FACULTY OF ENGINEERING

DEGREE OF

BACHELOR OF TECHNOLOGY

IN

BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM

(2025 - 2026)

KARPAGAM ACADEMY OF HIGHER EDUCATION

Deemed to be University

(Established Under Section 3 of UGC Act, 1956)

(Accredited with A+ Grade by NAAC in the Second Cycle)

Pollachi Main Road, Eachanari Post, Coimbatore - 641 021, Tamil Nadu, India.

Phone: 0422 – 2980011 – 14 | Email: info@kahedu.edu.in

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FACULTY OF ENGINEERING

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

REGULATIONS
(2025)

CHOICE BASED CREDIT SYSTEM

KARPAGAM ACADEMY OF HIGHER EDUCATION

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

Eachanari, Coimbatore-641 021. INDIA

FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY

REGULAR PROGRAMME

REGULATIONS 2025

CHOICE BASED CREDIT SYSTEM

These regulations are effective from the academic year 2025 – 2026 and applicable to the candidates admitted to B. E. / B. Tech programmes. during 2025- 2026 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) prescribed by the State Government / Central Government with Mathematics/ Physics/ Chemistry/ Computer Science/ Electronics/ Information Technology/ Biology/ Informatics Practices/ Biotechnology/ Technical Vocational subject/ Agriculture/ Engineering Graphics/ Business Studies/ Entrepreneurship. (Any of the above three subjects) or any similar Examination of any other institution/ University or authority accepted by the Karpagam Academy of Higher Education as equivalent thereto).

Should have obtained at least 45% marks (40% marks in case of candidates belonging to SC / ST reserved category) in the above subjects taken together.

1.2 Lateral Entry Admission

Candidates who possess Diploma in Engineering / Technology (10+3 or 10+2+2) awarded by the Directorate of Technical Education with passed minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to SC / ST reserved category) in ANY branch of Engineering and Technology are eligible to apply for admission to the third semester of B. E./B. Tech., subject to vacancies in the First Year, in case the vacancies at lateral entry are exhausted. (The University will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

(OR)

B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40%

marks in case of candidates belonging to SC / ST reserved category) and passed 10+2 examination with Mathematics as a subject.

(OR)

Passed D.Voc. Stream in the same or allied sector.

(The University will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

Eligibility criteria for admission in the third semester is given in the table below.

S. No.	Programme	Eligibility criteria
1	B.E Bio Medical Engineering	Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case ofcandidates belonging to reserved category) in ANY branch of Engineering and Technology. **OR** Passed B.Sc. Degree from a recognizedUniversity as defined by UGC, with at least 45%marks (40% marks in case of candidates belonging to SC / ST reserved category) and passed 10+2 examination with Mathematics as a subject. **OR** Passed D.Voc. Stream in the same or allied sector. (The Universities will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)
2	B. E. Civil Engineering	
3	B. E. Computer Science and Engineering	
4	B. E. Computer Science and Engineering (Cyber security)	
5	B. E. Electrical and Electronics Engineering	
6	B. E. Electronics and Communications Engineering	
7	B. E. Mechanical Engineering	
8	B. Tech. Artificial Intelligence and Data Science	
9	B. Tech. Computer Science and Business Systems	
10	B. Tech Bio – Technology	
11	B. Tech Food Technology	

1.3 Migration from other University

Candidates who are willing to migrate to Karpagam Academy of Higher Education for admission to their next semester of B. E./B. Tech programme may get admitted from 2nd semester onwards upto 5th semester. 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 Competent authority, he/she has undergone. Programme Equivalence Certificate shall be given by the respective Head of the Department of Karpagam Academy of Higher Education, after verifying the credentials.

2. PROGRAMMES OFFERED

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

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

1. B.E Bio Medical Engineering
2. B. E. Civil Engineering
3. B. E. Computer Science and Engineering
4. B. E. Computer Science and Engineering (Cyber Security)
5. B. E. Electrical and Electronics Engineering
6. B. E. Electronics and Communications Engineering
7. B. E. Mechanical Engineering
8. B.Tech. Artificial Intelligence and Data Science
9. B. Tech. Computer Science and Business Systems
10. B. Tech. Bio-Technology
11. 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 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, internship, seminar presentation, project work, 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.
- Other Co-Curricular and Extra Curricular activities

(V) **Choice Based Credit System**

CBCS is introduced for students admitted in the academic year 2017-18 onwards. 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 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 and register for the course for every semester within the first week of semester.** Maximum number of students to be registered in each course shall be decided by the HoD in consultation with the Dean. 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 weeks of field project/internship training during semester vacations	: 1

4.3 In every semester, the curriculum shall normally have a blend of theory courses not exceeding 6 and practical courses not exceeding 4.

4.4 The prescribed credits required for the award of the degree shall be 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 (VAC / Skill Development Course (SDC)

Besides core courses and elective courses, VAC / SDC are provided. The blend of different courses is so designed that the interested students would be trained for the holistic development to enhance employment opportunity. Upon completion of 30 Practical Hours / 15 Theory hours and evaluation, a student can claim for 1 additional credit.

4.7 Evaluation of the courses comprises of two parts, one is the Continuous Internal Assessment (CIA) and the other one is the End Semester Examination (ESE). Evaluation of a mandatory course 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. ofsemesters
B. E./B. Tech. (HSC Candidates)	8	14
B. E./B. Tech. (Lateral Entry Candidates)	6	12

5.2 Each semester shall normally consists 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 least75% of the classes and the conduct of the candidate has been satisfactory during the course.

6.2 A candidate who has secured attendance between 65% and 74.4% (both included), due to medical reasons (Hospitalization / Accident / Specific Illness) shall produce medical certificate and fitness certificate by a Registered Medical Practitioner. The Head of the Department has to verify and certify the genuineness of the case before recommending to the Dean concerned. However, the candidate has to execute a one-time bond in Stamp paper duly signed by the parent and the student.

6.3 Candidates who have not produced / submitted relevant documents for condonation 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. Mentor

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 Faculty of the Department who shall function as Mentor for those students throughout their period of study. Such Mentors 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 Mentor 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. 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.

8.2. 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 all the students, the details of Regulations regarding weightage 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.

8.3 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 Executive Council, the same shall be brought to the notice of the Registrar/VC 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 one batch of students shall have a "Course Committee" comprising of all the faculty teaching the common course with one of them nominated as Course Coordinator. The nomination of the Course Coordinator shall be made by the Head of the Department/Dean depending upon whether all the faculty teaching the common course belong to a single department or several departments. The "Course committee" shall meet at least three times and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the course committee may also prepare a common question paper for the assessment test(s). The letter "**G**" is to be mentioned in the course code for the common course.

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 course will becontinuously assessed by the respective teachers as per the guidelines given below:

a. THEORY COURSES

S. No.	CATEGORY	MAXIMUM MARKS
1.	Assignment	5
2.	Seminar *	5
3.	Attendance	5
4.	Test – I	12.5
5.	Test – II	12.5
Continuous Internal Assessment: TOTAL		40

*Evaluation shall be made by a seminar committee.

PATTERN OF TEST QUESTION PAPER (Test I & II)

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part – A	Question no. 1 to 10 Two Mark Questions, covering 2.5 units of the syllabus. **(10 x 2= 20 Marks)**
Part- B	Question 11 to 15 will be of either-or type, covering 2.5 units of the syllabus. Each Question may have subdivision. **(5 x 16=80 Marks)**

b. PRACTICAL COURSES

S. No	CATEGORY	MAXIMUM MARKS
1.	Attendance	5
2.	Observation work	5
3.	Record work	5
4.	Internal Practical Assessment	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.

c. INTEGRATED THEORY AND PRACTICAL COURSES

The Continuous Internal Assessment for Integrated Theory and Practical Course is awarded for 40 Marks with mark split up similar to regular theory course. But Assignment and Seminar components are replaced by Observation and Record marks.

S.No.	CATEGORY	MAXIMUM MARKS
1.	Observation	5
2.	Record	5
3.	Attendance	5
4.	Test –I	12.5
5.	Test –II	12.5
Continuous Internal Assessment: TOTAL		40

The end semester evaluation of integrated practical component is for 50 Marks and it is scaled down to 15 Marks. Similarly, the end semester evaluation for integrated theory is 100 Marks and it is scaled down to 45 Marks. Hence, the external evaluation of integrated theory and practical elements accounts for 60 marks.

For the integrated course, the ESE mark distribution is as follows:

Theory	Practical	Total
45 marks	15 Marks	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

10.4.1 Project Work

Final year project work will be normally 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 that institution/research organization/industry.

The evaluation of Project phase I shall be through Continuous Internal assessment mode and Project phase II evaluation shall be through continuous assessments (Three reviews), evaluation of

project thesis report and viva-voce examination. Continuous assessment shall have the weightage of 40%. Evaluation of Project thesis report and viva-voce examination shall have the weightage of 60% each. Break-up of marks is as shown below:

Project Phase I Evaluation:

Continuous Internal Assessment (100 marks)		
Review I	**Review II**	**Review III**
30 marks	30 marks	40 marks

Project Phase II Evaluation:

Continuous Internal Assessment (40 marks)			**ESE (60 marks)**			
			Project Report (30 marks)		**VIVA VOCE (30 marks)**	
Review I	**Review II**	**Review III**	**Supervisors**	**External**	**Internal**	**External**
5 marks	15 marks	20 marks	15 marks	15 marks	15 marks	15 marks

10.4.2 Internships

Students must complete Internship for the duration specified in the program's corresponding curriculum. The industry in which the student intends to undergo internship should be aligned in line with the programme of study. The student must submit a report detailing observations, skills learned, usefulness, etc., together with the attendance certificate granted by the relevant industry after completing the internship or industrial training. A committee made up of three faculty members, appointed by the department head, will review this report. One faculty member will be designated as the coordinator. A student can claim one credit if he/she completes one week of training as per curriculum

Weightage for Assessment for Internship

Report	**Presentation**	**Viva-Voce**
30 Marks	40 Marks	30 Marks

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 5.2) and has registered for Examination in all courses of the semester. Registration is mandatory for

Semester Examinations as well as arrear Examinations failing which the candidate will not be permitted to attend the next semester. A candidate already appeared for a course in a semester and passed the Examination is not entitled to reappear in the same course of the semester for improvement of grade.

12. END SEMESTER EXAMINATION

ESE will be held at the end of each semester for each course, for 100 marks, it is scaled down to 60 marks.

12.1 ONLINE EXAMINATIONS

The students who are going for Project / Internship / Coursework at National level are permitted to write their CIA test through Online Mode and ESE in Offline/Online mode. When they go for an International Project / Internship / Coursework, both the CIA and ESE shall be conducted through online mode.

PATTERN OF ESE QUESTION PAPER:

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part – A	Question no. 1 to 10 Two Mark Questions, covering all the 5 units. **(10 x 2= 20 Marks)**
Part- B	Question 11 to 15 will be of either or type, covering Fiveunits of the syllabus. Each Question may have subdivision. **(5 x 16=80 Marks).**

13. PASSING REQUIREMENTS

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

13.1.1 The minimum marks to pass for the Value Added Course /Skill Development is 50 marks out of 100marks. There will 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 ESE of a particular course, it is 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 CIA of a particular course, 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). The Evaluation for the CIA reappearance is as follows:

Test 1	Test 2	Assignment	Total
15 marks	15 marks	10 marks	40 marks

13.4 CREDIT TRANSFER THROUGH ONLINE PLATFORM / INTERNATIONAL STUDIES

The MOOC coordinator shall assist the students for the online courses offered by the NPTEL/SWAYAM/Other online platforms periodically and also monitor their course.

Students are encouraged to enroll in courses offered by NPTEL/Swayam/ Swayam Plus platforms and international institutions of higher learning, either virtually or in person. The equivalent credits for these courses will be determined by a committee named Subject & Grade Equivalence Committee comprising the Dean of the Faculty as Chairman, Dean (R&D, Industrial Relations), Head of the Department (HoD) and one faculty member nominated by the Vice Chancellor as members. The committee's decision will be submitted for ratification/approval by the Board of Studies (BoS) and the Academic Council.

13.4.1 Online Courses / Self Study Courses

Students may be permitted to earn credit through online courses (which are provided with certificate) with the approval of Head of the Department and Dean. The credit may be transferred with the due approval for either programme core, elective or open elective course and complete at any time within the duration of the programme before the last semester.

13.4.2 One credit course

One credit elective course shall be offered by the department in collaboration with the industry/research organizations / higher learning institutions. A student shall be permitted to register for the one-credit courses offered by other departments with approval of both the Heads of the departments. A student shall replace a three credit programme elective / open elective course if he / she registered for three one credit courses and appear for the examination of the courses and get qualified in the examination. Three elective courses of 1 credit shall replace a 3-credit elective course as given in Table.

REPLACEMENTS OF ONE CREDIT COURSES

Number of credits earned		**Eligible to replace**	
Core electives	**Interdisciplinary electives**	**PEC**	**OEC**
3	0	1	-
2	1	1	-
1	2	-	1
0	3	-	1

Refer the Annexure I for NPTEL Course Durations and credit Equivalence. The Registration / Application form for Credit Transfer of SWAYAM-NPTEL / MOOC Courses shall be submitted as shown in Annexure I.

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+	61- 70	7	GOOD
B	56-60	6	AVERAGE
C	50-55	5	PASS
RA	Below 50	-	REAPPEARANCE
AAA	-	-	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.

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

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**.

14.3 REVALUATION

Revaluation and Re-totaling are 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.
- 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 numberof semesters (vide Clause 5.1) securing a CGPA of not less than **7.5** shall be declared to have passed the Examination in First Class with Distinction.

16.2 A regular candidate/lateral entrant is eligible to register for B.E. (Honours)/ B.Tech.(Honours), if he/she has passed all the courses in first attempt from first/third semester onwards and holds / maintains a CGPA of 7.5 in III and IV Semester. Prior approval of the concerned Head of the Department and respective Dean for the enrolment into Honours degree before the commencement of V semester is mandatory. A candidate is eligible for the award of BE(Honours) / B.Tech.(Honours), if he/she earns an additional 18 credits by undergoing additional courses over and above the courses prescribed in the respective curriculum. The opted additional courses shall be Emerging / Multidisciplinary /MOOC /NPTEL/KAHE/Industrial courses which are related to the major discipline of study. All these 18 credits need to be completed in III year and IV year only. However, if he/she fails to secure 18 additional credits but maintains a CGPA of 7.5 and above is not eligible for Honours 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.

16.4 All other candidates (not covered in Clauses 17) who qualify for the award of the degree (vide Clause 15) shall be declared to have passed the Examination in Second Class.

17. 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.

18. 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 in to 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.

19. ADVANCED LEARNERS & ON-DEMAND EXAMINATION

Students

1. Who secure 7.5 CGPA and maintain an attendance of 75% in every semester
2. Clear all the courses in their first appearance itself

are referred to as advanced learners.

When a student fails to maintain any of the above conditions at any given time, he cannot be an advanced learner further.

These advanced learners can request for an on-demand examination for the courses from IV semester onwards. These students on prior permission can appear for such examinations well in advance and complete the entire courses well before the prescribed period of study and can progress for a full time Research Project/Internship/Minor Project during the remaining prescribed period of study. The Internal and External examinations will be conducted for these courses as like the other courses. One or more faculty mentors will be allocated based on the number of students/courses enrolled for the on-demand examination.

Also, these advanced learners can also register for online courses from NPTEL/Swayam/Swayam Plus portals on prior and proper approval from the department. The credits earned from those courses will be transferred to the mark statement of the students.

20. 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 Executive council of Karpagam Academy of Higher Education.

21. KARPAGAM INNOVATION AND INCUBATION COUNCIL (KIIC)

(A Section 8 Company)

Based on the 2019 National Innovation and Startup Policy and the 2019–2023 Tamil Nadu Startup Policy, KIIC has recommended to the KAHE students who are affiliated with the KIIC that it be incorporated in the university Program Regulations 2023-24 onwards and implement from this academic year.

21.1 Norms to Student Start-Ups

a) Any (UG/PG /(Ph.D.) Research scholars, student, right from the first year of their programme is allowed to setup a startup (or) to work as part time in a startup or work as intern in a startup.

b) Any (UG/PG / (Ph.D.) Research scholars) student right from the first year of their programme is allowed to earn credit for working on Innovative prototypes/business Models/ Pre incubation (case to case basis). Start Up activities will be evaluated based on the guidelines being given by the expert committee of the KIIC.

c) Student Entrepreneurs may use the address of incubation center (KIIC) to register their venture while studying in KAHE.

d) Students engaged in startups affiliated with the KIIC or those who work for them, their attendance may be accepted by KAHE for KAHE's attendance requirements for academic courses under current regulations, up to a maximum of 30% attendance per semester, including claims for ODs and medical emergencies. Potential Students who have been incubated at KIIC may be permitted to take their university semester exams even provided by the KIIC's attendance report, with the proper authorization from the head of the institution.

(On case-to-case basis depends upon the applicability strength, societal benefits and quality of the Innovation and Subsequent engagement of the students with the/ her business)

e) Any Students Innovators/entrepreneurs are allowed to opt their startup in place of mini project/ major project, /seminar and summer training etc. (In plant training, Internship, value added Course.). The area in which the student wishes to launch a Startup may be interdisciplinary or multidisciplinary.

f) Student's startups are to be evaluated by Expert committee, formed by KIIC and KAHE.

22.2 Guide lines to award Credits/ Marks to a Student startup

S. No.	Description/Startup phases	In place of the Subject / Coursetitle	Grades/Credits /Marks
1	Idea stage/Problem Identification	Seminar/Presentation of concept	Same Marks/ Credits can be awarded thatare listed in the course title's curriculum for the respective startup phases.
2	Proof of Concept (POC) /Solutiondevelopment	In-plant training /Internship	
3	Product Development (Lab scale) /Prototype Model/ Company Registered	Mini Project/Value added Course	
4	Validation/Testing	Main Project phase I	
5	Business Model / Ready for Commercialization/ Implementation	Main Projectphase II	

Student's startup stages are divided into five phases and these startup phases can be considered equally in place of the course title as mentioned below with the same credits allotted to the course title in university curriculum.

PROGRAM OUTCOMES (POS)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering
problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.
(WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for

i) independent and life-long learning

ii) adaptability to new and emerging technologies

and iii) critical thinking in the broadest context of technological change. (WK8)

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost,reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs):

1. To prepare the graduates with strong knowledge and practical skills in their professional career.
2. To enable 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.

PROGRAMME SPECIFIC OUTCOMES(PSOs)

Engineering Graduates will be able to

1) Apply the knowledge of fundamental sciences and engineering concepts that are essential to understanding the complex biological systems
2) Apply the engineering principles to address research gaps and problems in biological sciences and technologies.

PEO – PO Mapping

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

PEO-PSO Mapping

	PSO 1	PSO 2
PEO1	✓	✓
PEO2		✓
PEO3	✓	✓

Annexure I

Credit Transfer of Online Courses (SWAYAM / NPTEL)

1. The credit transfer shall be applicable to the students of UG programme from 2022 Batch onwards

The proposed conversion from percentage marks given by (SWAYAM NPTEL) to the corresponding grades shall be as follows: -

NPTEL Course Durations and credit Equivalence		
S. NO	**Course Duration**	**Credit Equivalence for Transfer of Credits**
1	4 Weeks	1 Credit
2	8 Weeks	2 Credit
3	12 Weeks	3 Credit
4	16 Weeks	4 Credit

Type of NPTEL certificate	NPTEL Score	Equivalent Grade (KAHE)	KAHE Score
Elite + Gold	>=90	O	91-100
Elite + Silver	75-89	A+	81-90
Elite	60-74	A	71-80
Successfully completed	40-59	B+	66-70
No certificate	< 40	-	-

KARPAGAM ACADEMY OF HIGHER EDUCATION

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

Pollachi Main Road, Eachnari Post, Coimbatore – 641 021

Registration / Application form for Credit Transfer of SWAYAM-NPTEL / MOOC Courses (Academic Year 2025-2026)

1. Name of Student: _____
2. Register No : _____

3. Faculty :

	FOE		FASCM		FOP		FADP

4. Department/Centre _____
5. Name of the programme : _____ 5. Year/Semester:_____

6. Details of SWAYAM-NPTEL / MOOC Courses:

S. No.	NPTEL Course Title	Duration (In Weeks)	NPTEL Roll No	Month & Year of Exam	Registered Against			PE/OE (KAHE Course Code)
					PE	OE	EX	

PE: Professional Elective, OE: Open Elective, EX: Extra / add- on Course

Declaration by the Student:

I hereby declare that all the information given by me in this application are true and correct to the best of my knowledge and belief. I will comply with the all rules and regulations of SWAYAM NPTEL/MOOC's courses notified by the Course. I also undertake that after completion of the registered course/s, it's my duty to submit the course completion certificate to HOD otherwise my Marks / Grades shall not be incorporated in Grade Statement of the respective Semester.

Date:_____ **Signature of candidate**

For Dean / HoD Office:

As per the student application and provision in Academic Regulations, the courses of the above student is /are approved for Registration / Transfer of credits:

Sl. No	Course Title	Registered Apporved			Semester (I / II / III /IV / V / VI / VII / VIII	Course Code Assigned	Name of Course Coordinator (If applicable)
		PE	OE	EX			

NPTEL Certificate verified by**: Name:** _____ **Signature:** _____

Approved by:

Coordinator **HoD** **Dean**

For Controller of Examinations Office:

NPTEL Course Durations and credit Equivalence (As per Regulation)		
S. No	Course Duration	Credit Equivalence for Transfer of Credits
1	4 Weeks	1 Credit
2	8 Weeks	2 Credit
3	12 Weeks	3 Credit
4	16 Weeks	4 Credit

Type of NPTEL certificate	NPTEL Score	Equivalent Grade (KAHE)	KAHE Score
Elite + Gold	>=90	O	91-100
Elite +Silver	75-89	A+	81-90
Elite	60-74	A	71-80
Successfully completed	40-59	B+	66-70
No certificate	< 40	-	-

S. No	Course Code (KAHE)	Course Title (KAHE)	NPTEL Certificate /Roll No	Duration	Credits	Marks	Grade Awarded

Grades to be incorporated in the Semester:

I		II		III		IV		V		VI		VII		VIII	

For Scrutiny and Tabulation Section:

Grades Incorporated in the Semester: _____ **Grade Awarded: _____**

CONTROLLER OF EXAMINATION

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University Established Under Section 3 of UGC Act 1956)
(Accredited with A+ Grade by NAAC in the Second Cycle)
Pollachi Main Road, Eachanari Post, Coimbatore - 641 021, Tamil Nadu, India.

FACULTY OF ENGINEERING B.Tech. -BIOTECHNOLOGY

COURSE OF STUDY AND SCHEME OF EXAMINATION

2025 BATCH ONWARDS

Semester – I												
Course code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**TOTAL**	
25BTHS101G	Technical English -I	HS	5,7,8, 9,11	1	3	0	0	3	40	60	100	1
25BTHS103G	Matrices and Calculus	BS	1,2,3,1 1	1	3	1	0	4	40	60	100	4
25BTHS106G	Physics for Life Sciences	BS	1,2,3,9 ,11	1	3	0	0	3	40	60	100	6
25BTHS107G	Environmental Studies	BS	1,2,6,7 ,11	1	3	0	0	3	40	60	100	9
25BTAD141G	Python Programming	ES	1,2,3,4 ,8,9,11	1	3	0	2	4	40	60	100	12
25BTHS111G	Communication Skills Laboratory	HS	5,7,8,9 ,11	1	0	0	2	1	40	60	100	15
25BTMC151G	Women Safety and Security*	MC	-	-	1	0	0	0	100	-	100	17
25BTMC152G	தமிழர் மரபும் பண்பாடும்*	MC	-	-	1	0	0	0	100	-	100	18
				Total	**17**	**1**	**4**	**18**	**440**	**360**	**800**	

Semester -II												
Course code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**TOTAL**	
25BTHS201G	Technical English -II	HS	5,7.8,9 ,11	1	3	0	0	3	40	60	100	20
25BTHS202CG	Transforms and its Applications	BS	1,2,3,1 1	1	3	1	0	4	40	60	100	23
25BTHS206	Bio Physics	BS	1,2,3,6 ,7,9,11	1	3	0	0	3	40	60	100	25
25BTBT201	Introduction to Bio technology	ES	1,2,10	1	3	0	0	3	40	60	100	27
25BTHS245G	Engineering Chemistry	BS	1,2,3,6,7 8,11	1,2	3	0	2	4	40	60	100	29
25BEEE242G	Basic Electrical and Electronics Engineering	ES	1,2,4,9	1	3	0	1	4	40	60	100	32
25BTHS213G	Physical Sciences Laboratory	HS	1,2,3,8, 9, 11	1,2	0	0	2	1	40	60	100	35
25BTHS246G	Yoga	SD	-	-	1	0	2	2	100	-	100	36
25BTMC251G	Vedic Mathematics	MC	-	-	1	0	0	0	100	-	100	38
	Total				**20**	**1**	**7**	**24**	**480**	**420**	**900**	

SEMESTER III												
Course Code	Course Title	Category	Objectives & Outcomes		Instruction Hours/week			Credits	Maximum Marks			Page No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
25BTBT301	Principles of Chemical Engineering	ES	1, 2, 6,9	1, 2	3	1	0	4	40	60	100	39
25BTBT302	Molecular Biology	PC	1, 2, 3, 6,9,11	1, 2	3	0	0	3	40	60	100	41
25BTBT341	Biochemistry	PC	1, 2,3, 6,8,9,11	1,2	3	0	2	4	40	60	100	44
25BTBT342	Microbiology	PC	1, 2, 3, 6, 9, 11	1,2	3	0	2	4	40	60	100	47
25BTBT343	Cell Biology	PC	1, 2, 3, 6,8,9, 11	1	3	0	2	4	40	60	100	50
25BTMC351G	Aptitude and Reasoning	MC	1,2,3,11	-	1	0	0	0	100	-	100	53
25BTBT391	Internship- I /Field Project	PW	-	-	0	0	2	1	100	-	100	55
25BTBT311	Skill Development-I	SD	1, 2,3, 4,5,7,8,9,11	1,2	0	0	2	1	100	-	100	56
TOTAL					16	1	10	21	500	300	800	

SEMESTER IV												
Course Code	Course Title	Category	Objectives & Outcomes		Instruction hours/week			Credits	Maximum Marks			
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
25BTHS401	Biostatistics	BS	1, 2, 3, 11	1	3	1	0	4	40	60	100	57
25BTBT402	Chemical and Biochemical Thermodynamics	ES	1, 2,3,9	1	3	1	0	4	40	60	100	60
25BTBT403	Industrial Biotechnology	PC	1, 2, 8,9, 11	1,2	3	0	0	3	40	60	100	62
25BTBT404	Good Manufacturing and Laboratory Practice	PC	1, 2, 3, 4,6, 9, 11	1, 2	3	0	0	3	40	60	100	64
25BTBT441	Bioanalytical Techniques	PC	1, 2, 3, 8,9 11	2	3	0	2	4	40	60	100	66
25BTBT442	Genetic Engineering	PC	1, 2, 3, 6, 8,9,11	1, 2	3	0	2	4	40	60	100	69
25BTMC451G	Foundation of Entrepreneurship	MC	7,8,9,11	-	1	0	0	0	100	-	100	71
25BTMC452G	Essence of Traditional Indian Knowledge and Heritage	MC	-	-	1	0	0	0	100	-	100	73
25BTBT411	Skill Development-II	SD	1, 2,3, 9, 10, 12	2	0	0	2	1	100	-	100	74
	TOTAL				20	2	6	23	540	360	900	

SEMESTER V												
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			**Page No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
25BTBT501	Fundamentals of Heat and Mass Transfer	PC	1, 2, 3,9	1,2	3	1	0	4	40	60	100	75
25BTBT541	Immunology and Immunotechnology	PC	1, 2, 3, 8,9, 11	2	3	0	2	4	40	60	100	78
25BTBT542	Bioinformatics	PC	1, 2, 3, 5, 6,7,9, 11	2	3	0	2	4	40	60	100	81
25BTBT5E_	Professional Elective-I	PE	-	-	3	0	0	3	40	60	100	-
25BTBT5E_	Professional Elective -II	PE	-	-	3	0	0	3	40	60	100	-
25BTMC551G	Cybersecurity	MC	1,2,3,6	-	2	0	0	-	100	-	100	84
25BTBT543	Community Engagement and Social Responsibility	ES	6,7,8,9,10,11	-	1	0	2	2	100	-	100	86
25BTBT591	Internship-II /Field Project	PW	1,2,6,7,8,9,10,12	2	0	0	2	1	100	-	100	88
TOTAL					**18**	**1**	**8**	**21**	**500**	**300**	**800**	

SEMESTER VI												
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			
			PO	**PSO**	**L**	**T**	**P**		**CI A**	**ESE**	**Total**	
									40	**60**	**100**	
25BTBT601	PharmaceuticalTechnology	PC	1, 2,3,6,7,8,9, 11	2	3	0	0	3	40	60	100	89
25BTBT641	Bioprocess Engineering	PC	1, 2, 3, 9, 10	1, 2	3	1	2	4	40	60	100	91
25BTBT642	Animal and Plant Biotechnology	PC	1, 2, 3,5,6,7,8 9, 11	1, 2	3	0	2	4	40	60	100	94
25BTBT643	Enzymology and Enzyme Technology	PC	1, 2, 3,8, 9	1, 2	3	0	2	4	40	60	100	97
25BTBT6E_	Professional Elective-III	PE	-	-	3	0	0	3	40	60	100	-
25BTHS601G	Universal Human Values	HS	8,9,10,12	-	2	0	0	2	40	60	100	100
25BTBT691	Mini project	PW			0	0	2	2	40	60	100	102
TOTAL					**17**	**1**	**8**	**22**	**280**	**420**	**700**	

