetic analysis

LABORATORY COMPONENT

1. Finding patterns in genomes.
2. Implementation of motif finding algorithms.
3. Identifying various regions around genes using Genome browsers
4. Browsing genetic variation databases such as dbSNP, ClinVar.
5. Accessing databases from NCBI.
6. Extracting protein and nucleotide sequences from NCBI.
7. Database Search Tools.
8. Similarity search using BLAST and FASTA.
9. Pairwise sequence alignment.
10. Multiple sequence alignment.

11. Conserved domain analysis.
12. Construction of Phylogenetic trees.

SUGGESTED READINGS:

1. Jonathan. P. (2019). Bioinformatics and Functional Genomics. 3rd Edition. Wiley India Exclusive.
2. Greg. G., and Spencer. V. M. (2009). A Primer of Genome Science, 3rd Edition. Sinauer Associates, Inc.
3. Jin. X. (2006). Essential Bioinformatics, 1st Edition. Cambridge University Press.
4. Rastogi., S. C. (2013). Bioinformatics: methods and applications, 4th Edition PHI learning.
5. Günter., K. (2015). The Dictionary of Genomics, Transcriptomics and Proteomics, Willey VCH.
6. David., W. M. (2004). Bioinformatics: Sequence and Genome Analysis. CBS publishers, New York.

20BTBT551 **Constitution of India** **2H-0C**

Instruction Hours/week: L:2 T:0 P:0 **Marks:** Internal**:100** External**:**-Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Explain about Indian constitution.
- Outline the central and state government functionalities in India.
- Discuss about Indian society.

Course outcomes

Upon successful completion of the course, students will be able to

1. Describe the functions of the Indian government.
2. Tell about the rules of the Indian constitution.
3. Illustrate the different culture among the people.

UNIT I - INTRODUCTION

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

UNIT II - STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT

Union Government – Structures of the Union Government and Functions – President – Vice President– Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT III - STRUCTURE AND FUNCTION OF STATE GOVERNMENT

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – StateLegislature – Judicial System in States – High Courts and other Subordinate Courts.

UNIT IV - CONSTITUTION FUNCTIONS

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments –Constitutional Functionaries - Assessment of working of the Parliamentary System in India.

UNIT V - INDIAN SOCIETY

Society : Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

SUGGESTED READINGS

1. Durga Das Basu, Introduction to the Constitution of India, Prentice Hall of India, New Delhi
2. R.C.Agarwal., (1997), Indian Political System, S.Chand and Company, New Delhi.
3. Maciver and Page, Society: An Introduction Analysis, Mac Milan India Ltd, New Delhi
4. K.L.Sharma., (1997), Social Stratification in India: Issues and Themes, Jawaharlal Nehru University, New Delhi.
5. Sharma, Brij Kishore., (2011), Introduction to the Constitution of India, Prentice Hall of India, New Delhi.
6. U.R.Gahai., (1998), Indian Political System, New Academic Publishing House, New Delhi.
7. R.N. Sharma., (1987), Indian Social Problems, Media Promoters and Publishers Pvt. Ltd, New Delhi.

Semester-V

20BTBT552 **Production of commercially valuable bioproducts** **1H-0C**

Instruction Hours/week: L:0 T:0 P:1 **Marks:** Internal**:100** External**:0** Total**:100**

End Semester Exam: 3 Hours

Course Objective

- Discuss the manufacturing of industrially important bioproducts from different natural source.

Course Outcome

- Demonstrate the production of commercially valuable bioproducts like biofertilizers, ethanol, mushroom from molasses and grapes.

1. Production of ethanol from molasses and grapes
2. Production of Biofertilizers
3. Production of Single cell protein (Spirullina)
4. Mushroom cultivation
5. Production of jam from mixed fruits

Semester-V

20BTBT591	**Summer Internship - I**	**4H-2C**

Instruction Hours/ week: L: 0 T: 0 P: 4 **Marks:** Internal**: 100** External**: 0** Total**: 100**

End Semester Exam: 3 Hours

Minimum of six weeks in an Industry preferably in the area of Biotechnology. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: AICTE Internship Policy available on AICTE's website may be referred for more information regarding Internship.

Guidance/Remarks:

Internship needs to be done in Summer Break after Semester - IV and will be considered for evaluation in Semester - V.

SEMESTER VI

B.Tech Biotechnology		**2020-2021**
		Semester-III
20BTBT601	**Heat and Mass Transfer**	**4H-4C**

Instruction Hours/week: L: 3 T: 1 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basic concepts of heat transfer operations.
- Infer the significance of heat exchangers and heat transfer with phase change.
- Evaluate the diffusion and liquid vapour mass transfer.
- Explain the mass transfer in liquid-gas and liquid-liquid.
- Interpret the applications of heat and mass transfer in biological systems.

Course Outcomes

Upon successful completion of the course, students will be able to

7. Gain knowledge about the concepts of heat transfer operations.
8. Illustrate the design of heat exchangers and transfer of heat with phase change.
9. Explain the theories of diffusion and the distillation processes.
10. Describe the types and characteristics of various industrial absorbers.
11. Acquire knowledge about the liquid-liquid extraction and its calculations.
12. Understand the importance and applications of heat and mass transfer in bioreactors.

UNIT - I BASICS OF HEAT TRANSFER OPERATIONS

Modes of heat transfer operation: Fourier's law of heat conduction ,heat transfer resistance and conductance, thermal conductivity, steady state conduction, heat flow through plane wall, composite wall, cylindrical surface and sphere; convection; individual heat transfer coefficient and overall heat transfer coefficient.

UNIT - II HEAT EXCHANGERS AND HEAT TRANSFER WITH PHASE CHANGE

Heat exchangers-shell and tube and double pipe heat exchangers, flow arrangements in heat exchangers, energy balance, LMTD, single and multiple effect evaporators; natural and forced circulation evaporators; heat transfer in condensation of single vapour, drop wise condensation and film wise condensation and heat transfer to boiling liquids.

UNIT - III DIFFUSION AND LIQUID-VAPOUR MASS TRANSFER

Diffusion: Molecular diffusion, Fick's law of diffusion, steady state molecular diffusion in gases and liquids, mass transfer coefficients, penetration and surface renewal theories, diffusivity and flux calculations; Differential or Simple distillation Continuous rectification- Binary systems, McCabe Thiele analysis and calculations.

UNIT - IV LIQUID-GAS/LIQUID MASS TRANSFER

Absorption: Selection criteria for solvents, material balance, minimum liquid-gas ratio, calculations on circulation rate and composition; Industrial absorbers - types, characteristics and channelling of tower packings, Liquid-liquid extraction-distribution co-efficient, ternary systems and triangular diagrams, Solvent selection criteria for extraction, extraction equipments and material balance calculations.

UNIT - V APPLICATIONS OF HEAT AND MASS TRANSFER IN BIOLOGICAL SYSTEMS

Heat transfer in bioreactors, Relationship between heat transfer cell concentration and stirring conditions. Analogy between heat and mass transfer. Role of diffusion in bioprocess, film theory, Oxygen uptake in cell cultures-oxygen transfer to cell, Oxygen transfer in fermentors and measurement of dissolved oxygen concentration

SUGGESTED READINGS

1. Gavhane, K.A. (2013). Unit Operations - II. 29th edition. Nirali Prakasan Publication, Pune, India.
2. Pauline M. Doran. (2013). Bioprocess Engineering principles. 2nd Edition. Elsevier.
3. McCabe, W.L., and Smith J.C. (1993). Unit Operations of Chemical Engineering. 7th edition. McGraw Hill, Singapore.
4. Treybal R.E. (1982). Mass Transfer Operations. 3rd edition. McGraw-Hill, New Delhi, India.

Semester-VI

20BTBT602 Intellectual Property Rights (IPR) & Regulatory 3H-3C

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Disseminate the knowledge on patents, patent regime in India and abroad and registration aspects
- Outline the current trends in IPR and Govt. supports in promoting IPR
- Classify the role of regulatory committees in controlling the risk.
- Illustrate the biosafety regulations and frameworks in IPR.
- Create patents and copyrights for developed process and products.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Recognize the adequate knowledge on patent and copyright.
2. Exemplify the way for developing their idea or innovations.
3. Identify the role of regulatory committees in controlling the risk.
4. Tell enough information on ethical issues linked to research on animal models, transgenics, clinical trials.
5. Consider Intellectual Property (IP) as a career option as IP Counsel/Patent Examiner/Patent agent..
6. Relate the importance of copy rights and patent.

UNIT-I INTELLECTUAL PROPERTY RIGHTS

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994 India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.

UNIT-II BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA & AT INTERNATIONAL LEVEL

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic

Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol. Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries

UNIT-III IPR-POLICIES

Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification, (1989). Convention of Biological Diversity (1992).

UNIT-IV BIOETHICS

Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals, Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

UNIT- V CASE STUDIES

Case Studies on - Patents (Basumati rice, curcumin, Neem, etc.) - Copyright and related rights - Trade Marks - Industrial design and Integrated circuits - Geographic indications - Protection against unfair competition.

SUGGESTED READINGS:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India. Cengage Learning India Private Limited.
2. Neeraj P., & Khusdeep, D. (2014). Intellectual Property Rights. India. PHI learning Private Limited.
3. V Sreekrishna. (2017). Bioethics and Biosafety in Biotechnology. New Age International publishers.

E-RESOURCES:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organization. (2004). WIPO Intellectual Property Handbook. (https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)

Semester-VI

20BTBT641 **Animal & Plant Biotechnology (Theory & Lab)** **5H-4C**

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Describe the basic view of animal cell culture and scale up.
- Explain the manipulation of embryos and concept of transgenic animals
- Apply the concepts of plant tissue culture for crop improvement
- Illustrate the principles and methods of genetic transformation
- Clarify the basic concept on molecular pharming

Course Outcomes

Upon successful completion of the course, students will be able to

1. Outline the methods to culture animal cell and techniques to scale up.
2. Discuss the breeding of farm animals through micromanipulation of embryos.
3. Explain the concept of transgenic animals & its applications.
4. Utilize the concept of plant tissue culture for crop improvement.
5. Illustrate the methods of genetic transformation in agrobacterium.
6. Summarize the concept of molecular farming and its applications.

UNIT I - ANIMAL CELL CULTURE, GROWTH & SCALE UP

History of Animal Cell Culture, Characteristics of animal cell, nutritional requirements, Culture Media and Growth Conditions, Development of Primary Culture and Cell Lines, Suspension Culture, Characterization and maintenance of cell lines, Cryopreservation, Common Cell Culture Contaminants, Marker Gene Characterization, Transfection and Transformation of Cells. Growth & Scale up - Need for scaling-up of cells for vaccine or antigen or pharmaceutical protein production, Hybridoma Technology, Cell culture reactors, Scale-Up in suspension and monolayer cultures, Factors affecting cell growth, Growth Monitoring, Mass Transfer.

UNIT II - MICROMANIPULATION OF EMBRYOS & TRANSGENIC ANIMALS

Breeding of farm animals to biopharming - equipments - enrichment of x and y bearing sperms from semen samples - artificial insemination - germ cell manipulations – In vitro fertilization - embryo transfer - micromanipulation technology and breeding of farm animals. Concept of transgenic animals, Methods of transgene delivery, Microinjection of recombinant DNA into fertilized eggs/stem cells, Animal Pharming, Organ Culture, Regenerative Medicine, Human Embryonic Stem Cell research, Ethical Concerns and Biosafety.

UNIT III - PLANT TISSUE CULTURE

History of plant tissue culture, plasticity and totipotency. Laboratory setup for a typical plant tissue culture facility. Sterilization methods used in plant tissue culture. Types of nutrient media and plant growth regulators in plant regeneration. Pathways for *in vitro* regeneration: organogenesis, somatic and gametic embryogenesis; protoplast isolation, culture and regeneration; culture of other explants, somatic hybridization; Haploid and triploid production and their applications. Genetic fidelity of plants raised through tissue culture. Applications of micro-propagation, meristem culture, embryo rescue, somaclonal and androclonal variations. Application of tissue culture for crop improvement. Methods for Plant Conservation, Cryopreservation, synseed production. Production of bio active secondary metabolites by plant tissue culture.

UNIT IV - PRINCIPLES AND METHODS OF GENETIC TRANSFORMATION

Introduction to Agrobacterium biology and biotechnology. Mechanism of T-DNA transfer to plants and Agro infection. A. rhizogenes and its application. Transplastomics and its utility. Methods for direct gene transfer, Marker and reporter genes; Promoters used in plant vectors. Plant viral vectors. Molecular techniques for analysis of transgenics (copy number, transgene stability, silencing; segregation). Marker-free transgenics and environmental, social and legal issues associated with transgenic plants. Case studies for genetic engineering in plants for traits of agronomic value, biotic, abiotic stresses and herbicide tolerance.

UNIT V MOLECULAR FARMING

Transgenic crops for production of antibodies, viral antigens and peptide hormones in plants, Edible vaccines and Nutraceuticals. Plant Biotechnology for biofuels.

ii) Laboratory

Course Objectives

The goal of this course is for students to

- Explain the basics of animal cell culture and plant tissue culture
- Outline the concept of biosafety and ethics
- Apply the methods to prepare media for cell culture
- Carry out the different test to study the characteristics of cell
- Apply the methods to prepare media for plant tissue culture
- Develop the plants through the process of regeneration

Course Outcomes

Upon successful completion of the course, students will be able to

1. Reproduce the basics of animal cell culture and plant tissue culture
2. Use the concept of biosafety and ethics
3. Demonstrate the preparation of media for cell culture

4. Infer the different tests to characterize the cell culture
5. Demonstrate the preparation of media for plant tissue culture
6. Execute the generation of explants

LABORATORY COMPONENT

1. Animal Cell Culture Biosafety and Ethical Concerns
2. Preparation of reagents and media for cell culture
3. Cell counting and plating
4. Maintenance of Adherent (Monolayer) and Suspension Cell culture
5. Cell Viability Assay (MTT reagent)
6. Cell Cytotoxicity Assay (Trypan Blue Assay)
7. Preparation and sterilization of standard tissue culture media.
8. Sterilization of explants and generation of undifferentiated mass of cells. Regeneration of plants from undifferentiated cells.