	SEMESTER VII											Page No.
Course Code	Course Title	Category	Objectives & Outcomes		Instruction hours/week			Credits	Maximum Marks			
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
25BTBT701	Genomics and Proteomics	PC	1, 2,3,6,7, 9, 11	2	3	0	0	3	40	60	100	103
25BTBT702	Biosafety, Bioethics and IPR	PC	1, 2, 3,6,7,9, 11	1	3	0	0	3	40	60	100	105
25BTBT741	Bioseparation Engineering	PC	1, 2, 3, 5,8, 9, 11	2	3	0	2	4	40	60	100	108
25BTBT7E_	Professional Elective-IV	PE	-	-	3	0	0	3	40	60	100	
25BTBT7E_	Professional Elective -V	PE	-	-	3	0	0	3	40	60	100	
25BTBT791	Project Work Phase – I/Field Project / Internship-III	PW	1,2,6,7,8,9, 1,0,11,12	2	0	0	8	4	40	60	100	111
TOTAL					**15**	**0**	**10**	**20**	**240**	**360**	**600**	
SEMESTER VIII												
Course Code	**Course Title**	**Category**	**Objectives & Outcomes**		**Instruction hours/week**			**Credits**	**Maximum Marks**			
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
25BTBT891	Project Work Phase - II	PW	1,2,6,7,8,9 ,1,0,11,12	2	0	0	16	8	120	180	300	112
TOTAL					**0**	**0**	**16**	**8**	**120**	**180**	**300**	

Open Elective*

Course Details	Platform	Category		Credits	Total
Open Elective -I	NPTEL SWAYAM	OE		3	100
Open Elective -II	NPTEL SWAYAM	OE		3	100
TOTAL				6	200

Total Credits	**163**
Total Marks	**5,800**

List of Professional Electives

Vertical domain	Medical Biotechnology	Bioprocess technology	Computational biology	Applied Biotechnology
Professional elective -I	Cancer Biology	Fermentation Technology	Fundamentals of Algorithms for Bioinformatics	Environmental Biotechnology
Professional elective -II	Stem Cell Technology	Bioprocess Instrumentation and Control	Metabolomics and Metabolic Engineering	Molecular Techniques in Biotechnology
Professional elective -III	Tissue Engineering	Bioprocess Economics and Plant Design	Molecular Modelling and Drug Design	Biomaterials
Professional elective -IV	Molecular Pathogenesis and Diagnostics	Food Process Technology	AI in Biotechnology	Biosensors
Professional elective -V	Clinical Trial and Management	Biomass Conversion and Biorefinery	Systems Biology	Fundamentals of Nanotechnology

LIST OF ELECTIVES

Professional Elective - I

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			Page No.
		PO	PSO	L	T	P		CIA	ESE	Total	
								40	60	100	
Professional Elective - I **SEMESTER – V**											
25BTBT5E01	Cancer Biology	1, 2, 5,9,11	1,2	3	0	0	3	40	60	100	113
25BTBT5E02	Fermentation Technology	1, 2,3,5,9,11	1,2	3	0	0	3	40	60	100	115
25BTBT5E03	Fundamentals of Algorithms for Bioinformatics	1, 2, 3, 6, 9, 11	1,2	3	0	0	3	40	60	100	117
25BTBT5E04	Environmental Biotechnology	1, 2, 3, 5, 6, 11	1	3	0	0	3	40	60	100	119
Professional Elective – II											
Course code	**Name of the course**	**Objectives and outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			
		PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
								40	**60**	**100**	
25BTBT5E05	Stem Cell Technology	1, 2, 3, 4, 5, 11	2	3	0	0	3	40	60	100	121
25BTBT5E06	Bioprocess Instrumentation and Control	1, 2, 3, 5, 9 11	1, 2	3	0	0	3	40	60	100	123
25BTBT5E07	Metabolomics and Metabolic Engineering	1, 2, 3, 4,5, 9, 11	2	3	0	0	3	40	60	100	125
25BTBT5E08	Molecular Techniques in Biotechnology	1, 2, 3, 5,6, 7,9, 11	1,2	3	0	0	3	40	60	100	127
SEMESTER – VI **Professional Elective – III**											
25BTBT6E01	Tissue Engineering	1, 2, 3, 5, 9, 11	1, 2	3	0	0	3	40	60	100	129
25BTBT6E02	Bioprocess Economics and Plant Design	1, 2, 3, 5, 6,9,7, 11	1,2	3	0	0	3	40	60	100	131
25BTBT6E03	Molecular Modelling and Drug Design	1, 2, 3,5,6,9	1,2	3	0	0	3	40	60	100	133
25BTBT6E04	Biomaterials	1, 2,3, 4, 5, 9, 11	2	3	0	0	3	40	60	100	135

SEMESTER -VII

Professional Elective – IV

Course code	Name of the course	Objectives and Outcomes		Instruction hours / week			Credits	Maximum Marks			Page No.
		PO	PSO	L	T	P		CIA	ESE	Total	
								40	60	100	
25BTBT7E01	Molecular Pathogenesis and Diagnostics	1, 2, 3,6,9,11	1,2	3	0	0	3	40	60	100	137
25BTBT7E02	Food Process Biotechnology	1, 2, 3, 6, 8,9,11	1,2	3	0	0	3	40	60	100	139
25BTBT7E03	AI in Biotechnology	1, 2, 3, 5, 6,7, 9, 11	1,2	3	0	0	3	40	60	100	141
25BTBT7E04	Biosensors	1, 2, 3,5,6,9	1,2	3	0	0	3	40	60	100	144

SEMESTER – VII

Professional Elective – V

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credits	Maximum Marks			
		PO	PSO	L	T	P		CIA	ESE	Total	
								40	60	100	
25BTBT7E05	Clinical trial and Management	1, 2, 3,7,9	1, 2	3	0	0	3	40	60	100	146
25BTBT7E06	Biomass Conversion and Biorefinery	1, 2, 3,5, 6,7,9,11	1,2	3	0	0	3	40	60	100	148
25BTBT7E07	Systems Biology	1, 2, 3, 4, 6,9,11	1,2	3	0	0	3	40	60	100	150
25BTBT7E08	Fundamentals of Nanotechnology	1, 2, 3,5,9	1,2	3	0	0	3	40	60	100	152

Open Electives*

The **Open Elective** Courses being offered in **NPTEL SWAYAM** platform (which are totally beyond the scope of the programme under consideration) can be chosen by the students and completed at any time (I semester to VII semeseter) within the duration of the Programme but before the last semester. This is a mandatory requirement for completion of the programme..

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)	2	2			1	1			10	6.6
2.	Basic Sciences (BS)	3	3		1					25	15.1
3.	Engineering Sciences-Common (ES)	1	2	1	1	1				21	12.7
4.	Professional Subjects-Professional Core (PC)			6	5	3	4	3		66	40
5.	Professional Electives (PE)					2	1	2		15	9.1
6.	Open Electives (OE)	2								6	3.6
7.	Mandatory Courses (MC)	2	1	1	2	1				0	0
8.	Project Work, Seminar, Internship (PW)					1	1	1	1	16	9.6
9.	Skill development (SD)		1	**1**	1					4	2.4
Total Credits										163	100

25BTHS101G **SEMESTER-I**

TECHNICAL ENGLISH – I **3H-3C**

(Theory)

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:

- To acquire the fundamental reading and writing skills, proper grammar usage, listening, and speaking
- To understand and improve skills in listening and speaking, in expressing oneself formally in writing, and in deducing meaning from what one reads
- To apply one's receptive (reading and listening) and productive (writing and speaking) language skills

COURSE OUTCOMES

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

- Replicate grammar usage in reading, speaking, and writing skills. **P2**
- Describe precise transitions while reading, writing, and speaking to enhance communication coherence and clarity. **A2**
- Report the interpretation of linguistic parameters in day-to-day reading, listening, and speaking interactions. **A2**
- Point out errors to restructure paragraphs, compose, compile, and synthesize documents for presentations. **P2**
- Demonstrate proficiency in reading, writing, and critical listening and the ability to interpret and articulate complex ideas persuasively in written and oral forms. **A3**

***P- Psychomotor skills, A-Affective Domain Skills**

UNIT I 9

Grammar : Parts of Speech – Gerunds and infinitives – Sentence Pattern
Reading : Reading comprehension: (vocabulary, referents, and inferences/conclusions)
Writing : Business letter – e-mail Writing
Listening : Listening to different short recordings – Listen to a longer recording
Speaking : Introduction to Phonetics, Diphthongs

UNIT II 9

Grammar : Tenses: Simple Tenses – Concord – Types of Sentences
Reading : Identifying main and secondary information
Writing : Check lists – Building Itineraries
Listening : Listening Comprehension – Job Description
Speaking : Pronunciation – Describing people, places, jobs and things – Asking and answering question.

UNIT III **9**

Grammar : Tenses: Progressive Tenses – Direct and Indirect speech – Concord
Reading : Identifying, organizing, comparing and interpreting information
Writing : Writing Articles – Paragraph Writing
Listening : Telephonic conversation
Speaking : Stress, Intonation – Self Introduction

UNIT IV **9**

Grammar : Tenses: Perfect Tenses – Active and Passive voice
Reading : Reading Comprehension (Reconstruction, Rewording)
Writing : Memo – Notice – Agenda
Listening : Critical Listening
Speaking : Oral presentation

UNIT V **9**

Grammar : Tenses: Perfect Continuous Tenses – Reported Speech
Reading : Reading Comprehension (Cause and Effect identification)
Writing : Creative writing – Copy Writing
Listening : Listening and Interpretation of ideas
Speaking : Group Discussion

TOTAL: 45

TEXT BOOKS:

1. Richards J C, Hull J, et al., "Interchange 2 Student's Book", 5th Edition, Cambridge University Press, 2022.
2. Kumar Sanjay and Pushp Latha, "English Language and Communication Skills for Engineers", 1st Edition, Oxford University Press, 2018.

REFERENCE BOOKS:

1. Swan Michael and Walter Catherine, "Oxford English Grammar Course", 1st Edition, Oxford University Press, 2019.
2. Sudharshana N P and Savitha C, "English for Engineers", 1st Edition, Cambridge University Press, 2018.
3. Brook-Hart G, "Business Benchmark: Upper intermediate: Business Vantage: Student's Book", 2nd Edition,
Cambridge University Press, 2021.

WEB URLs:

1. www.onestopenglish.com
2. www.britishcouncil.org
3. www.cambridgeenglish.org/learning-english

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C101.1	-	-	-	-	2	-	2	2	3	-	2	1	-
C101.2	-	-	-	-	2	-	2	2	3	-	2	1	-
C101.3	-	-	-	-	2	-	2	2	3	-	2	1	-
C101.4	-	-	-	-	2	-	2	2	3	-	2	1	-
C101.5	-	-	-	-	2	-	2	2	2	-	2	1	-
C101	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**2**	**2.8**	**-**	**2**	**1**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS103G **SEMESTER-I**

MATRICES AND CALCULUS **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 provide sufficient knowledge in calculus and matrix algebra in the respective fields
- To find an extremum value for a function of several variables subject to a given constraint.
- To provide knowledge in evaluating double and triple integrals
- To apply mathematical tools to solve second and higher order ODE and PDE with constant coefficients.

COURSE OUTCOMES:

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

- Make use of orthogonal transformation to reduce the quadratic form to canonical form**(K3)**
- Utilize differential calculus of multivariable to optimization problems**(K3)**
- Apply multiple integrals for finding area and volume **(K3)**
- Solve the n^{th} order Ordinary Differential Equations (ODE) and Homogeneous equation of Euler's type **(K3)**
- Solve the n^{th} order Partial Differential Equations **(K3)**

UNIT – I MATRICES **12**

Eigenvalues and Eigenvectors of a real matrix– Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT – II DIFFERENTIAL CALCULUS OF MULTIVARIABLE FUNCTIONS **12**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions –Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT – III MULTIPLE INTEGRALS **12**

Definite and Indefinite Integrals – Double integrals – Change of order of integration – Double integrals in polar coordinates – Area using double integrals – Evaluation of Triple Integrals- Volume of Solids.

UNIT – IV ORDINARY DIFFERENTIAL EQUATIONS 12

Linear differential equation of second and higher order with constant coefficients –Cauchy-Euler linear differential equation – Method of Variation of parameters.

UNIT – V PARTIAL DIFFERENTIAL EQUATIONS 12

Homogeneous linear partial differential equations of second and higher order with constant coefficients – Classification of partial differential equations.

TOTAL HOURS: 45+15

TEXT BOOKS:

1. Hass, Heil and Weir, "Thomas Calculus", 14th Edition, Pearson Education, 2018.
2. Dennis G. Zill, "Advanced Engineering Mathematics", 7th Edition, Jones & Bartlett Learning, 2022.

REFERENCE BOOKS:

1. Rogawski, Adams and Franzosa, "Calculus", 4th Edition, W. H. Freeman, 2019.
2. Boyce, DiPrima and Meade, "Elementary Differential Equations and Boundary Value Problems", 12th Edition, John Wiley & Sons, 2021.
3. Alexander Graham, "Matrix Theory and Applications for Scientists and Engineers", 1st Edition, Dover Publications Inc.,2018.
4. Grewal, B. S.,Higher engineering mathematics. 2018, Khanna Publishers, New Delhi.

WEBSITES:

1. www.classcentral.com/course/matrix-methods-13644
2. www.classcentral.com/course/brilliant-calculus-ii-59290
3. www.classcentral.com/course/differential-equations-engineers-13258

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C102.1	3	2	1	-	-	-	-	-	-	-	1	2	-
C102.2	3	2	1	-	-	-	-	-	-	-	1	2	-
C102.3	3	2	1	-	-	-	-	-	-	-	1	2	-
C102.4	3	2	1	-	-	-	-	-	-	-	1	2	-
C102.5	3	2	1	-	-	-	-	-	-	-	1	2	-
C102	3	2	1	-	-	-	-	-	-	-	1	2	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS106G **SEMESTER-I**

PHYSICS FOR LIFE SCIENCES **3H-3C**

(Theory)

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

End Semester Exam: 3 Hours

(i)Theory

COURSE OBJECTIVES

The goal of this course is to

- Introduce the concepts of quantum mechanics and crystal for diverse applications.
- Understand the basics of laser and optical fiber with appropriate applications.
- Inculcate the basics of properties of matter and its applications.

COURSE OUTCOMES

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

- Outline the basics of crystals, structures and its defects **(K2)**
- Examine the performance of light and laser **(K3)**
- Identify the numerical aperture and acceptance angle of an optical fibre (**K3)**
- Relate the quantum concepts in electron microscope **(K2)**
- Apply the elastic properties of the materials to understand the modulus of the material **(K3)**

UNIT I – CRYSTAL PHYSICS **9**

Classification of solids: Crystalline and amorphous solids – crystal structure - unit cell, primitive cell – seven crystal systems, Bravais lattices, Miller indices – inter-planar distances (Qualitative) - Coordination number and atomic packing factor for Simple Cubic, Body Centered Cubic, Face Centered Cubic– Defects in crystal: Point & Line defect.

UNIT II – LASERS **9**

LASER: Introduction - characteristics –Absorption- Spontaneous emission- stimulated emission- Einstein’s co-efficients derivation- principle of laser action- population inversion-pumping methods -Types of lasers - Nd: YAG, Semiconductor Laser (Homo Junction Laser)- Applications of LASER in industry and medicine.

UNIT III - FIBRE OPTICS **9**

Fiber optics – principle and propagation of light in optical fibers – numerical aperture and acceptance angle – types of optical fibers (Material, refractive index and mode) – types of loses in optical fibers -fiber optical communication system (block diagram).

UNIT IV – QUANTUM PHYSICS **9**

Black body radiation - Energy Distribution laws (Qualitative): Stefan Boltzmann's law, Wein's Displacement law - Rayleigh Jeans Law. Photo electric effect (Qualitative) – Compton effect (Qualitative) – De Broglie hypothesis - uncertainty principle – physical significance of wave function - Schrödinger's Time dependent wave equation - Schrödinger's Time independent wave equation – Particle in one dimensional box- Scanning Electron Microscope and Transmission Electron Microscope.

UNIT V – PROPERTIES OF MATTER **9**

Elasticity – stress – strain – Hooke's law- classification of elastic modulus -Poisson's ratio - Stress-Strain diagram and its uses - factors affecting elastic modulus and tensile strength - Moment, Couple and Torque– Twisting couple on a wire – bending moment – cantilever-young's modulus uniform bending – I- shaped girders and its applications.

Total: 45

TEXT BOOKS:

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. Charles Kittel, Kittel's Introduction to Solid State Physics, Wiley India Edition, 2019.
5. P.M. Mathews, K.Venkatesan, A text book of Quantum Mechanics, 2/e, Mc Graw Hill Education, 2017.
6. Laser Fundamentals, William T Silfvast, Cambridge Univ Press. 2012.
7. Fiber Optics and Optoelectronics, R P Khare, Oxford, 2012.
8. D.S. Mathur, Elements of properties of matter, S.Chand, 2010.

REFERENCES:

1. Halliday. D. Resnick R. & Walker. J, Principles of Physics, Wiley, 2015.
2. Daniel V. Schroeder, An Introduction to Thermal Physics, Pearson, 2014.

WEBLINKS:

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

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C103.1	2	1	-	-	-	-1	-	1		-	1	1	-
C103.2	3	2	1	-	-	-1	-	1		-	1	2	-
C103.3	3	2	1	-	-	-1	-	1		-	1	1	-
C103.4	2	1	-	-	-	-1	-	1		-	1	1	-
C103.5	3	2	1	-	-	-1	-	1		-	1	1	-
C103	2.6	1.6	1.0	-	-	-1.0	-	1.0		-	1.0	1.2	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS107G **SEMESTER-I**

ENVIRONMENTAL STUDIES **3H-3C**

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

End Semester Exam: 3 Hours

(i) Theory

COURSE OBJECTIVES:

The goal of this course is for students to:

- Create a basic understanding about ecosystem and natural resources.
- Acquire knowledge on biodiversity conservation and pollution eradication.
- Introduce the roles and responsibilities about social issue and improvement in the interconnected world

COURSE OUTCOMES:

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

- Outline the ecological processes supporting the life system **(K2)**
- Infer the importance of environment and impact of human activities on natural resources **(K2)**
- Demonstrate the levels and values of biodiversity and its conservation **(K2)**
- Summarize the problems of environmental pollution and its control measures **(K2)**
- Interpret the remediation methods for social issues and degraded environment **(K2)**

UNIT I – ENVIRONMENT & ECOSYSTEMS **9**

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

UNIT II - NATURAL RESOURCES **9**

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 9

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 9

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, E-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 9

Concept of sustainability, Goals and sustainable development-circular economy- Water Conservation-Rainwater harvesting, watershed management. Climate change, global warming, ozone layer depletion, acid rain and its impacts on human communities and agriculture. Disaster management (floods, earthquake, cyclones and landslides). Environmental Movements (Chipko Silent valley, Bishnois of Rajasthan). Environmental ethics: Human population growth- Impacts on environment, human health and Welfare-Variation among nations.

Total Hours: 45

TEXT BOOKS:

1. Anubha Kaushik., and Kaushik, C.P. 7Th Edition, 2021. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, New Delhi.
2. Prabhakar S Mithra, “Methodologies for environmental studies”, 1st Edition, Academic Aspirations, 2021.
3. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.
4. Erach Bharucha, “A Textbook of Environmental Studies for UG Courses” 3rd Edition, University Press India ltd, 2021.
5. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, New Delhi.

REFERENCE BOOKS:

1. G.Tyler Miller and Scott Spoolman, “Living in the Environment”, 20th Edition, Cengage Learning, 2021.
2. Linda D Williams, “Environmental Science” 1st Edition, Tata McGraw Hill, 2017.
3. Sing, J.S., Sing. S.P. and Gupta, S.R. 2022. Ecology, Environmental Science and

Conservation. S. Chand & Publishing Company, New Delhi.
4. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S. Chand& Company Pvt. Ltd., New Delhi.
5. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.

WEB REFERENCES:

1. https://www.insightsonindia.com/2013/09/06/environment-biodiversity
2. https://www.nptelvideos.in/2012/11/energy-resources-and-technology.html
3. https://www.msubbu.in/ln/environment/

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C104.1	2	1	-	-	-	3	3	-	-	-	2	2	-
C104.2	2	1	-	-	-	3	3	-	-	-	2	2	-
C104.3	2	1	-	-	-	3	3	-	-	-	2	2	-
C104.4	2	1	-	-	-	3	3	-	-	-	2	2	-
C104.5	2	1	-	-	-	3	3	-	-	-	2	2	-
C104	**2**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

SEMESTER-I

25BTAD141G PYTHON PROGRAMMING 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

PRE-REQUISITES: Nil

i) Theory

COURSE OBJECTIVES:

The goal of this course is for students to

- Learn about basic python syntax and semantics like control structures and functions.
- Develop logical thinking abilities and to propose novel solutions for real world problems through object-oriented programming concepts.
- Model the empirical knowledge on applying programming on business domains.

COURSE OUTCOMES:

Upon completion of this course students will be able to

1. Interpret the basic representation of the data structures and sequential programming (K2)
2. Solve the problems using list, dictionaries, tuples, and sets core data structures (K3)
3. Build applications using functions, modules and packages (K3)
4. Examine the error-handling constructs for unanticipated states/inputs. (K4)
5. Analyze the applications on real-world problems using object-oriented concepts (K4)

UNIT I INTRODUCTION TO PYTHON BASICS 9

Fundamentals of Computing - Building blocks of algorithms - Introduction to Programming - Elements of python - Variables - Data Types - Operators - Operator Precedence - Expressions - Conditional statement - Loops - Break, Continue and Pass - Illustrative problems: square root, GCD, LCM, Sum an array of numbers, Linear search, Binary search.

UNIT II PYTHON DATA STRUCTURES 9

Mutable vs immutable data types - String - Indexing and slicing - String functions - List - List slices - List methods - Iterate over a list - Mutability - Aliasing - Cloning lists - List parameters - List comprehension- Tuples- Tuple assignment - Tuple as return value - Dictionaries - Operations and methods - Set - Set operations - Illustrative programs: Simple sorting, pattern matching, Fibonacci, Factorial, Prime numbers.

UNIT III FUNCTIONS, MODULES AND PACKAGES 9

Built-in functions - User defined functions - Creating function - Calling functions - Types of function arguments - Recursion and lambda or anonymous functions - Packages: Defining - Creating and accessing a package - Python libraries NumPy, pandas, Matplotlib - Flask/Django

UNIT IV FILE HANDLING, CLASS AND OBJECT 9

Introduction to files - File path - Opening and closing files - Reading and writing files - File position - Decorators - Introduction to elements of OOP - Class - Object - Inheritance - Data abstraction - Encapsulation - Polymorphism - UML class diagram - Access specifiers - Creating classes - Creating object - Accessing members - init() method - Instance, static and class methods - Importance of self - Implementing encapsulation. Illustrative programs: File operations on TEXT and CSV, Scientific calculator using class and objects.

UNIT V ERROR HANDLING, TESTING 9

Exception handling with try, except, finally - Exception handling: Errors vs exceptions - Handling exceptions - Raising exception - Creating user defined exception - Debugging techniques- Unit testing with unit test - Writing test cases - web scraping - Data analysis project - Automation script

TOTAL: 45

ii) Laboratory

LIST OF EXPERIMENTS:

1. Write conditional and looping statements in Python.
2. Create and manipulate strings using indexing, slicing,and various string functions.
3. Create and manipulate lists using operations, slices, methods, list comprehension, and looping.
4. Create and manipulate tuples, dictionaries, and sets, and understand the differences between mutable and immutable types.
5. Implement user-defined functions and understand the different types of function arguments, such as positional, keyword, and default arguments.
6. Implement inheritance and understand the different types of inheritance.
7. Implement polymorphism through method overloading, overriding, and operator overloading.

TOTAL: 30

TEXT BOOKS:

1. Allen B Downey,Jeffrey Elkne, Chris Meyers ,"How to Think Like a Computer Scientist: Learning with Python 3 Documentation",3rd Edition, Green Tea Press,2020.
2. Steven F. Lott ,Dusty Phillips,"Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries"4th Edition , Packt Publishing Limited ,2021.

REFERENCE BOOKS:

1. R. Nageswara Rao," Core Python Programming", 3rd Edition, Dream tech Press,2022.
2. Mark Lutz , "Learning Python" ,5th Edition , O'Reilly Publication , 2018.
3. Mark and Summerfield , "Programming in Python 3",2ndEdition ,Dorling Kindersley India Pvt. Ltd, 2019.

WEBSITES:

1. https://realpython.com/
2. www.programiz.com/python-programming
3. https://www.geeksforgeeks.org/python-programming-language/
4. https://www.pythonspot.com/

CO, PO, PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	3	1	-
CO2	3	2	1	-	-	-	-	2	2	-	3	1	-
CO3	3	2	1	-	-	-	-	2	2	-	3	1	-
CO4	3	3	2	1	-	-	-	2	2	-	3	1	-
CO5	3	3	2	1	-	-	-	2	2	-	3	1	-
Avg	**2.8**	**2.4**	**1.4**	**1**	-	-	-	**2**	**2**	-	3	1	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS111G **SEMESTER-I**

COMMUNICATION SKILLS LABORATORY **2H-1C**

(Laboratory)

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is;

- To acquire different listening techniques for understanding different kinds of audio content, including lectures, conversations, videos, etc. and to effectively communicate their ideas using a variety of media
- To understand the "English language skills" by engaging them in listening and reading activities that are relevant to authentic contexts and to help learners use language effectively in academic /work contexts
- To apply the communicative competence of learners in listening, speaking, reading and writing

COURSE OUTCOMES:

Learners will be able to,

- Organize the context, topic, and pieces of specific information of English through all four skills. **P1**
- Identify the purpose and clarity of facts and reflect their thoughts, opinions, and knowledge through all the language skills. **A1**
- Put together skimming, scanning, and listening techniques effectively to acquire the gist from the context. **P2**
- Demonstrate in communication more effectively with their peers, instructors, and colleagues. **A2**
- Master public speaking techniques, business writing, and listening with professional speaking techniques. **P3**

***P-Psychomotor Skills, A- Affective Domain Skills**

LIST OF EXPERIMENTS:

S.No.	SKILLS	TOPICS
1	Listening	Dialogues from TV/radio/Ted talk/Podcast
2	Listening	Listening for gist
3	Reading	Reading for detail, global understanding
4	Speaking	Presentations and interactive communication – Pair presentations
5	Listening	Listen and respond appropriately

6	Reading	Reading different genres
7	Writing	Documentary and Movie review
8	Writing	Informational or Analytical Reports
9	Speaking	Mock Interview
10	Speaking	Group Discussion

TOTAL: 30

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C106.1	-	-	-	-	2	-	2	3	3	-	2	1	-
C106.2	-	-	-	-	2	-	2	3	3	-	2	1	-
C106.3	-	-	-	-	1	-	2	3	3	-	2	1	-
C106.4	-	-	-	-	1	-	1	2	3	-	2	1	-
C106.5	-	-	-	-	1	-	1	2	3	-	2	1	-
C106	**-**	**-**	**-**	**-**	1.4	**-**	1.6	2.6	3	**-**	**2**	**1**	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTMC151G **SEMESTER-I**

WOMEN SAFETY AND SECURITY **1H-0C**

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to

- Make aware about the practical issues concerning gender and politics.
- Acquaint knowledge about the national policies and programmes and the gendered structures of governance and polity
- Observe the liability of women and women's work in the context of globalization.

COURSE OUTCOMES:

Upon completion of this course the students will be able to

- Infer into the basic concepts related to sex, gender, femininity etc.
- Demonstrate the rationale for women's studies
- Compare Gender Equality Issues and Movements in Women's Studies
- Summarize the Social construction of Gender, Gender Roles and Gender stereotyping.
- Illustrate Social Structures, Changing Status of Women in India.

UNIT I: FUNDAMENTAL CONCEPTS OF WOMEN'S STUDIES **5**

Definition- Objectives of Women's Studies; Importance of Women's Studies; Women's Studies as an Academic Discipline; Role of UGC Centre for Women's Studies

UNIT II: SOCIAL EMPOWERMENT **5**

Women in Higher Education; Gender issues in Health, Environment, Family welfare Measures, Indecent representation of Women in media; Women in Difficult circumstances; Constitutional.

UNIT III: POLITICAL EMPOWERMENT **5**

Women leaders in politics- Women in Local Governance- Barriers- Reservation policies- Women's Political Rights, Property Rights - Violence against Women - Women's work

TEXT BOOKS:

1. Amy S. Wharton. (2005). "The Sociology of Gender: An Introduction to Theory and Research". (Key Themes in Sociology) Blackwell Publishing, UK, Indian Reprint, Kilaso Books, New Delhi.
2. Devaki Jain and Pam Rajput (Ed). (2003). "Narratives from the Women's Studies Family: Recreating Knowledge, Sage, and New Delhi.
3. Jasbir Jain (Ed). (2005). "Women in Patriarchy: Cross Cultural". Rawat Publication Jaipur.

25BTMC152G **பருவம் -I**

தமிழர் மரபும் பண்பாடும் 1H-0C

கற்பித்தல் நேரம்/வாரம்: L:1 T:0 P:0

மதிப்பெண்: இடைத்தேர்வு: 100 **மொத்தம்:**100

பாடத்திட்டப் பொதுநோக்கம்:

1. இந்தியக்குடியுரிமைப்பணி முதலான போட்டித்தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
2. கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத்தேடலுக்குரிய ஆய்வுமனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
3. தமிழின்வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்'; 'இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச்சிந்தனை மேம்பாடு.
4. வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
5. சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப்பேணுவதற்குக்கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மைவளர்ச்சி. மொழிபெயர்ப்புத்துறை சார்ந்த வேலைவாய்புத்திறன் பெற்றிருத்தல்.

பாடத்திட்ட பயன் விளைவு:

1. வரலாற்றிற்கு முற்பட்ட தமிழகத்தை மாணவர்களுக்கு அறிமுகப்படுத்துதல்
2. பழந்தமிழர் பண்பாடு சார்ந்த வாழ்க்கை முறையை மாணவர்கள் அறிய ஊக்குவித்தல்
3. தமிழ்மொழியின் பழைமையும், திராவிடமொழிகளில் தமிழ்மொழியின் தனிச்சிறப்பையும் மாணவர்களுக்கு அறிமுகப்படுத்துதல்.
4. தமிழர்களின் வாழ்வியல், தமிழர்கலைகள், ஆற்றங்கரைப்பண்பாடுகள் குறித்து மாணவர்கள் அறியச்செய்தல்.
5. இந்தியக்குடியுரிமைப்பணி முதலான போட்டித்தேர்வுகளில் விருப்பப்பாடமாக இடம்பெறுகின்ற தமிழ்நாகரிகமும் பண்பாடும் குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்

அலகு:1 தமிழர்மரபு

மரபு - விளக்கம் - சங்ககால தமிழர் மரபு - திணைப்பகுப்பும் தமிழர் மரபும் -உலகப் பொதுமை - அகத்திணை மரபு - புறத்திணைமரபு- இடைக்காலத்தமிழர்மரபு - பிற்காலமரபும்மாற்றமும் - தற்காலதமிழர்மரபு - வளர்ச்சி.

அலகு: 2 தமிழர்பண்பாடு

பண்பாடு - விளக்கம் - பழந்தமிழர்பண்பாடு - இயற்கைசார்ந்தவாழ்வியல் - தமிழர்சமயம் - அரசியல்நிலை-சமூகப்பழக்கவழக்கங்கள் - நம்பிக்கைகள் - வாழ்வியல்அறங்கள் - வணிகம்போன்றவை.

அலகு:3 தமிழர் கலைகள்

தமிழகத்தில்கலைகளின்வளர்ச்சி - சிற்பக்கலைவளர்ச்சி -கோயில்கலை - கற்கோவில்கள் - ஓவியக்கலை - அழகுக்கலைகள் - கூத்துக்கலை - மருத்துவக்கலை - நாடகக்கலை- இசைக்கலைபோன்றவை.

அலகு: 4 தமிழர் சமயம்

பழந்தமிழரின் சமயம் - சங்ககால சமயம் - தொல்காப்பியத்தில் சமயம் - சைவ சமயம் - வைணவம் - தமிழ்ப்பண்பாட்டில் பௌத்தம் - தமிழ்ப்பண்பாட்டில் சமணத்தின் தாக்கம்-தமிழ்ப்பண்பாட்டில் இசுலாம் மற்றும் கிறித்துவ சமயத்தின் தாக்கம்-தமிழர் பண்பாட்டில் விழாக்கள்-கோயில்களும் விழாக்களும் - சமூக ஒருங்கிணைப்பில் விழாக்களின் பங்கு-சங்க இலக்கியத்தில் விழாக்கள் பற்றிய குறிப்புகள்-இடைக்கால இலக்கியங்களில் விழாக்கள் பற்றிய செய்திகள் - விழாக்களின் சமூகப்பங்களிப்பு - தற்காலத்தில் தமிழர் விழாக்கள் - விளையாட்டும் விழாக்களும்.

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அலகு: 5 இலக்கியங்களில் தமிழர் பண்பாட்டுப்பதிவுகள்

சங்க இலக்கியமும் வாழ்வியலும் - திருக்குறளில் வாழ்வியல் நெறிகள் - இரட்டைக்காப்பியங்களும் வாழ்வியலும் - சிற்றிலக்கியங்களில் வாழ்வியல் பதிவுகள்-இக்கால இலக்கியமும் வாழ்வியலும்.

பார்வை நூல்கள்:

1. தமிழ் இலக்கிய வரலாறு - தமிழண்ணல், மீனாட்சி புத்தக நிலையம்- மதுரை-இரண்டாம் பதிப்பு-ஜூலை - 2000.
2. தமிழர் நாகரிகமும் பண்பாடும், அ. தட்சிணாமூர்த்தி, ஐந்திணைப் பதிப்பகம், சென்னை, திருத்திய பதிப்பு - 2022.
3. தமிழர் வரலாறும் பண்பாடும், நா. வானமாமலை, நியூ செஞ்சுரி புக்ஹவுஸ், சென்னை, ஆறாம் பதிப்பு - 2007 .
4. தமிழக வரலாறுமக்களும் பண்பாடும், கே.கே. பிள்ளை, உலகத் தமிழராய்ச் சிநிறுவனம், சென்னை.

25BTHS201G **SEMESTER-II**

TECHNICAL ENGLISH – II **3H-3C**

(Theory)

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;

- To acquire the context of grammar and the importance of Listening, Speaking, Reading and Writing
- To understand and develop critical Listening, Speaking, Reading, and Writing skills
- To apply students' capability to listen vigilantly, read proficiently, innovative writing, and speak fluently

COURSE OUTCOMES

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

- Demonstrate the aspects of writing, speaking, reading, and listening with grammar. **P2**
- Refine speaking, listening, reading, and writing skills in the social milieu. **P3**
- Justify the text critically in reading, writing, speaking, and listening. **A3**
- Differentiate grammatical structures in reading and listening and apply the structure in speaking and writing. **A3**
- Adapt writing, reading, listening, and speaking rules in formal and informal situations. **P3**

***P- Psychomotor skills, A-Affective Domain Skills**

UNIT I **9**

Grammar : Prepositions – Adjectives – Adverbs
Reading : Reading comprehension: Skimming and Scanning
Writing : Letter writing (Formal and Informal) – Letter to Editor
Listening : Listening to Business talks – TED Talks

UNIT II **9**

Grammar : Use of sequence words – Modal Verbs
Reading : Mind Mapping (Structured thinking and related ideas)
Writing : Interpreting visual materials – Note Making – Recommendations
Listening : Listening to specific tasks – Focused Listening – Note Taking.
Speaking : Making presentations on given topics – Speaking in formal Situations

UNIT III **9**

Grammar : Contextual usage of Tenses – Connectives
Reading : Cohesion and Coherence in Reading
Writing : Paragraph writing: Compare and Contrast – Cause and Effect – Jumbled sentences
Listening : Listening and responding to video lectures
Speaking : Role-play – Group Interaction

UNIT IV **9**

Grammar : WH Questions – Identifying Common Errors
Reading : Critical Reading Shifting facts from opinions
Writing : Resume writing with cover letter – Free writing
Listening : Watching videos or documentaries and answering
Speaking : Responding to questions – Mock Interviews

UNIT V **9**

Grammar : Use of Imperatives – Confusing words in English
Reading : Reading and making inference
Writing : Essay writing – Report – Proposals
Listening : Listening to different accents – Listening to Speeches
Speaking : Impromptu Speeches – Describing a process

TOTAL: 45

TEXT BOOKS:

1. Richards J C, Hull J, et al. “Interchange 3 Student's Book”, 5th Edition, Cambridge University Press, 2022.
2. Harding, Keith, and Appleby, Rachel, "International Express: Pre-Intermediate: Student's Book", 3rd Edition, Oxford University Press, 2019.

REFERENCE BOOKS:

1. Swan, Michael and Walter Catherine, “Oxford English Grammar Course”, 1st Edition, Oxford University Press, 2019.
2. Sudharshana N P and Savitha C, “English for Engineers”, 1st Edition, Cambridge University Press, 2018.
3. Brook-Hart G, “Business benchmark: Upper intermediate: Business vantage: Student’s book”, 2nd Edition, Cambridge University Press, 2021.

WEBSITE URLs:

1. www.myenglishpages.com
2. www.cambridgeenglish.org/learning-english/
3. www.eslvideo.com/index.php

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C107.1	-	-	-	-	2	-	2	2	3	-	2	1	-
C107.2	-	-	-	-	2	-	2	2	3	-	2	1	-
C107.3	-	-	-	-	2	-	2	2	3	-	2	1	-
C107.4	-	-	-	-	2	-	2	2	3	-	2	1	-
C107.5	-	-	-	-	2	-	2	2	2	-	2	1	-
C107.6	-	-	-	-	**2**	-	**2**	**2**	**2.8**	-	**2**	**1**	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS202CG **SEMESTER-II**

TRANSFORMS AND ITS APPLICATIONS **4H-4C**

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

End Semester Exam: 3 Hours

Pre-Requisites: Matrices and Calculus

COURSE OBJECTIVES:

The goal of this course is for students:

- To understand the concept of periodic functions and represent it as Fourier series.
- To provide knowledge of Fourier series techniques in solving heat flow problems and wave equations.
- To acquaint Fourier transforms techniques used in various applications.
- To impart the knowledge of Laplace Transforms and Inverse Laplace Transforms techniques and its applications.

COURSE OUTCOMES:

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

- Illustrate Fourier series representation of periodic functions **(K2)**
- Apply Fourier series in one dimensional heat flow and wave equation **(K3)**
- Make use of Fourier transform for converting elementary functions into frequency domain **(K3)**
- Utilize Laplace Transform to convert time-domain systems into frequency-domain systems **(K3)**
- Apply Inverse Laplace Transform in linear differential equations **(K3)**

UNIT I FOURIER SERIES **12**

Dirichlet's conditions – General Fourier series in the interval (0,2l) & (-l,l) – Half range sine series –Half range cosine series –Parseval's Identity – Harmonic analysis.

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **12**

Fourier series solution for one dimensional wave equation – Fourier series solution for one dimensional heat equation with zero end conditions.

UNIT III FOURIER TRANSFORMS **12**

Fourier Integral Theorem – Fourier transform pair –Fourier sine and cosine transforms –Properties – Convolution theorem – Parseval's identity of Fourier transform.

UNIT IV LAPLACE TRANSFORM **12**

Transforms of standard functions – Properties of Laplace transform – Transforms of derivatives and integrals –Initial and final value theorem – Transforms of periodic functions.

UNIT V INVERSE LAPLACE TRANSFORM **12**

Inverse Laplace transforms of standard functions – Inverse Laplace transform using second shifting theorem – Method of partial fractions– Convolution– Solution of ordinary differential equations with constant coefficients using Laplace transforms

Total Hours: 45+15

TEXT BOOKS:

1. Boyce, Diprima and Meade, "Elementary Differential Equations and Boundary Value Problems", 12th Edition, John Wiley & Sons, 2021.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, 2017

REFERENCE BOOKS:

1. T. Hillen, "Partial Differential Equations", 2nd Edition, Friesen Press, 2019.
2. Dennis G. Zill, "Advanced Engineering Mathematics", 7th Edition, Jones and Bartlett Publishers, 2020.
3. Richard Haberman, "Applied Partial Differential Equations with Fourier Series and Boundary Value Problems", 5th Edition, Pearson, 2021.
4. Grewal B.S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi, 2018.

WEBSITES:

1. www.infocobuild.com/education/audio-video-courses/mathematics/Transform TechniquesForEngineers-IIT-Madras/lecture-01.html
2. www.infocobuild.com/education/audio-video-courses/mathematics/ordinary-and-partial-differential-equations-iit-roorkee.html
3. www.electrical4u.com/laplace-transformation/

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C108.1	2	1	-	-	-	-	-	-	-	-	1	1	-
C108.2	3	2	1	-	-	-	-	-	-	-	1	1	-
C108.3	3	2	1	-	-	-	-	-	-	-	1	1	-
C108.4	3	2	1	-	-	-	-	-	-	-	1	1	-
C108.5	3	2	1	-	-	-	-	-	-	-	1	1	-
C108	2.8	1.8	1	-	-	-	-	-	-	-	1	1	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

SEMESTER-II

25BTHS206

BIOPHYSICS **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:

- Introduce the Students to the fundamental concepts of physics applicable in biological systems.
- Inculcate the basics of biomolecules such as lipids, fats and oils nucleic acids, amino acids and proteins.
- Study the concepts of light and its optical principle.
- Understand the various spectroscopic techniques for studying the properties of biomolecules
- Study the fluid properties and the fluid relation with blood vessels and its effect.

COURSE OUTCOMES:

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

- Explain the basics of biomolecules and its types **(K2)**
- Outline the concept of light in optical microscope **(K2)**
- Identify the biomolecules using UV-Visible, IR and NMR spectroscopy. **(K3)**
- Relate the properties of fluid flow in blood vessels**(K2)**
- Illustrate the process of radiation traces and its harmful effects**(K2)**

UNIT I – BIOMOLECULES **9**

Introduction to biomolecules, Structure and function of mono, di, oligo and polysaccharides- Nucleic acids: biophysics of RNA and DNA- Amino acids: Amino acid general structure & types - Proteins: Structure of Proteins - primary, secondary, tertiary and quaternary - Lipids, types of lipids, fatty acids, Fats & oils, Phospholipids, Glycolipids; lipoproteins, Molecular confirmation – docking theory, Ramachandran plot.

UNIT II - LIGHT AND OPTICS **9**

Physics of light, Reflection, Refraction, absorption and scattering – Basics of lenses, Interference phenomena, Refractometry : Refraction of light, principle ,design, working and application of Abbe's refractometer, Human eye- limits of vision and colour vision - Light microscopy: Simple, compound optical microscope, Polarimetry: Polarization of light, optical activity and its measurement.

UNIT III SPECTROSCOPY TECHNIQUES **9**

Interaction of electromagnetic radiation with Matter: electromagnetic spectra - regions of spectrum – numerical - Introduction to spectroscopy: UV-Visible, IR and NMR - Spectrometric Instrumentation of UV-Visible, IR and NMR: sources, monochromators, sample cells, detectors -

Spectrometric applications to biomolecule: Quantitative analysis using the Lambert - Beer's Law.

UNIT IV FLUIDS **9**

Physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapour pressure - Reynolds number - Determination of coefficient of viscosity by Poiseuille's method – Oswald viscometer - Buoyancy and floatation - Bernoulli's equation – fluid flow in constricted tube – blood flow through a blood vessel with a partial blockage – angioplasty.

UNIT V – RADIATION **9**

Absorption of radiation by body tissues - damage effect of neutrons - radiation measurement & units: expose, absorbed dose, stopping power - Radiation detection and measurements - Radioactive tracers - labelling with isotopes - stable radioactive isotopes – application of traces - dosimetry – relative biological effectiveness (RBE) – DNA mutation.

Total Hours: 45

TEXT BOOKS:

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).

REFERENCES:

1. Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL.New York: W H Freeman; (2002).
2. Gerhart Friedlander, Joseph W. Kenedy, Ed Ward S. Macias and J.M. Miller Jones, "Nuclear and Radiochemistry", Wiley & Sons Ltd (2013).

WEBSITES:

1. www.nptel.ac.in/courses/104102009/
2. www.nptel.ac.in/content/syllabus/104102009

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C109.1	2	1	-	-	-	-	-	-	1	-	1	1	-
C109.2	2	1	-	-	-	-	-	-	1	-	1	1	-
C109.3	3	2	1	-	-	1	1	-	1	-	1	1	-
C109.4	2	1	-	-	-	1	1	-	1	-	1	1	-
C109.5	2	1	-	-	-	1	1	-	1	-	1	1	-
C109	2.2	1.2	1.0	-	-	1.0	1.0	-	1.0	-	1.0	1.0	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-II

25BTBT201 INTRODUCTION TO BIOTECHNOLOGY 3H-3C

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

End Semester Exam: 3 Hours

Prerequisite: Nil

COURSE OBJECTIVES

The goal of this course is to

- Understand the scope and basics of biotechnology in India.
- Explain the structure and functions of cell, biomolecules and growth requirement of microorganisms.
- Describe the applications of biotechnology in different fields
- Discuss the biotechnology regulations and ethical issues related to biotechnology research and development.

COURSE OUTCOMES

Upon completion of this course, the students will able to

1. Summarize the scope and basics of biotechnology and its branches. **(K2)**
2. Outline basics of cell structure, classification of molecules and its functions. **(K2)**
3. Explain the growth media requirement for microorganism cultivation and its screening for large scale production. **(K2)**
4. Infer the applications of biotechnology in different fields and its importance. **(K2)**
5. Illustrate the biotechnology regulations, polices and ethical issues to be followed in various sectors. **(K2)**

Unit-I Scope and Introduction to Biotechnology 9

History & Introduction to Biotechnology, Definition of Biotechnology, Traditional and Modern Biotechnology, Scope and Importance of Biotechnology, Interdisciplinary nature of Biotechnology, Overview of Branches of Biotechnology; Tools in biotechnology, Overview of Biotechnology Research in India.

Unit-II Cell and Biomolecules 9

Structure and functions of a cell, cell theory, structure of prokaryotic and eukaryotic cell. Biomolecules: Classification and functions of Carbohydrates, Nucleic acids, proteins, lipids; Properties and functions of enzymes, vitamins and hormones; Introduction to genes and chromosome.

Unit-III Growth media and screening 9

Medium requirements for fermentation process-carbon, nitrogen, minerals, vitamins and other nutrients- examples of simple and complex media; Industrial substrates. Screening and isolation of microorganisms.

Unit-IV Applications of Biotechnology 9

Genetically engineered foods, Bioremediation, DNA fingerprinting, Molecular diagnostics, Molecular forensics, Transgenic plants and organisms.

Unit –V Regulations and ethical issues 9

Overview of biotechnology regulations and policies, international regulatory frameworks for biotechnology, controversies and challenges in biotechnology regulation, ethical considerations in biotechnology research and development, social and environmental impacts of biotechnology, public attitudes towards biotechnology.

Total: 45 h

Text Books:

1) A Textbook of Biotechnology (2022) by R. C. Dubey, S. Chand Publishing, India.
2) Biotechnology (2020) by U Satyanarayana, Books and Allied (P) Ltd, India.
3) Introduction to Biotechnology (2019), 4th Edition by William Thieman and Michael Palladino, Pearson publisher, India.

Reference Books

1) Biotechnology, Bioethics, and the Law (2015) by Michele Goodwin, Shine Tu, John Paris; Carolina Academic Press, Durham North California.
2) Introduction to Biotechnology (2013), by A.K. Chakravarty, Oxford University Press, India.

Web links

1. https://archive.nptel.ac.in/content/storage2/courses/102103045/download/mod1.pdf
2. https://sc.uobaghdad.edu.iq/wpcontent/uploads/sites/64/mainfiles/suha/Dr.Mohamed.pdf
3. https://www.rug.nl/research/irees/research/edulink-fsba/fsba-course-modules/fsba-module-5- unit-3-notes-english.pdf

CO-PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	1	-	1	-
CO2	2	1	-	-	-	-	-	-	-	1	-	1	-
CO3	2	1	-	-	-	-	-	-	-	1	-	1	-
CO4	2	1	-	-	-	-	-	-	-	1	-	1	-
CO5	2	1	-	-	-	-	-	-	-	1	-	1	-
Avg.	2	1	-	-	-	-	-	-	-	1	-	1	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS245G **SEMESTER-II**

ENGINEERING CHEMISTRY **5H-4C**

(Theory & Lab)

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

End Semester Exam: 3 Hours

(i) Theory

COURSE OBJECTIVES:

The goal of this course is to:

- Summarize water treatment process and engineering materials.
- Acquire knowledge on fuels, lubricants and principles of corrosion.
- Explain the concepts of analytical techniques and its applications.

COURSE OUTCOMES:

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

- Identify the quality of water and its treatment methodologies **(K3)**
- Interpret the basics of engineering materials and its applications **(K2)**
- Outline the methods to enhance the quantity & quality of fuels and Lubricants **(K2)**
- Illustrate the types of corrosion and its prevention techniques **(K2)**
- Demonstrate the principle and working of analytical techniques **(K3)**

UNIT I – WATER TECHNOLOGY **9**

Sources-Characteristics - Specification for drinking water, BIS &WHO-Alkalinity- Types of alkalinities 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 II – ENGINEERING MATERIALS **9**

Plastics – Thermoplastics & Thermosets. Preparation, properties and engineering applications of Poly vinyl chloride and Bakelite. Alloys – Introduction – Definition – Properties of alloys – Significance of alloying, functions and effect of alloying elements – Nichrome and stainless steel (18/8) – Heat treatment of steel. Refractories – Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories. Composites– Properties and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites.

UNIT III – FUELS AND LUBRICANTS **9**

Fuels – Introduction- Analysis of coal (proximate and ultimate), Carbonization- Manufacture of metallurgical coke (Otto Hoffmann method) – Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking – Octane number– Cetane number- Power alcohol and biodiesel. Lubricants – Introduction – Characteristics of a good lubricant – Classification, Physical and Chemical Properties – Mechanism of lubricants – Applications.

UNIT IV - CORROSION AND ITS CONTROL 9

ChemicalandElectrochemicalcorrosion-Galvaniccorrosion-Differentialaerationcorrosion- Factors influencing the rate of 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 V – ANALYTICAL TECHNIQUES AND APPLICATIONS 9

Introduction-Instrumentation and applications of Colorimetry, Flame Photometry, Potentiometry, Conductometry (Strong acid with strong base, Mixture of acids with strong base, precipitation titrations)-Electronic spectroscopy- Vibrational spectroscopy-Atomic Absorption spectroscopy.

Total Hours: 45+30

TEXT BOOKS:

1. P C Jain & Monica Jain, (2022). Engineering Chemistry, 18th edition, Dhanpat Rai Publishing Company
2. Shivani Jaggi Guleria, "Engineering Chemistry", Concept for engineers, 1st Edition, Atlantic, 2021.
3. S S Dara, S SUmare, "A Text book of Engineering Chemistry", 12th Edition, S Chand, 2015.
4. B. H. Mahan, (2010). University chemistry, Pearson Education.
5. R V Gadag, A Nithyananda Shetty, "Engineering Chemistry", 3rd Edition, Wiley India Pvt, 2019.

REFERENCE BOOKS:

1. M. J. Sienko and R. A. Plane, (1976) Chemistry: Principles and Applications. 5th edition, McGraw-Hill Higher Education.
2. C. N. Banwell, (2001) Fundamentals of Molecular Spectroscopy, McGraw-Hill.
3. P. W. Atkins, (2022) Physical Chemistry, Oxford University Press.
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web-book)
5. K. P. C. Volhardt and N. E. Schore, (2014). 5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman Publications.

WEB REFERENCES:

1. https://www.bspublications.net/downloads/0523ff2e4a5331_chemistry_ch_01_JNTUK.pdf
2. https://www.uobabylon.edu.iq/eprints/publication_10_31957_6172.pdf
3. https://www.researchgate.net/publication/265602506_chapter_engineering_materials_and_ engineering_plastics

(ii) Laboratory

LIST OF EXPERIMENTS – CHEMISTRY

1. Determination of Ca/Mg using complexometric titration
2. Determination of chloride content of water
3. Determination of the rate of corrosion by weight loss method
4. Conductometry-Determination of conductance of solutions (strong acid Vs strong base)
5. pH Metry – Determination of Acid/Base
6. Potentiometry- Estimation of iron content in a water sample.
7. Estimation of Copper and Zinc in Brass

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C111.1	3	2	1	-	-	2	1	1	-	-	1	2	-
C111.2	2	1	-	-	-	2	1	1	-	-	1	1	-
C111.3	2	1	-	-	-	2	1	1	-	-	1	1	-
C111.4	2	1	-	-	-	2	1	1	-	-	1	1	-
C111.5	3	2	-	-	-	2	1	1	-	-	1	2	1
C111	2.4	1.4	1	-	-	2	1	1	-	-	1	**1.4**	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BEEE242G **SEMESTER-II**

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BASIC ELECTRICAL & ELECTRONICS ENGINEERING

(Theory & Lab) **4H-4C**

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

End Semester Exam:3Hours

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
- To acquire knowledge about Digital circuits
- To impart the basic knowledge of smart sensors

COURSE OUTCOMES

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

- Build the electric circuits with DC and AC excitation by applying various circuit laws.
- Explain the basic principles, construction and working of AC, DC Motor and transformer
- Identify the various characteristics of semiconductor devices
- Explain the combinational digital circuits using logic gates.
- Compare the different types of transducers and sensors with its application.

UNIT I – Electric Circuits (9)

DC Circuits: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Independent and Dependent Sources – Simple problems in series and parallel combinations of resistors.

AC Circuits: Representation of sinusoidal waveform - peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. – simple problems in single-phase ac circuits consisting of RL, RC, RLC Network.

UNIT II - Electrical Machines (9)

Construction, working: DC machines (generator & motor) - BLDC motor – three phase and Single-phase induction motor. Magnetic materials, BH characteristics, Construction and working of single-phase transformer- emf equation.

UNIT III- Analog Electronics (9)

Construction and operation: PN diode, Zener diode and V-I characteristics – Bipolar Junction Transistor – FET – introduction to Operational Amplifier.

UNIT IV- Digital Electronics (9)

Number Systems — Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes - Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates – SOP, POS -Realization of logic gates.

UNIT V- Transducers and Electrical Installation (9)

Transducer–Classification of transducers- Piezoelectric transducer – Hall Effect transducers – Smart sensors – Switch Fuse Unit (SFU), MCB, ELCB - Earthing - Elementary calculations for energy consumption and battery backup.

Text Books

S. K. Bhattacharya, "Basic Electrical Engineering", Pearson, 2019.
E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.

Reference Books

1. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. VN Mittle and Arvind Mittal, "Basic Electrical Engineering", McGraw Hill, 2006.

A. Sudhaka and Shyammohan S Palli, "Circuits and Networks", McGraw Hill, 2013.

3. R. Muthusubramanian and S. Salivahanan, "Basic Electrical and Electronics Engineering", TMH, 2014.

Web Links:

- www. nptel.ac.in.
- encyclopedia-magnetica.com/doku.php/co energy.
- https://en.wikibooks.org/wiki/electronics/measuring instruments.

(ii) Laboratory

List of Experiments

1. Experimental verification of electrical circuit problems using Ohms law
2. Experimental verification of electrical circuit problems using Kirchhoff's Voltage law.
3. Experimental verification of electrical circuit problems using Kirchhoff'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.

CO-PO Mapping chart

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	1	-	-	1.5	2	-	-	-	-
CO2	3	3	2	1	1	-	-	1.5	2	-	-	-	-
CO3	3	3	2	1	1	-	-	1.5	2	-	-	-	-
CO4	3	3	2	1	1	-	-	1.5	2	-	-	-	-
CO5	3	3	2	1	1	-	-	1.5	2	-	-	-	-
CO	3	3	2	1	1	-	-	1.5	2	-	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS213G **SEMESTER-II**

PHYSICAL SCIENCES LABORATORY **2H-1C**
(Laboratory)

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

End Semester Exam: 3 Hours

LIST OF EXPERIMENTS – PHYSICS

1. Determination of Band gap of a semiconductor.
2. Uniform bending – Determination of young's modulus.
3. Non-uniform Bending – Determination of young's modulus.
4. Laser - Determination of the wave length of the laser using grating
5. Laser – Determination of Particle size
6. Optical Fiber – Determination of Numerical Aperture and Acceptance angle of the optical fiber.
7. Air wedge – Determination of thickness of a thin sheet/wire.

CO, PO, PSO Mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
C113.1	2	1	-	-	-	-	-	1	1	-	1	1	1
C113.2	2	1	-	-	-	-	-	1	1	-	1	1	1
C113.3	3	2	1	-	-	-	-	1	1	-	1	1	1
C113.4	2	1	-	-	-	-	-	1	1	-	1	1	1
C113.5	2	1	-	-	-	-	-	1	1	-	1	1	1
CO 113	2.2	1.2	1.0	-	-	-	-	1.0	1.0	-	1.0	1.0	1.0

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTHS246G YOGA 3H-2C

Instruction Hours/week: L: 1 T: 0 P: 2 **Marks:** Internal**: 100** External**: 0 T**otal**:100**

PRE-REQUISITE: NIL

COURSE OBJECTIVES:

The goal of this course for students is to

- Understand the concepts of Yoga and Physical Health
- Provide value education to improve the students character, understanding greatness of life force and Mind.
- Learning introspection practices like analysis of Thought, Moralization of Desires, Neutralization of Anger and Eradication of Worries

COURSE OUTCOMES:

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

1. Practice physical activities and yoga for strength, flexibility and relaxation.
2. Use techniques for increasing concentration and decreasing anxiety for stronger academic
3. performance.
4. Perform yoga exercises in various combination and forms.
5. Improve personal fitness through participation in sports and yoga activities.
6. Follow sound nutritional practices for maintaining good health and physical performance.

UNIT I INTRODUCTION TO PHYSICAL FITNESS **15**

Explain importance of physical education - Describe importance of Physical Fitness & Wellness - Explain the components of physical fitness - Demonstrate healthy life style -Prevent health threats by changing life style.

UNIT II FUNDAMENTALS OF ANATOMY & PHYSIOLOGY IN SPORTS & YOGA **15**

Explain importance of anatomy and physiology - Describe effects of exercise in various body systems - Describe concept of correct posture - Explain corrective measures for posture deformities.

UNIT III YOGA & PRANAYAMA **15**

Explain importance of yoga - Perform various pranayama for increasing concentration - Use meditation and other relaxation techniques for improving concentration.

TOTAL: 45

SUGGESTED READINGS

1. Ajmer Singh, Modern Trends and Physical Education class 11 & class 12, Kalyani Publication, New Delhi ISBN: 9789327264319.
2. B.K.S. Iyengar, Light on Yoga, Thomson's Publication, New DelhiISBN: 8172235011
3. V.K.Sharma, Health and Physical Education, NCERT Books; Class11,12 Saraswati House Publication, New Delhi
4. Acharya Yatendra, Yoga and Stress Management, Fingerprint Publishing ISBN: 938905303X
5. Swami Vivekanand, Patanjali Yoga Sutras, Fingerprint Publishing ISBN 9389567351.
6. Ramdev, Pranayam Rahasya, Patanjali-Divya Prakashan, HaridwarISBN: 9788189235017
7. Ramdev, Yoga its Philosophy & Practice, Divya Prakashan, Haridwar.