SUGGESTED READINGS:

1. Freshney R.I. (2016). Culture of Animal Cells. 7th edition, Wiley-Blackwell.
2. Portner R. (2017). Animal Cell Biotechnology. Humana Press.
3. Davis, J.M. (2005). Basic Cell Culture Second Edition. Oxford University Press.
4. George Acquaah. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing.
5. Razdan M.K. (2003). An introduction to Plant Tissue culture. Oxford & IBH Publishing Co, New Delhi.
6. Adrian Slater, Nigel W. Scott, Mark R. Fowler. (2008). Plant Biotechnology: An Introduction to Genetic Engineering. Oxford University Press.
7. Bob Buchanan, Wilhelm Gruissem, Russell Jones. (2002). Biochemistry & Molecular Biology of Plants. John Wiley & Sons.

Semester-VI

20BTBT642	**Cheminformatics and Medicinal Chemistry (Theory & Lab)**	**6H-5C**

Instruction Hours/ week: L: 3 T: 1 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Describe the basics of cheminformatics.
- Analyse the different chemical databases and molecular screening tools.
- Discuss the concept of medicinal chemistry and study its tools.
- Outline the overview of computer aided drug design.
- Restate the preformulation studies of different molecules and study its properties.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Recall the role of cheminformatics and its basics.
2. Infer the data using chemical databases and molecular screening tools.
3. Explain the development of medicinal chemistry and usage of medicinal chemistry tools.
4. Demonstrate the computer aided drug design tools and study its combinatorial libraries.
5. Perform the preformulation studies of different molecules.
6. Apply the cheminformatics and medicinal chemistry in designing of drug molecules.

UNIT-1 INTRODUCTION TO CHEMINFORMATICS

History and Evolution of cheminformatics, Role of Chemoinformatics in pharmaceutical/chemical research, Molecular Drawing and Interactive Visualization: Building molecules on a computer, Molecular Modeling, Representing 1D, 2D and 3D structures, Molecular file formats (SMILES, WLN, SDF, MOL), Molecular patterns- SMARTS, SMIRKS, Molecular Descriptors (1D, 2D and 3D) and MACCS Keys.

UNIT-2 CHEMICAL DATABASES AND MOLECULAR SCREENING

Data Mining, Chemical/biochemical data collation, retrieval, analysis & interpretation. Molecular Database Screening: (Lipinski Rule: Drug/Lead like molecules) Molecular Similarity and Molecular Diversity Analysis. Similarity metrics: Tanimoto Coefficient, Euclidean distance and Tversky Index. Chemical Structure based Search techniques: Exact, Sub-structure and similar structure searches. Artificial intelligence in chemistry, Simulation methods for molecules and materials.

UNIT-3 INTRODUCTION TO MEDICINAL CHEMISTRY

History and development of Medicinal Chemistry, Physico chemical properties in relation to biological action. Stereochemistry and mechanism, Overview of Rational Drug design, Ligands and Targets, *in-silico* representation of chemical information, coordination chemistry for drug design, *in silico* tools for medicinal chemistry (docking, MD, *de novo* drug design), Organic reaction mechanism, Logic in organic synthesis, chemistry of drug action.

UNIT-4 COMPUTER-AIDED DRUG DESIGN

Overview of computer aided drug design, Ligand based drug design, Analysis of combinatorial libraries, QSAR, and Structure based drug design, Structural Homology Modeling Tools, Docking Tools, Molecular Dynamics Tools and Screening Tools., Introduction to Molecular Properties and its applications in drug design. HighThroughput Vs Virtual screening,

UNIT-5 PREFORMULATION AND PHARMACOKINETICS

Pharmaceutical Preformulation studies of small molecules, proteins and peptides, Development challenges: Druggability, Solid State Pharmaceutics: types and development of solid dosage forms, Drug metabolism, pharmacokinetics (ADME), Bioavailability, pharmacodynamics, drug delivery problems, and challenges, Role of regulatory affairs, various phases of clinical trials.

ii) Laboratory

Course Objectives

The goal of this course is for students to

- Perform the *in silico* analysis of compounds from NCI library.
- Demonstrate the MD simulation.
- Analyse the PK and PD data for drug molecules.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Develop a target protein through *in silico* analysis of compound using NCI library.
2. Analyse the protein using docking and MD simulation.
3. Illustrate the PK and PD data for drug molecules

LIST OF EXPERIMENTS

1. In silico selection of compound from an NCI library against a target protein.
2. Docking, energy minimization and MD simulation of Cyclosporine-CyclophilinA complex
3. Structure based drug design against a target protein such HIV-1 protease using crystal structure from Protein Data Bank
4. Analysis of PK and PD data of a drug candidate
5. Organic synthesis of a small molecular compound and its purification

SUGGESTED READINGS

1. Muthukumarasamy Karthikeyan and Renu Vyas. (2014) Practical chemoinformatics. Springer, soft-cover ISBN 9788132234913.
2. Silverman, Richard B., and Mark W. Holladay. (2014) The organic chemistry of drug design and drug action. Academic Press.
3. Bajorath, Jurgen. (2013). Chemoinformatics for Drug Discovery. John Wiley & Sons.
4. Cramer, C.J., (2004). Essentials of Computational Chemistry, 2nd Ed., John Wiley & Sons Ltd.,.
5. Thomas L. Lemke, David A. Williams, S. William Zito, Victoria F. Roche. (2016). Essentials of Foye's Principles of Medicinal Chemistry. Wolters Kluwer.
6. Graham L. Patrick. (2013). An Introduction to Medicinal Chemistry, Fifth edition. Oxford.
7. Ashutosh Kar. (2018). Medicinal Chemistry. Seventh edition. New Age International Publishers.

Semester-VI

20BTBT651 Separation of Bioactive compounds from plant material 1H-0C

Instruction Hours/week: L:0 T:0 P:1 **Marks:** Internal**:100** External**:0** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basic concepts of natural product isolations.
- Demonstrate the extraction and isolation of caffeine from tea leaves.

Course Outcomes

- Outline the general concepts of bioproduct isolation from various natural sources.
- Perform the experiments related to extraction and isolation of caffeine from Tea Leaves.

UNIT- I GENERAL CONCEPT OF NATURAL PRODUCT ISOLATION

Natural Product Isolation, Extraction of Plant Secondary Metabolites, Biochemical analysis of secondary metabolites, Selecting General Separation Conditions, Principles of Chromatography, An Introduction to Planar Chromatography, Applications of Liquid Chromatography, Isolation of Natural Products by Low-Pressure Column Chromatography, Crystallization in Final Stages of Purification, Determination of the Nature of the Compound, Applications of Modern NMR Techniques in the Structural Elucidation, Identification and Characterization

UNIT-II LABORATORY- EXTRACTION AND ISOLATION OF CAFFEINE FROM TEA LEAVES

General background and overview of the experiment, Caffeine extraction: Solid-liquid Extraction, Overview of the extraction process, Purification, Isolation of caffeine from tea leaves.

SUGGESTED READINGS:

1. Satyajit D. Sarker, Zahid Latif and Alexander I. Gray. (2005). Methods in biotechnology, Natural products isolation. Springer.
2. Corrado Tringali. (2011). Bioactive Compounds from Natural Sources. CRC press.
3. Mayo. D.W., Pike. R.M. and Butcher. S.S. (1986). Microscale Organic Laboratory. John Wiley & Sons.
4. Hill. R. and Barbaro. J. (2005). Experiments in Organic Chemistry. 3rd Edition, Contemporary Publishing Company.

SEMESTER VII

B.Tech Biotechnology		2020-2021
		Semester-VII
20BTBT701	Entrepreneurship and startups	3H-3C

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Understanding the Entrepreneurial spirit and resourcefulness.
- Explain the various uses of human resource for earning dignified means of living.
- Understanding the concept and process of entrepreneurship - its contribution and role in the growth and development of individuals and the nation.
- Outline the entrepreneurial quality, competency, and motivation.
- List the process and skills of creation and management of entrepreneurial venture.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Explain the organizing and managing a small Business
3. Understand the financial planning and control
4. Explain the forms of ownership for small Business
5. Outline the strategic marketing planning
6. Summarize the business plan creation

UNIT-I INTRODUCTION TO ENTREPRENEURSHIP AND STARTUPS

Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation. Factors influencing entrepreneurship.Types of Business Structures, Similarities/differences between entrepreneurs and managers. Barriers to entrepreneurship.

UNIT-II BUSINESS IDEAS AND THEIR IMPLEMENTATION

Discovering ideas and visualizing the business Social Responsibility of business. Activity map.Business Plan, Business Ethics.

UNIT-III IDEA TO START-UP

Market Analysis – Identifying the target market, Competition evaluation and Strategy Development, Marketing and accounting, Risk analysis.

UNIT-IV MANAGEMENT

Company's Organization Structure, Recruitment and management of talent. Financial organization and management, Sales Management and Promotion, Marketing Research and Consumer Behaviour.

UNIT- V FINANCING AND PROTECTION OF IDEAS

Financing methods available for start-ups in India. Communication of Ideas to potential investors – Investor Pitch.Patenting and Licenses, Basic Accounting Procedure.

SUGGESTED READINGS:

1. Steve. B., and Bob D.(2012).The Startup Owner's Manual: The Step by- Step Guide for Building a Great Company. K & S Ranch ISBN – 978-0984999392.
2. Clayton. M., Christensen.(2011).The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business. Harvard Business ISBN: 978-142219602.
3. Khanka. S.S.,(2006). Entrepreneurial Development, S.Chand and Co. Ltd., NewDelhi.

Semester-VII

20BTBT702	**Economics for Engineers**	**3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Understanding the fundamentals of Engineering Economics.
- Explain the functions of financial management.
- Understanding the concept of capital market,.
- Outline the basic knowledge about national income and international trade.
- Summarize the basic cost concepts, break even point analysis and depreciation

Course Outcomes

Upon successful completion of the course, students will be able to

1. Explain the fundamentals of Engineering Economics and Law of supply.
2. Outline the financial statements, working capital management.
3. Understand the stock excahnes, money and banking and commercial bank.
4. Explain the forms of ownership for small Business.
5. Outline the methods of calculating national income and international trade.
6. Summarize the basic cost concepts and methods of computing Depreciation.

UNIT- I FUNDAMENTALS OF ENGINEERING ECONOMICS

Introduction to Engineering Economics – Definition and Scope – Significance of Engineering Economics- Demand and supply analysis-Definition – Law of Demand – Elasticity of Demand – Demand Forecasting. Supply – Law of supply – Elasticity of Supply.

UNIT- II FINANCIAL MANAGEMENT

Objectives and functions of financial management – financial statements, working capital management – factors influencing working capital requirements – estimation of working capital. Capital budgeting - Need for Capital Budgeting – Project Appraisal Methods - Payback Period – ARR – Time Value of Money.

UNIT- III CAPITAL MARKET

Stock Exchanges – Functions – Listing of Companies – Role of SEBI – Capital Market Reforms. Money and banking - Money – Functions –Inflation and deflation – Commercial Bank and its functions – Central bank and its functions.

UNIT- IV NEW ECONOMIC ENVIRONMENT

National Income – concepts – methods of calculating national income - Economic systems, Economic Liberalization –Privatization – Globalization. An overview of International Trade – World Trade Organization – Intellectual Property Rights.

UNIT- V COST ANALYSIS AND BREAK EVEN ANALYSIS

Cost analysis - Basic cost concepts – FC, VC, TC, MC – Cost output in the short and long run. Depreciation - meaning – Causes – Methods of computing Depreciation (simple problems in Straight Line Method, Written Down Vale Method). Meaning – Break Even Analysis - Managerial uses of BEA.

SUGGESTED READINGS:

1. Ramachandra Aryasri .A, and V. V.Ramana Murthy. (2007). Engineering Economics & Financial Accounting. Tata McGraw Hill,–,New Delhi.
2. Varshney R. L., and K.L Maheshwari. (2001). Managerial Economics. Sultan Chand & Sons, New Delhi.
3. M.L.Jhingan. (2010). Principles of Economics, Konark Publications.
4. Prasanna Chandra. (2007). Fundamentals of Financial Management, Tata McGraw Hill, New Delhi.
5. D.M.Mithani. (2004). Money, Banking, International Trade & Public Finance, Himalaya Publishing House.

Semester-VII

20BTBT741	Bioseparation Engineering (Theory & Lab)	5H-4C

Instruction Hours/ week: L: 3 T: 0 P: 2 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

i) Theory

Course Objectives

The goal of this course is for students to

- Explain the basics of separation of biomolecules.
- Illustrate the primary separation and isolation of biomolecules.
- Summarize the techniques of product recovery and concentration.
- Outline the various methods of product purification.
- Design the final product purification and product polishing.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the fundamentals of separation of biomolecules and various cell disruption techniques.
2. Design and analyze the various methods of primary separation and isolation of biomolecules.
3. Illustrate the method of adsorption, extraction and membrane separation process.
4. Outline the basic of chromatography and various types of chromatographic techniques.
5. Explain the process of crystallization, drying and its industrial applications.
6. Design and relate the various methods of bioseparation techniques.

UNIT - I - INTRODUCTION TO SEPARATION OF BIOMOLECULES

Introduction to separation of biomolecules and its importance in Biotechnology - characteristics of biomolecules - physico chemical basis of bioseparation - location of products and product release kinetics - cell disruption methods: mechanical, chemical and enzymatic process; pretreatment and stabilization of bioproducts.