CO, PO, PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	1	1	1	1	-	3	*	*
CO2	-	-	-	-	-	1	1	1	1	-	3	*	*
CO3	-	-	-	-	-	1	1	1	1	-	3	*	*
CO4	-	-	-	-	-	1	1	1	1	-	3	*	*
CO5	-	-	-	-	-	1	1	1	1	-	3	*	*
Average	-	-	-	-	-	1	1	1	1	-	3	*	*

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTMC251G **SEMESTER–II**

VEDIC MATHEMATICS **1H–0C**

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

EndSemesterExam:3Hours

COURSE OBJECTIVES:

The goal of this course is;

- To overcome the fear of maths, acquire knowledge in Logical thinking, increase concentration and improve critical thinking.
- To build the skill to perform basic math fast and accurately with confidence.
- To enhance computation skills through Vedic Mathematics

COURSEOUTCOMES:

Upon completion of this course, the student will be able to;

1. Apply Vedic sutras for arithmetic computation. **(K3)**
2. Utilize Urdhva Tiryagbhyam for solving complex multiplication problems. **(K3)**
3. Make use of Vedic division method for basic word problems. **(K3)**

UNIT I **5**

Application of vedic sutras, Arthimetic computation, Shudh method for a list of number, Rapid Addition- Single to Double-Digit, Subtraction using Nikliam 3 Digit

UNIT II **5**

Multiplication by Thumb Rule, Multiplication Vertically and cross wise, Urdhvatiryagbhyam, Anurupyena.

UNIT III **5**

Squaring numbers, Traditonal Division, Straight Division, Facts of Division, Basic Word Problems.

Total Hours: 15

REFERENCES:

1. Jagadguru swami sri Bharathi krsnatirthaji maharaja,"Vedic Mathematics", International Best seller, New RevisedEdition.
2. Sri Bharati Krsna Tirthaji, "Vedic Mathematics", published by Motilal Banarsidass, 1965.
3. Williams K.R. "Discover Vedic Mathematics." Vedic Mathematics Research Group, 1984.
4. Rajesh Kumar Thakur, "Advanced Vedic Mathematics", Rupa Publications India Pvt. Ltd 2019.

WEBSITES:

1. 1. www.nptel.ac.in/courses/111101080
2. 2. www.https://vedicmathworld.com/

SEMESTER-III

Semester-III

25BTBT301 PRINCIPLES OF CHEMICAL ENGINEERING 4H-4C

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

End Semester Exam: 3 Hours

Prerequisite: Nil

Course Objectives

The goal of this course is for students to

- Understand and apply the basics of chemical calculations and material balances.
- Explain the principles of filtration, sedimentation and evaporation operations.
- Outline the fluid flow properties and explain the fluid transportation system.

Course Outcomes

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

1. Apply the basics of chemical calculations in gas and liquid system. **(K3)**
2. Solve different types of material balance equation for various unit operations. **(K3)**
3. Apply dimensional analysis for agitation system and outline the principles of filtration, centrifugation and evaporation. **(K3)**
4. Identify types of fluid flow and understand the fluid flow concept in chemical industries. **(K3)**
5. Choose fluid flow transportation system and flow measurement devices. **(K3)**

UNIT I - BASIC CHEMICAL CALCULATIONS 12 h

Units and dimension - various systems of units, conversion of units, basic chemical calculations – mole, mole fraction, methods of expressing the composition of mixtures; Concept of Normality, Molarity and Molality: Ideal gas law- Ideal mixtures and solutions; Dalton’s law, Henry’s law, Raoult’s law, effect of temperature on vapor pressure; density of gas mixture.

UNIT II - MATERIAL BALANCES 12 h

Overall and component balances, law of conservation of mass, steady & unsteady state operation, material balances without chemical reactions – unit operations; material balances with chemical reactions - stoichiometric equation, stoichiometric coefficient, stoichiometric ratio, limiting reactant; excess reactant; recycling, purge and bypassing operations; selectivity and yield.

UNIT III – UNIT OPERATION **12 h**

Dimensional analysis, dimensional less numbers, Mixing and agitation, Filtration -types, filter media, selection of medium, filter aids-filter theory, Sedimentation - principles, settling velocity; Centrifugation: principles, types; Evaporators: Single effect and multiple effect.

UNIT IV - FLUID MECHANICS **12 h**

Fluids: properties and types; fluid statics and fluid dynamics, Continuity equation; bernoulli's equation; applications in chemical engineering; Fluid flow: laminar and turbulent flow, pressure drops in flow pipes; compressible fluid flow concepts; multiphase flow concepts.

UNIT V - TRANSPORTATION OF FLUIDS **12 h**

Pumps-types, working principle, characteristics, suction and cavitation; Measurements of flowing fluids – orifice, venturi and rotameter; Fluidization and flow through Packed Bed Column.

Total: 60 h

Text Books:

1. Sikdar, D.C., (2013) Chemical Process Calculations, PHI Learning, India.
2. K A Gavhane (2016), Introduction to Process Calculations (Stoichiometry), Nirali Prakasan Publication, Pune, India.
3. Gavhane, K.A. (2013). Unit Operations - I. Nirali Prakasan Publication, Pune, India.

Reference Books:

1. Geankoplis C.J. (2016). Transport Processes and separation process principles.(Includes unit operations). 4th Edition, Pearson.
2. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services, 2015

Web Links

1. https://archive.nptel.ac.in/courses/103/103/103103165/

CO-PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	1	-	-	2	-
CO2	2	1	-	-	-	-	-	-	1	-	-	2	-
CO3	2	1	-	-	-	-	-	-	1	-	-	2	1
CO4	2	1	-	-	-	1	-	-	1	-	-	2	-
CO5	2	1	-	-	-	-	-	-	1	-	-	2	1
Avg.	2	1	-	-	-	1	-	-	**1**	-	-	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-III

25BTBT302 **MOLECULAR BIOLOGY** **3H-3C**

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

End Semester Exam: 3 Hours

Prerequisite: Nil

Course Objectives

The goal of this course is to

- Outline the classical genetics concepts of eukaryotes, prokaryotes, structure of nucleic acids and DNA replication.
- Understand the molecular mechanism of transcription, translation and regulation of gene expression.
- Outline the various types of mutation, synthesis of RNA and post-transcriptional modifications.

Course Outcomes

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

1. Infer the knowledge of genetics prokaryotes and eukaryotes. **(K2)**
2. Classify structure of nucleic acids, DNA replication and chromosome organization**. K2)**
3. Illustrate the prokaryotic and eukaryotic transcription, and its post transcriptional modifications. **(K2)**
4. Relate the concept of genetic code, translation process and post translation modifications. **(K2)**
5. Identify the process of regulation of gene expression and its importance. **(K3)**

UNIT I - CLASSICAL GENETICS **9h**

Overview of Central dogma; Prokaryotic genetics: Bacterial conjugation, transduction and transformation; Mendelian inheritance; Eukaryotic genetics: Gene interaction, Recombination and chromosomal mapping; crossing over and linkage; classical experiments: Hershey and Chase, Avery McLeod & McCarty.

UNIT II - STRUCTURE OF NUCLEIC ACIDS AND DNA REPLICATION 9h

Molecular structure of genes and chromosomes; Models of DNA; Features of Watson & Crick model; Replication in prokaryotes; Meselson & Stahl experiment; D-loop and rolling circle mode of replication; replication of linear viral DNA; Regulation of replication, Inhibitors of replication; Replication of telomeres in eukaryotes; DNA damage and repair mechanisms.

UNIT III – TRANSCRIPTION **9h**

Conformation of RNA: Prokaryotic and Eukaryotic transcription; RNA polymerase; Transcription: Initiation, transcription factors, Inhibitors of transcription; Features of promoters and enhancers, ribozymes; Post transcriptional modification: 5' capping, polyadenylation, splicing; processing of mRNA, rRNA and tRNA; RNA editing; Regulators: SiRNA, mRNA.

UNIT IV – TRANSLATION **9h**

Genetic code; Salient features: Wobble hypothesis; basic machinery of translation: prokaryotes and eukaryotes; protein folding; codon usage; Inhibitors of translation; post translational modifications; Glycosylation, methylation; protein targeting.

UNIT V - REGULATION OF GENE EXPRESSION **9h**

Principles of gene regulation: suppressor, activators, co suppressor, moderator, silencer, enhancer; Operon concept: Lac operon, ARA operon and TRP operon; Mutation: types, transition, transversion, artificial & natural mutation, suppressor mutation; RNA interference technology.

Total: 45 h

Text Books:

1. Watson. J.D., Baker Bell, Gann, Levine and Losick. (2004). Molecular Biology of the Gene. Pearson Education.
2. Benjamin. L. (2004). Gene XII, 2018. Pearson Education.

Reference Books

1. Alberts B., Johnson A, Lewis J, Morgan D, Raff M, Roberts K and Walter P., Molecular Biology of the Cell, 6th Edition, Garland Science Publisher, New York, (2014). ISBN:9780815344322.
2. Weaver. R.F. (2011). Molecular Biology. Mc Graw Hill.

Web Links

1: https://www.sciencedirect.com/journal/journal-of-molecular-biology/vol/435/issue/17 /
2: https://academic.oup.com/mbe/issue/40/7
3: https://www.springer.com/journal/11008

CO-PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	1	-	-	1	-	1	2	-
CO2	2	1	-	-	-	1	-	-	1	-	1	2	-
CO3	2	1	-	-	-	1	-	-	1	-	1	2	-
CO4	3	2	1	-	-	1	-	-	1	-	1	2	-
CO5	3	2	1	-	-	1	-	-	1	-	1	2	-
Avg.	**2.4**	**1.4**	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**2**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-III

25BTBT341 **BIOCHEMISTRY** **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

Prerequisite Nil

i) Theory

Course Objectives

The goal of this course is to

- Understand the structural and functional properties of biomolecules.
- Discuss the anabolism and catabolism of biomolecules.
- Summarize the biomolecular metabolism and its associated genetic disorders.

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Course Outcomes

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

1. Outline the basics of biochemistry and its calculation. **(K3)**
2. Summarize the forms of carbohydrates, lipids and its properties. **(K3)**
3. Make use of amino acid and nucleotide basics to elucidate their structural properties. **(K3)**
4. Identify the metabolic pathways of carbohydrate and lipid. **(K2)**
5. Apply the knowledge of amino acids and nucleic acid to address metabolic disorders. **(K2)**

UNIT I INTRODUCTION TO BIOCHEMISTRY **9h**

Introduction to Biochemistry, weak acid and bases, pH, buffers, pKa, Henderson, Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems.

UNIT II STRUCTURE AND PROPERTIES OF BIOMOLECULES-CARBOHYDRATES AND LIPIDS **9h**

Carbohydrates- Definition, types, classification. Aldose, Ketose, epimers, anomers, Haworth formula, sugars as reducing agents; Monosaccharides: pyronoses, furanoses, conformation of pyranoses; Disaccharides: Glycosidic bonds, hydrolysis, Polysaccharides: homopolysaccharides and heteropolysaccharides, Glycoconjugates. Methods of carbohydrate analysis; Fatty acids: Saturated and unsaturated fatty acids, TAG, saponification, iodination, hydrogenation. Fluid mosaic model, lipid extraction.

UNIT III STRUCTURE AND PROPERTIES OF BIOMOLECULES - PROTEINS AND NUCLEIC ACID **9h**

General structure of amino acid, properties, classification of amino acids by R group, Zwitterion. Peptides: Peptide bond, polypeptides. Proteins: hierarchy, primary, secondary, tertiary and quaternary four levels of structure in protein, Ramchandran Plot. Nucleotides and nucleic acid nomenclature, Phosphodiesterase Linkage, structure of purine and pyrimidine, nucleoside, RNA, DNA models.

UNIT IV - METABOLISM OF CARBOHYDRATES AND LIPIDS **9h**

Major pathways of glucose utilization: Glycolysis, HMP pathway; TCA cycle; Electron transport chain. Biosynthesis of fatty acid. The α, β- oxidation pathway. Oxidation of monounsaturated and polyunsaturated fatty acid.

UNIT V - METABOLISM OF AMINO ACIDS AND NUCLEIC ACIDS **9h**

Biosynthesis of amino acids from acetyl CoA, Biosynthesis of essential amino acids, Urea cycle. Pathways of degradation of aromatic, glucogenic and ketogenic amino acids. Inborn errors of amino acid metabolism. Biosynthesis of nucleotides, *de novo* and salvage synthesis pathways for purines and pyrimidines, regulatory mechanisms; catabolism of purine & pyrimidine.

Total: 45 h

ii) Laboratory

List of experiments

1. Preparation of stock solutions and buffers.
2. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
3. Quantification of glucose by DNS method
4. Test and Quantification of Cholesterol (Zak's method)
5. Quantification analysis of amino acids using TLC
6. Quantification of proteins by Lowry' s method
7. Quantification of proteins by Bradford's method
8. Estimation of DNA (DPA method)
9. Estimation of RNA (Orcinol method) /spectrometric method for quantification

Total: 30 h

Text Books

1. Nelson. D.L., Cox. M., and Cox. M.M. (2017). Lehninger Principles of Biochemistry. 7 Edition Freeman W.H. & Company, New York.
2. Zubay. G.L. (2017). Principles of Biochemistry. Med Tech.

Reference Books

1. Pedersen SH (2021). Reviews of Physiology, Biochemistry and Pharmacology, 178 (Doctoral dissertation, Department of Biomedical Sciences, University of Copenhagen).
2. Murray. R.K., Granner. B.K., Mayes. P.A. and Rodwell. V.W. (2018). Harper's Illustrated Biochemistry, 31st edition, McGraw-Hill Education.
3. Voet. G. and Voet. A. (2018). Fundamentals of Biochemistry. 2nd Edition. John Wiley &Sons, Inc.

Web Links

1. https://nptel.ac.in/courses/102106087
2. https://ocw.mit.edu/courses/7-05-general-biochemistry-spring-2020/

CO-PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	1	2	-
CO2	2	2	-	-	-	-	-	2	2	-	1	2	-
CO3	3	2	1	-	-	-	-	2	2	-	1	2	-
CO4	3	2	1	-	-	1	-	2	2	-	1	2	-
CO5	3	2	1	-	-	1	-	2	2	-	1	2	1
Avg.	**3.2**	**1.6**	**1**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**1**	**2**	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-III

25BTBT342 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

Prerequisite Nil

i) Theory

Course Objectives

The goal of this course is for students to

- To illustrate the basic concepts of microbiology and different microbial identification techniques.
- To interpret the microbial growth and genetics in molecular level.
- To outline the mechanism for the control of microorganisms and its interaction and ecological diversity.

Course Outcomes

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

1. Experiment with the microbial staining and isolation techniques. **(K3)**
2. Choose the basic requirements for microbial growth. **(K3)**
3. Summarize the gene transfer strategies involved in microorganism. **(K2)**
4. Outline the major microbial interactional and its diversity. **(K2)**
5. Select the controlling mechanism of microorganisms. **(K3)**

UNIT I INTRODUCTION TO MICROBIOLOGY 9h

History and Scope of Microbiology, Taxonomy and classification of microorganisms,Organization of Prokaryotic and Eukaryotic cell structure and Function, Bacteria-gram negative and gram positive, fungi- Ascomycetes and basidomyctes; Virus and classification of virus- bacteriophage.

UNIT II MICROBIAL NUTRITION AND GROWTH ASSESSMENTS 9h

Nutrients- micronutrients and macronutrients; Types of growth media, Different phases of growth curve, Culture methods, preservation methods; observations- Different staining techniques, Microscopy–compound microscope, phase contrast microscope, Fluorescence microscope and Electron Microscopes.

UNIT III MICROBIAL MOLECULAR BIOLOGY AND GENETICS 9h

Gene structure, bacterial and viral genome, Bacterial plasmids, Gene transfer- Transformation, Conjugation and Transduction; Applications-Microbial bioremediation by superbugs.

UNIT IV MICROBIAL ECOLOGY AND INTERACTION 9h

Microbes from marine, freshwater and terrestrial environments, Various microbial interactions – Symbiotic, Non-symbiotic and pathogenic microbes, host-microbe interactions, role of microorganism in biogeochemical cycles- Carbon cycle, Nitrogen cycle, Sulphur cycle.

UNIT V CONTROL OF MICROOGANISMS 9h

Pathogenic and nonpathogenic microorganisms, host-microbe interactions in human, Physical and chemical control of microorganisms, Mode of action of antimicrobial agents (antibacterial, anti-fungal, anti-viral agents), resistance to antibiotics and strategies to encounter.

Total: 45 h

ii) Laboratory

List of experiments

1. Microbial Good Lab Practices and Biosafety
2. Media preparation and sterilization
3. Microscopic examination of different groups of microorganisms-bacteria and fungi
4. Simple streaking, T-streaking and quadrant streaking of bacteria.
5. Simple and differential staining methods (Gram's staining)
6. Isolation and culture using serial dilution from soil.
7. Microbial Growth Curve Determination
8. Effect of physical (Temperature) and chemical (pH) environment on growth
9. Biochemical tests for microbial identification-IMViC test
10. Antibiotic Sensitivity of Microorganisms

Total: 30h

Text Books:

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. TataMcGraw-Hill Education.

References Books

1. Talaro. K.P. and Chess. B. (2017). Foundations in microbiology. 10th Edition. Tata McGraw-Hill Education.
2. Kolwzan. B., Adamiak. W., Grabas K. and Pawelczyk. A. (2006). Introduction to Environmental Microbiology, ebook

Web Links

1. https://microbiologyinfo.com/
2. https://microbenotes.com/

CO PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	2	2	-	1	2	-
CO2	3	2	1	-	-	1	-	2	2	-	1	2	-
CO3	2	1	-	-	-	1	-	2	2	-	1	2	-
CO4	2	1	-	-	-	1	-	2	2	-	1	2	-
CO5	3	2	1	-	-	1	-	2	2	-	1	2	1
Avg.	**2.6**	**1.6**	**1**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**1**	**2**	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-III

25BTBT343 **CELL BIOLOGY** **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

Prerequisite: Nil

i) Theory

Course Objectives

The goal of this course is to

- Understand the basic knowledge on the properties of cell and cell structure.
- Familiarize the concepts involved in the process of cell division and movement of molecules across the cell membrane.
- Explain the role of receptors in cell signalling and process of ATP synthesis in chloroplast and mitochondria.

Course Outcomes

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

1. Infer the knowledge on the structure of cell components. **(K2)**
2. Classify the functions of cytoskeletal proteins and cell cycle checkpoints. **(K2)**
3. Summarize the transport process across the cell membrane. **(K2)**
4. Outline the basic ideas on signaling process through the receptors. **(K2)**
5. Experiment with eukaryotic cell for the isolation and characterization of mitochondria and chloroplast. **(K3)**

UNIT-I CELLULAR ARCHITECTURE **9h**

History, Basic properties of cell, comparison of eukaryotic and prokaryotic cells, Structure of prokaryotic cells - cilia, flagella, cell wall; Structure and function of eukaryotic cell organelles: cytoplasm, endoplasmic reticulum, mitochondria, chloroplast, peroxisomes, nucleus, membrane organization, theories, components.

UNIT-II CYTOSKELETAL PROTEINS & CELL DIVISION **9h**

Cell-cell interaction, Cytoskeletal proteins - Types, contractile proteins - actin & myosin, cell adhesion proteins; extracellular matrix; Types of cell division: mitosis & meiosis, Cell cycle, Checkpoints in cell cycle.

UNIT-III TRANSPORT ACROSS CELL MEMBRANES **9h**

Diffusion, osmosis, Passive & active transport, Permeases, sodium potassium pump, Ca_2^+ ATPase pumps, lysosomal and vacuolar membrane ATP dependent proton pumps, co-transport, ABC transport, symport, antiport; endocytosis and exocytosis; Entry of viruses and toxins into cells.

UNIT-IV CELL SIGNALLING **9h**

Cytosolic, nuclear and membrane bound receptors, examples of receptors, Signal transduction by hormones, secondary messengers, autocrine, paracrine and endocrine modes of action, programmed cell death-apoptosis.

UNIT- V FUNCTIONS OF MITOCHONDRIA AND CHLOROPLAST **9h**

Chloroplast: photosynthetic stages and light-absorbing pigments, Mitochondria: Electron transport chain, Reduction Potentials of Electron Carriers, oxidative phosphorylation, ATP synthesis, cell lines.

Total : 45 h

ii) Laboratory

List of experiment

1. Laboratory Safety and Aseptic Techniques
2. Identification of given plant, animal and bacterial cells and their components by microscopy.
3. Staining Techniques: Giemsa Leishmann staining.
4. Staining for different stages of mitosis in *Allium cepa* (Onion).
5. Identification of different types of blood cells
6. Isolation of chloroplasts from spinach leaves.
7. Quantitative analysis of lipid classes by TLC
8. Cell fractionation
9. Isolation of Mitochondria

Total : 30 h

Text Books

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). MolecularBiology of the Cell, Garland PUB.
3. Benjamin. A. pierce. (2016).Genetics a conceptual approach., Published by W. H. Freeman.
4. Venkata. R., Prakash.D. (2015). Key Notes on Genetics and Plant Breeding. Astral International publishers.

Reference Books

1. De Robertis. E.D.P. and De Robertis E.M.F. (2005). Cell and Molecular biology. B.I publications Pvt Ltd.
2. James. D. W., Baker.T., Bell Stephen.P., Gann Alexander., Levine Michael., and Losick Richard.(2004) Molecular Biology of the Gene.

Web Links

1. https://microbiologyinfo.com/

2. https://microbenotes.com/

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	1	-	2	2	-	1	2	-
CO2	2	1	-	-	-	1	-	2	2	-	-	2	-
CO3	2	1	-	-	-	1	-	2	2	-	-	2	-
CO4	2	1	-	-	-	1	-	2	2	-	-	2	-
CO5	3	2	1	-	-	1	-	2	2	-	-	2	-
Avg.	**2.2**	**1.2**	**1**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**1**	**2**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTMC351G **SEMESTER-III**

APTITUDE AND REASONING **1H - 0C**

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

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for the students to

- Categorize, apply, and use thought processes to distinguish between concepts of Quantitative methods.
- Prepare and explain the fundamentals related to various possibilities and probabilities related to quantitative aptitude.
- Understand and solve puzzle-related questions from specific and other competitive tests.

Course Outcomes

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

1. Understand the basic concepts of quantitative ability
2. Understand the basic concepts of logical reasoning Skills
3. Acquire satisfactory competency in the use of reasoning
4. Solve campus placements aptitude papers covering Quantitative Ability, Logical
5. Gaun Reasoning Ability Compete in various competitive exams like CAT, CMAT, GATE, GRE, GATE, UPSC, GPSC etc

UNIT - I 1. Quantitative Ability (Basic Mathematics)

1.1. Number Systems
1.2. LCM and HCF
1.3. Decimal Fractions
1.4. Simplification
1.5. Square Roots and Cube Roots
1.6. Problems on Ages
1.7. Surds & Indices
1.8. Percentages

UNIT – II 2. Quantitative Ability (Applied & Engineering Mathematics)

2.1. Logarithm
2.2. Permutation and Combinations
2.3 Probability
2.4 Profit and Loss
2.5 Simple and Compound Interest
2.6. Time, Speed and Distance
2.7. Time & Work
2.8. Ratio and Proportion
2.9. Area
2.10 Mixtures and Allegation

UNIT – III 3. Verbal - Aptitude

1.1 Words
1.2 Idioms
1.3 Phrases in Context
1.4 Reading comprehension techniques
1.5 Narrative sequencing
1.6 Data interpretation

Textbooks:

1. A Modern Approach to Verbal &Non-Verbal Reasoning by R S Agarwal
2. Analytical and Logical Reasoning by Sijwali B S
3. Quantitative aptitude for Competitive examination By R S Agarwal
4. Analytical and Logical Reasoning for CAT and other management entrance tests By Sijwali B S
5. Quantitative Aptitude by Competitive Examinations by Abhijit Guha 4th edition

WEBSITES

1. https://prepinsta.com/
2. https://www.indiabix.com/
3. https://www.javatpoint.com/

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	-	-	-	-	-	-	3	-	-
CO4	3	2	1	-	-	-	-	-	-	-	3	-	-
CO5	3	2	1	-	-	-	-	-	-	-	3	-	-
Avg.	**2.8**	**1.8**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	-	**3**	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

25BTBT391 INTERNSHIP-I / FIELD PROJECT 2H-1C

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

End Semester Exam: 3 Hours

Minimum of three 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 or field project 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.

25BTBT311 **SEMESTER-III**

SKILL DEVELOPMENT-I **2H-1C**

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

End Semester Exam: 3 Hours

Students have to undergo skill-oriented courses offered in latest engineering trends from reputed industries

PRE-REQUISITES: None

Course Objectives

The goal of this course for the students is to

- Acquire experience with techniques and instrumentation related to new technologies.
- Identify technical skills required for developing, implementing and production of a product.
- Develop practical solutions to demonstrate the effective use of new technologies to address the key life science related problems

Course Outcomes

Upon completion, the students will be able to

1. Interpret proficiency in implementing industry best practices in job-related tasks. **(K2)**
2. Build skills to generate and validate new ideas and drive innovation within startups or existing businesses. **(K3)**
3. Develop the ability to adapt emerging technologies relevant to business and research contexts **(K3)**
4. Utilize research skills necessary for higher studies and research projects. **(K3)**
5. Make use of emerging technologies to solve complex life science problems. **(K3)**

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	2	-	1	2	2	-	2	2	1
CO2	3	2	1	1	2	-	1	2	2	-	2	2	1
CO3	3	2	1	1	2	-	1	2	2	-	2	2	1
CO4	3	2	1	1	2	-	1	2	2	-	2	2	1
CO5	3	2	1	1	2	-	1	2	2	-	2	2	1
Avg.	**2.8**	**1.8**	**1**	1	2	**-**	1	2	2	-	2	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

SEMESTER-IV

25BTHS401	**SEMESTER-IV**
BIOSTATISTICS	**4H-4C**
Instruction Hours/week: L:3 T:1 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 is to

- Gain knowledge in various methods of data collection.
- Provide the required fundamental concepts of probability theory and Random variables.
- Inculcate the knowledge of Measures of Central tendencies, Dispersions and testing of hypothesis using small and large sampling tests.
- Introduce the basic concepts of classifications of design of experiments.

Course Outcomes

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

- Illustrate the data set graphically to display the given information**. (K2)**
- Explain the fundamentals of probability and standard distributions. **(K2)**
- Make use of statistical data for finding the measures of central tendency and measures of dispersion. **(K3)**
- Apply small and large samples tests in Biometric experiments. **(K3)**
- Utilize analysis of variance in completely randomized design, Randomized block design and Latin square design. **(K3)**

UNIT I DATA COLLECTION **12**

Definition, scope, functions and limitations of Statistics – Collection, Classification, Tabulation of data, Diagrammatic representation of data – Simple, Multiple and Percentage Bar diagram, Pie diagram and Graphical representation of data – Histogram, frequency polygon, frequency curve and ogives. Primary and Secondary data – Questionnaire method.

UNIT II PROBABILITY AND RANDOM VARIABLES **12**

Concept of Probability – Conditional probability – Total Probability – Baye's theorem and its applications – One dimensional Random Variables (Discrete and Continuous) – Mathematical Expectation -Distributions – Binomial, Poisson and Normal - Applications of Binomial and Normal distributions - Applications to Biological Studies

UNIT III DESCRIPTIVE STATISTICS **12**

Measures of central tendency —Measures of Dispersions — Measures of Skewness – Pearson's, Bowley's method. Measure of Bivariate data – Simple, Partial and Multiple Correlation. Scatter diagram, Pearsons's method and Rank correlation method. Regression and their equations.

UNIT IV SAMPLING THEORY **12**

Test of hypothesis – Large sample tests based on normal distribution – Test for single mean – Difference between means – Proportion – Difference between proportion – Small sample test – Student-t test – Test for single mean – Difference between means – Snedecor's F test – Chi-square test for goodness of fit, independence of attributes. Applications to Biometric experiments.

UNIT V DESIGN OF EXPERIMENTS **12**

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

Total: 60 h

TEXT BOOKS:

1. Gupta, S.P. (2011) Statistical Methods, Sultan Chand & Sons, Pvt. Ltd, New Delhi.
2. Gupta, S.C and V.K. Kapoor, (2011) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Pvt. Ltd, New Delhi
3. Darren George, Paul Mallery (2011) SPSS for Windows, 10th Edition, PEARSON.
4. Geoffrey Grimmett and David Stirzaker, Probability and Random Processes, Oxford University Press, Fourth Edition, 2020.
5. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson, Eighth Edition, 2019.

REFERENCE BOOKS:

1. Irwin Miller and Marylees Miller, John E Freund's Mathematical Statistics with Applications Pearson, Eighth Edition, 2014.
2. Sheldon M Ross, Introduction to Probability and statistics for Engineers and scientists Elsevier, Fourth Edition, 2014.
3. Douglas C. Montgomery & George C. Runger, Applied Statistics and Probability for Engineers, John Wiley, Sixth Edition, 2016.

WEB URLs:

1. https://onlinecourses.nptel.ac.in/noc23_ge25/preview
2. https://nptel.ac.in/courses/111106112
3. https://nptel.ac.in/courses/111104032
4. https://nptel.ac.in/courses/111105042
5. https://nptel.ac.in/courses/103106120

CO PO MAPPING:

CO - PO Mapping:													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO.1	2	1	-	-	-	-	-	-	-	-	1	1	-
CO.2	2	1	-	-	-	-	-	-	-	-	1	1	-
CO.3	3	2	1	-	-	-	-	-	-	-	1	1	-
CO.4	3	2	1	-	-	-	-	-	-	-	1	1	-
CO.5	3	2	1	-	-	-	-	-	-	-	1	1	-
AVG	2.6	1.6	1	-	-	-	-	-	-	-	1	1	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-IV

25BTBT402 CHEMICAL AND BIOCHEMICAL THERMODYNAMICS 4H-4C

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

End Semester Exam: 3 Hours

Prerequisite: Principles of Chemical Engineering

Course Objectives

The goal of this course is for students to

- Explain the thermodynamic properties of fluids.
- Illustrate the phase equilibria concepts for various systems.
- Outline the equilibrium criteria for various chemical reactions.
- Apply the thermodynamic principle in biological system.

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Course Outcomes

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

1. Summarize various properties of the fluids. **(K2)**
2. Outline the concept of solution thermodynamics and composition models. **(K2)**
3. Solve phase equilibria for different component system. **(K3)**
4. Identify the chemical reaction equilibria and equilibrium conversion for a solution. **(K3)**
5. Apply the chemical thermodynamic principles in biological system. **(K3)**.

UNIT-I BASIC CONCEPTS IN CHEMICAL THERMODYNAMICS 12h

First and second law of thermodynamics, calculation of work, energy and property changes in reversible processes, thermodynamics of flow processes, power cycles (rankine, regenerative, reheat); liquefaction and refrigeration cycle.

UNIT-II THERMODYNAMIC PROPERTIES OF FLUIDS 12h

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

UNIT- III SOLUTION THERMODYNAMICS 12h

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- IV PHASE & CHEMICAL REACTION EQUILIBRIA **12h**

Criteria - phase equilibria; V-L-E calculations for binary and multi component systems; liquid-liquid equilibria, evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant

UNIT- V BIOLOGICAL THERMODYNAMICS **12h**

Energy coupling reactions: Thermodynamics and feasibility. Thermodynamic analysis of metabolic pathways: Glucose metabolism, Photosynthesis. - Thermodynamics of Protein folding and unfolding: Gibbs energy, entropy and melting temperature. - Thermodynamic analysis of fermentation process: Degree of reduction, Feasibility analysis of process.

Total : 60h

Text Books

1. Smith. J.M., Van Ness H.C. and Abbot. M.M. (2012). Chemical Engineering Thermodynamics. McGraw-Hill.
2. Narayanan. K.V. (20013). A Text Book of Chemical Engineering Thermodynamics. PrenticeHall India.

Reference Books

1. Sandler. S.I. (2017). Chemical and Engineering Thermodynamics. John Wiley.
2. Stockar. U.V., Luuk A.M. and Wielen V.D. (2013). Biothermodynamics: The Role of Thermodynamics in Biochemical Engineering. EPFL Press.

Web Links

1. https://chem.libretexts.org/Bookshelves/General_Chemistry/

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	1	-	-	2	-
CO2	2	1	-	-	-	-	-	-	1	-	-	2	-
CO3	3	2	1	-	-	-	-	-	1	-	-	2	-
CO4	3	2	1	-	-	-	-	-	1	-	-	2	-
CO5	3	2	1	-	-	-	-	-	1	-	-	2	-
Avg.	**2.6**	**1.6**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**2**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-IV

25BTBT403 **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

Prerequisite: Introduction to Biotechnology, Microbiology

Course Objectives

The goal of this course is to

- Understand the scope and basics of biotechnology in India.
- Explain the structure and functions of cells, biomolecules, and growth requirements of microbes.
- Describe the applications of biotechnology in different fields.
- Discuss the regulations and ethical issues related to biotechnology research and development

Course Outcomes

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

1. Summarize the scope and basics of biotechnology. **(K2)**
2. Outline the basics of cell structure, classification of molecules, and its functions**. (K2)**
3. Explain the growth media used for the large-scale production of microbial growth. **(K2)**
4. Infer the applications of biotechnology in different fields. **(K2)**
5. Illustrate the biotechnology regulations, policies, and ethical issues. **(K2)**

UNIT I- INTRODUCTION TO INDUSTRIAL BIOPROCESS **9h**

Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Traditional and modern biotechnology, industrially important organisms, fermentation processes – Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

UNIT II - PRODUCTION OF PRIMARY METABOLITES **9h**

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

UNIT III- PRODUCTION OF SECONDARY METABOLITES **9h**

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

UNIT IV- PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9h

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 9h

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).

Total :45 h

Text Books:

1. Casida Jr. L.E. (2019). Industrial Microbiology. New Age International Private Limited, India.
2. Reed G. (2004). Prescott & Dunn's Industrial Microbiology. 4th Edition. CBS Publishers, India.
3. Cruger. W. (2017). Crueger's Biotechnology: A Textbook of Industrial Microbiology. 3rd Edition. Medtech: scientific international, India.

Reference books

1. Dubey. R.C. (2014). Text book of Biotechnology. 5th Edition. S Chand Publishers, India.

Web Links

1: https://archive.nptel.ac.in/courses/102/105/102105058/

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	1	1	-	1	2	1
CO2	2	1	-	-	-	-	-	1	1	-	1	2	1
CO3	2	1	-	-	-	-	-	1	1	-	1	2	1
CO4	2	1	-	-	-	-	-	1	1	-	1	2	1
CO5	2	1	-	-	-	-	-	1	1	-	1	2	1
Avg.	2	1	-	-	-	-	-	**1**	**1**	-	**1**	2	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-IV

25BTBT404 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

Prerequisite: **NIL**

Course Objectives

The goal of this course is for students to

- Outline the requirements and guidelines of 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. Infer the requirements for GMP and GLP. **(K2)**
2. Summarize the upgraded personnel to maintain GMP. **(K2)**
3. Outline diverse properties production area and equipment. **(K2)**
4. Recall the design for the correct documentation. **(K2)**
5. Apply the knowledge on quality control department. **(K3)**

UNIT - I INTRODUCTION AND GUIDELINES 9h

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), WHO guidelines on GLP and GMP-Introduction to ICH guidelines and their usage. Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies, Formulation, Production Management, Authorization and marketing of drugs.

UNIT - II PERSONNEL 9h

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 9h

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 **9h**

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 **9h**

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.

Total : 45 h

Text Books

1. Emmet P. Tobin. (2016). cGMP starter guide: Principles in Good Manufacturing Practicesfor Beginners. Createspace Independent Publishing Platform.
2. B Cooper. (2017). Good Manufacturing Practices for Pharmaceuticals: GMP in Practice.Createspace Independent Publishing Platform.

Reference Books

1. Sarwar Beg and Md Saquib Hasnain. (2019). Pharmaceutical Quality by design: Principles andapplication. Academic press.
2. 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.
3. Andrew Teasdale, David Elder, Raymond W. Nims. (2017). ICH quality guidelines-Animplementation guide.

Weblink

1. https://www.ich.org/page/ich-guidelines

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	1	-	-	1	-	1	2	1
CO2	2	1	-	-	-	1	-	-	1	-	1	2	1
CO3	2	1	-	-	-	1	-	-	1	-	1	2	1
CO4	2	1	-	-	-	1	-	-	1	-	1	2	1
CO5	3	2	1	1	-	1	-	-	1	-	1	2	1
Avg.	2.2	1.2	1	1	-	1	-	-	1	-	1	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-IV

25BTBT441 **BIOANALYTICAL TECHNIQUES** **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

Prerequisite Nil

i) Theory

Course Objectives

The goal of this course is for students to

- Understand fundamental principles and applications of bioanalytical techniques.
- Develop practical skills in handling various bioanalytical instruments and techniques.
- Analyze and interpret data to analyze and interpret experimental data.

Course Outcomes

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

1. Apply the basic radiation concepts in quantification of biomolecules **(K3)**
2. Outline the advance microscopy techniques involved imaging. **(K2)**
3. Identify suitable chromatography technique for analysis of biomolecules. **(K3)**
4. Utilize electrochemistry for the separation of biomolecules **(K3)**
5. Infer the working mechanism of real time analytical techniques. **(K2)**

UNIT-I SPECTROSCOPY **9h**

Overview of Bioanalytical Techniques, Concepts of chromophores, auxochromes, energy bands; Beer Lambert law, Deviation from Beer Lambert law, Working Principle, Instrumentation and Applications- Absorption and Emission Spectroscopy, UV-Visible, Infrared, Raman spectroscopy.

UNIT-II MICROSCOPY TECHNIQUES **9h**

Introduction to optics, digital imaging; Phase Contrast and Differential Interference Contrast (DIC) Microscopy, Super-Resolution Microscopy-STED (Stimulated Emission Depletion), Stochastic Optical Reconstruction Microscopy (STORM) and PALM (Photo Activated Localization Microscopy), Cryo-Electron Microscopy (Cryo-EM), Fluorescence Lifetime Imaging Microscopy (FLIM), Atomic Force Microscopy

UNIT-III CHROMATOGRAPHY TECHNIQUES **9h**

General description and classification of Chromatography - Theory, instrumentation and Applications of the following chromatographic techniques: Ion-Exchange, Affinity, Hydrophobic, Size exclusion, FPLC, HPLC: Detectors, Columns and applications; Gas

Chromatography – FID, MS, LC/MS, MS/MS

UNIT-IV ELECTROPHORESIS AND ELECTROCHEMISTRY **9h**

Concept and Application - Agarose, SDS and Native PAGE, Isoelectric Focusing, Isotachophoresis, Pulsed Field Gel Electrophoresis, Capillary Electrophoresis; Electrochemistry, Electrochemical Cells, Ion Selective Electrodes, Patch Clamp Techniques

UNIT- V REAL TIME ANALYTICAL TECHNIQUES **9h**

Introduction of real time analytical techniques - Proteomics, MS and NMR based Metabolomics, X-ray crystallography. DNA and RNA sequencing for genomics, PCR for transcriptomic, Real time PCR, qRT-PCR, Droplet PCR, Surface Plasmon Resonance (SPR), High content screening. Analysis of cell culture, cell solving FASC

Total : 45 h

(ii) Laboratory

List of experiment

1. Determination of maximum wavelength of $KMNO_4$ using spectrophotometer.
2. Absorption spectrum of plant pigments.
3. Analysis of FTIR data
4. Separation and identification of amino acid using paper chromatography
5. Separation and identification of amino acid using TLC
6. Molecular Weight Determination using Native PAGE
7. Isoelectric focusing for commercial enzymes/ proteins
8. Protein purification using gel filtration chromatography.
9. DNA amplification using PCR

Total : 30 h

Text Books

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.

Reference Books

1. Barbar Stuart, 2004, Infrared Spectroscopy Fundamentals and Applications, Wiley online library.
2. Richard L. McCreery, 2000, Raman Spectroscopy for Chemical Analysis, Wiley online library.
3. Harald Gunther, 2013, NMR spectroscopy, 3rd Edition, Wiley.

Weblink

1. www.labcompare.com/Laboratory-Analytical-Instruments/

CO / PO Mapping

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

CO No'	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	1	1	-	1	-	2
CO2	2	1	-	-	-	-	-	-	1	-	-	-	2
CO3	3	2	1	-	-	-	-	1	1	-	1	-	2
CO4	3	2	1	-	-	-	-	1	1	-	1	-	2
CO5	2	1	-	-	-	-	-	-	1	-	-	-	2
Avg.	**2.6**	**1.6**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**1**	**-**	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-IV

25BTBT442 **GENETIC ENGINEERING** **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

Prerequisite: Molecular Biology and Genetics

i) Theory

Course Objectives

The goal of this course is to

- Understand the basic concept in rDNA technology and importance of recombinant molecules in rDNA technology.
- Outline the concept involved in gene library construction and differentiate between different gene libraries.
- Explain the different types of PCR and importance of DNA sequencing methods.

Course Outcomes

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

- Discuss about the basic concepts in rDNA technology. (**K2)**
- Infer the recombinant molecules in research and development. **(K2)**
- Utilize gene library construction to create collection of cloned DNA. (**K2)**
- Apply the principles of PCR reactions for DNA amplification. (**K3)**
- Identify the importance of DNA sequencing methods**. (K3)**

UNIT I - BASICS OF RECOMBINANT DNA TECHNOLOGY **9h**

Genetic elements that control gene expression in prokaryotes and eukaryotes. Repressors and promoters-methods of creating DNA molecules, Isolation and separation of genomic and plasmid DNA; restriction and modifying enzymes, safety guidelines of recombinant DNA research.

UNIT II - CREATION OF RECOMBINANT MOLECULES **9h**

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 **9h**

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 –POLYMERASE CHAIN REACTION AND SEQUENCING **9h**

DNA amplification, primer synthesis – Taq polymerase – Types of PCR -Inverse PCR, Nested PCR, Real-time PCR/qPCR; SYBR green assay, RACE PCR, RAPD, Taqman assay, Molecular beacons, site directed mutagenesis (Kunkels Method) - methods of nucleic acid sequencing- Sangers method.

UNIT V –APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 9h

Applications of recombinant DNA Technology in agriculture, pharmaceutical industry and medicine- knockout animals, Production of novel products, Antisense technology - transgenic animals - embryo transfer eg.Dolly : Cloning in plants, Ti plasmid, Methods of producing transgenic animals and their applications, gene therapy.

Total : 45 h

ii) Laboratory

List of experiment

1. Isolation of plasmid DNA and genomic DNA from bacterial cell
2. Isolation of RNA
3. Purification of DNA from agarose gel
4. Restriction enzyme digestion and ligation
5. Protein isolation using SDS PAGE
6. Western blotting
7. Polymerase Chain Reaction
8. Competent cells preparation ($CaCl_2$ method)
9. Transformation and screening for recombinants- Blue white screening assay

Total : 30h

Text Books

1. Primrose. S.B. and Twyman. R.M. (2006). Principles of GeneManipulation 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.

Reference Books

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.

Weblinks

1. https://www.genome.gov/genetics-glossary/Genetic-Engineering

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	1	-	2	2	-	1	2	1
CO2	2	1	-	-	-	1	-	2	2	-	1	2	1
CO3	3	2	1	-	-	1	-	2	2	-	1	2	1
CO4	3	2	1	-	-	1	-	2	2	-	1	2	1
CO5	3	2	1	-	-	1	-	2	2	-	1	2	1
Avg.	**2.6**	**1.6**	**1**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**1**	**2**	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester -IV

25BTMC451G FOUNDATION OF ENTREPRENEURSHIP 2H - 0C

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

End Semester Exam: 3 Hours

Prerequisite: Nil

Course Objectives

The goal of this course is for the students to

- Equip and develop the learners' entrepreneurial skills and qualities essential to undertake business.
- Impart the learner's entrepreneurial competencies needed for managing business efficiently and effectively.
- Understand basic concepts in the area of entrepreneurship
- Develop personal creativity and entrepreneurial initiative
- Adopt the key steps in the elaboration of business idea

Course Outcomes

Upon completion of this course the students will be able to

1. Summarize entrepreneurial competence to run the business efficiently. **(K2)**
2. Identify businesses in the entrepreneurial environment **(K3)**
3. Apply business plans and undertake feasible projects. **(K3)**
4. Plan efficiently in launching and develop their business ventures successfully **(K3)**
5. Organize the business effectively towards growth and development **(K3)**

Unit I Entrepreneurial Competence **3h**

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful Entrepreneurs – Knowledge and Skills of an Entrepreneur.

Unit II Entrepreneurial Environment **3h**

Business Environment - Role of Family and Society - Entrepreneurship Development

Unit III Business Plan Preparation **3h**

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership

UNIT IV Launching of Small Business **3h**

Finance and Human Resource Mobilization - Operations Planning - Market and Channel Selection - Growth Strategies

UNIT V Management of Small Business **3h**

Monitoring and Evaluation of Business - Effective Management of small Business - Case Studies.

Total : 15 h

Text Books

1. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2016.
2. R.D.Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2018.
3. Rajeev Roy ,Entrepreneurship, Oxford University Press, 2nd Edition, 2011.
4. Donald F Kuratko,T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning, 2012.

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	-	1	1	1	-	1	-	-
CO2	-	-	-	-	-	-	1	1	1	-	1	-	-
CO3	-	-	-	-	-	-	1	1	1	-	1	-	-
CO4	-	-	-	-	-	-	1	1	1	-	1	-	-
CO5	-	-	-	-	-	-	1	1	1	-	1	-	-
Avg.	-	-	-	-	-	-	1	1	1	-	1	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - IV

25BTMC452G ESSENCE OF TRADITIONAL INDIAN KNOWLEDGE AND HERITAGE **2H - 0C**

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

Pre- requisites: Nil

Course Objectives

The goal of this course is for the students to

- Impart a holistic understanding about Indian Culture and Thoughts from a Historical perspective.
- Encourage critical appreciation of the Indian thoughts and cultural manifestations.
- Gain knowledge of Indian heritage and cultural heritage on various epistemological inquiries.

Course Outcomes

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

1. Understand the cultural diversity **(K2)**
2. Infer the need of cultural unity **(K2)**
3. Summarize the Dravidian culture **(K2)**
4. Illustrate the power of the Indian educational system called gurukul **(K2)**
5. Outline the concepts of Vedic thought **(K2)**

UNIT I Introduction to Indian Thought and Culture **5**
Plurality of Indian Culture - Cultural Diversity and Cultural Unity -Different Manifestations of Indian Culture: Indus Valley culture -Vedic Culture and Dravidian culture.-The Medieval Bhakti Culture

UNIT II Traditional Knowledge Systems of India **5**
Introduction to the Traditional Indian Education System of Gurukul - Parampara -Understanding Indian Philosophy: Vedic Thought and the nine schools of Philosophy - Indigenous Knowledge and Women in India

UNUI III Protection of Traditional Knowledge **5**
Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, the value of TK in the global economy, Role of Government to harness TK.

Textbooks:

1. Chatterjee, Satishchandra, and Dhirendramohan Datta. (2007) Introduction to Indian Philosophy. Rupa Publications, New Delhi.
2. Husain,S. Abid. (2003). The National Culture of India. National Book Trust, New Delhi.

SEMESTER-IV

25BTBT411 **SKILL DEVELOPMENT- II** **2H-1C**

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

End Semester Exam: 3 Hours

Students have to undergo skill-oriented courses offered in latest engineering trends from reputed industries

PRE- REQUISITES: None

Course Objectives

The goal of this course for the students is to

- Acquire experience with techniques and instrumentation related to new technologies.
- Identify technical skills required for developing, implementing and production of a product.
- Develop practical solutions to demonstrate the effective use of new technologies to address the key life science related problems

Course Outcomes

Upon completion, the students will be able to

1. Interpret proficiency in implementing industry best practices in job-related tasks. **(K2)**
2. Build skills to generate and validate new ideas and drive innovation within startups or existing businesses. **(K3)**
3. Develop the ability to adapt emerging technologies relevant to business and research contexts **(K3)**
4. Utilize research skills necessary for higher studies and research projects. **(K3)**
5. Make use of emerging technologies to solve complex life science problems. **(K3)**

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	2	-	1	2	2	-	2	2	1
CO2	3	2	1	1	2	-	1	2	2	-	2	2	1
CO3	3	2	1	1	2	-	1	2	2	-	2	2	1
CO4	3	2	1	1	2	-	1	2	2	-	2	2	1
CO5	3	2	1	1	2	-	1	2	2	-	2	2	1
Avg.	**2.8**	**1.8**	**1**	1	2	**-**	1	2	2	-	2	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

SEMESTER-V

25BTBT501 FUNDAMENTALS OF 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

Prerequisite **:** Principles of Chemical Engineering

Course Objectives

The students will be able to

- Understand the basic principles of heat and mass transfer operations.
- Discuss the principles of heat exchangers and evaporation.
- Familiarize the basics of diffusion and mass transfer operations in liquid-gas and liquid-liquid systems.
- Explore the applications of heat and mass transfer in biological systems.

Course Outcomes

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

1. Build the basic concepts of heat transfer operations and different modes of heat transfer. **(K3)**
2. Identify the working process of heat exchangers and heat transfer concepts with phase change. **(K3)**
3. Apply the theories of diffusion and distillation principles in distillation unit design calculations. **(K3)**
4. Make use of the principles of gas liquid and liquid-liquid mass transfer operations to design absorber. **(K3)**
5. Apply the principles of heat and mass transfer mechanism to understand the working of bioreactor system. **(K3)**

UNIT - I BASICS OF HEAT TRANSFER OPERATIONS 12 h

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 12 h

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 singlevapour, drop wise condensation and film wise condensation and heat transfer to boiling liquids.

UNIT - III DIFFUSION AND LIQUID-VAPOUR MASS TRANSFER 12 h

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

UNIT - IV LIQUID-GAS/LIQUID MASS TRANSFER 12 h

Absorption: selection criteria for solvents, material balance, minimum liquid-gas ratio, calculations on circulation rate and composition; Industrial absorbers – types and characteristics, Liquid-liquid extraction-distribution co-efficient, ternary systems and triangular diagrams, solvent selection criteria for extraction, material balance calculations -single stage extraction, extraction equipment's.

UNIT-V APPLICATIONS OF HEAT AND MASS TRANSFER IN BIOLOGICAL SYSTEMS 12 h

Heat transfer in bioreactors, design of heat exchangers, 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.

Total: 60 h

Text Book:

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. Treybal R.E. (2017). Mass Transfer Operations. 3rd edition. McGraw-Hill, New Delhi, India.

References Books

1. McCabe, W.L., and Smith J.C. (2021). Unit Operations of Chemical Engineering. 7th edition. McGraw Hill, Singapore.
2. James Bailey & David Ollis (2017), Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill.

Web References

1. https://nptel.ac.in/courses/103103032
2. https://nptel.ac.in/courses/103103145
3. https://www.researchgate.net/publication/358073978

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	-	-	-	-	-	1	-	-	1	-
CO2	3	3	1	-	-	-	-	-	1	-	-	1	-
CO3	3	3	1	-	-	-	-	-	1	-	-	1	-
CO4	3	3	1	-	-	-	-	-	1	-	-	1	-
CO5	3	2	1	-	-	-	-	-	1	-	-	1	2
Avg.	3	2	1	-	-	-	-	-	1	-	-	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-V

25BTBT541 IMMUNOLOGY AND IMMUNOTECHNOLOGY 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

Prerequisite Nil

i) Theory

Course Objectives

The goal of this course is for students to

- Understand the basic knowledge of cells and organs of Immune system.
- Explain the different cellular responses and its functions.
- Outline the Immune responses to various disease and different immunologic reactionsin Human body.
- Explain the organ transplantation and tumor immunology.

Course Outcomes

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

1. Identify various cells and components of immune system. **(K3)**
2. Summarize the T cell and B cell functionality against an antigen **(K2)**
3. Make use of basic antibody antigen interaction to identify infection **(K3)**
4. Infer the concept of immunity and various immunological responses to infections **(K2).**
5. Experiment with immune assays to study the biomolecules interaction **(K3)**

UNIT-I INTRODUCTION 9h

Organization and classification of immune system: Cells of immune system & primary and secondary lymphoid organs, types of immune responses: innate and acquired immunity, Components of immune system: Types of antibodies, classification of antigens- chemical and molecular nature; haptens, adjuvants; cytokines, Allergens

UNIT-II CELLULAR RESPONSES 9h

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

UNIT-III INFECTION AND IMMUNITY 9h

Injury and inflammation; immune responses to infections, Complementary system, Transplantation: laws of transplantation, Graft rejection – Mechanisms; Allergy and

hypersensitivity – Types of hypersensitivity, Auto immune disorders and diagnosis

UNIT - IV IMMUNO PATHOLOGY **9h**

Preparation of storage of tissues- tissue processing, histology-preparation, straining method, immunohistology; identification of various cell types and antigens in tissues, fluroscenes activated cell sorting (FACS); cell isolation and characterization of cell types from inflammatory sites and infected tissues, immune cytochemistry – immuno fluoresecence.

UNIT-V IMMUNOTECHNIQUE **9h**

Isolation of immune cells from Human and animals; Antigen & antibody interaction-based techniques - precipitation reaction, agglutination reaction, Radio-immunoassay, ELISA, Western Blot, Immunoprecipitation, flow cytometry, immune electron microscopy; Classification of Vaccines, methods of vaccine development, immune modulatory drugs.

Total : 45h

i) Laboratory

List of experiments

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

Total : 30h

Text Books

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.

Reference Books

1. David W. Mount. (2004). Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press, U.S.
2. Chakravarty. A.K.. (2006). Immunology and Immunotechnology. 1st Edition. Oxford University Press.

Weblinks

1. https://www.immunology.org/public-information/what-immunology

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	-	-	-	1	1	-	1	-	2
CO2	2	1	-	-	-	-	-	-	1	-	-	-	2
CO3	3	2	1	-	-	-	-	1	1	-	-	-	2
CO4	2	1	-	-	-	-	-	-	1	-	-	-	2
CO5	3	2	1	-	-	-	-	1	1	-	-	-	2
Avg.	**2.6**	**1.6**	**1**	**-**	**-**	**-**	**-**	**1**	1	**-**	**1**	**-**	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-V

25BTBT542 **BIOINFORMATICS** **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

Prerequisite Nil

i) Theory

Course Objectives

The goal of this course is for students to

- Summarize the various algorithmic concepts involved in solving biological problems.
- Outline, analyze and interpret biological database, evolutionary and protein analysis using computational approaches.
- Provide an appropriate information on Pharmacy system, medical bioinformatics.
- Understand the fundamentals of machine learning techniques.

Course Outcomes

After successful completion of the course, the students should be able to

1. Utilize the knowledge of mathematics and science in biological sequence analysis **(K3)**
2. Apply the basics of computer in biological sequence data analysis. **(K3)**
3. Identify various interaction among protein molecules using various software tools. **(K3)**
4. Understand the role of informatics in pharmacy and medical field **(K3)**
5. Build the model of bio-based system using artificial neural networks. **(K3)**

UNIT - I BASICS OF BIOINFORMATICS & BIOLOGICAL DATABASES 9h

Introduction to Bioinformatics; Computers in Biology to understand Biological System; Introduction to Biological Databases Protein Sequence and Structural Databases; Nucleic acid databases; Genome databases; Specialized Databases; Carbohydrate Databases; Clinically relevant drug interactions databases; Information retrieval from Biological databases: Entrez system, TCGA data bases, Bioportal.

UNIT II : SEQUENCE ALIGNMENT 9h

Types of Sequence alignment: Pairwise and Global alignment, Local alignment, Dotplot; Multiple sequence alignment (MSA, Assessing the quality of an alignment, Profiles; Hidden Markov models, Phylogeny - Clustering method, Cladistics methods, Bootstrapping. Case study: Phylogenetic Analysis with a new distance measure

UNIT III : PROTEIN STRUCTURE ANALYSIS 9h

Protein stability and folding, Superposition of structures and structural alignments-DALI and

MUSTANG, Evolution of protein structure - classification, databases; Protein structure prediction and modeling - Aprori and Empirical methods; Secondary structure prediction, Homology modeling, foldrecognition, Protein structure comparison

UNIT IV MEDICAL AND PHARMACY INFORMATICS **9h**

Introduction to pharmacy informatics, Medical Transcription, Role of informatics to enhance the services provided by pharmaceutical care givers. Data standards in healthcare system; Health Data Management, Medical Coding, Telemedicine and Telehealth, Ethics in medical informatics, Informatics applications in pharmacy

UNIT V : APPLICATIONS IN BIOINFORMATICS **9h**

Artificial Neural Network – Perceptron, Characteristics of neural networks, Application of ANN, Microarray data analysis; Peptide mass fingerprinting; Introduction to Drug Discovery Process, Target Identification and Validation, Virtual Screening of lead compounds, Docking (Principles, Rigid and Flexible docking).

Total: 45h

ii) Laboratory:

List of experiments:

1. Biological Databases- Sequence Databases, Structure Databases, Specialized Databases; Data Retrieval tools and methods; Database file formats.
2. Pairwise alignment of sequence
3. Multiple sequence alignment- Dotplot analysis - Clustal OMEGA, ClustalX, ClustalW, T-Coffee.
4. Molecular visualization using Pymol and Chimera
5. Primer design using BLAST
6. Construction of phylogenetic tree - Maximum Parsimony & Maximum Likelihood method - NJ,UPGMA method – PHYLIP program
7. Protein sequence analysis -ExPASy proteomics tools.
8. Autodock

Total: 30h

Textbook:

1. Bioinformatics: Methods and Applications. United Kingdom, Elsevier Science, 2021.

2 Hasija, Yasha. All About Bioinformatics: From Beginner to Expert. Netherlands, Elsevier Science, 2023.

References Books

1. Rastogi, Parag, et al. Bioinformatics: Methods and Applications: Genomics, Proteomics and

Drug Discovery. India, Prentice Hall India Pvt., Limited.
2. Mallick, Bibekanand, and Ghosh, Zhumur. Bioinformatics: Principles and Applications. India, Oxford University Press, 2008.

WEBSITES

1: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1122955/
2: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6893424/
3: https://www.nature.com/articles/s41598-020-57916-9

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	-	-	-	1	1	-	1	-	2
CO2	3	2	1	-	1	-	-	-	1	-	1	-	2
CO3	3	2	1	-	1	-	-	-	1	-	-	-	2
CO4	3	2	1	-	1	1	1	1	1	-	-	-	2
CO5	3	2	1	-	1	1	-	1	1	-	1	-	2
Avg.	**3**	**2**	**1**	**-**	**1**	1	1	**1**	1	**-**	**1**	-	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

SEMESTER-V

25BTMC551 **CYBER SECURITY** **2H-0C**

Instruction Hours/week: L:2 T:0 P:0 **Marks: Internal:100 External:0 Total:100**
End Semester Exam:3 Hours

Prerequisite : Nil

Course Objectives

The goal of this course is for students to

- Understand the fundamental concepts of cyber-crime.
- Aware of tools used in the cyber security.
- Familiarize with various Indian IT Act in cyber-crime and cyber security

Course Outcomes

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

CO1:	Explain the basic concepts of cyber crime and its perspectives.	**K2**
CO2:	Summarize cryptographic encryption techniques	**K2**
CO3:	Outline the types of fraud techniques.	**K2**

UNIT I : Cyber Security Fundamentals **5**

Information Assurance Fundamentals – Authentication-Authorization-Nonrepudiation-Confidentiality-Integrity-Availability.