UNIT - II - PRIMARY SEPARATION AND ISOLATION

Principle of batch filtration - pretreatment of fermentation broth, design of industrial filters: plate and frame filter press, leaf filter, continuous filtration: rotary drum filter - working principles of centrifugation - centrifugation-based methods for separation of the cell organelles and biomolecules (DNA, RNA, Proteins and secondary metabolites) - separation of different types of DNA from cells, Separation of the different types of RNA from biological samples.

UNIT - III - PRODUCT RECOVERY AND CONCENTRATION

Adsorption: isotherms, adsorption in batch, CSTR and fixed bed - problems in adsorption isotherms and break point time in fixed bed adsorption - principle of cloud point, aqueous two phase and supercritical fluid extraction - membrane separation processes: microfiltration, ultrafiltration, reverse osmosis and dialysis, precipitation of proteins by different methods.

UNIT - IV - PRODUCT PURIFICATION

Basics of chromatography and its use in separation of biomolecules - thin-layer, ion exchange, size exclusion, bioaffinity, hydrophobic interaction, reverse phase, pseudo affinity chromatography, high performance liquid chromatography, flash chromatography and gas chromatographic techniques.

UNIT - V - FINAL PRODUCT PURIFICATION AND POLISHING

Crystallization: nucleation, crystal growth, crystal size distribution, kinetics of crystallization, population density, industrial crystallizers, recrystallization; drying - drying terminologies, drying curve, industrial dryers, freeze drying principles and applications - problems related to relative humidity and population density.

ii) Laboratory

Course Objectives

The goal of this course is for students to

- Perform the separation using different techniques
- Demonstrate the isolation of DNA, RNA, Protein using different methods
- Illustrate the different unit operations such as filtration, separation, extraction, crystallization and drying

Course Outcomes

Upon successful completion of the course, students will be able to

1. Interpret the separation process using different separation techniques.
2. Perform the isolation of DNA, RNA and Protein.
3. Demonstrate the different unit operations

LIST OF EXPERIMENTS

1. Studies on cell disruption and cell separation by different methods
2. Isolation of the plant cell organelles using centrifugation methods.
3. Isolation of the photosynthetic pigments using centrifugation methods.
4. Isolation and separation of the DNA, RNA and proteins using centrifugation and biochemical methods.
5. Separation of the proteins with suitable chromatography methods.
6. Filtration and ultrafiltration method for separation of proteins.
7. Use TLC for separation of the biolipids.

8. Liquid-Liquid extraction.
9. Crystallization.
10. Drying of solid by heat source.

SUGGESTED READINGS:

1. Nooralabettu Krishna Prasad. (2012). Downstream Process Technology - A New Horizon in Biotechnology. PHI Learning Private Limited, New Delhi.
2. Sivasankar B. (2006). Bioseparations - Principles and Techniques. Prentice Hall of India Private Limited, New Delhi.
3. Roger. G, Harrison, Paul Todd, Scott R. Rudge and Demetri P. Petrides. (2003). Bioseperation Science and Engineering. Oxford University Press, Newyork.
4. Belter P. A., Cussler E.L. and Wei-Houhu. (1988). Bioseparations - Downstream Processing For Biotechnology. Wiley Interscience Pub., New Delhi.

Semester-VII

20BTBT791	**Project-I**	**4H-2C**

Instruction Hours/ week: L: 0 T: 0 P: 4 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Objective: To synthesize and apply the knowledge gained over the engineering programme to solve real world problems.

Guidance/Remarks: Project-I can be done either during the Summer Break between Semester VI and Semester VII or during the Semester VII. It will be evaluated as part of Semester VII. It may either be a complete project related to the field of Biotechnology or it may be an initiation (Phase I) of Project-II present in Semester VIII, provided the "Project Work II" is expected to extend beyond the duration of 6 months.

Semester-VII

20BTBT792	**Summer Internship - II**	**6H-3C**

Instruction Hours/ week: L: 0 T: 0 P: 6 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Minimum of six weeks in an Industry preferably in the area of Biotechnology. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: AICTE Internship Policy available on AICTE's website may be referred for more information regarding Internship.

Guidance/Remarks:

Internship needs to be done in Summer Break after Semester - VI and will be considered for evaluation in Semester - VII.

20BTBT891	**Project-II**	**18H-9C**

Instruction Hours/ week: L: 0 T: 0 P: 18 **Marks:** Internal**: 120** External**: 180** Total**: 300**

End Semester Exam: 3 Hours

Objective: To synthesize and apply the knowledge gained over the engineering programme to solve real world problems.

Guidance/Remarks: Project-II has to be done during Semester VIII. It may be initiated in the break between Semester VII & VIII although it is not mandatory to initiate in the break. It will be evaluated as part of Semester VIII. It may either be a complete project related to the field of Biotechnology or it may be an extension (Phase II) of Project-I present in Semester VII, provided the Project in charge agrees that "Project Work I" is worthy enough to extend across two semesters (i.e. VII & VIII). It may also be a startup in the field related to Biotechnology. In the case of startups, substantial evidence has to be produced for evaluation of the work carried out as part of Project-II.

PROFESSIONAL ELECTIVES

SEMESTER V

B.Tech Biotechnology **2020-2021**

Semester - V

20BTBT5E01 **Environmental Biotechnology** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- To explain basic knowledge on soil microbes and its characteristics.
- To demonstrate the effects of xenobiotic compounds.
- To discuss various methods for industrial waste water management.
- To explain the effects of various industrial wastes and to infer basic concepts for its management.
- To outline the natural and engineered bio-treatment methods to remediate the pollutants.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the characteristics of soil microbes and its interactions.
2. Evaluate the different xenobiotics present and methods to degrade them.
3. Describe the industrial waste management systems.
4. List the opportunities in waste treatment industries and its management.
5. Recognize natural and engineered biotreament methods to remediate pollutants.
6. Identify and list different environmental issues and its remedy.

UNIT - I INTRODUCTION

Microbial flora of soil, growth and ecological adaptations of soil microorganisms, interactions among soil microorganisms - biogeochemical role of soil microorganisms.

UNIT - II DEGRADATION OF XENOBIOTIC COMPOUNDS

Aromatics - benzene, pentachlorophenol, Polyaromatic hydrocarbons (PAHs) naphthalene, Polychlorinated biphenyls (PCBs) hexachloro biphenyl, Pesticides - DDT and Surfactants – LAS.

UNIT - III INDUSTRIAL WASTE WATER MANAGEMENT

Wastewater characteristics - physical, chemical and biological, Biological processes - unit operations, aerobic treatment processes, activated sludge process - characteristics of activated sludge and process configuration, anaerobic treatment by methanogenesis

UNIT - IV TREATMENT OF INDUSTRIAL WASTE

Dairy, Paper & Pulp, Textile, leather, hospital and pharmaceutical industrial waste management, e-waste-radioactive and nuclear power waste management.

UNIT - V DEVELOPMENTS PERTAINING TO ENVIRONMENTAL BIOTECHNOLOGY

Solid waste management, Role of biosensors in Environmental monitoring, Heavy metal pollution and their control strategies, Prevention of environmental damage with respect to nitrogen fixation, Bioremediation, Production of bioelectricity from microbial fuel cell (MFC), Improvement of water quality by denitrification, Role of biotechnology on agricultural chemical use

SUGGESTED READINGS:

1. Prescott. M., Harley. J. P. and Klein. D. A. (2008). Microbiology. Boston. McGraw-Hill Higher Education.
2. Connell.D.W. (2005). Basic concepts of Environmental chemistry. Lewis publishers.
3. Scragg. A. H. (2005). Environmental Biotechnology. Oxford University press.
4. Rittmann. B. E. and Mccarty. L. P. (2001). Environmental Biotechnology: Principle and Applications. McGraw Hill.
5. Mecalf and Eddy. (1991). Waste water engineering: Treatment Disposal Reuse. McGraw Hill.

Semester - V

20BTBT5E02 **Good Manufacturing and Laboratory Practice** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Outline the requirements and guidelines of GLP and GMP.
- Describe the duties of key personnel in GLP and GMP.
- Record the basic notion on production area and documentation types in GMP.
- Discuss the basic theory of Quality Control and various testing methods.
- Apply GMP and GLP for the biotech based products and process.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Compare and contrast requirements for GMP and GLP.
2. Summarize the upgraded personnel to maintain GMP.
3. Prioritize diverse properties production area and equipment.
4. Construct and design the correct documentation.
5. Apply the knowledge on quality control department.
6. Examine and solve the problems related to manufacturing flaws.

UNIT - I INTRODUCTION AND GUIDELINES

Introduction to GMP and GLP, Basic requirements of GMP and GLP compliance for regulatory approval, importance of GMP, Principles of quality by design (QBD), Introduction to the concept of Design of Experiment (DOE), Introduction to ICH guidelines and their usage, National and international regulatory authorities and their function, Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies, Formulation, Production Management, Authorization and marketing of drugs.

UNIT - II PERSONNEL

Key personnel, background and duties of the qualified person, duties of the head of the production department, duties of the head of quality department, person releasing the batch, consultants, personnel training and hygiene, Ethics in manufacturing of control.

UNIT - III PREMISES AND DOCUMENTATION

Premises, production area, storage area, quality control areas, ancillary areas, equipment, Generation and control of documents, types of documents and specifications, procedures and records, Computer simulation on process design.

UNIT - IV PRODUCTION AND QUALITY CONTROL

General principles, prevention of cross contamination in production, Quality control – principles, main tasks of QC department, technical transfer of testing methods, transfer protocol.

UNIT - V CASE STUDY

Principle of QBD and DOE in pharmaceutical quality system, principle and DOE approaches in medical devices, principle of QBD and DOE in human cell tissue products, principle of QBD and DOE in biological products.

SUGGESTED READINGS:

1. Emmet P. Tobin. (2016). cGMP starter guide: Principles in Good Manufacturing Practices for Beginners. Createspace Independent Publishing Platform.
2. B Cooper. (2017). Good Manufacturing Practices for Pharmaceuticals: GMP in Practice. Createspace Independent Publishing Platform.
3. Sarwar Beg and Md Saquib Hasnain. (2019). Pharmaceutical Quality by design: Principles and application. Academic press.
4. Ron S. Kenett, Shelemyahu Zacks, Daniele Amberti. (2014). Modern Industrial Statistics: with applications in R, MINITAB and JMP. 2nd Edition. Wiley.
5. N Politis S, Colombo P, Colombo G, M Rekkas D. (2017). Design of experiments (DoE) in pharmaceutical development, Drug Dev Ind Pharm., 43(6):889-901. doi: 10.1080/03639045.2017.1291672.
6. Andrew Teasdale, David Elder, Raymond W. Nims. (2017). ICH quality guidelines-An implementation guide.
7. Gajendra Singh, Gaurav Agarwal an Vipul Gupta. (2005). Drug regulatory affairs, CBS publication.
8. Marc P. Mathieu. (2000). New Drug Development: A regulatory overview.
9. ICH guidelines available in the official website “https://www.ich.org”.

Semester - V

20BTBT5E03 **Synthetic & Systems Biology** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Understand the basics of system and synthetic biology.
- Outline the principle of biobricks.
- Understand tremendous application potentials of synthetic biology in the fields of biofuels, biomedicine etc.
- Examine the online bio-design software for modeling and simulation.
- Articulate the ethical principles and policies.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Learn the concept of synthetic biology and system biology
2. Examine the biological circuits to make a biosensor or even to engineer organisms.
3. Appraise the application of synthetic and system biology in current scenario.
4. Understand various design strategies.
5. Incorporate new ideas in the field of biology.
6. Understand the importance of ethics in biological field.

UNIT - I INTRODUCTION TO SYNTHETIC BIOLOGY & SYSTEMS BIOLOGY

Introduction to synthetic biology. Background of Gene Regulatory Mechanisms (Gene Parts- Gene Structure, Promoters, Terminators, Enhancers, Inducers, Repressors, Transcription Factors, Co-factors, transcriptional and post-transcriptional regulation, post-translational modifications). Genetic Engineering and Genome Editing Various Omics & role in systems biology - genomics, proteomics, transcriptomics, metabolomics.

UNIT - II ELEMENTS OF SYNTHETIC BIOLOGY

Tools, circuits, BioBricks Gene shuffling for large scale pathway assembly and engineering; Choices for microbial hosts for industrial applications– bacteria, yeast, insect. Gene editing methods – CRISPR/ Cas; Introduction to Bio Bricks & its applications. Microarrays & systems biology - a basic introduction.

UNIT - III MATHEMATICAL MODELING

Mathematical Modeling and Simulation. Biosensors. Application of software tools for modelling gene expression. Various markup languages used in systems biology. Introduction to various metabolic pathway databases.

UNIT - IV COMMERCIAL APPLICATIONS

Biomedicine, Biomaterials, Biofuels and Bioremediation; Production of artemisinin as case study. Green chemistry - use of plants for engineering biologics & small molecules. Biosurfactants as an example of microbial cell factory based production. Global events & competitions- iGEM, synbiobeta.

UNIT - V ETHICAL REGULATIONS

Regulations & ethics Safety & bioethics, legal & IP elements involved in synthetic biology applications for human, animals and plants.

SUGGESTED READINGS:

1. Singh V. & Dhar P.K. (2015). Systems and Synthetic Biology. Springer publishing, Netherlands
2. Fu. P. & Panke. S. (2009). Systems Biology and Synthetic Biology. Wiley Publishing.
3. Covert. M.W. (2014). Fundamentals of Systems Biology: from Synthetic Circuits to Whole Cell Models. CRC Press
4. Konopka. A. K. (2006). Systems Biology: Principles, Methods, and Concepts. CRC Press.
5. Church. G. & Regis. E. (2012). Regenesis: How Synthetic Biology will Reinvent Nature and Ourselves. Basic Books.
6. Standards for Plant Synthetic Biology http://onlinelibrary.wiley.com/doi/10.1111/nph.13532/full
7. http://www.nature.com/articles/npjsba20169.
8. Biotechnology and Synthetic Biology Approaches for Metabolic Engineering of Bioenergy Crops.https://www.ncbi.nlm.nih.gov/pubmed/27030440.

Semester - V

20BTBT5E04 **Biosimilars Technology** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basic concepts of Biopharmaceutical Technology.
- Infer the various types of biosimilar drugs.
- Comprehend the different types of characterization methods.
- Explain the importance of immunogenicity and allergenicity.
- Interpret the applications of biosimilar technology in reputated industries.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Gain knowledge about the biosimilar development and regulatory challenges.
2. Design the different types of biosimilar drugs.
3. Comprehend and choose the methods to characterize the drugs.
4. Discuss the factors affecting bioequivalence.
5. Acquire knowledge about the Indian companies developing Biosimilar technologies.
6. Understand the importance and applications of Biosimilar technology.

UNIT I - INTRODUCTION TO BIOPHARMA

Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars, developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

UNIT II - TYPES OF BIOSIMILAR DRUGS

Peptides, proteins, antibodies, enzymes, vaccines, nucleic acid based therapies (DNA & RNA), Cell based therapies (including stem cells)

UNIT III - CHARACTERIZATION METHODS

Aggregation - precipitation, floccule strength, precipitate ageing and kinetics, adsorption of proteins and peptides on surfaces, effect of temperature on protein structure, hydration and thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination.

UNIT IV - BIOEQUIVALENCE STUDIES

Immunogenicity and allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalence (average, population, individual), experimental designs and statistical considerations for bioequivalence studies (Non-replicated designs - General Linear Model, Replicated crossover designs), introduction to "ORANGE BOOK" & "PURPLE BOOK".

UNIT V - CASE STUDIES

Indian companies working in this space and their product pipeline (Biocon, Intas, Dr Reddy's, Reliance, Bharat Biotech, Lupin, Cipla and Shanta); products - Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase and monoclonal antibodies.

SUGGESTED READINGS

1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow. (2017). Biosimilar Drug Development, Drugs and Pharmaceutical Sciences. Volume 216. CRC Press.
2. Cheng Liu and K. John Morrow Jr. (2016). Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development. John Wiley & sons, Inc.
3. https://www.drugs.com/medical-answers/many-biosimilars-approved-unitedstates-3463281/

Semester - V

20BTBT5E05 **Genome Editing** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Understand the basics of genome editing.
- Describe the traditional methods of gene editing.
- Examine the current genome editing technologies.
- Outline the mechanism behind the development of GMO's.
- Gain knowledge on the application of modern tools for precision gene targeting and editing.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Explain the features of various genome editing technologies.
2. Appraise the technological background behind genome editing.
3. Formulate methods for creating GMO's.
4. Appreciate the vast applications of gene editing in the field of medicine, agriculture, and the environment.
5. Understand the ethical issues in genome editing.
6. Illustrate recent innovations in genome editing.

UNIT - I INTRODUCTION

Basics of Recombinant DNA Technology - Restriction and modifying enzymes, construction of recombinant DNA molecules, transformation of r-DNA molecules into target host organisms; Calcium chloride mediated- electroporation- microinjection- gene gun, selection methods for recombinants; antibiotic resistance - blue & white selection, GFP and Luciferase based selection.

UNIT - II OVERVIEW OF TRADITIONAL METHODS

Homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems.

UNIT - III ENGINEERED ENZYME SYSTEMS

Zinc finger nucleases (ZFNs), transcription-activator like effector nucleases (TALEN), meganucleases and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system. Design of sgRNA. Multiplex Automated Genomic Engineering (MAGE).

UNIT - IV APPLICATIONS OF GENOME EDITING

Application of genetically modified organisms; Molecular Diagnosis of human genetic diseases, pathogenic virus and bacteria, agriculture – Transgenic Bt cotton- round-up ready soybean transgenic crops, Biosafety levels for microbial, plant and animals, safety guidelines and release procedure for GMOs in India, effect of GMOs on environment, patenting of gene sequences and its issues.

UNIT - V CASE STUDIES

Recent innovations in the technology and case studies where current genome editing technologies has been used for various purposes like health, agriculture and environment.

SUGGESTED READINGS:

1. Yonglun Luo. (2019). CRISPR Gene Editing, Methods and Protocols. 1st Edition. Humana Press.
2. Krishnarao A. (2018). Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Cambrigde University Press.
3. Stephen H. Tsang. (2017). Precision Medicine, CRISPR, and Genome Engineering - Moving from Association to Biology and Therapeutics. 1st Edition. Springer.
4. Brown. T.A. (2006). Genomes 2. 3rd Edition. Bios Scientific Publishers Ltd, Oxford.
5. Glick. B. R. & Pasternick. J. J. (2003). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd Edition, ASM press, Eashington.

20BTBT6E01 **Big Data Analytics** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Summarize the overview of approaches facilitating data analytics on huge datasets.
- Explain the characteristics of Big data.
- Analyze the big data processing concepts and big data analysis techniques.
- Discuss the various types of tools in Big data.
- Outline the application of Big data in various sectors.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Outline the sources of Big data and types of Digital data.
2. Illustrate the different data types of Big data and its architecture.
3. Explain the concepts of Big data storage and its technology.
4. Evaulate the types of tools used in Big data and its platform.
5. Discuss the fundamentals and basics of SQL and Hadoop.
6. Establish Big data and adopt it for various realtime support.

UNIT - I FUNDAMENTALS OF BIG DATA

Overview of Big Data: history of big data, Concepts and terminology, Big Data Skills and Sources of Big Data, elements, advantages, disadvantages. Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Hadoop.

UNIT - II UNDERSTANDING OF BIG DATA

Characteristics of Big Data - Four V's, Basic operations of in big data, Datasets , Data analysis, Data Analytics, different data types of big data, Awareness of Architecture . Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

UNIT - III BIG DATA ANALYSIS

Big data storage concepts: Source, Difference of Big data from other source, Data Generation points, Big Data processing concepts, Sorting, selection of data, Storage Technology, Big data analytics, Big Data Analysis techniques: Big Data Analytics Lifecycle.

UNIT - IV THE BIG DATA TECHNOLOGY

Key aspects, Types of tools used in Big data, Platform, Querying big data with Hive- Introduction to the SQL Language Technologies to handle Big Data: Introduction to Hadoop, functioning of Hadoop, Cloud computing (features, advantages, applications).

UNIT - V BIG AND PLANNING

Organization Prerequisites, Data Procurement, Privacy, Security, Provenance, Limited Realtime Support, Distinct Performance Challenges, Distinct Governance, Requirements, Distinct Methodology, Clouds, Application of Big Data, Five High Value Big Data Use Cases.

SUGGESTED READINGS

1. Bart Baysen. (2014). Analytics in a Big Data World: The Essential Guide to Data Science and its Applications. Wiley Big Data Series.
2. Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman. (2012). Big Data For Dummies, Wiley.
3. O'Reilly Radar. (2012). Big Data Now: Current Perspectives. O'Reilly Media.
4. Thomas Erl, Wajid Khattak, and Paul Buhler. (2012). Big Data Fundamentals, Concepts, Drivers & Techniques. Prentice hall.

Semester - VI

20BTBT6E02 **Waste Management & Upcycling** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the fundamental aspects of types of waste and its management.
- Disseminate the knowledge on various waste management technologies.
- Outline the concepts of handling and recycling wastes.
- Develop knowledge on how waste can be converted to wealth in a sustainable way.
- Think in an innovative way to develop concepts in waste management.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the basic ideas on waste and its sustainable management.
2. List the modern technologies for waste management.
3. Illustrate the safety guidelines of waste management.
4. Outline the basic ideas on landfill techniques.
5. Develop concepts in managing waste of their institutions.
6. Experiential learning with a waste management company in the vicinity.

UNIT - I WASTE MANAGEMENT

The definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions. Liquid waste collection, treatment and disposal systems: Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system. Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions;

UNIT - II TECHNOLOGIES FOR WASTE TREATMENT

Waste incineration and energy from waste, pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes, managing biomedical waste.

UNIT - III HANDLING AND RECYCLING TECHNIQUES

Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added value products; Landfill engineering and the management of landfill leachate and the mining of old landfills.

UNIT - IV TOOLS FOR WASTE MANAGEMENT

Interface of waste and resource management and civil engineering in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and life- cycle analysis, as appropriate.

UNIT - V SUSTAINABLE WASTE MANAGEMENT

Waster Upcycling, waste reuse, Waste down cycling, waste upcycling a social enterprise, Case study in each area. Innovative technologies for sustainable waste management.

SUGGESTED READINGS:

1. Gupta O.P. (2019). Elements of Solid & Hazardous Waste Management. Khanna Publishing House, New Delhi.
2. Bilitewski B., HardHe G., Marek K., Weissbach A., and Boeddicker H. (1994). Waste Management. Springer.
3. George Tchobanoglous et.al. (1993). Integrated Solid Waste Management. McGraw-Hill Publishers.

20BTBT6E03 **Nano Biotechnology** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- To explain basic knowledge on nanotechnology.
- To demonstrate the structural and functional principles of bionanotechnology.
- To discuss various methods for microfluidic components.
- To explain the effects of various protein and DNA based nanostructures.
- To outline the basic concepts of nanoparticles in cancer therapy.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the characteristics different nanoparticles.
2. Evaluate the different structural and functional principles of biotechnology.
3. Explain the microfluidic devices.
4. Discuss the protein and DNA based nanostructures.
5. Recognize cancer curing nanoparticles.
6. Identify and list different nanoparticles for different controlling measures.

UNIT - I INTRODUCTION TO NANOTECHNOLOGY

Background and definition of nanotechnology, chemical bonds in nanotechnology - Scales at the bio-nano interface – Basic capabilities of nanobiotechnology and nanomedicine – Biological tradition and mechanical tradition biotechnology – Applications of Nanotechnology in biotechnology.

UNIT - II STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY

Self-assembly - Self-organization - Molecular recognition - Information driven nanoassembly - Biomolecular motors - Traffic across membranes - Biomolecular sensing - Self-replication - Machine-phase bionanotechnology.

UNIT - III MICROFLUIDICS

Concepts and advantages of microfluidic devices - Materials and methods for the manufacture of microfluidic component - Fluidic structures - Surface modifications - Lab-on-a-chip for biochemical analysis, Nano printing of DNA, RNA, and proteins biochips applications in nano scale detection.

UNIT - IV PROTEIN AND DNA BASED NANOSTRUCTURES

S-Layers - Engineered nanopores - Microbial nanoparticle production - DNA-Protein nanostructures - Biomimetic fabrication of DNA based metallic nanowires and networks, DNA based nanomaterials as biosensors - DNA-Gold nanoparticle conjugates - Nanoparticles as non-viral transfection agents.

UNIT - V NANOPARTICLES IN CANCER THERAPY

Magnetic nano and microparticles for embolotherapy - hyperthermic therapy - delivery of chemotherapeutic drugs-brachytherapy, Thermoresponsive liposomes for hyperthermic chemotherapy assemblies and ultrasound activation. Nanotechnology in Biomedical Application: micro- and Nano electromechanical devices in drug delivery.

SUGGESTED READINGS:

1. Shoseyov. O. and Levy. I. (2007). Nanobiotechnology: Bioinspired Devices and Materials of the future. Human Press.
2. Bhushan. B. (2004). Springer Handbook of Nanotechnology. Springer-Verlag Berlin Heidelberg.
3. Freitas. R. A. (2004). Nanomedicine. Landes Biosciences.
4. Goodsell. D.S. (2004). Bionanotechnology. John Wiley and Sons, Inc.
5. Kohler. M. and Fritzsche. W. (2004). Nanotechnology-An Introduction to Nanostructuring Techniques. Wiley VCH.
6. Niemeyer. C. M. and Mirkin. C. (2004). A Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH.

20BTBT6E04 **Immunotechnology** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students

- To explain basic knowledge on antigen structure and preparation.
- To discuss the structural and functional principles of antibodies and immunodiagnosis.
- To construct various parameters of B cells and T cells.
- To explain the effects of preparation and storage of tissues in immuno pathology.
- To outline the basic concepts of preparations of vaccine in molecular immunology.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the characteristics of different methods of antigens production.
2. Evaluate the different structural and functional principles of antibodies and immunodiagnosis.
3. List the various parameters of B cells and T cells.
4. Explain the preparation and storage of antibodies and immunodiagnosis.
5. Recognize basic concepts of vaccine preparation in molecular immunology.
6. Identify and list different techniques for antigen and antibody synthesis.

UNIT - I ANTIGENS

Types of antigens, their structure, factors affecting antigenicity, preparation of antigens for raising antibodies, handling of animals, adjuvants and their modeofaction.

UNIT - II ANTIBODIES & IMMUNODIAGNOSIS

Monoclonal and polyclonal antibodies – their production and characterization, Westernblotanalysis, Immunoelectrophoresis, SDS-PAGE - purification and synthesis of antigens, ELISA – principle and applications, adioimmunoassay (RIA) - principles and applications,nonisotopic methods of detection of antigens-enhanced chemiluminescence assay.

UNIT - III ASSESMENT OF CELL MEDIATED IMMUNITY

Identification of lymphocytes and their subsets in blood. T cell activation parameters,estimation of cytokines, macrophage activation,macrophage microbicidal assays, in-vitro experimentation - application of the above technology to understand the pathogenesis of infectious diseases.

UNIT - IV IMMUNO PATHOLOGY

Preparation of storage of tissues, identification of various cell types and antigens in tissues, isolation and characterization of cell types from inflammatory sites and infected tissues, functional studies on isolated cells, immune cytochemistry – immuno fluoresecence,immune enzymatic and immuno ferritin techniques, immuno electron microscopy.

UNIT - V MOLECULAR IMMUNOLOGY

Preparation of vaccines, application of recombinant DNA technology for the study of the immune system, production of anti idiotypic antibodies, catalytic antibodies, application of PCR technology to produce antibodies and other immunological reagents, immuno therapy with genetically engineered antibodies – Tetramer, recombinant vaccines.

SUGGESTED READINGS:

1. Talwar. G.P. and Gupta. S. K. (2006). A hand book of practical and clinical immunology (Vol 1 & 2), 2nd edition. CBS Publications.
2. Weir. D.M. (1990). Practical Immunology. Blackwell Scientific Publications Oxford.
3. Austin. J. M. and Wood. K. J. (1993). Principle of cellular and molecular immunology. Oxford university.

20BTBT6E05 **Genomics and Proteomics** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basics of genome organization of prokaryotes and eukaryotes.
- Discuss the effects of cytogenetic mapping.
- Outline the various methods for gene finding and annotations in functional genomics.
- Explain the effects of various protein level estimation in proteomics
- Outline the post translational modification and other protein interactions.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the characteristics of genomic organization of prokaryotes and eukaryotes.
2. Evaluate the different physical mapping techniques.
3. Discuss the gene findings in functional genomics.
4. Explain the protein estimation through different techniques.
5. Recognize different protein analysis techniques.
6. Identify and list different protein interactions.

UNIT - I OVERVIEW OF GENOMES OF BACTERIA, ARCHAE AND EUKARYOTA

Genome organization of prokaryotes and eukaryotes, gene structure of bacteria, archaebacterial and eukaryotes, Human genome project, Introduction of functional and comparative genomics.

UNIT - II PHYSICAL MAPPING TECHNIQUES

Cytogenetic mapping, radiation hybrid mapping, Fish, STS mapping, SNP mapping optical mapping, Top down and bottom up approach, linking and jumping of clones, gap closure, pooling strategies, genome sequencing.

UNIT - III FUNCTIONAL GENOMICS

Gene finding; annotation; ORF and functional prediction; Substractive DNA library screening; differential display and representational difference analysis; SAGE.

UNIT - IV TECHNIQUES IN PROTEOMICS

Protein level estimation; Edman protein microsequencing; protein cleavage; 2 D gel electrophoresis; metabolic labeling; detection of proteins on SDS gels.Mass spectrometry- principles of MALDI-TOF; Tandem MS-MS; Peptide mass fingerprinting.

UNIT - V PROTEIN PROFILING

Post translational modification; protein-protein interactions; glycoprotein analysis; phosphor protein analysis.

SUGGESTED READINGS

1. Brown. T. A. (2019). Genomes, 4th edition. Bios Scientific Publishers Ltd
2. Pennington and Dunn. (2001). Proteomics. BIOS Scientific Publishers.
3. Livesey. H. (2000). Functional Genomics. Oxford University press.
4. Cantor and Smith. (1999). Genomics. John Wiley & Sons.

SEMESTER VII

B.Tech Biotechnology		**2020-2021**
		Semester - VII
20BTBT7E01	**Gene Expression and Transgenics**	**3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the use of different gene expression systems.
- Outline the over expression of recombinant proteins and protein complexes for different applications.
- Understand purification of proteins expressed in different expression systems.
- Outline the hazardous biological materials and the risks associated with them.
- Explain the applications of transgenics.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Gain the knowledge of tools and strategies used in gene expression studies.
2. Understanding of applications of transgenics in industrial perspective
3. Explain gene expression in microbial and eukaryotic Systems.
4. Understand and apply the classical and largescale techniques in gene expression study.
5. List the applications of gene expression studies.
6. Understand the biosafety measures and ethical issues.

UNIT - I INTRODUCTION

Role of genes within cells, genetic elements that control gene expression, Overview of recombinant protein expression vectors and promoters: Vectors with tags His, GST, MBP, GFP. Cleavable tag and non-cleavable tags. Vectors for tag free protein expressions. Over-expression of integral membrane proteins.

UNIT - II GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES

Overexpression in *E. coli*, *B. subtilis*, *Corynebacterium*, *Pseudomonas fluorescens*, yeasts like *S. cerevisiae* and *Pichia pastoris*, insect cell lines like Sf21 and Sf9, Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell. Chloroplast transformation and protein expression in chloroplasts. Cell free protein Expression-Cell free extracts from *E. coli*, rabbit, insects.

UNIT - III METHODS OF GENE TRANSFER

Gene transfer in bacteria: conjugation, transformation, transduction.Methods for creation of transgenic animals-DNA microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer. Vector mediated gene transfer.

UNIT - IV APPLICATIONS OF GENE EXPRESSION AND TRANSGENICS

Use transgenic animals in medical research, in toxicology, in mammalian developmental genetics, in molecular biology in the pharmaceutical industry, in biotechnology, in aquaculture and in xenografting. Humanised animal models.

UNIT - V BIOSAFETY MEASURES

GMP and GLP requirements. Risk Assessment. Personal Protective Equipment: Types, Laboratory Security & Emergency Response, Use of transgenic animals. History, safety and ethics of transgenic animals.

SUGGESTED READINGS:

1. Benjamin. A. Pierce. (2016). Genetics a conceptual approach. W.H. Freeman publishers.
2. Venkata R. and Prakash D. (2015). Key Notes on Genetics and Plant Breeding. Astral International publishers.
3. Old R.W., Primrose. S.B. (1993). Principles of gene manipulation an introduction to genetic engineering. Blackwell Science Publications.

20BTBT7E02 **Machine Learning** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basic concepts and techniques of machine learning.
- Outline and perform the various linear models.
- Discuss the concept of supervised and unsupervised learning techniques.
- Illustrate the various probability based learning techniques.
- Outline the graphical models of machine learning algorithms.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the various types of machine learning.
2. Outline the concepts of linear models and support vector machines.
3. Illustrate the difference between supervised, unsupervised and semi-supervised learning.
4. Evaluate the dimensionality reductiona and evolutionary models for realtime applications.
5. Interpret the various graphical models of machine learning algorithms.
6. Apply the apt machine learning strategy for any given problem.

UNIT - I INTRODIUTION

Learning - Types of Machine Learning - Supervised Learning - The Brain and the Neuron - Design a Learning System - Perspectives and Issues in Machine Learning - Concept Learning Task - Concept Learning as Search - Finding a Maximally Specific Hypothesis - Version Spaces and the Candidate Elimination Algorithm - Linear Discriminants - Perceptron - Linear Separability - Linear Regression.

UNIT - II LINEAR MODELS

Multi-layer Perceptron - Going Forwards - Going Backwards: Back Propagation Error - Multi-layer Perceptron in Practice - Examples of using the MLP - Overview - Deriving Back-Propagation - Radial Basis Functions and Splines - Concepts - RBF Network - Curse of Dimensionality - Interpolations and Basis Functions - Support Vector Machines.

UNIT - III TREE AND PROBABILISTIC MODELS

Learning with Trees - Decision Trees - Constructing Decision Trees - Classification and Regression Trees - Ensemble Learning - Boosting - Bagging - Different ways to Combine Classifiers - Probability and Learning - Data into Probabilities - Basic Statistics - Gaussian Mixture Models - Nearest Neighbor

Methods - Unsupervised Learning - Kmeans Algorithms - Vector Quantization - Self Organizing Feature Map.

UNIT - IV DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS

Dimensionality Reduction - Linear Discriminant Analysis - Principal Component Analysis - Factor Analysis - Independent Component Analysis - Locally Linear Embedding - Isomap - Least Squares Optimization - Evolutionary Learning - Genetic algorithms - Genetic Offspring: - Genetic Operators - Using Genetic Algorithms - Reinforcement Learning - Overview - Getting Lost Example - Markov Decision Process.

UNIT - V GRAPHICAL MODELS

Markov Chain Monte Carlo Methods - Sampling - Proposal Distribution - Markov Chain Monte Carlo - Graphical Models - Bayesian Networks - Markov Random Fields - Hidden Markov Models - Tracking Methods.

SUGGESTED READINGS:

1. Jeeva Jose. (2019). Introduction to Machine Learning using Python. 1st Edition. Khanna Publishing House.
2. Rajiv Chopra. (2019). Machine Learning. Khanna Book Publishing Co.
3. Ethem Alpaydin. (2014). Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series). 3rd Edition, MIT Press.
4. Jason Bell. (2014). Machine learning - Hands on for Developers and Technical Professionals‖, 1st Edition, Wiley.
5. Stephen Marsland. (2014). Machine Learning - An Algorithmic PerspectivE. 2nd Edition. Chapman and Hall/CRC Machine Learning and Pattern Recognition Series.
6. Tom M Mitchell. (2013). Machine Learning. 1st Edition, McGraw Hill Education.
7. Peter Flach. (2012). Machine Learning: The Art and Science of Algorithms that Make Sense of Data. 1st Edition, Cambridge University Press.

Semester - VII

20BTBT7E03 **Rational Drug Discovery** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basics of molecular modelling in drug discovery
- Summarize the concepts of quantum mechanics and molecular mechanics
- Analyze the various molecular dynamics simulation methods
- Perform the molecular docking and lead optimization
- Summarize the concept of pharmacophore and QSAR methodology

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the role of bioinformatics in drug design.
2. Outline the features of molecular mechanics and its applications.
3. Illustrate the molecular dynamics using simple methods.
4. Explain the types of molecular docking and applications of 3D databases.
5. Summarize the lead optimization and computer based tools for drug design.
6. Explain the pharmacophore prediction and application in drug discovery and QSAR.

UNIT - I MOLECULAR MODELLING IN DRUG DISCOVERY

Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

UNIT - II QUANTUM MECHANICS AND MOLECULAR MECHANICS

Features of molecular mechanics force fields; Bond structure and bending angles - electrostatic, van der Waals and non-bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

UNIT - III MOLECULAR DYNAMICS SIMULATION METHODS

Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time - dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

UNIT - IV MOLECULAR DOCKING AND LEAD OPTIMIZATION

Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design.

UNIT - V PHARMACOPHORE AND QSAR

Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

SUGGESTED READINGS:

1. Jan H. Jensen. (2010). Molecular Modeling Basics. 1st Edition. CRC Press.
2. Alan Hinchliffe. (2008). Molecular Modelling for Beginners. 2nd Edition. John Wiley & Sons Inc.
3. Ramachandran K.I, Deepa Gopakumar, Namboori Krishnan. (2008). Computational Chemistry and Molecular Modeling: Principles and Applications. Springer - Verlag Berlin Heidelberg.
4. Arup K. Ghose, Vellarkad N. Viswanadhan. (2001). Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery. CRC Press.
5. Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin. (1998). 3D QSAR in Drug Design: Recent Advances. Springer Science & Business Media.

Semester - VII

20BTBT7E04 **Stem Cell Technology** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain basic knowledge on stem cells and stem cell niche.
- Illustrate the function and properties of adult and embryonic stem cells.
- Discuss the cell cycle regulations, checkpoints and its epigenetic control.
- Explain the types of stem cells from different origin and its regeneration and experimental methods.
- Outline the usage of stem cells in different medical applications.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Summarize the characteristics of stem cells.
2. Evaluate the properties of adult and embryonic stem cells.
3. Examine the role of checkpoints in cell cycle regulation and significance of epigenetic control.
4. Outline the different sources of stem cells
5. Restate the function of regeneration and its experimental methods.
6. Explain the application of stem cells in medical field.

UNIT - I INTRODUCTION TO STEM CELLS & STEM CELL NICHE

Introduction to Stem Cells: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells. Scope of stem cells - definition of stem cells - concepts of stem cells - differentiation, maturation , proliferation , pluripolericy, self - maintenance and self - renewal. Stem Cell Niche: Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues.

UNIT - II EMBRYONIC & ADULT STEMCELLS

In vitro fertilization - culturing of embryos-isolation of human embryonic stem cells - blastocyst - inner cell mass - growing ES cells in lab - laboratory tests to identify ES cells - stimulation ES cells for differentiation - properties of ES cells. Somatic stem cells - test for identification of adult stem cells - adult stem cell differentiation - trans differentiation - plasticity.

UNIT - III CELL CYCLE, DEVELOPMENT AND EPIGENETIC CONTROL

Cell Cycle and Development: Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self-renewal. Epigenetic Control: DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications.

UNIT - IV TYPES AND REGENERATION, EXPERIMENTAL METHODS

Types and regeneration: Stem cells derived from amniotic fluid, extra embryonic membrane, germ cells, hematopoietic organs, neurons and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, bone marrow and cord blood collection procedures and cryopreservation and their applications. Experimental Methods: Isolation and differentiation of human adult stem cells, embryonic stem cells and mouse stem cells, stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

UNIT - V POTENTIAL USES OF STEM CELLS

Cellular therapies - vaccines - gene therapy - immunotherapy - tissue engineering. Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns, Organ farming.

SUGGESTED READINGS

1. Lanza. R. P. (2013). Essentials of stem cell biology, 3rd edition. Academic Press.
2. Kursad and Turksen. (2012). Adult and Embryonic Stem cells, 2nd edition. Humana Press.
3. Treleaven J. (2009). Hematopoietic Stem Cell Transplantation. 1st Edition. Elsevier Health - UK.
4. Lodish et al. (2008). Molecular Cell Biology. 6th Edition. W.H. Freeman & Co.
5. Svendensen. C. and Ebert. A. D. (2008). Encyclopedia of stem cell research vol 1 & 2. Sage pub.
6. Ariff Bongso and Eng Hin Lee. (2005). Stem Cells: From Bench to Bedside. World Scientific Pulishing Co Pte Ltd.
7. Potten C.S. (1997). Stem cells. Elsevier.

20BTBT7E05 **Molecular Modeling** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Explain the basic concepts of molecular modelling.
- Outline the computational quantum mechanics through different methods.
- Discuss the general features of molecular mechanics.
- Perform the molecular dynamics simulation methods.
- Outline the concept on cheminformatics molecular modeling.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Identify different views on global and local energy minima through molecular modeling.
2. Differentiate various calculations on molecular properties.
3. Illustrate the concept behind molecular mechanics through derivative methods.
4. Evaluate and characterize molecules simulation through dynamics methods.
5. Analyze and categorize the structure based drug design for targets.
6. Explain the diverse techniques on molecular modeling.

UNIT - I MOLECULAR MODELLING

Introduction to concept of molecular modeling, molecular structure and internal energy, applications of molecular graphics, coordinate systems, potential energy surfaces, discussion of local and global energy minima.

UNIT - II QUANTUM MECHANICS

Introduction to the computational quantum mechanics; one electron atom, ply electronic atoms and molecules, Hartree Fock equations; calculating molecular properties using ab initio and semi empirical methods.

UNIT - III MOLECULAR MECHANICS

Molecular mechanics; general features of molecular mechanics force field, bond stretching, angle bending, torsional terms, non-bonded interactions; force field parameterization and transferability;

effective pair potential, energy minimization; derivative and non-derivative methods, applications of energy minimization.

UNIT - IV MOLECULAR DYNAMCS

Molecular dynamics simulation methods; molecular dynamics using simple models, molecular dynamics with continuous potential, setting up and running a molecular dynamic simulation, constraint dynamics; Monte Carlo simulation; Monte Carlo simulation of molecules.

UNT - V MODELLING AND DRUG DESIGN

Introduction to cheminformatics, Macromolecular modeling, design of ligands for known macro molecular target sites, Drug- receptor interaction, classical SAR /QSAR studies and their implications to the 3 D modeler, 2-D and 3-D database searching, pharmacophore identification and novel drug design, molecular docking, Structure-based drug design for all classes of targets.

SUGGESTED READINGS:

1. Leach. A. (2001). Molecular modeling: Principles and application. Prentice Hall.
2. Yvonne, Martin. C. and Willett. P. (1998). Designing bioactive molecules: three dimensional techniques and applications. Washington, DC. American chemical society.
3. Schlecht. M. F. (1998). Molecular modeling on the PC. Wiley - Blakwell; Har.
4. Cohen. N. C. (1996). Guide book on molecular modeling in drug design. Academic Press.

Semester - VII

20BTBT7E06 **Precision Medicine & Wellness** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Describe the intergrative omics in understanding disease condition.
- Apply the concept of biomarker identification for HGP.
- Outline the tests for genetic screening and diagnosis.
- Assess the risk in omics approach and study about personalised omics
- Infer the different case studies in precision medicine

Course Outcomes

Upon successful completion of the course, students will be able to

1. Assess the disease conditions using integrative omics.
2. Identify and validate of biomarkers for different projects.
3. Illustrate the genetic screening for mendelian diseases.
4. Explain the personalised omics and infer the risk assessment.
5. Resolve the different health conditions using precision medicine.
6. Apply the concept of personalised medicine for the wellness of human kind.

UNIT - I INTEGRATIVE OMICS FOR HEALTH AND DISEASE

Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease condition. Tools for genomics analysis. Technologies and methods for transcriptomics analysis, Proteomics and protein structure analysis, Epigenomics, Drugomics.

UNIT - II BIOMARKER IDENTIFICATION

Introduction to Biomarkers- Biomarker identification and validation of a disease state. Human Genome project. Cancer genome project. Different types of genetic and nongenetic variations.

UNIT - III GENETIC SCREENING AND DIAGNOSIS

Genetic screening and diagnosis: prenatal carrier testing and newborn screening for Mendelian diseases, Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs, Tumor profiling, Patient data and clinical decisions.

UNIT - IV PERSONALIZED OMICS AND RISK ASSESSMENT

Genomics in disease-oriented medicine, integrative omics in preventative medicine, Risk assessment through omics approach. Ethical, legal, and social implications of health privacy and policy laws for precision medicine. Ayurveda system of *Prakriti* and *Agni*.

UNIT - V CASE STUDIES IN PRECISION MEDICINE

A case of familial hypercholesterolemia as we investigate how we use genomic medicine to move from a rare disease to a common medication, using genomics to find new drug targets, illustrate how personalized medicine informs treatment decisions related to specific diseases/conditions - cystic fibrosis, Marfan syndrome, heart failure, neuropsychiatric diseases, and diabetes.

SUGGESTED READINGS:

1. Bethesda. (2010). The New Genetics. NH Pulication. National Institute of General Medical Sciences, U.S. Department of Health and Human Services.
2. Geoffrey Ginsburg and Huntington Willard. (2018). Genomic and Precision Medicine. Elsevier.
3. Francis S. Collins. (2011). The Language of Life: DNA and the Revolution in Personalized Medicine. Harper Perennial.

20BTBT7E07 **Tissue Engineering** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Explain the different cell types and their advances in tissue engineering.
- Discuss the various biomaterials for tissue engineering.
- Outline the basic concepts of tissue engineering and tissue creation.
- Discuss the principles and practice of gene therepy.
- To identify and organize differeing views on advances on tissue engineering.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Compose about basic concepts in tissue engineering
2. Assemble different biomaterials for tissue engineering
3. Classify about methods for Tissue Engineering.
4. List the techniques in tissue typing
5. Explain the principles of gene therapy
6. Summarize the concepts of tissue engineering in different fields.

UNIT - I BIOLOGICAL STUDY OF DIFFERENT CELL TYPES

Cell line, Establishment of cell lines, Different cell types: Endothelial cell, Fibroblast cells, Epithelial cell, Myoblast cells, chromaffin cell, Smooth muscle cells & plasma cell.

UNIT - II BIOMATERIALS FOR TISSUE ENGINEERING

Biomaterials: Degradable polymeric scaffolds, Acellular Bio-Matrices, Biological derived polymersin tissue engineering: Natural BD Polymers & Synthetic BD polymers, Cell seeding of scaffolds, Cell source: Allogenic cells, Autologous cells & stem cells. Bioreactors used in tissue engineering: Gail Naughtom's Bioreactor, Pulsatile Bioreactor.

UNIT - III TISSUE ENGINEERING AND CONCEPTS OF TISSUE CREATION

Concepts of Tissue Creation: Sources, Stem Cells, Cells from Tissues, Culture Methods for Tissue Engineering, Maturation of Tissue Construct- Tissue Constructs, Cell therapies, Organ Modules, Cosmetic Measures. Methods to develop Scaffolds for Tissue engineering: hydrogel, porous scaffold,

and Textile-based techniques used for medical application, Rapid prototyping/3D printing, Wound healing.

UNIT - IV PRINCIPLES AND PRACTICE OF GENE THERAPY

Introduction to gene therapy, Requirements of gene therapy, Genetic defects, Target cells for gene therapy, process of gene therapy, Factors responsible for gene therapy for making effective treatment of genetic disease, Recent developments in gene therapy research, ethical considerations of gene therapy.

UNIT - V ADVANCES IN TISSUE ENGINEERING

Development of artificial tissues; Transplantation biology: Tissue typing, Techniques of tissue typing, Minor histocompatibility antigens, Immuno-suppression, Side effects of immuno- suppression. Organ regeneration: Cartilage, Skin, Liver, Blood Vessel, Kidney, Urinary bladder, Tendons, Ligaments, Cornea.

SUGGESTED READINGS:

1. Ranga. M. M. (2010). Animal Biotechnology. Agrobios.
2. Bhojwani. S. S. and Razdan. M. K. (1996). Plant Tissue Culture (Theory and Practice). Elseveir.
3. Watson. J. D. and Gilman. M. (1992). Recombinant DNA. Scientific American Books.
4. Robert Lanza, Robert Langer, Joseph Vacanti. (2014). Principles of Tissue Engineering. 4th Edition. Academic Press. eBook ISBN: 9780123983701.
5. John P. Fisher, Antonios G. Mikos, Joseph D. Bronzino, Donald R. Peterson. (2013). Tissue Engineering: Principles and Practices. 1st Edition. CRC Press. ISBN 9781138077867 - CAT# K34349.
6. Bikramjit Basu, Sourabh Ghosh. (2016). Biomaterials for Musculoskeletal Regeneration-Applications. Springer. ISBN 978-981-10-3017-8.

Semester - VII

20BTBT7E08 **Clinical Trial and Management** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Explain the types and scope of clinical research.
- Illustrate the various ethical theories and foundations of clinical trials.
- Discuss the evolution and regulation of clinical research.
- Outline the various designing protocols and amendments of clinical research.
- Summarize the different biostatistics and data management.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Discuss the scope of clinal research and deisgn of clinical trials.
2. Outline the ethical theories of clinical research.
3. Discuss the history and regulation of clinical research.
4. Explain the various protocol developments in clinical research.
5. Identify the basic views in different situations of biostatictics in clinical trials.
6. Design the perspective techniques and create data on different clinal research.

UNIT - I INTRODUCTION TO CLINICAL RESEARCH

Definition, Types and Scope of Clinical Research, Good Clinical Practices - Introduction to study designs and clinical trials - Careers in Clinical Research.

UNIT - II ETHICS IN CLINICAL RESEARCH

Ethical Theories and Foundations, Ethics Review Committee, Ethics and Historically derived principles - Nuremberg Code, Declaration of Helsinki, Belmont Report, Equipoise, Informed consent, Integrity & Misconduct.

UNIT - III REGULATIONS IN CLINICAL RESEARCH

Evolution and History of Regulations in Clinical Research, Patents US Regulatory Structure, IND, NDA, ANDA, Post Drug Approval Activities, PMS, FDA Audits and Inspections EURegulatory Affairs, EMEA Organization and Function, INDIAN Regulatory system, Schedule Y- Rules and

Regulations, Description of trial phases (Phase 0, Phase I, II, III, and IV), Trial contexts (types of trials: pharma, devices, etc.), Trial examples.

UNIT - IV CLINICAL RESEARCH METHODOLOGY AND MANAGEMENT

Designing of Protocol, CRF, e-CRF, IB, ICF, SOP; Study Protocol -Introduction, background, Objectives Eligibility, Design, Randomization - Intervention details, assessments and data collection, case report forms –Violations -. Amendments. Study/ Trial Design- Phase I designs - Dose-finding designs. Phase II designs - Pilot studies, Single arm, Historical control designs. Phase III designs - Factorial designs, Crossover designs, Multicenter studies, Pilot studies. Phase IV designs- Preparation of a successful clinical study, Study management, Project management Documentation, Monitoring, Audits and Inspections, Pharmacovigilance training in clinical research budgeting in clinical research, Supplies and vendor management.

UNIT - V BIOSTATISTICS AND DATA MANAGEMENT

Introduction to Power and Sample Size- Hypothesis testing, P-values, confidence intervals, General power/sample size, estimating effect size, Matching sample size calculations to endpoints. Importance of statistics in clinical research Statistical considerations at the design, analysis and reporting stage Data management - Data collection, Paper or electronic, Parsimony, Data validation, SAE reconciliation, query management Software considerations. Data Monitoring, Trial Conduct - Data quality assurance, Data delinquency, Data Monitoring, d. Trial Conduct, Occurrence and control of variation and bias.

SUGGESTED READINGS:

1. Piantadosi. S. (2017). Clinical Trials: A Methodologic Perspective. John Wiley and sons.
2. Friedman. M., Furberg. C. and Demets D. L. (2015). Fundamentals of clinical trails. Springer.
3. Machin. D. and Fayers. P. (2010). Randomized Clinical Trails: Design Practice and Reporting. Wiley-Blackwell

20BTBT7E09 **Bioimaging** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Illustrate the techniques of traditional imaging methods.
- Explain the basic features of deterministic functional imaging techniques.
- Outline the basic knowledge on single molecule super super resolution imaging.
- Discuss the basic theory and working of metabolic functional imaging.
- Acquisition of basic knowledge on magnetic resonance imaging.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Recall the instrumentation and working of traditional imaging techniques.
2. Summarize the concepts and working mechanism of deterministic functional imaging techniques.
3. Reproduce the working mechanism of single molecule super super resolution imaging.
4. Construct and design the metabolic functional imaging.
5. Apply the knowledge on the working of magnetic resonance imaging.
6. Examine and solve the problems related to various imaging techniques.

UNIT - I TRADITIONAL IMAGIMNG METHODS

Overview and limitations of traditional imaging methods. Confocal microscopy, Super-resolution microscopy, X-Ray, Ultrasound imaging, Radio nuclide imaging.

UNIT - II DETERMINISTIC FUNCTIONAL IMAGING

Introduction, Theory, Instrumentation and Application for the following techniques: Stimulated emission depletion (STED), Ground state depletion (GSD), Saturated Structured Illumination Microscopy (SSIM), Magnetoencephalography (MEG)

UNIT - III SINGLE MOLECULE SUPER RESOLUTION IMAGING

Stochastic optical reconstruction microscopy (STORM), photo activated localization microscopy (PALM) and fluorescence photo-activation localization microscopy (FPALM), Points accumulation for imaging in nanoscale topography (PAINT), Label-free localization microscopy.

UNIT - IV METABOLIC FUNCTIONAL IMAGING

Multi-photon imaging systems, Real time imaging, Theory, Instrumentation and Application of computerized tomography (CT) imaging, Theory, Instrumentation and Application of Positron Emission Tomography (PET).

UNIT - V MAGNETIC RESONANCE IMAGING

Magnetic Resonance Imaging (MRI): Angular momentum, Magnetic dipole moment, Magnetization, Larmor frequency, Rotating frame of reference, Free induction decay, Relaxation times, Pulse sequences, Functional MRI (fMRI), Tissue imaging through mass spectroscopy. Image recognitions and artificial intelligence.