UNIT II : Cryptography **5**

Basic Cryptography- Symmetric Encryption- Example of Simple Symmetric Encryption with Exclusive OR (XOR)- Public Key Encryption

UNIT III : Fraud Techniques **5**

Phishing- Smishing- Vishing. Mobile Malicious Code-Phishing against Mobile Devices. Rogue Antivirus-Following the Money: Payments. Click Fraud-Pay-per-Click-Click Fraud Motivations- Click Fraud Tactics and Detection- Threat Infrastructure-Botnets-Fast-Flux.

TOTAL HRS : 15

TEXT BOOKS:

1.Introduction to Cyber Security, Guide to the world by Anand Shinde, Wiley Publisher, 2021

2. James Graham, Ryan Olson and Rick Howard, “Cyber Security Essentials”, First Edition, CRC Press, 2010.

WEBSITES:

1. www.lexology.com/library/
2. www.swayam.gov.in/nd2_ugc19_hs25/preview
3. www.educba.com/cyber-security-tools/

CO, PO, PSO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-		
CO2	2	2	1	-	-	-	-	-	-	-	-		
CO3	2	2	1	-	-	-	-	-	-	-	-		
Average	**2**	**1.6**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-V

25BTBT512 COMMUNITY ENGAGEMENT AND SOCIAL RESPONSIBILITY 3H-2C

Instruction Hours/ week: L: 1 T: 0 P: 2 **Marks:** Internal**: 100** External**: 0** Total**: 100**
End Semester Exam: 3 Hours

Course Objectives

The goal of this course is for students to

- Achieve socio economic development through active community engagement.
- Improve the quality of research for better understanding of issues in the society.
- Create awareness on the role of a citizen in improving the community and hence the nation

Course Outcomes

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

1. Interpret the role of community engagement in the development of the nation.
2. Infer the role of rural institutions and community involvement
3. Explain the social problems, social contribution of community networking and various government schemes supporting the community engagement.
4. Analyze the factors that mitigate the distress & disasters
5. Understand the role of Indian citizens towards community development by adopting a village and carrying out the field work

UNIT I **5**

Concept, Ethics and Spectrum of Community Engagement-Local community, Rural culture and Practice of community engagement. Stages, Components and Principles of community development, Utility of public resources – Contributions of self-help groups

UNIT II **5**

Rural Development Programs and Rural institutions- Local Administration and Community Involvement

UNIT III **5**

Social contribution of community networking, various government schemes– Programmes of community engagement and their evaluation.

UNIT IV **5**

Community Engaged Research and Ethics in Community Engaged Research- Rural Distress, Rural Poverty, Impact of COVID-19 on Migrant Laborers, Mitigation of Disaster.

UNIT V (Field Work) **5**

Service-learning: address the challenges of a specific community, Community-based Participatory Research (CBPR) approaches, Knowledge sharing and knowledge mobilization to the local community, social innovations by students

25h

REFERENCES:

1. Principles of Community Engagement, 2nd Edition, NIH Publication No. 11-7782, Printed June 2011.

WEB SITES:

1. https://onlinecourses.swayam2.ac.in/ugc23_ge04/preview

CO, PO, PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	3	1	1	-	-	3	-	-
CO2	-	-	-	-	-	3	1	1	-	-	3	-	-
CO3	-	-	-	-	-	3	1	1	-	-	3	-	-
CO4	-	-	-	-	-	3	1	1	-	-	3	-	-
CO5	-	-	-	-	-	3	3	3	3	3	3	-	-
Avg	-	-	-	-	-	3	1.4	1.4	3	3	3	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-V

25BTBT591 **INTERNSHIP-II / FIELD PROJECT** **2H-1C**

Instruction Hours/ week: L: 0 T: 0 P: 2 **Marks:** Internal**: 100** External**: 0** Total**: 100**
End Semester Exam: 3 Hours

Minimum of three 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

Semester - VI

25BTBT601 PHARMACEUTICAL TECHNOLOGY 3H-3C

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

Prerequisite **:** Nil

Course Objectives

The goal of this course is for students to

- Summarize the basic concepts of Biopharmaceutical Technology.
- Infer the various steps involved in drug action, mechanism and production of novel drugs
- Explain the key principle, types and applications of drug manufacturing process
- Outline the quality management system and GMP involved in biologic drug production

Course Outcomes

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

1. Summarize about the biopharmaceutical drug development and regulatory challenges. **(K2)**
2. Explain the key concept in drug action, metabolism and pharmacokinetics. **(K2)**
3. Apply the important principles in drug manufacturing process. **(K3)**
4. Identify the various process and application involved in drug manufacturing process. **(K3)**
5. Utilize the facility management for Biopharmaceutical production**. (K3)**

UNIT I – DRUG ACTIONS INTRODUCTION TO DRUGS 9h

Generics in Biopharma, definition of biologics, biosimilars, super biologics, Characteristics of high selling peptides and proteins, Biopharmaceutical classification system; developmental and regulatory challenges in biopharmaceutical drug development, Prerequisites for biosimilar development, Biosimilar market potential, small and large molecule protein.

UNIT II -METABOLISM AND PHARMACOKINETICS 9h

Drug Target; Mechanism of drug action; physico-chemical principle of drug metabolism; radioactivity;Pharmacodynamic and pharmacokinetic studies, Bioavailability.

UNIT III – PRINCIPLE OF DRUG MANUFACTURE 9h

Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oral liquids – vegetable drugs –topical application; preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques; quality management; GMP.

UNIT IV – MANUFACTURE OF DRUGS, PROCESS AND APPLICATION 9h

Process of manufacturing drug; Clean room and its classification, Scale up criteria, SCADA, Process development, production, formulation and sterile packing. Types of reaction process and special requirements for bulk drug manufacture.

UNIT V - CASE STUDIES 9h

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.

Total : 45h

Text Books

1. Crommelin Dwan J.A., Robert D. Sindelar and Bernd Meibohm. (2013). Pharmaceutical
2. Biotechnology: Fundamentals and application. Springer, 4th Edition.
3. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow. (2017). Biosimilar Drug Development, Drugs and Pharmaceutical Sciences. Volume 216. CRCPress.
4. 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.

Reference Books

1. Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development. (2018). Germany: Springer International Publishing.

Weblinks

1. https://www.drugs.com/medical-answers/many-biosimilars-approved-unitedstates-3463281/

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	1	-	-	-	2
CO2	2	1	-	-	-	-	-	-	1	-	-	-	2
CO3	2	1	1	-	-	1	1	-	1	-	1	-	2
CO4	2	1	1	-	-	1	1	-	1	-	1	-	2
CO5	2	1	-	-	-	1	-	-	1	-	1	-	2
Avg.	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**1**	1	**-**	**1**	**-**	**2.0**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VI

25BTBT641 **BIOPROCESS ENGINEERING** **5H-4C**

(Theory & Lab)

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

End Semester Exam: 3 Hours

Prerequisite Heat and Mass Transfer

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.
- Analyze the rheological parameters and scale up of fermentation process.
- Perform 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. **(K2)**
2. Experiment with the growth kinetics of microorganisms. **(K3)**
3. Identify various designs of bioreactor and its control mechanisms. **(K2)**
4. Solve the problems associated with scale up parameters for mixing requirements. **(K3)**
5. Make use of the simulation software for the design of bioreactors. **(K3)**

UNIT - I - INTRODUCTION OF BIOPROCESS ENGINEERING **12h**

Historical development of Bioprocess technology, Overview of bioprocessing: upstream, fermentation and downstream processing, General requirements and types of fermentation processes - aerobic and anaerobic fermentation process, solid-state and submerged fermentation. Modes of bioprocess - batch, fed-batch and continuous bioreactors, Immobilization systems.

UNIT - II - GROWTH KINETICS **12h**

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

UNIT - III - PROCESS DESIGN AND CONTROL OF BIOREACTORS **12h**

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).

UNIT - IV - RHEOLOGY AND SCALE UP OF FERMENTATION 12h

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

UNIT - V – MODELING AND SIMULATION IN BIOPROCESS TECHNOLOGY 12h

Introduction to Process Analytical Technology (PAT) and Quality by Design (QbD). Simulation: Types of simulation, Simulation tools and software's (Aspen Plus, MATLAB, COMSOL, BioSolve, SuperPro Designer), Modeling approaches (DOE, MATLAB), assumptions, and validation. Dynamic modeling, Application of modelling and simulation in bioprocess industries

Total :60 h

ii) Laboratory:

List of experiments

1. Enzyme immobilization techniques
2. Microbial growth kinetics and estimation of cell mass
3. Product formation kinetics in a fermentation process
4. Enzyme kinetics in immobilized and free enzyme system
5. Measurement of viscosity using drop method
6. Effect of additives on the rheological properties (with respect to viscosity and foaming)
7. Effect of mixing and agitation in bioreactors
8. Estimation of volumetric oxygen transfer coefficient using Sulphur oxidation method
9. Simulation of batch reactors using software

Total : 30 h

Text Books

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.

Reference Books

1. Bailey J.E. and Ollis D.F. (2015). Biochemical Engineering Fundamentals. 2nd Edition. Tata McGraw-Hill.
2. Pauline M. Doran. (2013). Bioprocess Engineering principles. 2nd Edition. Elsevier.
3. Blanch H.W. and Clark D.S. (2012). Biochemical Engineering. 2nd Edition. Marcel Dekker.

Weblink

1. https://onlinecourses.nptel.ac.in/noc22_bt19/preview

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	2	1	-	-	2	-
CO2	3	2	1	1	-	-	-	2	1	-	-	2	-
CO3	3	2	1	-	-	-	-	2	1	-	-	2	-
CO4	3	2	1	-	-	-	-	2	1	-	-	2	-
CO5	3	2	1	-	1	-	-	2	1	-	-	2	1
Avg.	**2.8**	**1.8**	**1**	**1**	**-**	**-**	**-**	2	1	**-**	**-**	**2**	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VI

25BTBT642 ANIMAL AND PLANT BIOTECHNOLOGY 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

Prerequisite Cell Biology

i) Theory

Course Objectives

The goal of this course is to

- Describe the basic view of animal cell culture and scale up
- Explain the manipulation of embryos and concept of transgenic animals
- Discuss the concepts of plant tissue culture for crop improvement

Course Outcomes

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

1. Identify the methods used to culture animal cell. **(K3)**
2. Summarize the breeding of farm animals through micromanipulation of embryos. **(K2)**
3. Apply the concept of plant tissue culture for crop improvement. **(K3)**
4. Infer the role of vectors in genetic transformation in plants. **(K2)**
5. Make the use of basic concepts of biotechnology for the development of transgenic animals and plants. **(K3)**

UNIT I - ANIMAL CELL CULTURE **9h**

History of Animal Cell Culture, nutritional requirements, Culture Media and Growth Conditions, Primary culture, Suspension Culture, Characterization and maintenance of cell lines: Cryopreservation, Cell Culture Contamination, Cell Proliferation and Viability Assays Transfection and Transformation of Cells. Hybridoma Technology, Cell culture reactors

UNIT II - MICROMANIPULATION OF EMBRYOS & TRANSGENIC ANIMALS 9h

Introduction to Micromanipulation and Transgenic Technologies, Fundamentals of Embryo Development, Generation of Transgenic Animals – Overview, Methods of transgene delivery, Gene Targeting and Knockout Models Animal Pharming, Organ Culture, Regenerative Medicine, Human Embryonic Stem Cell research, Ethical Concerns and Biosafety.

UNIT III - PLANT TISSUE CULTURE **9h**

History of plant tissue culture, Laboratory setup for a typical plant tissue culture facility. Sterilization methods. Types of nutrient media and plant growth regulators in plant regeneration. Pathways for *in vitro* regeneration; protoplast isolation, culture and regeneration; culture of other explants, somatic hybridization; Methods for Plant Conservation,

Cryopreservation, synseed production. Application of tissue culture for crop improvement

UNIT IV - PRINCIPLES AND METHODS OF GENETIC TRANSFORMATION 9h

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. Marker-free transgenics and environmental.

UNIT V MOLECULAR FARMING 9h

Transgenic crops for production of antibodies, viral antigens and peptide hormones in plants, Edible vaccines and Nutraceuticals. Plant Biotechnology for biofuels. Case studies pertinent to Indian scenario

Total : 45h

ii) Laboratory

List of Experiments:

1. Preparation of reagents and media for cell culture
2. Maintenance of Adherent (Monolayer)
3. Cell Viability Assay (MTT reagent)
4. Cell Cytotoxicity Assay (Trypan Blue Assay)
5. Preparation and sterilization of standard plant tissue culture media.
6. Sterilization of explants
7. Generation of undifferentiated mass of cells (Callus).
8. Regeneration of plants from undifferentiated cells (Callus).

Total: 30h

Text Books:

1. Freshney R.I. (2016). Culture of Animal Cells. 7th edition, Wiley-Blackwell.
2. George Acquaah. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing.
3. Razdan M.K. (2003). An introduction to Plant Tissue culture. Oxford & IBH Publishing Co, NewDelhi.
4. Adrian Slater, Nigel W. Scott, Mark R. Fowler. (2008). Plant Biotechnology: An Introduction toGenetic Engineering. Oxford University Press.

Reference Books:

1. Singh, B., Mal, G., Gautam, S. K., & Mukesh, M. (2019). Advances in Animal Biotechnology.Springer International Publishing.
2. Prasad, B. D., Sahni, S., Kumar, P., & Siddiqui, M. W. (Eds.). (2017). Plant

Biotechnology, Volume1: Principles, Techniques, and Applications. CRC Press.

Weblinks

1. https://www.onlinebiologynotes.com/animal-cell-culture/
2. https://www.plantcelltechnology.com/blogadvantages-and-disadvantages-of-plant-tissue-culture/

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	1	-	1	2	2	-	1	1	2
CO2	2	1	-	-	-	1	1	2	2	-	1	-	2
CO3	3	2	1	-	1	1	1	2	2	-	1	1	2
CO4	2	1	-	-	-	1	1	2	2	-	1	-	2
CO5	3	2	1	-	1	-	1	2	2	-	1	1	2
Avg.	**2.2**	**1.2**	**1**	**-**	**1**	**1**	1	**2**	**2**	**-**	1	**1**	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VI

25BTBT643 ENZYMOLOGY AND ENZYME TECHNOLOGY 5H-4C
(Theory and Lab)

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

End Semester Exam: 3 Hours

Prerequisite Biochemistry

i)Theory

Course Objectives

The goal of this course is for students to

- Understand the fundamental principles of enzymology and enzyme kinetics.
- Learn about the methods used to characterize and manipulate enzymes.
- Explore the applications of enzymes in industrial processes and biotechnology.

Course Outcomes

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

1. Summarize the basics of the enzymology. **(K2)**
2. Identify various extraction, purification and characterization of enzymes strategies. **(K3)**
3. Experiment with the kinetics of substrate enzyme action. **(K3)**
4. Select suitable enzyme immobilization techniques with respect to its application in bioreactor. **(K3)**
5. Utilize bioinformatics tools to analyze enzyme functionality based on predicted structures. **(K3)**

UNIT-I INTRODUCTION TO ENZYMES **9h**

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 **9h**

Strategies used for enzyme production, isolation and purification at laboratory and industrial scale from plant, animal and microbial sources, method of calculating the purification fold; estimation of enzyme activity; characterization of an enzyme, criteria of enzyme purity, determination of the molecular weight (MW) and the number of sub-units of an enzyme; development of enzymatic assays.

UNIT-III KINETICS OF MULTISUBSTRATE-ENZYME ACTION **9h**

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 **9h**

Enzyme immobilization, Physical and chemical methods of immobilization, applications, advantages and disadvantages, Mass transfer in immobilized system Immobilized enzyme bioreactors.

UNIT- V ENZYME ENGINEERING AND BIOSENSORS **9h**

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

Total : 45 h

ii) Laboratory

List of experiments

1. Extraction of enzymes (peroxidase)
2. Extraction of amylase from plants materials
3. Determination of α-amylase activity
4. Effect of temperature on enzyme activity
5. Effect of pH on enzyme activity.
6. Determination of K_m and V_{max}
7. Enzyme inhibition kinetic assay
8. Partial purification of enzymes
9. Immobilization of enzymes.
10. Enzymatic assay using molar adsorbility

Total : 30 h

Text Books

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.

Reference Books

1. Blanch. H.W. and Clark. D.S. (1996). Biochemical engineering. Marcel Dekker Inc.
2. Pye E.K. and Wingard L.B. (1974). Enzyme Engineering II. Plenum Press.

3. Singh, S. P., Pandey, A., Singhania, R. R., Larroche, C., & Li, Z. (Eds.). (2020). Biomass, Biofuels,Biochemicals: Advances in Enzyme Catalysis and Technologies. Elsevier.

Weblinks

1. https://conductscience.com/introduction-to-enzymology/

CO / PO Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	1	-	-	-	2
CO2	3	2	1	-	-	-	-	1	1	-	-	1	2
CO3	3	2	1	-	-	-	-	1	1	-	-	-	2
CO4	3	2	1	-	-	-	-	1	1	-	-	1	2
CO5	3	2	1	-	-	-	-	1	1	-	-	-	2
Avg.	**2.8**	**1.8**	**1**	**-**	**-**	**-**	**-**	**1**	1	**-**	**-**	**1**	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VI

25BTHS601G **UNIVERSAL HUMAN VALUES** **2H - 2C**

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

End Semester Exam:3 Hours

Prerequisite Nil

Course Objectives

The goal of this course is for the students to

- Help students to understand the need, basic guidelines, content and process of value education.
- Help students distinguish between values and skills
- Help students initiate a process of dialog within themselves to know what they 'really want to be' in their life and profession
- Help students understand the meaning of happiness within their selves.
- Help students understand the meaning of happiness and prosperity for a human being.

Course Outcomes

Upon completion of this course the students will be able to

1. Illustrate the significance of value inputs in a classroom, distinguish between values and skills. **(K2)**
2. Interpret the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society **(K3)**
3. Compare between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body. **(K2)**
4. Illustrate the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human-human relationships. **(K2)**
5. Identify the role in ensuring a harmonious society. **(K3)**

UNIT-1 Course Introduction - Need, Basic Guidelines, Content and Process for Value Education **5h**

Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

Unit II: Understanding Harmony in the Human Being - Harmony in Myself **5h**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as

an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

Unit III: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship **5h**

Understanding harmony in the Family- the basic unit of human interaction , Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals, Visualizing a universal harmonious order in societyUndivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family!

Total : 15 h

TEXT BOOKS

1. R R Gaur, R Sangal and G P Bagaria(2009)."A Foundation Course in Human Values and Professional Ethics"
2. 1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
3. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
4. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
6. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
7. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
8. A N Tripathy, 2003, Human Values, New Age International Publishers.

Semester-VI

25BTBT691	**MINI PROJECT**	**2H-2C**

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

The students will be directed to do a mini project in their domain field for 3 months. Their project work will be evaluated for forty percentages by internal examiner and sixty percentage by external examiner for End Semester Examination. End Semester Examination evaluation will be based on the report submitted by the student after the completion of their project report.

Semester-VII

Semester-VII

25BTBT701 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

Prerequisite: Protein Engineering, Molecular Biology

Course Objectives

The goal of this course is for students to

- Explain the basics of genome organization of prokaryotes and eukaryotes.
- Outline the various methods for gene finding and annotations in functional genomics.
- Infer the post translational modification, protein level estimation and other protein interactions.
- Discuss the application of proteome analysis

Course Outcomes

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

1. Summarize the characteristics of genomic organization of prokaryotes and eukaryotes. **(K2)**
2. Choose the different physical mapping techniques to analyze genomic organization. **(K3)**
3. Organize the gene findings in functional genomics. **(K3)**
4. Select the protein estimation through different techniques. **(K3)**
5. Identify the principle and methods of protein profiling techniques. **(K3)**

UNIT - I OVERVIEW OF GENOMES OF BACTERIA, ARCHAE AND EUKARYOTA 9h

Organization and structure of genomes, Genome size - organization of prokaryotes and eukaryotes, Sequence complexity, Introns and Exons - gene structure of bacteria, archaebacterial and eukaryotes - Current status of genome sequencing projects - Human genome project, Isolation of Chromosomes; Introduction of functional genomics, proteogenomics and comparative genomics.

UNIT - II PHYSICAL MAPPING TECHNIQUES 9h

Cytogenetic mapping, radiation hybrid mapping, genetic mapping, FISH mapping, STS mapping, SNP mapping optical mapping, Top down and bottomup approach, linking and jumping of clones, gapclosure, pooling strategies, Restriction Enzyme Finger Printing.

UNIT - III FUNCTIONAL GENOMICS 9h

Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Gene finding; annotation; ORF, Tools in ORF and functional prediction; Subtractive hybridization, DNA library screening; differential display and representational difference analysis, TOGA.

UNIT - IV TECHNIQUES IN PROTEOMICS **9h**

Introduction to Proteomics. Proteomics and the new biology, 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 **9h**

Introduction to protein profiling - Post translational modification; protein-protein interactions; glycoprotein analysis; phosphor protein analysis. Application of proteome analysis, Analysis of Genomes: Human, Mouse, Saccharomyces cerevisiae, Mycobacterium tuberculosis: - Drug Development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Proteomics in Plant genetics and breeding.

Total: 45 h

Text Books

1. Brown. T. A. (2019). Genomes, 4th edition. Bios Scientific Publishers Ltd
2. Pennington and Dunn. (2001). Proteomics. BIOS Scientific Publishers.

Reference Books

1. Livesey. H. (2000). Functional Genomics. Oxford University press**.**
2. Cantor and Smith. (1999). Genomics. John Wiley & Sons.

Weblinks

1. https://www.ebi.ac.uk/training/

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	-	1	-	-	-	2
CO2	3	2	1	-	-	-	-	-	1	-	-	-	2
CO3	3	2	1	-	-	-	-	-	1	-	-	-	2
CO4	3	2	1	-	-	-	-	-	1	-	1	-	2
CO5	3	2	1	-	-	1	1	-	1	-	1	-	2
Avg.	**2.8**	**1.8**	1	-	-	1	1	-	1	-	1	-	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VII

25BTBT702 **BIOSAFETY, BIOETHICS AND IPR** **3H-3C**

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

End Semester Exam: 3 Hours

Prerequisite: Industrial Biotechnology

Course Objectives

The goal of this course is to

- Summarize 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

Course Outcomes

Upon completion, students will be able to

1. Summarize the concept of patent and copyrights. **(K2)**
2. Outline the regulatory framework for GMOs in India. **(K2)**
3. Infer the role of regulatory committees in controlling the risk. **(K2)**
4. Relate the information on ethical issues linked to research on animal models, transgenics, clinical trials. **(K2)**
5. Identify the importance of copy rights and patent. **(K3)**

UNIT-I INTELLECTUAL PROPERTY RIGHTS **9h**

Introduction and the need for intellectual property right (IPR) – Types of intellectual property rights - IPR in India: IPR in abroad - Major International Instruments concerning Intellectual Property Rights :–Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP -

UNIT-II BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA & AT INTERNATIONAL LEVEL **9h**

Biosafety, Regulatory frameworks 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.

UNIT-III IPR-POLICIES **9h**

Seed Policy (1988) and 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 **9h**

Introduction to Bioethics, Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, . 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 **9h**

IPR in current scenario with case studies.- Copyright and related rights - Trade Marks - Industrial design and Integrated circuits - Geographic indications - Protection against unfair competition.

Total : 45 h

Text Books

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.

Reference Books

1. V Sreekrishna. (2017). Bioethics and Biosafety in Biotechnology. New AgeInternational publishers.
2. Nambisan, P. (2017). An introduction to ethical, safety and intellectual propertyrights issues in biotechnology. Academic Press.

Weblinks

1. http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipopub_489.pdf

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	2	2	-	1	-	3	1	-
CO2	2	1	-	-	-	2	2	-	1	-	3	1	-
CO3	2	1	-	-	-	2	2	-	1	-	2	1	-
CO4	2	1	-	-	-	2	2	-	1	-	2	1	-
CO5	3	2	1	-	-	2	2	-	1	-	2	1	-
Avg.	**2**	**1**	**1**	**-**	**-**	**2**	**2**	**-**	1	**-**	**2.4**	**1**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VII

25BTBT741 **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

Prerequisite: Bioprocess engineering

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.

Course Outcomes

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

1. Outline the fundamentals of separation of biomolecules and various cell disruption techniques. **(K2)**
2. Identify various primary separation and biomolecules isolation techniques. **(K3)**
3. Summarize the principles of adsorption, extraction and membrane separation process to recover products. **(K2)**
4. Make use of the principles of various chromatographic techniques to purify biomolecules. **(K3)**
5. Apply various drying and crystallization methods for product purification and polishing. **(K3)**

UNIT - I - INTRODUCTION TO SEPARATION OF BIOMOLECULES 9h

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: importance of cell disruption in product release, mechanical, chemical and enzymatic process; pretreatment and stabilization of bioproducts.

UNIT - II - PRIMARY SEPARATION AND ISOLATION 9h

Basic separation techniques; Sedimentation, centrifugation, ultracentrifugation, Principle of batch filtration - pretreatment of fermentation broth, design of industrial filters: plate and frame filter press, leaf filter, continuous filtration, Fouling problems: rotary drum filter – working principles of centrifugation - centrifugation based methods for separation of the

cellorganelles and biomolecules (DNA, RNA, Proteins and secondary metabolites).

UNIT - III - PRODUCT RECOVERY AND CONCENTRATION 9h

Adsorption: isotherms, adsorption column dynamics, 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 proteinsby different methods.

UNIT - IV - PRODUCT PURIFICATION 9h

Basics of chromatography and its use in separation of biomolecules - thin-layer, ion exchange, size exclusion, GLC, 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 9h

Crystallization: nucleation, crystal growth, crystal size distribution, kinetics of crystallization, industrial crystallizers; lyophilzation, chemistry of extraction, use of solvent extraction in antibiotic separation, drying - drying curve, industrial dryers - spray dryer, fluid dryer/ drum dryer, freeze drying principles and applications; problems related to relative humidity and population density. **Formulation strategies**: Importance of formulation, formulation of Enzymes and pharmaceutical products.

Total : 45 h

ii) Laboratory

List of experiments

1. Cell disruption by Sonication
2. Cell disruption by enzymatic method
3. Cell fractionation and isolation of chloroplasts by differential centrifugation
4. Isolation of casein from milk (Isoelectric precipitation)
5. Precipitation of protein by salting out (Ammonium sulphate precipitation)
6. Aqueous two-phase extraction of protein
7. Adsorption Studies
8. Separation of the proteins with suitable chromatography methods
9. Crystallization
10. Drying

Total : 30h

Text Books:

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.

Reference Books

1. Belter P. A., Cussler E.L. and Wei-Houhu. (1988). Bioseparations – Downstream Processing for Biotechnology. Wiley Interscience Pub., New Delhi.

Web links:

1. https://nptel.ac.in/courses/102/106/102106022/

CO / PO Mapping													
CO No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	-	1	-	-	-	2
CO2	3	2	1	-	-	-	-	1	1	-	-	-	2
CO3	3	2	1	-	1	-	-	1	1	-	-	-	2
CO4	3	2	1	-	1	-	-	1	1	-	-	-	2
CO5	3	2	1	-	1	-	-	1	1	-	1	-	2
Avg.	2.8	1.4	1	-	1	-	-	1	1	-	1	-	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-VII

25BTBT791 PROJECT WORK PHASE – I/FIELD PROJECT / INTERNSHIP III 8H-4C

Instruction Hours/ week: L: 0 T: 0 P: 8 **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 VIand 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-VIII

Semester-VIII

25BTBT891 **PROJECT WORK PHASE – II** **16H-8C**

Instruction Hours/ week: L: 0 T: 0 P: 16 **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
ELECTIVE – I

Semester - V

25BTBT5E01 CANCER BIOLOGY 3H-3C

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

Prerequisite: **Biochemistry, Cell biology & Stem cell**

Course Objectives

The goal of this course is for students to

- Understand the basics of normal cell structure and cancer cells
- Unravel the concepts of oncogenes and proteins associated with them
- Know about the concepts of cell cycle regulation
- Design and develop novel drugs for cancer

Course Outcomes

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

1. Summarize the basics in cancer biology **(K2)**
2. Outline the principles of carcinogenesis **(K2)**
3. Explain the molecular mechanism of cancer biology **(K2)**
4. Infer the cancer metastasis of cancer **(K2)**
5. Identify various treatment strategies of cancer. **(K3)**

UNIT 1: FUNDAMENTALS OF CANCER BIOLOGY 9h

Epidemiology of cancer: environmental factors: tobacco, alcohol, diet, occupational exposure, hormones. Regulation of cell cycle, modulation of cell cycle in cancer. Different forms of cancers. Specific type of cancer hepato cellular, melanoma, breast, lung cancer. Genetic basis of cancer- DNA repair. mutations that cause changes in signal molecules, signal switches.

UNIT II: PRINCIPLES OF CARCINOGENESIS 9h

Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, xray radiation-mechanisms of radiation carcinogenesis.

UNIT III: PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER 9h

Signal targets and cancer, activation of kinases; tumor suppressor genes, Oncogenes, identification of

oncogenes, Virus and cancers: DNA virus-retroviruses detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases.

UNIT IV: PRINCIPLES OF CANCER METASTASIS 9h

Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT V: CANCER THERAPY 9h

Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Advances in cancer detection. Different forms of therapy, chemotherapy, radiation therapy, immunotherapy, molecular therapy, use of signal targets towardstherapy of cancer; Gene therapy.