SUGGESTED READINGS:

1. Hartveit. (2019) Espen, Multiphoton Microscopy. Springer, Humana Press.
2. Udo J. Birk. (2018). Super-Resolution Microscopy: A Practical Guide. Wiley.
3. Erfle, Holger. (2017). Super-Resolution Microscopy, Methods and Protocols. Springer, Humana Press, New York.
4. Alberto Diaspro, Marc A.M.J. Van Zandvoort. (2016). Super-Resolution Imaging in Biomedicine. CRC Press.
5. Stewart C. Bushong. (2015). Magnetic Resonance Imaging: Physical and Biological Principles. 4th Edition. Elsevier.
6. Saha, Gopal B. (2010). Basics of PET Imaging, Physics, Chemistry, and Regulations. Springer-Verlag New York.
7. Setou, Mitsutoshi. (2010). Imaging Mass Spectrometry, Protocols for Mass Microscopy. Springer, Japan.
8. Alberto Diaspro. (2001). Confocal and Two-Photon Microscopy: Foundations, Applications and Advances. Academic Press, Wiley.
9. Jagannathan N.R. (2001). MRI and Spectroscopy in Pharma. & Clinical Research. Jaypee Brothers Medical Publishers Pvt Ltd.

20BTBT7E10 **Data analysis and simulations** **3H-3C**

Instruction Hours/ week: L: 3 T: 0 P: 0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Describe the concept of data preprocessing and visualization.
- Analyse the data using statistical tools.
- Discuss the mining frequent patterns
- Outline the usage of machine learning.
- Explain the artificial neural networks and its types.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Perform data preprocessing and recall the types of data.
2. Illustrate the data using testing hypothesis and statistical tools.
3. Examine the mining frequent patterns.
4. Explain the concept of machine learning.
5. Infer the artificial neural networks and its types.
6. Apply the concept of deep learning in bio applications.

UNIT - I DATA PREPROCESSING AND VISUALIZATION

Introduction to data preprocessing and visualization, Types of data, dealing with missing data, data visualization: Scatter Plot, histogram, group plots, box plots etc., dimensionality reduction.

UNIT - II DATA ANALYSIS

Data analysis: Statistical analysis, hypothesis testing, significance of p-value, chi-square, T-test, ANOVA, Bayesian Probability.

UNIT - III MINING FREQUENT PATTERNS

Mining Frequent Patterns: Associations and Correlations, Classification.

UNIT - IV MACHINE LEARNING

Machine learning: Supervised, unsupervised, logistic regression, SVMs, decision trees, clustering and model evaluation.

UNIT - V ARTIFICIAL NEURAL NETWORKS

Artificial neural networks: Types of ANN, case studies for the application of deep learning in biology and health care research.

SUGGESTED READINGS

1. Jeeva Jose. (2019). Introduction to Machine Learning using Python. Khanna Publishing House.
2. Jiawei Han, Jian Pei, Micheline Kamber. (2007). Data Mining: Concepts and Techniques. Elsevier. Third edition.
3. Ian Goodfellow, Yoshua Bengio. (2017). Deep Learning. MIT Press.
4. Kieran Healy. (2019). Data Visualization – A Practical Introduction by, Princeton University Press.
5. Rajiv Chopra. (2019). Deep Learning. Khanna Publishing House.

Semester-

20BTBTOE01 **BIOREACTOR DESIGN** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives:

- Impart basic knowledge in bioprocess Engineering
- Design the bioreactors for various operations.
- Discuss the principle and working of heat transfer equipments.
- Extend the knowledge in principle of heat transfer inside a bioreactor
- Construct the equipments used in mass transfer operations.
- Illustrate the equipments used in separation process.

Course Outcomes

After completing the course, the students will be able to

- Summarize the basic concepts in bioprocess Engineering.
- Design the bioreactors for various operations.
- Develop the heat transfer equipments for Bioprocess Engineering.
- Construct the equipments used in mass transfer operations.
- Categorize the equipments used in separation process.
- Describe the applications of bioreactors.

UNIT I: **INRODUCTION TO BIOPROCESS ENGINEERING**

Introduction – Biotechnology and Bioprocess Engineering- Biologists and Engineers Differ in their approach to research-How Biologists and Engineers work Together- Bioprocesses: Regulatory constraints.

UNIT II: REACTOR DESIGN

Design of Airlift fermentor, Bubble column reactor and Continuous stirred tank reactor.

UNIT III: HEAT TRANSFER EQUIPMENTS

Design of Shell and tube Heat exchanger, Double pipe heat exchanger, long tube vertical evaporator and forced circulation evaporator.

UNIT IV : MASS TRANSFER EQUIPMENTS

Design of Bollmann extractor, fractionating column, packed tower and spray tray absorber

UNIT V: SEPARATION EQUIPMENTS

Design of plate and frame filter press, leaf filter, rotary drum filter, disc bowl centrifuge, rotary drum drier and Swenson –walker crystallizer.

SUGGESTED READINGS:

1. James Edwin Bailey, David F. Ollis (2015) Biochemical Engineering Fundamentals, Second Edition. McGraw-Hill Education (India) private limited.
2. Don W. Green, Robert H.Perry (2008). Chemical Engineer Hand book. The McGraw-Hill Companies, Inc.
3. Pauline. M. Doran (2015). Bioprocess Engineering Principles Second Edition . Academic Press.

20BTBTOE02 FOOD PROCESSING AND PRESERVATION 3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course Objectives

- Discuss the scope and importance of food processing.
- Impart basic knowledge in different food processing methods carried out in the food tech companies.
- Extend the brief knowledge in food conservation operations.
- Explain the methods of food preservation by cooling.
- Tell the concepts of preservation methods for fruits.
- Create deeper understanding on preservation methods for vegetables.

Course Outcomes

After completing the course, the students will be able to

- Describe the scope and importance of food processing.
- Outline the various processing methods for foods.
- Extend the knowledge in food conservation operations.
- Describe the methods of food preservation by cooling.
- Summarize the preservation methods for fruits.
- Demonstrate the preservation methods for vegetables.

UNIT I : SCOPE AND IMPORTANCE OF FOOD PROCESSING

Properties of food - Physical, thermal, mechanical, sensory. Raw material Preparation - Cleaning, sorting, grading, peeling.

UNIT II: PROCESSING METHODS

Heating- Blanching and Pasteurization. Freezing- Dehydration- canning-additives-fermentation- extrusion cooking- hydrostatic pressure cooking- dielectric heating- micro wave processing and aseptic processing – Infra red radiation processing-Concepts and equipment used.

UNIT III: FOOD CONVERSION OPERATIONS

Size reduction – Fibrous foods, dry foods and liquid theory and foods – equipments - membrane separation- filtration- equipment and application.

UNIT IV: FOOD PRESERVATION BY COOLING

Refrigeration, Freezing-Theory, freezing time calculation, methods freezing of freezing equipments, freeze drying, freeze concentration, thawing, effect of low temperature on food. Water activity, methods to control water activity.

UNIT : PRESERVATION METHODS FOR FRUITS AND VEGETABLES

Pre processing operations - preservation by reduction of water content: drying / dehydration and concentration – chemical preservation – preservation of vegetables by acidification, preservation with sugar - Heat preservation– Food irradiation- Combined preservation techniques.

SUGGESTED READINGS:

1. R. Paul Singh, Dennis R.Heldman (2014).Introduction to food engineering. Academic press.
2. P.Fellows. (2017). Food processing technology principles and practice, Fourth Edition. Wood head publishing Ltd.
3. Mircea Enachescu Dauthy. (1995). Food and vegetable processing.FAO agricultural services bulletin.
4. M.A. Rao, Syed S.H.Rizvi, Ashim K. Datta. (2014). Engineering properties of foods. CRC press.
5. B. Sivasankar. (2002). Food processing and preservation.PHI learning Pvt.Ltd.

20BTBTOE03 **BASIC BIOINFORMATICS** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

- Elaborate the available tools and databases for performing research in bioinformatics.
- Expose students to sequence alignment tool in bioinformatics.
- Construct the phylogenetic trees for evolution.
- Discuss the 3D structure of protein and classification.
- Acquire basic knowledge in protein secondary structure prediction.
- Extend the brief knowledge in Micro array data analysis.

Course Outcomes

After completing the course, the students will be able to

- Summarize the basic concepts and importance of Bioinformatics in various sectors.
- Demonstrate the sequence alignment tool in bioinformatics.
- Construct the phylogenetic trees for evolution.
- Analyze the three dimensional protein structure and classification using various tools.
- Illustrate the protein secondary structure prediction by comparative modeling.
- Extend the knowledge in micro array technology and applications of bioinformatics in various sectors.

UNIT I: OVERVIEW OF BIOINFORMATICS

The scope of bioinformatics; bioinformatics & the internet; useful bioinformatics sites. Data acquisition: sequencing DNA, RNA & proteins; determination of protein structure; gene & protein expression data; protein interaction data. Databases – contents, structure & annotation: file formats; annotated sequence databases; miscellaneous databases.

UNIT II: RETRIEVAL OF BIOLOGICAL DATA

Data retrieval with Entrez & DBGET/ LinkDB; data retrieval with SRS (sequence retrieval system).Searching sequence databases by sequence similarity criteria: sequence similarity searches; amino acid substitution matrices; database searches, FASTA & BLAST; sequence filters; iterative database searches & PSI-BLAST. Multiple-sequence alignment, gene & protein families: multiple-sequence alignment & family relationships; protein families & pattern databases; protein domain families.

UNIT III: PHYLOGENETICS

Phylogenetics, cladistics & ontology; building phylogenetic trees; evolution of macromolecular sequences. Sequence annotation: principles of genome annotation; annotation tools & resources.

UNIT IV: STRUCTURAL BIOINFORMATICS

Conceptual models of protein structure; the relationship of protein three-dimensional structure to protein function; the evolution of protein structure & function; obtaining, viewing & analyzing structural data; structural alignment; classification of proteins of known three-dimensional structure: CATH & SCOP; introduction to protein structure prediction; structure prediction by comparative modeling; secondary structure prediction; advanced protein structure prediction & prediction strategies.

UNIT V: MICROARRAY DATA ANALYSIS

Microarray data, analysis methods; microarray data, tools & resources; sequence sampling & SAGE. Bioinformatics in pharmaceutical industry: informatics & drug discovery; pharma informatics resources. Basic principles of computing in bioinformatics: running computer software; computer operating systems; software downloading & installation; database management.

SUGGESTED READINGS:

1. Dan E krane Michael L Rayme. (2004). Fundamental concepts of Bioinformatics. Pearson Education.
2. Andreas D Baxevanis B.F. Franchis Ouellette. (2004). Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley-Interscience.
3. David W. Mount. (2004). Sequence and Genome Analysis. Cold Spring Harbor Laboratory.
4. Jonathan Pevsner.(2015). Bioinformatics and functional genomics. wiley-Liss.
5. Michael J Koernberg. (2016).Microarray Data Analysis: Methods and applications. Humana Press

20BTBTOE04 FUNDAMENTALS OF NANOBIOTECHNOLOGY 3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

- Impart the skills in the field of nano biotechnology and its applications.
- Acquire knowledge in the nano particles and its significance in various fields.
- Extend the knowledge in types and application of nano particles in sensors.
- Define the concepts of biomaterials through molecular self assembly.
- Equip students with clinical applications of nano devices.
- Describe deeper understanding of the socio-economic issues in nanobiotechnology.

Course Outcomes

After completing the course, the students will be able to

- Develop skills in the field of nano biotechnology and its applications.
- Summarize the nanoparticles and its significance in various fields.
- Extend the knowledge in types and application of nano particles in sensors.
- Define the concepts of biomaterials through molecular self assembly.
- Outline the clinical applications of nano devices.
- Describe the socio-economic issues in nanobiotechnology.

UNIT I: INTRODUCTION

Introduction, Scope and Overview, Length scales , Importance of Nanoscale and Technology, History of Nanotechnology, Future of Nanotechnology: Nano Technology Revolution, Silicon based Technology, Benefits and challenges in Molecular manufacturing: The Molecular assembler concept, Controversies and confusions, Understanding advanced capabilities, Nanotechnology in Different, Fields: Nanobiotechnology, Materials, Medicine, Dental care.

UNIT II: NANO PARTICLES

Introduction, Types of Nanoparticles, Techniques to Synthesize Nanoparticles, Characterization of Nanoparticles, Applications, Toxic effects of Nanomaterials, Significance of Nanoparticles Nanofabrications- MEMS/NEMS, Atomic Force Microscopy, Self assembled monolayers/ Dip- pen Nanolithography, Soft Lithography, PDMS Molding, Nano Particles, Nano wires and Nanotubes.

UNIT III: MEDICAL NANOTECHNOLOGY

Nanomedicine, Nanobiosensor and Nanofludics. Nanocrystals in biological detection, Electrochemical DNA sensors and Integrated Nanoliter systems. Nano-Biodevices and Systems. Fabrication of Novel Biomaterials through molecular self assembly- Small scale systems for in vivo drug delivery- Future nanomachine.

UNIT IV: NANOBIOTECHNOLOGY

Clinical applications of nanodevices. Artificial neurons. Real-time nanosensors- Applications in cancer biology. Nanomedicine. Synthetic retinyl chips based on bacteriorhodopsins. High throughput DNA sequencing with nano carbontubules. Nanosurgical devices.

UNIT V: ETHICAL ISSUES IN NANOTECHNOLOGY

Introduction, Socioeconomic Challenges, Ethical Issues in Nanotechnology: With Especial Reference to Nanomedicine, Nanomedicine Applied in Nonmedical Contexts, Social Issues Relating to Nanomedicine. Social and Ethical Issues, Economic Impacts, Other Issues, Nanotechnology and Future Socio-economic challenges.

SUGGESTED READINGS:

1. Niemeyer, C.M. and Mirkin, C.A (2005). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH.
2. Goodsell, D.S. (2004). Bionanotechnology. John Wiley and Sons, Inc.
3. Shoseyov, O. and Levy, I (2008).Nanobiotechnology: Bioinspired Devices and Materials of the Future. Humana Press.
4. Bhushan, B. (2017). Springer Handbook of Nanotechnology. Springer-Verlag Berlin Heidelberg.
5. FreitasJr R.A (2006) Nanomedicine. Landes Biosciences.
6. Kohler, M. and Fritzsche, W. (2008). Nanotechnology – An Introduction to Nanostructuring Techniques. Wiley-VCH.

LIST OF OPEN ELECTIVES (COURSES PREFERRED BY BIOTECHNOLOGY)

SUB. CODE	TITLE OF THE COURSE	L	T	P	C	CIA	ESE	TOTAL
SCIENCE AND HUMANITIES								
20BTSHOE02	Green Chemistry	3	0	0	3	40	60	100
CHEMICAL ENGINEERING								
20BTCEOE04	Solid and hazardous waste management	3	0	0	3	40	60	100
FOOD TECHNOLOGY								
20BTFTOE04	Agricultural Waste and Byproducts Utilization	3	0	0	3	40	60	100
BIOMEDICAL ENGINEERING								
20BEBMEOE03	Artificial Organs And Implants	3	0	0	3	40	60	100

20BESHOE06, 20BTSHOE06 GREEN CHEMISTRY 3 0 0 3

Course Objective

The goal of this course is for students to

- To make the students conversant about the green chemistry
- To make the student acquire sound knowledge of the atom efficient process and synthesis elaborately.
- To acquaint the student with concepts of green technology.
- To develop an understanding of the basic concepts of renewable energy resources.
- To acquaint the students with the basics information on catalysis.

Course Outcomes

Upon completion of the course the students will be able to

- Outline the basic principles of green chemistry
- Examine the different atom efficient process and synthesis elaborately
- Apply the concepts combustion of green technology
- Identify and apply the concepts of renewable energy
- Apply the concepts of green catalysts in the synthesis
- Integrate the chemical principles in the projects undertaken in field of engineering and technology

UNIT I INTRODUCTION TO GREEN CHEMICAL PRINCIPLES (9)

Definition, tools, and twelve principles of green chemistry, solvent-less reactions and reactions in water, microwaves and fluorous solvents, green resolution of racemic mixtures, materials for a sustainable economy, chemistry of longer wear, agrochemicals: problems and green alternate solutions.

UNIT II ATOM EFFICIENT PROCESSES (9)

Atom efficient processes, evaluating chemical reagents according to their yield and atom efficiency, examples of efficient stoichiometric and catalytic processes, atom economy and homogeneous catalysis, halide-free synthesis and alternatives to Strecker synthesis.

UNIT III BIOTECHNOLOGY AND GREEN CHEMISTRY (9)

Bio technology and its applications in environmental protection-Bio informatics-Bio remediation, biological purification of contaminated air. Green chemistry for clean technology-Significance of green chemistry-Basic components of green chemistry, Industrial applications of green chemistry, green fuels-e-green propellants and bio catalysts.

UNIT IV RENEWABLE RESOURCES (9)

Use of renewable materials, evaluating feedstock and starting materials and their origins, toxicity, sustainability and the downstream implications of the choice of feedstock, commodity chemicals from glucose and biomass conversion.

UNIT V CATALYSIS IN GREEN CHEMISTRY (9)

Catalysis, energy requirements and usage, optimization of the reaction by minimizing the energy requirements, examples of efficient catalytic reactions including the use of heterogeneous catalysis, zeolites, oxidation using molecular oxygen.

Total: 45

SUGGESTED READINGS

1. Sanjay K. Sharma, Ackmez Mudhoo (2010)Green Chemistry for Environmental Sustainability CRC Press , London
2. Ahluwalia V. K. and M.Kidwai (2007) New Trends in Green Chemistry 2nd edition Anamaya publishers., New Delhi.
3. Dr. Sunita Ratan (2012) A Textbook of Engineering Chemistry S.K. Kataria and Sons., New Delhi
4. Mukesh Doble. Ken Rollins, Anil Kumar (2007) Green Chemistry and Engineering, 1st edition Academic Press, Elesevier., New Delhi.
5. Desai K. R. (2005) Green Chemistry Himalaya Publishing House, Mumbai.
6. Matlack A. S. (2001) Introduction to Green Chemistry Marcel Dekker: New York
7. http://www.organic-chemistry.org/topics/green-chemistry.shtm
8. http://www.essentialchemicalindustry.org/processes/green-chemistry.html
9. http://www.chm.bris.ac.uk/webprojects2004/vickery/green_solvents.htm
10. http://www.epa.gov/research/greenchemistry/
11. http://www.amazon.in/Green-Chemistry-Catalysis

20BTSHOE05 SOLID WASTE MANAGEMENT 3 0 0 3

Course Objective

The goal of this course is for students to

- To make the students conversant with basics of Solid wastes and its classification.
- To make the student acquire sound knowledge of different treatments of solid wastes.
- To acquaint the student with concepts of waste disposals.
- To develop an understanding of the basic concepts of Hazardous waste managements.
- To acquaint the students with the basics of energy generation from waste materials.

Course Outcomes

Upon completion of the course the students will be able to

- Outline the basic principles of Solid waste and separation of wastes
- Identify the concepts of treatment of solid wastes
- Identify the methods of wastes disposals.
- Examine the level of Hazardousness and its management.
- Examine the possible of the energy production using waste materials.
- Integrate the chemical principles in the projects undertaken in field of engineering and technology

UNIT I SOLID WASTE (9)

Definitions – Sources, Types, Compositions, Properties of Solid Waste – Municipal Solid Waste – Physical, Chemical and Biological Property – Collection – Transfer Stations – Waste Minimization and Recycling of Municipal Waste

UNIT II WASTE TREATMENT (9)

Size Reduction – Aerobic Composting – Incineration – batch type and continuous flow type, Medical/ Pharmaceutical Waste Incineration – Environmental Impacts – Measures of Mitigate Environmental Effects due to Incineration

UNIT III WASTE DISPOSAL (9)

Sanitary Land Fill Method of Solid Waste Disposal – Land Fill Classficaition, Types, Methods &Siting Consideration – Layout & Preliminary Design of Land Fills – Composition, Characteristics generation, Movement and Control of Landfill Leachate & Gases – Environmental Monitoring System for Land Fill Gases, Waste landfill Remediation

UNIT IV HAZARDOUS WASTE MANAGEMENT (9)

Definition & Identification of Hazardous Waste – Sources and Nature of Hazardous Waste – Impact on Environment – Hazardous Waste Control – Minimization and Recycling - Assessment of Hazardous Waste Sites – Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure, Remediaiton, risk assessment.

UNIT V ENERGY GENERATION FROM WASTE (9)

Thermal conversion Technologies – Pyrolysis systems, Combustion systems, Gasification systems, Environment control systems, Energy recovery systems. Biological & Chemical conversion technologies – Aerobic composting, low solids. Anaerobic digestion, high solids anaerobic digestion, Energy production from biological conversion products, other biological transformation processes. Chemical transformation processes.

Total: 45

SUGGESTED READINGS

1. Dara.S.S,Mishra.D.D (2011) A Text book of Environmental Chemistry and Pollution ControlS.Chand and Company Ltd., New Delhi
2. Naomi B. Klinghoffer and Marco J. Castaldi (2013) Waste to Energy Conversion Technology (Woodhead Publishing Series in Energy) Woodhead Publishing Ltd., Cambridge, UK
3. Frank Kreith, George Tchobanoglous (2002) Hand Book of Solid Waste Management- 2nd edition McGraw Hill Publishing Ltd., Newyork
4. Shah, L Kanti (Basics of Solid & Hazardous Waste Management Technology Prentice Hall (P) Ltd.,New Delhi
5. Salvatore Caccavale (2016)A Basic Guide to RCRA: Understanding Solid and Hazardous Waste Management 2 edition American Society of Safety Professionals
6. www.iitk.ac.in/3inetwork/html/reports/IIR2006/Solid_Waste.
7. http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/
8. www.alternative-energy-news.info/technology/garbage-energy/
9. nzic.org.nz/ChemProcesses/environment/

B.Tech- Food Tech **2020-2021**

Semester-

20BTFTOE04 AGRICULTURAL WASTE AND BYPRODUCTS UTILIZATION 3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

- To categorize the types of agricultural wastes
- To outline the production and utilization of biomass
- To explain the various parameters considered to be important in the designing of biogas units
- To discuss the methods employed in the production of alcohol from agricultural wastes / byproducts
- To summarize the overall aspects involved in the production of paperboards and particle boards from agricultural wastes

Course Outcomes

After completing the course, the students will be able to

- List and classify the types of agricultural wastes
- Collect and generate number of value added products from agricultural wastes
- Recall the techniques involved in the production and utilization of biomass
- Assess the various parameters considered to be important in the designing of biogas units
- Illustrate the various methods employed in the production of alcohol from the byproducts of agricultural wastes
- Choose the appropriate materials to produce paperboards and particle boards from agricultural wastes

UNIT I: TYPES OF AGRICULTURAL WASTES

Introduction and background of agricultural waste, crop waste, agricultural residues (annual crops), technical terms, rice by-product utilization - rice bran and germ, rice bran oil, economic products from agriculture waste/by-products.

UNIT II: BIOMASS PRODUCTION AND UTILIZATION

Biomass gasifier, Technology used for the utilization of agricultural wastes: Biomass gasifier, Nimbkar Agricultural Research Institute (NARI) gasifier, rice-husk based gasifier, heat and steam from sugarcane leaf and bagasse.

UNIT III: BIOGAS DESIGN AND PRODUCTION

Biogas: Definition, composition, history of biogas, production of biogas; types of biogas plant (floating drum type and fixed dome type) and their components (inlet, outlet, stirrer, slanting pipe, digester, gas holder and gas outer pipe), selection and design of biogas plant.

UNIT IV: PRODUCTION OF ALCOHOL FROM WASTE MATERIALS

Production of alcohol from waste materials: Introduction, production methods, cellulolysis (biological approach): pretreatment, cellulolytic processes (Chemical and Enzymatic hydrolysis), microbial fermentation, gasification process (thermochemical approach).

UNIT V: PRODUCTION OF PAPERBOARDS AND PARTICLEBOARDS FROM AGRICULTURAL WASTE

Production and testing of paperboards and particleboards from agricultural waste: Introduction, history, terminology and classification, raw materials, production steps - pulping, classifications of pulp, bleaching, plies, coating, grades.

SUGGESTED READINGS

1. Efthymia Alexopoulou. (2020) Bioenergy and Biomass from Industrial Crops on Marginal Lands.1st Edition. Elsevier
2. Navanietha Krishnaraj Rathinam, Rajesh Sani. (2019). Biovalorisation of Wastes to Renewable Chemicals and Biofuels. 1st Edition. Elsevier.
3. Simona Ciuta, Demetra Tsiamis, Marco J. Castaldi. (2017). Gasification of Waste Materials. Academic Press, 1st Edition.
4. Nicholas E. Korres, Padraig O'Kiely, John A.H. Benzie, Jonathan S. West. (2013). Bioenergy Production by Anaerobic Digestion: Using Agricultural Biomass and Organic Wastes. Routledge, 1st Edition.
5. Albert Howard, Yashwant Wad. (2011). The Waste Products of Agriculture. Benediction Classics, 1st Edition.

20BEBMEOE02 ARTIFICIAL ORGANS AND IMPLANTS 3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

COURSE OBJECTIVES:

The goal of this course is for students:

- To discuss the overview of artificial organs & transplants
- To extend the principles of implant design with a case study
- To explain the implant design parameters and solution in use
- To simplify about various blood interfacing implants

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Explain the implant design parameters and solution in use
2. Analyze about various blood interfacing implants
3. Perceive knowledge about artificial organs & transplants
4. Demonstrate different types of soft tissue replacement and hard tissue replacement

UNIT I ARTIFICIAL ORGANS

Artificial blood, Artificial skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants

UNIT II IMPLANT DESIGN & MATERIALS

Principles of implant design, Clinical problems requiring implants for solution. Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications

UNIT III IMPLANT DESIGN PARAMETERS AND ITS SOLUTION

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.

UNIT IV BLOOD INTERFACING IMPLANTS

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

UNIT V IMPLANTABLE MEDICAL DEVICES AND ORGANS

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

SUGGESTED READINGS

1. Kopff W.J. (1976). Artificial Organs. 1st edition. John Wiley and sons, New York.
2. Park J.B. (1984). Biomaterials Science and Engineering. Plenum Press.
3. J D Bronzino. (2000). Biomedical Engineering handbook Volume II. CRC Press / IEEE Press.
4. R S Khandpur. (2003). Handbook of Biomedical Instrumentation. Tata McGraw Hill.
5. Joon B Park. (1992). Biomaterials – An Introduction. Plenum press, New York.
6. Yannas, I. V. (2001). Tissue and Organ Regeneration in Adults. New York, NY: Springer.
7. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino. (2010). Clinical Engineering. 1st edition. CRC Press.
8. Myer Kutz. (2003). Standard Handbook of Biomedical Engineering & Design. McGraw- Hill.
9. www.mit.edu
10. www.nptel.com

LIST OF VALUE ADDED COURSES OFFERED BY BIOTECHNOLOGY

S.No	Name of the Value Added Course	Duration
1.	Basic open source drug discovery tools	30 Hours
2.	Indispensable molecular techniques	30 Hours
3.	Basics of Chemoinformatics	30 Hours
4.	Formulation of biopharmaceutical products	30 Hours
5.	Micro RNA Prediction & protein structure modeling	30 Hours
6.	Chromatographic techniques	30 Hours
7.	Nanoparticles synthesis and its characterization	30 Hours
8.	Mushroom Cultivation	30 Hours
9.	Phytochemical analysis of Medicinal Plants	30 Hours
10.	Production and commercialization of bioproducts	30 Hours

THRUST AREAS FOR TECHNOLOGY BUSINESS INCUBATOR (TBI)

S.No	Thrust areas
1.	Healthcare Technology
2.	Bioinformatics
3.	Chemoinformatics
4.	Clinical genomics
5.	Medicinal plant extraction
6.	Herbal farming
7.	Waste water treatment
8.	Organic Foods
9.	Bioprocess Technology
10.	Green Biotechnology