Total : 45 h

Text Books

1. Raymond W. Ruddon, Cancer Biology, 2007, Oxford University Press, USA
2. Ian F.Tannock "The Basic Science of Oncology" 2nd edition, 1992, Richard P.Hill

Reference Books

1. Momna Hejmadi Introduction to Cancer Biology,2014, BoonBooks.com
2. Carsten Carlberg, Eunike Velleuer, Cancer Biology: How Science Works, 2021, Springer International Publishing

Weblinks

1. https://www.cancer.gov/research/areas/biology

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	1	-	1	-	2
CO2	2	1	-	-	1	-	-	-	-	1	-	1	1	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	-	1	-	-	-	-	1	-	1	-	2
CO5	3	2	1	-	1	-	-	-	-	1	-	1	1	2
Avg.	2.2	1.2	1	-	1	-	-	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester-V

25BTBT5E02 FERMENTATION TECHNOLOGY 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Bioprocess Engineering and Industrial Biotechnology**

Course Objectives

The goal of this course is for students to
• Recognize the overall industrial fermentation process and the process flow sheet.
• Understand the knowledge on medium optimization and sterilization techniques.
• Interpret the knowledge on production of commercially important primary metabolites & secondary metabolites.
• Understand the selection and design of fermenter

Course Outcomes

Upon completion of this course the student will be able to
1. Summarize the basics of industrial fermentation and other processes.**(K2)**
2. Outline on medium optimization and sterilization techniques. **(K2)**
3. Explain the importance of fermentation in the production of secondary metabolites**(K2)**
4. Summarize the criteria for selection and design of fermenter. **(K2)**
5. Apply the knowledge of fermentation on process economics**(K3)**

UNIT I INTRODUCTION TO FERMENTATION 9h

History and development of fermentation industry; General requirements of fermentation processes; types of fermentation – homo fermentation, hetero fermentation: category of fermentation based on end product formed – lactic acid fermentation, alcohol fermentation, acetic acid fermentation, butyric acid fermentation.

UNIT II Medium Optimization and Sterilization 9h

Medium requirements for fermentation processes, Carbon, Nitrogen, Minerals, Vitamins and Other Complex nutrients, Oxygen requirement. Medium optimization-Methods of media optimization (One factor method and Plackett- Burman design). Types of sterilization techniques; Thermal death kinetics of microorganisms, Batch and Continuous sterilization of liquid media, Filter sterilization, Design of sterilization equipment.

UNIT III ADVANCES IN FERMENTATION TECHNOLOGY 9h

Microbial fungicides and Pesticides, Chemicals and Pharmaceuticals made by fermentation, Fermented food products – Beer, Wine, Genetically Modified Organisms, Biopolymers. Microbial leaching, Effluent treatment using microbes, Future of fermentation technology and its products.

UNIT IV DESIGN OF FERMENTER 9h

Key components of fermenter, Types of fermenters- batch, CSTR, Fed batch; Design of fermenter body,

selection of impeller, baffles, Types of spargers; Types of sealing. Selection criteria of fermenter, Softwares for fermenter design and simulation.

UNIT V FERMENTATION PROCESS ECONOMICS 9h

Process economics: General fermentation process economics; materials usage and cost; capital investment estimate; production cost estimate. Case studies –Traditional product and recombinant product; Bioprocess validation: Introduction, why validation, when does validation occur, validation structure, resources for validation, validation of systems and processes including SIP andCIP.

Total: 45h

Text Books

1. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016)Butterworth-Heinemann Press. UK.
2. H. J. Peppler, D. Perlman. Microbial Technology: Fermentation Technology. (2014). AcademicPress.

Reference Books

1. T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. Fermentation Microbiology and Biotechnology. Second Edition. (2006). CRC Press, USA.
2. Pandey A, Lasroche C, Soccol C. R and Dussop C. G. Advances in Fermentation technology (2008).Asiatech publishers Inc.

Weblinks

1. https://microbenotes.com/fermentation/
2. https://www.cambridge.org/core/books/abs/biotechnology/bioprocessfermentation-technology

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	1	-	1	1	2
CO2	2	1	-	-	1	-	-	-	-	1	-	1	-	2
CO3	2	1	-	-	1	-	-	-	-	1	-	1	-	2
CO4	2	1	-	-	1	-	-	-	-	1	-	1	1	2
CO5	3	2	1	-	1	-	-	-	-	1	-	1	-	2
Avg.	2.2	1.2	1	-	1	-	-	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - V

25BTBT5E03 FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS 3H-3C

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

End Semester Exam: 3 Hours

Prerequisite: Bioinformatics

Course Objectives

The goal of this course is for students to

- Study various Algorithm design techniques and applying it in bioinformatics
- Understand the algorithms such as Dynamic programming, HMM and ANN in Biological applications.
- Summarize the algorithms utilized for the DNA and RNA analysis.

Course Outcomes

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

1. Understand the basics of algorithms used in Bioinformatics. **(K2)**
2. Outline various dynamic programming in sequence analysis. **(K2)**
3. Infer the strategies for matching the sequences. **(K2)**
4. Apply ANN in sequence analysis **(K3)**
5. Identify the macromolecules using HMM, ANN and other related algorithms. **(K3)**

UNIT - I INTRODUCTION TO ALGORITHMS 9h

Algorithms-Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, Travelling sales man problem, sorting

UNIT - II DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS 9h

Dynamic programming Principles and its uses. Local and Global alignment principles, Finding longest common subsequences, Heuristics second generation alignment tools for database searching : (Blast, FASTA, Clustal W), Statistical and Similarity based methods for gene prediction, Models of evolution.

UNIT - III EXACT MATCH AND HIDDEN MARKOV MODELS 9h

Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm, Hidden Markov Model: Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA..

UNIT - IV ARTIFICIAL NEURAL NETWORKS 9h

Introduction to Artificial Neural Networks (ANN): A Simple Neuron, Firing rule, Network layers, Architectures of Artificial Neural Network: Feed-Forward networks, Feed-Back networks, Perceptrons, Pattern recognition problems, Back Propagation Algorithm, Applications of Neural Networks

UNIT - V DNA AND RNA RELATED ALGORITHMS 9h

Restriction enzyme mapping algorithms: algorithms for partial digest- double digest problem, Motif finding, Finding regulatory motifs in DNA, DNA computing, Genome alignment, Suffix Trees, RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimization and the Zuker folding algorithm, Design of covariance models, Application of RNA Fold..

Total : 45 h

Text Books

1. Arabnia, H. R., & Tran, Q. N. (2015). Emerging trends in computational biology, bioinformatics, and systems biology: algorithms and software tools.
2. Horowitz, S. Sahini, and Rajasekharan : Fundamentals of Computer Algorithms , Galgotia Publications..

Reference Books

1. Neil C. Jones and Pavel .A Pevzner An introduction to Bioinformatics Algorthims. (computational Molecular Biology) (2004) MIT press. ISBN-10: 0262101068.
2. R. Durbin, S.Eddy, A.Krogh, G.Mitchison Biological sequence analysis : Probabilistic models of Proteins and Nucleic acids (2005) Cambridge University Press 0521540798
3. Michael.S. Waterman Introduction to Computational Biology : Maps, Sequences and Genomes . Waterman. Edition 2 (2012) Chapman and Hall/ CRC Press ISBN:1439861315

Web links

https://academic.oup.com/bib/article/8/1/45/264398

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO2	2	1	-	-	-	-	1	-	-	1	-	1	1	2
CO3	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO4	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO5	3	2	1	-	-	-	1	-	-	1	-	1	-	2
Avg.	2.2	1.2	-	-	-	-	1	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - V

25BTBT5E04 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

Prerequisite: Microbiology

Course Objectives

The goal of this course is for students to

- Understand the role of microbes in various ecosystem.
- Discuss various strategies for management of xenobiotics in ecosystem.
- Summarize the advance technologies utilized for the remediation of contaminants.

Course Outcomes

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

6. Summarize the role of soil microbes in enhancing soil properties**. (K2)**
7. Outline various strategies for remediation of environmental xenobiotics. **(K2)**
8. Infer the strategies for waste water management systems. **(K2)**
9. Illustrate about the various industrial waste management **(K2)**
10. Apply the biotechnological principle for remediation of contaminants. **(K3)**

UNIT - I INTRODUCTION 9h

Microbial flora of soil, growth and ecological adaptations of soil microorganisms, interactions among soil microorganisms - biogeochemical role of soil microorganisms. Role of microbes in improving soil fertility

UNIT - II DEGRADATION OF XENOBIOTIC COMPOUNDS 9h

Common xenobiotics- contaminants and pollutants -Soil, Air and water; Degradation vs Bioremediation; Bioremediation -strategies, types, Advantages and disadvantages; Role of GEMS in degradation of xenobiotics; Case study on degradation pattern of xenobiotics

UNIT - III WASTE WATER MANAGEMENT 9h

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, Different types of anaerobic reactors.

UNIT - IV TREATMENT OF INDUSTRIAL WASTE 9h

Dairy, Paper & Pulp, Textile, leather, hospital and pharmaceutical industrial waste, Properties, Toxicity and management; e- waste – types, toxicity and management, radioactive and nuclear power waste management, Case study

UNIT - V DEVELOPMENTS PERTAINING TO ENVIRONMENTAL BIOTECHNOLOGY 9h

Bioindicators, Biomarkers, 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.

Total : 45 h

Text Books

1. Rittmann. B. E. and Mccarty. L. P. (2020). Environmental Biotechnology: Principle and Applications. McGraw Hill.
2. Singh, A., Srivastava, S., Rathore, D., & Pant, D. (Eds.). (2020). Environmental Microbiology and Biotechnology: Volume 1: Biovalorization of Solid Wastes and Wastewater Treatment. Springer Singapore, Imprint: Springer.

Reference Books

1. Chatterji. A.K., (2003). Introduction to Environmental Biotechnology. Prentice Hall of India Pvt. Ltd., New Delhi.
2. Prescott. M., Harley. J. P. and Klein. D. A. (2008). Microbiology. Boston. McGraw-Hill Higher Education.
3. Rittmann. B. E. and Mccarty. L. P. (2001). Environmental Biotechnology: Principle and Applications. McGraw Hill.

Web links

https://www.sciencedirect.com/book/9780124077768/environmental-biotechnology

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO2	2	1	-	-	-	-	1	-	-	1	-	1	1	2
CO3	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO4	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO5	3	2	1	-	-	-	1	-	-	1	-	1	-	2
Avg.	2.2	1.2	-	-	-	-	1	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Professional Elective –II **Semester – V**

25BTBT5E05 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

Prerequisite: **Biochemistry & Molecular biology and genetics**

Course Objectives

The goal of this course is for students to

- Illustrate the function and properties of adult and embryonic stem cells.
- Discuss the cell cycle regulations, checkpoints and its epigenetic control.
- Outline various techniques utilized for the development of stem cells.
- Explain 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. **(K2)**
2. Outline the properties of adult and embryonic stem cells. **(K2)**
3. Infer the role of checkpoints in cell cycle regulation and significance of epigenetic control. **(K2)**
4. Outline the different sources of stem cells **(K2)**
5. Apply the basics of stem cells in medical field. **(K3)**

UNIT - I INTRODUCTION TO STEM CELLS & STEM CELL NICHE 9h

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 9h

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 9h

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 9h

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), fluorescent protein tagging.

UNIT - V POTENTIAL USES OF STEM CELLS 9h

Cellular therapies - vaccines - gene therapy - immunotherapy - tissue engineering. Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations-India and international, debate, social and ethical concerns, Organ farming.

Total : 45 h

Text Books

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.

Reference Books

1. Treleaven J. (2009). Hematopoietic Stem Cell Transplantation. 1st Edition. Elsevier Health - UK.
2. Lodish et al. (2008). Molecular Cell Biology. 6th Edition. W.H. Freeman & Co.
3. Ariff Bongso and Eng Hin Lee. (2005). Stem Cells: From Bench to Bedside. World ScientificPulishing Co Pte Ltd.

Weblinks

1. https://medlineplus.gov/stemcells.html

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO														
CO1	2	1	-	-	1	-	-	-	-	1	-	-	1	2
CO2	2	1	-	-	1	-	-	-	-	1	-	-	1	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	-	1	-	-	-	-	1	-	1	-	2
CO5	3	2	1	1	1	-	-	1	-	1	-	1	-	2
Avg.	2.2	1.2	1	1	1	-	-	1	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - V

25BTBT5E06 BIOPROCESS INSTRUMENTATION AND CONTROL 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Bioprocess Engineering**

Course Objectives

The goal of this course is for students to

- Describe fundamental bioprocess instrumentation, including temperature, pH, level, flow, pressure, and DO sensors.
- Explain the components of control systems and their significance in bioprocess engineering.
- Apply transient response analysis techniques to simple control systems in bioprocess applications.
- Utilize the frequency response methods for system stability assessment.

Course Outcomes

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

1. Outline the key bioprocess instrumentation sensors and their functions **(K2)**
2. Illustrate block diagrams and transfer functions for single-loop and multi-loop control systems. **(K2)**
3. Explain the transient response analysis and PID controller tuning methods. **(K2)**
4. Interpret frequency response techniques to determine system stability. **(K2)**
5. Identify different control strategies used in bioprocess industries. **(K3)**

UNIT – I BIOPROCESS INSTRUMENTATION 9 h

Temperature, pH, Level, Flow, Pressure, DO sensors. Response of First order systems: Transfer Function, Transient Response, Forcing Functions and Responses. Physical examples of First and second order systems: Examples of First order systems, Linearization, Transportation Lag.

UNIT – II COMPONENTS OF CONTROL SYSTEM 9h

Block Diagram, Development of Block Diagram, Controllers and Final Control Elements. Closed loop, Transfer functions: Standard Block-Diagram Symbols, Transfer Functions for Single-Loop Systems and Multi-loop Systems.

UNIT – III TRANSIENT RESPONSE OF SIMPLE CONTROL SYSTEMS 9h

Servo Problem, Regulatory Problem, Controllers: Proportional, Proportional-Integral, PID Controllers. Ziegler-Nichols Controller Settings. Stability: Routh Test for Stability, Root Locus.

UNIT – IV INTRODUCTION TO FREQUENCY RESPONSE 9h

Substitution Rule, Bode Diagrams. Control system design based on frequency response: Bode and Nyquist Stability Criterion, Gain and Phase Margins, Lead, Lag, and Lead-Lag Compensation, Frequency-Domain Performance Specifications, Applications

UNIT – V ADVANCED CONTROLS IN BIOREACTORS 9h

Introduction to dead time compensation, pH measurement and control, Oxygen measurement and control, Adaptive control and online estimation, Cascade control for jacketed bioreactors

Total :45 h

Textbooks

1. Doran, P. M. (2013). Bioprocess engineering principles (2nd ed.). Academic Press.
2. Stephanopoulos, G. (2018). Chemical process control: An introduction to theory and practice. Pearson.
3. Riggs, J. B., & Karim, M. N. (2016*).* Chemical and bio-process control (3rd ed.). Ferret Publishing.

Reference Books

1. Bailey, J. E., & Ollis, D. F. (2018). Biochemical engineering fundamentals *(*2nd ed.). McGraw-Hill.
2. Marlin, T. E. (2019). Process control: Designing processes and control systems for dynamic performance (2nd ed.). McGraw-Hill.
3. Seborg, D. E., Edgar, T. F., Mellichamp, D. A., & Doyle, F. J. (2020). Process dynamics and control (4th ed.). Wiley.

Website Link

1. https://mrcet.com/downloads/digital_notes/ECE/III%20Year/INSTRUMENTATION%20ENGINEERING.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	1	-	1	1	2
CO2	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	-	-	-	-	-	-	1	-	-	-	2
CO5	3	2	1	-	1	-	-	-	-	1	-	1	-	2
Avg.	2.2	1.2	1	-	1	-	-	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - V

25BTBT5E07 METABOLOMICS AND METABOLIC ENGINEERING 3H-3C

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

End Semester Exam: 3 Hours

Prerequisite: Bioinformatics & Biochemistry

Course Objectives

The goal of this course is for students to

- Understand the basics of metabolomics.
- Outline the enzyme kinetics and regulations in metabolism
- Know about the metabolic pathways of various metabolites
- Summarize the flux associated with metabolism

Course Outcomes

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

1. Outline the concept of Metabolome and Metabolomics **(K2)**
2. Apply the Bioinformatics tools in metabolomics. **(K3)**
3. Summarize the fundamentals of Metabolic engineering. **(K2)**
4. Analyze the metabolic pathways using flux control **(K2)**
5. Identify various application of metabolic networks **(K3)**

UNIT I: INTRODUCTION TO METABOLOMICS 9h

Role of metabolomics in systems biology –application of metabolomics- Analytical methods in metabolomics – Data standards– Databases for Chemical, Spectral and Biological Data –Reconstruction of dynamic metabolic network model- examples- study of metabolome of a simple organism like E.coli.

UNIT II: BIOINFORMATICS IN METABOLOMICS 9h

Online databases and pipelines for metabolomics – GC-MS based metabolomics – Computational methods to compute and integrate metabolic data-software for metabolomics- metabolomics and medical sciences

UNIT III: INTRODUCTIN TO METABOLIC ENGINEERING 9h

Metabolic engineering: introduction, mass balance, black box, metabolic flux analysis, stochiometry, Principles of metabolic engineering, Importance of metabolic engineering-comprehensive models for cellular reactions-material balances & data consistency- metabolic pathway synthesis.

UNIT IV: METABOLIC FLUX ANALYSIS 9h

Flux balance analysis, flux balance methods, group based flux balance, metabolic control analysis: overview, control coefficients, methods of measuring control. Flux analysis of networks- top down approach, bottom up approach.

UNIT V: METABOLIC NETWORK AND APPLICATIONS 9h

Kinetic model of metabolic networks-Systems metabolic engineering of E.coli. Applications of Metabolomics to biology: examples and case studies, Metabolome informatics, data integration and mining.

Text Books

1. Jens Hřiriis Nielsen, Michael C. Jewett, Metabolomics: A Powerful Tool in Systems Biology, Springer, 2007
2. Gregory Stephanopoulos, Jens Nielsen, Sang Yup Lee, Metabolic Engineering Concepts and Applications, Wiley, 2021
3. Sang Yup Lee, Jens Hoiris Nielson, Metabolic engineering concepts and applications:vol-13a, 2021.

Reference Books

1. Tomita M., T. Nishioka, Metabolomics:The Frontier of Systems Biology, Springer, 2003.
2. Hiroshi shimizu, Takashi Hirasawa Volker F. Wendish, Amino acid biosynthesis- pathways, regulationand metabolic engineering, Springer-Verlag Berlin Heidelberg, 2009.

Weblinks

1. https://onlinecourses.nptel.ac.in/noc23_bt06/preview

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	1	-	-	-	-	-	1	-	1	-	2
CO2	2	1	-	1	-	-	-	-	-	1	-	1	-	2
CO3	2	1	-	1	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	1	1	-	-	-	-	1	-	1	-	2
CO5	3	2	1	1	1	-	-	-	-	1	-	1	-	2
Avg.	2.2	1.2	1	1	1	-	-	-	-	1	-	1	-	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - V

25BTBT5E08 MOLECULAR TECHNIQUES IN BIOTECHNOLOGY 3H-3C

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

End Semester Exam: 3 Hours

Prerequisite: Microbiology

Course Objectives:

The goal of this course is for students to

- provide in-depth theoretical and practical understanding of key molecular biology tools used in biotechnology.
- Train students in advanced techniques for gene analysis, cloning, and expression studies.
- Prepare students for research and industrial applications of molecular biology in health, agriculture, and diagnostics.

Course Outcomes:

Through this subject the student will be able to:

1. Outline modern techniques for nucleic acid and protein isolation and analysis. **(K2)**
2. Summarizes PCR-based experiments, including advanced variants. **(K2)**
3. Infer the role of recombinant technology in development of clones and vectors. **(K2)**
4. Identify the gene/protein expression using blotting and hybridization techniques. **(K3)**
5. Apply the advanced molecular tools in biotechnological problem-solving. **(K3)**

UNIT I NUCLEIC ACID AND PROTEIN QUANTIFICATION AND ANALYSIS 9h

DNA and RNA structure, chemical properties, and stability; Genomic and plasmid DNA extraction methods (phenol-chloroform, spin column-based); Total RNA and mRNA isolation (including plant and animal tissue-specific protocols); Quantification techniques: UV spectrophotometry, Qubit, NanoDrop, agarose gel quantification; Electrophoresis: agarose and polyacrylamide gel systems; capillary electrophoresis; Protein extraction and quantification (Bradford, BCA, Lowry methods)

UNIT II POLYMERASE CHAIN REACTION (PCR) 9h

Conventional PCR: principle, components, thermal cyclers; Primer design tools and considerations (GC content, Tm, secondary structure); PCR variants: Real-Time PCR (SYBR Green, TaqMan probes);Reverse Transcription PCR (RT-PCR); Digital PCR and isothermal amplification (LAMP, RPA);Hot-start, Touchdown, Nested, and Multiplex PCR; Troubleshooting and optimization strategies. Applications: mutation detection, SNP analysis, pathogen detection, forensic DNA analysis.

UNIT III GENE CLONING, VECTOR SYSTEMS, AND EXPRESSION STRATEGIES 9h

Restriction enzymes: types, mechanism, and mapping. DNA ligation and linkers/adapters. Cloning vectors: plasmids, phagemids, cosmids, BACs, and YACs. Expression vectors: promoter systems (T7, lac, arabinose), tags (His, GST, FLAG).Recombinant DNA construction strategies (TA cloning, Gateway cloning, Gibson

assembly). Transformation and transfection techniques: chemical, electroporation, lipofection. Screening methods: colony PCR, reporter genes (GFP, LacZ), selection markers.

UNIT IV HYBRIDIZATION, BLOTTING, AND MOLECULAR DETECTION TECHNIQUES 9h

Southern, Northern, and Western blotting: protocols and applications. Gel transfer methods (capillary, electroblotting), membrane types (nylon, PVDF). Probe design and labeling: radioactive (32P) and non-radioactive (biotin, DIG). Hybridization parameters and signal detection. Dot blot, slot blot, and sandwich assays. ELISA: direct, indirect, sandwich, and competitive formats. Immunodetection techniques (chemiluminescence, fluorescence).

UNIT V ADVANCED MOLECULAR TOOLS, GENOME EDITING, AND OMICS 9h

DNA sequencing: Sanger method, Maxam-Gilbert method, principles of NGS (Illumina, Oxford Nanopore, PacBio). Genome editing tools: CRISPR-Cas9 system: mechanism, design of sgRNA, off-target effects TALENs and ZFNs RNA interference (siRNA, miRNA): design, delivery, and applications. DNA microarray and gene expression profiling. Introduction to transcriptomics, proteomics, and metabolomics. Mass spectrometry and bioinformatics tools in molecular biology (BLAST, Primer-BLAST, genome browsers). **Total : 45 h**

Text Books

1. Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
2. Primrose, S. B., & Twyman, R. (2006). Principles of gene manipulation and genomics. John Wiley & Sons.

Reference Books

1. Watson, J. D. (2004). Molecular Biology of the Gene. Pearson Education India.
2. Joseph, S., & David, W. R. (2001). Molecular cloning: a laboratory manual. Gold Spring Harbor, New York, 3, 17-3..

Website

1. https://pubs.acs.org/doi/abs/10.1021/acs.chemrev.1c00377

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	1	-	1	2	-
CO2	2	1	-	-	1	-	-	-	-	1	-	1	2	1
CO3	2	1	-	-	-	-	-	-	-	1	-	1	2	-
CO4	2	1	-	-	-	-	-	-	-	1	-	1	2	-
CO5	3	2	1	-	1	1	1	-	-	1	-	1	2	1
Avg.	2.2	1.2	1	-	1	1	1	-	-	1	-	1	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

PROFESSIONAL ELECTIVE –III **Semester - VI**

25BTBT6E01 **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

Prerequisite: **Biochemistry and Stem cell**

Course Objectives

The goal of this course is for students to

- Explain the different cell types and their advances in tissue engineering.
- Discuss the principles and practice of gene therapy.
- Identify and organize differing views on advances on tissue engineering.
- Utilize the process for the identification and development of a clinically relevant strategy to restore, repair or regeneration of a dysfunctional tissue or organ.

Course Outcomes

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

1. Outline the basic concepts in tissue engineering **(K2)**
2. Summarize different biomaterials for tissue engineering **(K2)**
3. Explain the components of the tissue architecture **(K2)**
4. Illustrate the principles of gene therapy **(K2)**
5. Apply the concepts of tissue engineering in different fields. **(K3)**

UNIT - I BIOLOGICAL STUDY OF DIFFERENT CELL TYPES 9h

Cell line, Establishment of cell lines, Different cell types: Endothelial cell, Fibroblast cells, Epithelialcell, Myoblast cells, chromaffin cell, Smooth muscle cells & plasma cell.

UNIT - II BIOMATERIALS FOR TISSUE ENGINEERING 9h

Biomaterials: Degradable polymeric scaffolds, Acellular Bio-Matrices, In-vitro and In-vivo evaluation of biomaterials ,Biological derived polymers in tissue engineering Cell seeding of scaffolds. Bioreactors used in tissue engineering . Role of Nanotechnology

UNIT III TISSUE ARCHITECTURE 9h

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic

properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

UNIT - IV PRINCIPLES AND PRACTICE OF GENE THERAPY 9h

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 makingeffective treatment of genetic disease, Recent developments in gene therapy research, ethical considerations of gene therapy.

UNIT - V ADVANCES IN TISSUE ENGINEERING 9h

Development of artificial tissues; Transplantation biology: Tissue typing, Techniques of tissue typing, Minor histocompatibility antigens, Immuno-suppression, Side effects of immuno-suppression. Organ regeneration. 3D bio printing for tissue engineering

Total : 45h

Text Books

1. Ranga. M. M. (2010). Animal Biotechnology. Agrobios.
2. Robert Lanza, Robert Langer, Joseph Vacanti. (2014). Principles of Tissue Engineering. 4thEdition. Academic Press. eBook ISBN: 9780123983701.

Reference Books

1. 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.
2. Bikramjit Basu, Sourabh Ghosh. (2016). Biomaterials for Musculoskeletal Regeneration-Applications. Springer. ISBN 978-981-10-3017-8.
3. Lanza R, Langer R, Vacanti JP, Atala A, editors.(2020) Principles of tissue engineering. Academic press.

Weblinks

1. https://www.frontiersin.org/articles/10.3389/fbioe.2017.00040/full

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	1	-	1	1	2
CO2	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	-	-	-	-	-	-	1	-	-	-	2
CO5	3	2	1	-	1	-	-	-	-	1	-	1	-	2
Avg.	2.2	1.2	1	-	1	-	-	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VI

25BTBT6E02 BIOPROCESS ECONOMICS AND PLANT DESIGN 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Bioprocess Engineering**

Course Objectives

The goal of this course is for students to

- Understand the basic economics involve in cost analysis.
- Summarizes the key consideration required for bioprocess economics.
- Outline the process design involve in plant design and selection of instruments.
- Utilize the knowledge to solve various design-based problems.

Course Outcomes:

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

1. Outline the basics of economic evaluation for a bioprocess.**(K2)**
2. Summarize Bioprocess Economics and its importance. **(K2)**
3. Illustrate the various strategies of process design**(K2)**
4. Infer various strategies of basic considerations in equipment design**(K2)**
5. Apply knowledge to solve various design-based problems. **(K3)**

UNIT I ECONOMIC EVALUATION 9h

Capital cost of a project; Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation; Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis.

UNIT II BIOPROCESS ECONOMICS 9h

Introduction, elements of total production cost, outline of the total capital investment, equipment sizing, capital cost estimates large-scale equipment and utilities. Manufacturing cost estimates – Operating costs-Raw materials, utilities, fixed costs and overhead costs, case studies of antibiotics, recombinant products, single cell protein.

UNIT III INTRODUCTION TO PROCESS DESIGN 9h

Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and

integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out.

UNIT IV BASIC CONSIDERATIONS IN EQUIPMENT DESIGN 9h

General design procedure, equipment classification, materials of construction - Mechanical properties - strength, elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals- ferrous metals, types of iron & steels, nonferrous metals and Non-metals. Corrosion: Forms of corrosion and their presentation, Choice of materials.

UNIT V BASIC DESIGN PROBLEMS 9h

Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization; Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics; Practical considerations in designing of Bioreactor/Fermentor construction. Design consideration of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Problems associated with design equations.

Total : 45 h

Text Book

1. Peters & Timmerhaus, Plant design and Economics for Chemical Engineers McGraw Hill Higher Education (2004).

Reference Books

1. M V Joshi & V .V. Mahajani, Process equipment design, 3rd Ed. Macmillan India Limited (2000)
2. Harvey W Blanch, Biochemical Engineering, 2nd Ed, Taylor &Francis. 2009

Weblinks

1. https://www.cheric.org/files/education/cyberlecture/d200301/d200301-1801.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	1	-	-	-	1	-	1	1	2
CO2	2	1	-	-	1	1	-	-	-	1	-	1	-	2
CO3	2	1	-	-	1	1	-	-	-	1	-	1	1	2
CO4	2	1	-	-	1	1	-	-	-	1	-	1	-	2
CO5	3	2	1	-	1	1	-	-	-	1	-	1	1	2
Avg.	2.2	1.2	1	-	1	1	-	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VI

25BTBT6E03 MOLECULAR MODELLING AND DRUG DESIGN 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Bioinformatics**

Course Objectives

The goal of this course is for students to

- Explain the basic concepts of molecular modelling.
- Discuss the general features of molecular mechanics.
- Outline the concept on cheminformatics molecular modeling.
- Explain the structure-based drug design for all classes of targets.

Course Outcomes

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

1. Outline basic concepts on molecular modeling. **(K2)**
2. Summarize various calculations on molecular properties. **(K2)**
3. Illustrate the concept behind molecular mechanics through derivative methods. **(K2)**
4. Identify the molecules simulation through dynamics methods. **(K3)**
5. Apply the diverse techniques on molecular modeling. **(K3)**

UNIT - I MOLECULAR MODELLING 9h

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. Bond Stretching – Angle Bending – Torsional terms — Electrostatic interactions – Van Der Waals interactions – Effective pair Potentials – Hydrogen Bonding – Simulation of liquid water.

UNIT - II QUANTUM MECHANICS 9h

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 empiricalmethods.

UNIT - III MOLECULAR MECHANICS 9h

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 9h

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. Molecular Dynamics using simple modules— Constant dynamics – Time dependent properties – Molecular Dynamics at constant temperature and pressure.

UNT - V MODELLING AND DRUG DESIGN 9h

Introduction to cheminformatics, Macromolecular modeling, design of ligands for known macromolecular 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. Deriving and using 3D Pharma cores – Structure Based methods to identify lead components- De novo ligand design.

Total : 45h

Text Books

1. Leach. A. (2001). Molecular modeling: Principles and application. Prentice Hall.
2. Yvonne, Martin. C. and Willett. P. (2010). Designing bioactive molecules: three dimensionaltechniques and applications. Washington, DC. American chemical society.

Reference Books

1. Schlecht. M. F. (2008). Molecular modeling on the PC. Wiley - Blakwell;
2. Andrew R. Leach. (2001), “Molecular Modeling: Principles and applications “, prentice hall publications.

Weblinks

1. https://www.schrodinger.com/intro-to-molec-model-course-page

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	1	-	-	1	2
CO2	2	1	-	-	-	-	-	-	-	1	-	-	-	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	3	2	1	-	1	1	-	-	-	1	-	-	-	2
CO5	3	2	1	-	1	1	-	-	-	1	-	-	-	2
Avg.	2.4	1.4	1	-	1	1	-	-	-	1	-	-	1	2

1 - Low, 2 - Medium, 3 - High, ‘-' - No Correlation

Semester - VI

25BTBT6E04 BIOMATERIALS 3H-3C

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

End Semester Exam: 3 Hours

Prerequisite: Nil

Course Objectives

The goal of this course is for students to

- Study the phenomena various metals used in implant applications.
- Acquire knowledge importance of ceramics and polymer used biomedical diagnostics
- Obtain the concept of different types biomaterials applied in-vitro and in-vivo biomedical implants
- Gain the knowledge about biomaterials used in various biomedical implant application

Course Outcomes

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

1. Outline the basic principle and properties of biomaterials **(K2)**
2. Apply various types of metals used in implant applications. **(K3)**
3. Summarize the process of importance of polymer used biomedical diagnostics. **(K2)**
4. Explain the role of ceramics as an implant **(K2)**
5. Identify various analysis used to test the bio-materials**(K3)**

UNIT I: INTRODUCTION 9 h

Definition of biomaterials, requirements and classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

UNIT II: METALLAIC IMPLANT MATERIALS 9 h

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

UNIT III POLYMERIC IMPLANT MATERIALS 9 h

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable of polymers for medical purposes,

Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.

UNIT IV CERAMIC IMPLANT MATERIALS 9 h

Definition of bio ceramics. Common types of bioceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction). Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Polymers Filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

UNIT V TESTING OF MATERIALS 9 h

Biocompatibility and Toxicological screening of biomaterials: Definition of biocompatibility blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (*in situ* implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests. **45h**

Text Books

1. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2004). Biomaterials science: an introduction to materials in medicine.
2. Basu, B. (2017). Biomaterials science and tissue engineering: principles and methods. Cambridge University Press.
3. Morganti, P. (2013). Biomaterials Science: An Integrated Clinical and Engineering Approach. Journal of Applied Cosmetology, 31(1/2), 49-53.

Reference Books

1. Park, J., & Lakes, R. S. (2007). Biomaterials: an introduction. Springer Science & Business Media.
2. Sarvazyan, N. (Ed.). (2020). Tissue Engineering: Principles, Protocols, and Practical Exercises. Springer Nature.

Weblinks

1. https://www.rsc.org/journals-books-databases/about-journals/biomaterials-science/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	1	-	-	-	-	-	1	-	1	-	2
CO2	2	1	-	1	-	-	-	-	-	1	-	1	-	2
CO3	2	1	-	1	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	1	1	-	-	-	-	1	-	1	-	2
CO5	3	2	1	1	1	-	-	-	-	1	-	1	-	2
Avg.	2.2	1.2	1	1	1	-	-	-	-	1	-	1	-	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Professional Elective –IV **Semester - VII**

25BTBT7E01 MOLECULAR PATHOGENESIS AND DIAGNOSTICS 3H-3C

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

Prerequisite: Microbiology

Course Objectives

The goal of this course is for students to

- Comprehend the definitions of pathogenicity and entrance points
- Examine the host's defense mechanisms against infections and their tactics
- Understand the molecular mechanism underlying pathogenicity
- Discover the most recent advances in molecular methods for regulating microbial pathogenicity

Course Outcomes

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

1. Outline the basic elements of pathogenesis and the role that microbes play in the development of diseases**. (K2)**
2. Summarize the defense mechanisms used in bacteria and viruses to thwart host defenses. **(K2)**
3. Explain the causes of bacterial infections and the molecular mechanisms underlying pathogenicity. **(K2)**
4. Infer the basic concepts of host-pathogen interactions **(K2)**
5. Identify the molecular methods for managing the infection by microbial pathogens. **(K3)**

UNIT-I OVERVIEW AND BASICS OF MICROBIAL PATHOGENESIS 9 h

Historical perspective - discovery of microscope, Louis Pasteur_s contributions, Robert Koch's postulates, early discoveries of microbial toxins, toxic assays, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, Various pathogen types (bacteria, fungi, virus and parasites) and their modes of entry.

UNIT-II HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES 9 h

Attributes & components of microbial pathogenesis, Host defense mechanism by humoral and cellular, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defenses.

UNIT-III MOLECULAR PATHOGENESIS (WITH SPECIFIC EXAMPLES) 9 h

Bacterial secretion system in Gram negative bacteria, *E.coli*, Enterotoxigenic *E.coli* (ETEC), Enterohaemerrohogi *E.coli* (EHEC). *Vibrio cholerae*: Choleratoxin, Bacterial secretion system in Gram

positive bacteria, *mycobacterium tuberculosis* – transmission and pathogenesis. Shigellosis, Candidiasis, Plasmodium: Life cycle and its mechanism. Influenza virus pathogenesis.

UNIT-IV EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 9 h

Virulence, virulence factors, virulence - associated factors and virulence lifestyle factors molecular genetics and gene regulation in virulence of pathogens, virulence assays: biofilm formation and development, adherence, invasion, cytopathic, cytotoxic effects. Criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses. Antibiotic resistant mechanism in pathogens.

UNIT-V MOLECULAR DIAGNOSTIC TECHNIQUES 9 h

Nucleic acid-based diagnostics: PCR, qPCR, LAMP, DNA microarrays, CRISPR diagnostics; Protein-based diagnostics: ELISA, immunofluorescence, flow cytometry; Point-of-care testing: lateral flow assays, paper-based diagnostics; Biosensors: electrochemical, optical, and microfluidic biosensors; Next Generation Sequencing (NGS) in diagnostics; Liquid biopsy and circulating tumor DNA (ctDNA)

Total: 45 h

Text Books

1. MacInnes, J. I., Van Immerseel, F., Boyce, J. D., Rycroft, A. N., & Vázquez-Boland, J. A. (2022). Pathogenesis of bacterial infections in animals. J. F. Prescott (Ed.). John Wiley & Sons, Incorporated.
2. Tang, Y. W., Hindiyeh, M., Liu, D., Sails, A., Spearman, P., & Zhang, J. R. (Eds.). (2023). Molecular medical microbiology. Academic press.
3. Koellner, C. M., Mensink, K. A., & Highsmith Jr, W. E. (2020). Essential Concepts in Molecular Pathology.
4. Schrijver, I. (Ed.). (2011). Diagnostic Molecular Pathology in Practice: A Case-Based Approach. Springer Science & Business Media.

Web links

1. https://edinburgh-infectious-diseases.ed.ac.uk/our-research/research-themes/molecular-pathogenesis

CO-PO MAPPING

CO	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PSO 1	PSO2
CO1	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO2	2	1	-	-	-	-	1	-	-	1	-	1	1	2
CO3	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO4	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO5	3	2	1	-	-	-	1	-	-	1	-	1	-	2
Avg.	2.2	1.2	-	-	-	-	1	-	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlatio

Semester - VII

25BTBT7E02 **FOOD PROCESS BIOTECHNOLOGY** **3H-3C**

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

End Semester Exam: 3 Hours

Prerequisite: Microbiology

Course Objectives:

The goal of this course is to

- Learn the concepts of food biotechnology.
- Understand the knowledge on various foods and its nutritional value.
- Infer the different techniques used for the preservation of foods.

Course Outcomes:

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

1. Summarize the functional properties of carbohydrates, fats, lipids, proteins in food. (K2)
2. Infer the importance of food additives and its functions. (K2)
3. Explain the unit operations in food processing and preservation. (K2)
4. Outline the types of food packaging (K2)
5. Identify the methods to control spoilage and deterioration in food. (K3)

UNIT I BASIC FOOD NUTRIENTS AND MICROBIOLOGY **9h**

Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; Fermented foods; Single cell protein

UNIT II FOOD ADDITIVES **9h**

Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids, food adulterants and their detection, Introduction to food safety and security.

UNIT III UNIT OPERATIONS IN FOOD PROCESSING **9h**

Raw material preparation- cleaning, sorting, grading and peeling; Size reduction; Pumping; Mixing and forming; Separation and concentration – centrifugation, filtration, extraction, crystallization; Heat transfer–conduction, convection, radiation, extruders (Theory and equipment only); Large scale processing – meat, beverage, confectionary, dairy, fresh fruits and veg

UNIT IV FOOD PACKAGING 9h

Types of packaging material and containers; Interactions between packaging and foods; Controlling packaging atmosphere, Modified atmosphere packaging, Aseptic packaging, Active and intelligent packaging; Packing – meat, dairy, fresh fruits and vegetables, beverages and confectionaries; Food packaging closure and sealing system; Nutrition labelling and legislative requirements.

UNIT V FOOD SAFETY AND QUALITY CONTROL 9h

Objectives, importance and functions of quality control; Food safety- definition, food laws and regulations – FSSAI, FDA; Grades and standards; Concept of codex almentarious/HACCP/ /ISO 9000 series etc; Food recalls.

Total: 45 h

Text Books

1. T.P. Coultate – Food – The Chemistry of Its Components, 2nd Edn. Royal Society, London, 2016.
2. B. Sivasanker – Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. New Delhi2002.
3. Fellows P.J, Food Processing Technology: Principles and Practices, Woodhead Publishing 4th edition,2016.

Reference Books

3. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4th Ed., McGraw - Hill Book Co., New York 2021.
4. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 2021.

Website

1. http://www.niftem-t.ac.in/food_biotechnology.php

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	1	1	-	1	2	-
CO2	2	1	-	-	-	-	1	-	1	1	-	1	2	1
CO3	2	1	-	-	-	-	-	-	1	1	-	1	2	1
CO4	2	1	-	-	-	-	1	-	1	1	-	1	2	-
CO5	3	2	1	-	-	-	1	-	1	1	-	1	2	1
Avg.	2.2	1.2	1	-	-	-	1	-	1	1	-	1	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VII

25BTBT7E03 AI IN BIOTECHNOLOGY 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Bioinformatics**

Course Objectives

The goal of this course is for students to

- Explain the fundamentals of AI and its role in biotechnology applications..
- Describe AI-driven approaches in genomics, precision medicine, and genetic engineering
- Apply AI techniques in biomedical image processing and disease diagnostics.
- Utilize the AI in bioprocess optimization and synthetic biology

Course Outcomes

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

1. Outline the AI methodologies and their applications in biotechnology. **(K2)**
2. Demonstrate the role of AI in genome sequencing and personalized medicine. **(K2)**
3. Outline the AI for biomedical image analysis and diagnostics. **(K2)**
4. Summarize the AI-driven techniques for bioprocess optimization and automation. **(K2)**
5. Identify AI-based advancements in healthcare and drug discovery. **(K3)**

UNIT I: INTRODUCTION TO AI IN BIOTECHNOLOGY 9h

Overview of Artificial Intelligence (AI) and Machine Learning (ML) in Biotechnology, Types of AI: Supervised, Unsupervised, and Reinforcement Learning, Data Acquisition and Processing in Biotechnology, Role of AI in Systems Biology and Computational Biology, AI-driven Drug Discovery and Development, Challenges and Ethical Considerations in AI-driven Biotech Research

UNIT II: AI IN GENOMICS AND PRECISION MEDICINE 9h

AI Applications in Genome Sequencing and Annotation, Machine Learning in Gene Expression Analysis, AI-based Prediction of Genetic Disorders and Disease Risk, Personalized Medicine and AI-driven Biomarker Discovery, CRISPR and AI-assisted Gene Editing, AI in Pharmacogenomics and Drug Response Prediction

UNIT III: AI IN BIOMEDICAL IMAGE PROCESSING 9h

Introduction to Biomedical Imaging and AI Applications, Deep Learning in Medical Image Analysis (MRI, CT, X-ray), AI-based Histopathology and Cancer Detection, AI-powered Microscopy for Cellular and Molecular Imaging, AI in Tissue Engineering and 3D Bioprinting, AI-driven Disease Diagnosis and Prognosis

UNIT IV: AI IN BIOPROCESS OPTIMIZATION AND SYNTHETIC BIOLOGY 9h

AI in Fermentation Process Control and Optimization, Machine Learning for Metabolic Pathway Engineering, AI-based Protein Structure Prediction and Folding (AlphaFold), AI in Microbial Strain Improvement for Industrial Applications, Smart Bioreactors and AI-driven Process Automation, AI in Environmental Biotechnology and Waste Treatment

UNIT V: AI IN HEALTHCARE AND FUTURE PROSPECTS 9h

AI-powered Digital Health Technologies and Wearable Devices, AI in Epidemiology and Disease Surveillance, AI-driven Drug Repurposing for Emerging Diseases, AI and Robotics in Personalized Healthcare and Surgery, AI in Vaccine Development and Pandemic Prediction, Future Trends and Innovations in AI and Biotechnology

Total :45 h

Textbooks

1. Dey, N., Ashour, A. S., & Borra, S. (2020). Machine learning in bio-signal analysis and diagnostic imaging. Academic Press.
2. Shanmughavel, P. (2018). Artificial intelligence and machine learning in biotechnology. Alpha Science International.
3. Ekins, S., Puhl, A. C., Zorn, K. M., & Lane, T. R. (2019). Artificial intelligence in drug discovery. Academic Press.

Reference Books

1. Zhou, J., & Wang, L. (2021). Artificial intelligence in bioinformatics: Theory and applications. Springer.
2. Murphy, K. P. (2022). Probabilistic machine learning: An introduction. MIT Press.
3. Chicco, D., & Jurman, G. (2021). Machine learning and data mining in bioinformatics and biomedicine. MDPI.

Web links

1. https://www.uspto.gov/sites/default/files/documents/Artificial-Intelligence-in-Biotechnology.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	1	-	1	-	1	-	1	1	2
CO2	2	1	-	-	2	1	-	1	-	1	-	-	-	2
CO3	2	1	-	-	2	1	-	1	-	1	-	-	-	2
CO4	2	1	-	-	2	1	-	1	-	1	-	-	-	2
CO5	3	2	1	-	2	1	-	1	-	1	-	1	-	2
Avg.	2.2	1.2	1	-	2	1	-	1	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VII

25BTBT7E04 BIOSENSORS 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Biochemistry & Enzymology**

Course Objectives

The goal of this course is for students to

- Explain the basic concepts of biosensor.
- Discuss the role of enzymes in development of biosensor.
- Apply the immunological techniques for designing therapeutic sensor.
- Identify novel technologies in biosensor and their potential applications.

Course Outcomes

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

1. Outline basic concepts of biosensor. **(K2)**
2. Summarize the role of enzymes in development of biosensor. **(K2)**
3. Utilize the antibodies for the development of affinity sensor. **(K3)**
4. Classify various types of novel biosensor based on the technologies. **(K2)**
5. Identify various application of biosensor **(K3)**

UNIT I FUNDAMENTALS OF BIOSENSOR 9h

Biosensors as functional analogs of chemoreceptors, structure and function of transducers, qualitative and quantitative sensors, sensor parameters, transduction methods-optical, calorimetric, electrochemical and piezoelectric sensors Supports and support modifications-synthetic polymers, carbon material supports, metal supports, bifunctional cross linkers.

UNIT II ENZYMATIC BIOSENSORS 9h

Methods of enzyme immobilization-adsorption, gel entrapment, covalent coupling, crosslinking immobilization effects in biosensors, characterization of immobilized enzymes in biosensors, effectiveness factor, enzyme loading test, Metabolic sensors-glucose, ascorbic acid, lactate sensors, determination of alcohols, sensors for phenols and amines, coupled enzyme reactors, sequence electrodes for nucleic acid, enzyme sensor for inhibitors.

UNIT III AFFINITY SENSORS AND REAGENTLESS SENSORS 9h

Affinity sensors based on small ligands, immunosensors, immunoassay-RIA, ELISA and TELISA, piezoelectric immunosensors, optical immunosensors, electrochemical immunoassay,
Biocompatibility of sensors, biomimetic sensors, bio-conjugated silica nanoparticles for bioanalysis.

UNIT IV NOVEL BIOSENSORS **9h**

Surface dielectric enhancement- gold nanoparticles enhanced surface plasmon resonance magnetic biosensors and biochips, quantum dot based biosensors, DNA and protein conformational changes, optical and magnetic sensors, micro and nanocantilevers, electrochemical QCM, MEMS, PCR microchamber array chip system, Detection of target DNA on a single chip.

UNIT V APPLICATIONS OF BIOSENSORS **9h**

Biosensors and diabetes management, Microfabricated biosensors and point-of-care diagnostics systems, Noninvasive biosensors in clinical analysis; Surface plasmon resonance and evanescent wave biosensors, Biosensor in cancer and HIV early diagnosis.

Total : 45h

Text Books

1. Floriner-Gabriel Banica Chemical sensors and Biosensors-Fundamentals and Applications, John-Wiley & Sons Ltd, 2012.
2. Malhotra, B. D. (2017). Biosensors: fundamentals and applications. Smithers Rapra Publishing.

Reference Books

1. Pandey, C. M., & Malhotra, B. D. (2019). Biosensors: fundamentals and applications. Walter de Gruyter GmbH & Co KG.
2. Sadana, A., & Sadana, N. (2010). Handbook of biosensors and biosensor kinetics. Elsevier.

Weblinks

1. https://www.onlinebiologynotes.com/cgi-sys/suspendedpage.cgi

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	1	-	-	1	2
CO2	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	3	2	1	-	1	1	-	-	-	1	-	-	-	2
CO5	3	2	1	-	1	1	-	-	-	1	-	-	-	2
Avg.	2.4	1.4	1	-	1	1	-	-	-	1	-	-	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Professional Elective –V **Semester - VII**

25BTBT7E05 **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

Prerequisite: **Regulatory Affairs for Biotechnology**

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.
- 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. Summarize the scope of clinal research and design of clinical trials. **(K2)**
2. Outline the ethical theories of clinical research. **(K2)**
3. Illustrate the history and regulation of clinical research. **(K2)**
4. Identify the basic views in different situations of biostatistics in clinical trials. **(K3)**
5. Apply the perspective techniques and create data on different clinal research. **(K3)**

UNIT - I INTRODUCTION TO CLINICAL RESEARCH **9h**

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 **9h**

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 **9h**

Drug development and trial Planning-Evolution and History of Regulations in Clinical Research, Patents US Regulatory Structure, IND, NDA, ANDA, Post Drug Approval Activities, PMS, FDA Audits and Inspections EU Regulatory Affairs, EMEA Organization and Function, INDIAN Regulatory system, Schedule Y- Rules and Regulations, Description of trial phases, Trial contexts and

examples

UNIT - IV CLINICAL RESEARCH METHODOLOGY AND MANAGEMENT 9h

Designing of Protocol, 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.

UNIT - V BIOSTATISTICS AND DATA MANAGEMENT 9h

Introduction to Power and Sample Size- Hypothesis testing, P-values, confidence intervals,analysis and reporting stage Data management - Data collection, Paper or electronic, Parsimony, Data validationData Monitoring, Trial Conduct - Data quality assurance, Data delinquency.

Text Books

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 trials. Springer.

Reference Books

1. Machin. D and Fayers. P(2010).Randomized Clinical Trials:Design Practice and Reporting. Wiley-BlackwellJ

Weblinks

1. https://www.niaid.nih.gov/research/dmid-clinical-research-selected-references.
2. https://www.globalresearchonline.net/volume1issue2/Article%20019.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3272827/.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	1	-	-	1	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	-	2
CO3	2	1	-	-	-	-	-	-	-	1	-	-	-	2
CO4	3	2	1	-	-	-	-	1	-	1	-	-	-	2
CO5	3	2	1	-	-	-	-	1	-	1	-	-	1	2
Avg.	2.4	1.4	1	-	-	-	-	1	-	1	-	-	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VII

25BTBT7E06 BIOMASS CONVERSION AND BIOREFINERY 3H-3C

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

End Semester Exam: 3 Hours

Prerequisite: Environmental Science, Microbiology

Course Objectives

The goal of this course is for students to

- Understand the fundamentals of biomass as a renewable resource and its role in sustainable development.
- Study various biomass conversion technologies including thermal, chemical, and biological methods.
- Explore the production of biofuels and value-added products from biomass.
- Summarize economic and environmental impacts through techno-economic analysis and life-cycle assessment (LCA).

Course Outcomes

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

1. Summarize the properties and types of biomass used in biorefineries. **(K2)**
2. Compare different biomass pretreatment and conversion technologies. **(K2)**
3. Illustrate the pathways for the production of biofuels and biochemicals. **(K2)**
4. Infer the structure and operation of integrated biorefineries. **(K2)**
5. Apply the economic feasibility and sustainability using LCA tools. **(K3)**

UNIT - I INTRODUCTION TO BIOMASS AND BIOREFINERY CONCEPTS 9h

Global energy scenario and need for renewable resources; Biomass as an energy source: definition, types, composition, and characterization; Dedicated energy crops and microalgae as feedstock; Basic concepts of biorefinery and its classification (chemical, thermochemical, biochemical); Biorefinery vs. petroleum refinery; Feedstock selection, economics, and policy considerations

UNIT - II BIOMASS PRETREATMENT AND PHYSICAL CONVERSION 9h

Structure of lignocellulosic biomass and barriers to conversion; Pretreatment methods: physical, chemical (acid, alkali, ozone), and hybrid processes; Size reduction, densification, and torrefaction; Overview of physical conversion techniques; Importance of pretreatment for microbial and catalytic processing

UNIT - III THERMAL AND THERMOCHEMICAL CONVERSION 9h

Fundamentals of pyrolysis, gasification, and combustion; Types of reactors used in thermal processes; Biooil and biochar production: factors, upgrading methods, and applications; Syngas production and its use for Fischer-Tropsch synthesis; Case studies of thermal conversion technologies in practice

UNIT - IV BIOCHEMICAL AND MICROBIAL CONVERSION PROCESSES 9h

Anaerobic digestion and biogas technology; Fermentation for bioethanol, biobutanol, acetone-butanol-ethanol (ABE pathway); Microbial production of biodiesel, hydrogen, methane, and methanol; Enzyme production, cellulase activity, SSF and CBP strategies; Organic acids and platform chemicals from biomass (lactic, succinic, propionic acid, etc.)

UNIT - V INTEGRATED BIOREFINERY, ECONOMICS & SUSTAINABILITY 9h

Integrated biorefinery models: lignocellulosic, algal, waste-based; Co-production of fuels, chemicals, and energy; Techno-economic evaluation and cost modeling; Life Cycle Assessment (LCA) for environmental impact; Recent advancements in lab-on-chip diagnostics, process intensification, and automation in biorefineries

Total : 45 h

Text Books

1. Basu, P. (2018). Biomass gasification, pyrolysis and torrefaction: practical design and theory. Academic press..
2. Vertes, A. A., Qureshi, N., Yukawa, H., & Blaschek, H. P. (Eds.). (2011). Biomass to biofuels: strategies for global industries. John Wiley & Sons.

Reference Books

1. Yang, S. T., El-Ensashy, H., & Thongchul, N. (Eds.). (2013). Bioprocessing technologies in biorefinery for sustainable production of fuels, chemicals, and polymers.
2. Yang, S. T. (Ed.). (2011). Bioprocessing for value-added products from renewable resources: new technologies and applications. Elsevier.

Website:

1. https://nptel.ac.in/courses/103103207

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	1	-	-	1	-	1	-	2
CO2	2	1	-	-	1	-	1	-	-	1	-	1	-	2
CO3	2	1	-	-	-	-	1	-	-	1	-	1	1	2
CO4	2	1	-	-	-	-	1	-	-	1	-	1	1	2
CO5	3	2	1	-	1	1	1	1	-	1	-	1	1	2
Avg.	2.2	1.2	1	-	1	1	1	1	-	1	-	1	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VII

25BTBT7E07 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

Prerequisite: **NIL**

Course Objectives

The goal of this course is for students to

- Introduce the fundamentals of mathematical modeling in biological systems
- Explore the representation and analysis of biological networks.
- Understand dynamic modeling techniques and parameter estimation.
- Study constraint-based approaches in metabolic network modeling.

Course Outcomes

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

1. Infer mathematical models to describe biological systems. **(K2)**
2. Explain biological networks using computational tools. **(K2)**
3. Outline dynamic modeling techniques to simulate biological processes. **(K2)**
4. Summarize constraint-based optimization methods in metabolic network analysis. **(K2)**
5. Apply the systems biology approaches to solve complex biological problems. **(K3)**

UNIT - I INTRODUCTION TO MATHEMATICAL MODELING 9h

Overview of systems biology and its significance. Introduction to mathematical modeling in biology; Types of models: deterministic vs. stochastic; Basic mathematical tools and techniques; Case studies illustrating the application of mathematical models in biology

UNIT - II REPRESENTATION AND ANALYSIS OF BIOLOGICAL NETWORKS 9h

Introduction to biological networks: gene regulatory, protein-protein interaction, and metabolic networks; Graph theory and its application in network analysis.;Topological properties of biological networks.; Network motifs and their biological significance.; Tools for network visualization and analysis (e.g., Cytoscape

UNIT - III DYNAMIC MODELING AND PARAMETER ESTIMATION 9h

Ordinary differential equations (ODEs) in modeling biological systems; Solving ODEs using MATLAB.; Parameter estimation techniques: least squares, maximum likelihood.; Sensitivity analysis and its importance; Applications of dynamic modeling in systems biology.

UNIT - IV CONSTRAINT-BASED METABOLIC NETWORK MODELING 9h

Introduction to constraint-based optimization; Flux balance analysis (FBA) and its applications. Elementary mode analysis; Metabolic control analysis; Integration of omics data into metabolic models

UNIT - V APPLICATIONS AND ADVANCED TOPICS 9h

Modeling of gene regulatory networks; Host-pathogen interaction modeling.; Robustness and evolvability in biological systems. Introduction to synthetic biology. Case studies on the application of systems biology in drug development and metabolic engineering..

Total : 45 h

Text Books

1. Raman K (2021) *An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks*. Chapman and Hall/CRC.
2. Voit E (2012) *A First Course in Systems Biology*. Garland Science.

Reference Books

1. Klipp E (2009) *Systems Biology: A Textbook*. Wiley-VCH.
2. Newman MEJ (2011) *Networks: An Introduction*. Oxford University Press.

Weblink

1. https://nptel.ac.in/courses/102106035

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	1	-	-	1	-	1	2	1
CO2	2	1	-	-	-	1	-	-	-	1	-	1	2	1
CO3	2	1	-	-	-	1	1	-	-	1	-	1	2	1
CO4	2	1	-	-	-	1	1	-	-	1	-	1	2	1
CO5	3	2	1	1	-	1	1	-	-	1	-	1	2	1
Avg.	2.2	1.2	1	1	-	1	1	-	-	1	-	1	2	1

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester - VII

25BTBT7E08 FUNDAMENTALS OF NANOTECHNOLOGY 3H-3C

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

End Semester Exam:3 Hours

Prerequisite: **Biochemistry & Analytical Techniques**

Course Objectives

The goal of this course is for students to

- Explain basic knowledge on nanotechnology.
- Demonstrate the structural and functional principles of bionanotechnology.
- Outline the basic concepts of nanoparticles in cancer therapy.
- Discuss the applications in nanoscale technology.

Course Outcomes

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

1. Summarize the characteristics different nanoparticles. **(K2)**
2. Outline the different structural and functional principles of biotechnology. **(K2)**
3. Illustrate the basic of nanostructures. **(K2)**
4. Outline the protein and DNA basis of nanoparticle. **(K2)**
5. Identify and list different nanoparticles for cancer therapy. **(K3)**

UNIT - I INTRODUCTION TO NANOTECHNOLOGY 9h

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 - NANO PARTICLES 9h

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 MICROFLUIDICS 9h

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 9h

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

UNIT - V NANOPARTICLES IN CANCER THERAPY 9h

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.

Total : 45 h

Text Books :

1. Shoseyov. O. and Levy. I. (2007). Nanobiotechnology: Bioinspired Devices and Materials ofthe future. Human Press.
2. Bhushan, B.(2017). Springer Handbook of Nanotechnology. Springer-Verlag Berlin Heidelberg.
3. Freitas. R. A. (2004). Nanomedicine. Landes Biosciences.

Reference Books

1. Kohler. M. and Fritzsche. W. (2004). Nanotechnology-An Introduction to Nanostructuring Techniques. Wiley VCH.
2. Niemeyer. C. M. and Mirkin. C. (2004). A Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH.

Weblink

1. https://www.nanowerk.com/nanobiotechnology.php

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	1	-	-	1	2
CO2	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO3	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO4	2	1	-	-	1	-	-	-	-	1	-	-	-	2
CO5	3	2	1	-	1	-	-	-	-	1	-	-	-	2
Avg.	2.2	1.2	1	-	1	-	-	-	-	1	-	-	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation