B. Tech (Biotechnology)

2018 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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CONTENTS

BANNARI AMMAN INSTITUTE OF TECHNOLOGY, SATHYAMANGALAM

REGULATIONS 2018

(CHOICE BASED CREDIT SYSTEM)

(Common to all B.E./B.Tech. Degree Programmes)

Regulation 2018 has been prepared in accordance with the guidelines given by the University Grants Commission, All India Council for Technical Education and affiliating University incorporating the features of the Choice Based Credit System (CBCS). The Regulation 2018 is applicable to the candidates admitted to the Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) Degree Programmes of the Institution in the academic year 2018-2019 for Regular admission (Academic year 2019-2020 for Lateral Entry) and subsequently.

The regulations hereunder are subjected to amendments as may be decided by the Academic Council of the Institution from time to time. Any or all such amendments will be effective from such date and to such batches of students (including those already in the middle of the programme) as may be decided by the Academic Council.

1. ADMISSION

Candidate, seeking admission to the B.E./B.Tech. Programme, shall satisfy the conditions of admission prescribed by the Directorate of Technical Education and Anna University, Chennai as given below.

1.1 Regular Admission

Candidates, for admission to the first semester of the eight semesters B.E./B.Tech. Degree Programmes, shall be required to have passed:

- Higher Secondary Examination (10 +2) of curriculum (Regular Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics, and Chemistry as three of the four subjects of the study prescribed under Part-III or any other examinations of any Board or University or authority accepted by the Syndicate of the University / Directorate of Technical Education (DoTE), Chennai as equivalent thereto.

(or)

- Should have passed Higher Secondary Examination of Vocational Stream (Engineering/Technology), prescribed by the Government of Tamil Nadu.

1.2 Lateral Entry Admission

1.2.1 The candidates who possess Diploma in Engineering / Technology awarded by the State Board of Technical Education and Training, Tamil Nadu or its equivalent are eligible to apply for Lateral Entry admission to the third semester of B.E. / B.Tech. Programmes in the branch of study as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time.

(or)

1.2.2 The candidates who possess the Bachelor Degree in Science (B.Sc.) (10+2+3 stream) with Mathematics as a subject in B.Sc. is eligible to apply for Lateral Entry admission to the third semester of B.E./B.Tech. Programmes, as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time. Such candidates shall undergo two additional Engineering subject(s) one each in third and fourth semesters, as bridge courses.

2. PROGRAMMES OFFERED

A candidate may be offered admission to any one of the programmes offered by the Institution for the candidates specified in Clause 1.1 and as per the eligibility criteria of DoTE for the candidates under Clause 1.2 from the list given below:

B. E. Programmes

i. Aeronautical Engineering
ii. Agricultural Engineering
iii. Automobile Engineering
iv. Civil Engineering
v. Computer Science and Engineering
vi. Electronics and Communication Engineering
vii. Electrical and Electronics Engineering
viii. Electronics and Instrumentation Engineering
ix. Mechanical Engineering
x. Mechatronics

B. Tech. Programmes

i. Biotechnology
ii. Fashion Technology
iii. Food Technology
iv. Information Technology
v. Textile Technology

3. STRUCTURE OF THE PROGRAMME

3.1 Every programme shall have a distinct curriculum with syllabi consisting of theory, laboratory, project, soft-skills and personality development courses, as prescribed by the respective Boards of Studies, broadly categorized under:

(i) **Basic Science** courses including Mathematics, Physics, Chemistry and further specialization in these subjects

(ii) **Basic Engineering** courses including Engineering Graphics, Engineering Practices, Basics of Electrical, Electronics, Civil, Mechanical Engineering, Engineering Mechanics and Computer Programming.

(iii) **Humanities and Social Science** courses including Language Courses, Management Courses, Soft Skills and Professional Ethics.

(iv) **Professional Courses** include Discipline Core Courses, Professional Electives, and Open Electives.

(v) **Employability Enhancement Courses (EEC)** includes Project Work and /or Internship, Seminar, Industrial /Practical Training, Value Added and Certificate Courses.

The medium of instruction is English for all the Courses, Examinations, Seminar Presentation, Projects and any other courses that a student registers for.

3.2 Each course is normally assigned a certain number of credits based on the following

Contact period per week	Credits
1 Lecture / 1 Tutorial period	1
2 laboratory Periods (Laboratory / Seminar / Project Work / etc.)	1

3.3 All the B.E. / B.Tech. Students will study Communicative English I during the First Semester. In the Second Semester, they will be divided into two streams based on their English language proficiency assessed in the Continuous Assessment during semester I, in which the upper segment will be provided an option to enroll and study Communicative English II / German / Japanese / French / Chinese / Hindi while the lower segment will study Communicative English II.

3.4 Every student shall be required to opt for **Nine** electives from the list of electives. Students can opt for the electives (Core / Professional) from his / her own discipline courses, during V to VIII Semesters, if he/she satisfies the prerequisite for that particular course.

3.5 However, out of nine electives, every student shall be required to opt for, a minimum of one and subject to a maximum of three courses as open elective from the list of electives of the branch / branches other than his / her branch of specialisation, if he/she satisfies the prerequisite for that particular course.

3.6 Students can also opt for **one-credit courses** of 15 to 20 hour duration, which will be offered by the experts from the industry on specialised topics. Students can opt for such **one-credit courses** during the semesters I to VII as and when these courses are offered. A student will also be permitted to register the **one-credit courses** offered by other Departments, provided the student has fulfilled the necessary pre-requisites or the courses that may not require any pre-requisites. Under no circumstances, the same one credit course shall be repeated in subsequent semesters in any Department / Centre for the same batch of the students and a maximum batch size for a given course shall not exceed 40. In case of disciplines with multiple divisions (intake more than 60) different course(s) shall be offered to other batch(es) of students.

On successful completion of one credit courses, Credits will be indicated in the Grade Sheet, but will not be considered for computing the Cumulative Grade Point Average (CGPA). However, if a student wishes to avail the exemption from any one of the Electives (other than open elective) of the Semester VIII, he / she can do so by exercising his / her option in writing to the respective Head of the Department during the beginning of the VIII Semester, following the equivalence norm, that one **regular elective** (in the **VIII Semester**) is equivalent to **three one-credit courses** completed by the student during the previous semesters, IV to VII. Details of the one credit courses offered by the department shall be forwarded to the Office of the Controller of Examinations. However one credit courses completed during I to III semesters shall be maintained in the Grade sheet as “Additional credits earned” (not considered for the computation of SGPA/CGPA).

3.7 A student can register for Self-Study Elective(s) over and above the electives from any branch of Engineering / Technology at the rate of one per semester starting from V semester onwards provided he/she maintains a Cumulative Grade Point Average (CGPA) of 8.50 or above till the previous semesters with no current arrears. Credits will be indicated for such courses in the grade sheets (additional credits) but will not be considered for computing the CGPA.

3.8 A Student may be permitted to credit only one online course with the approval of the Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. The student needs to obtain certification or credit to become eligible for writing the End Semester Examination to be conducted by the CoE. A student can get exemption for a maximum of 3 credits during the entire programme (in lieu of Core elective or Open elective). The Head of the Department may identify a faculty member as coordinator for the course, who is responsible for the evaluation process. The course shall be evaluated through the End Semester Examination only. The evaluation methodology may be decided by the course faculty coordinator.

3.9 Industrial Training / Internship

The students may undergo Industrial training / Internship optionally for a period as specified in the table during summer / winter vacation and the credits earned will be indicated in the Mark Sheet. If the student earns three credits in Industrial Training / Internship, the student may drop one Professional Elective. In such cases, Industrial Training / Internship need to be undergone continuously from one organization only. However, if the number of credits earned is 1 or 2, these credits shall not be considered for classification of the degree. The students may also undergo Internship at Research organization / University (after due approval from the Department Consultative Committee) during summer / winter vacation, in lieu of Industrial training.

Duration of Training / Internship	Credits
2 Weeks	1
1 Month	2
2 Months	3

3.10 Socially Relevant Projects

A Student may be permitted to carry out a socially relevant project during semester II to semester VI in consultation with the Faculty Guide and submit the project report, in the prescribed format, at the end of the Semester for the valuation.

On successful completion of socially relevant project work, one credit will be indicated in the grade sheet (Additional credits), but these credits will not be considered for computing the CGPA.

4. VALUE ADDED COURSES

A Student can opt for the Value Added Courses offered by the various Department / Centres from Semester II to VII. Head of the Department / Centre shall submit the list of such courses, duly approved / ratified by the Academic Council, to the Controller of Examinations to administer the examination process. A separate Certificate will be issued on successful completion of the course by the Office of the Controller of Examinations.

5. DURATION OF THE PROGRAMME

5.1 A regular student (admitted after 10+2) or equivalent is normally expected to satisfactorily fulfil the requirements for award of the degree B.E. / B.Tech. within four academic years (8 semesters) from the date of admission but in any case not more than 7 years (14 Semesters); lateral entry students shall fulfil such requirements within three academic years (6 semesters) from the date of admission but in any case not more than six years (12 Semesters) leading to the award of Degree of Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) of Anna University, Chennai.

5.2 The total period for completion of the programme from the commencement of the semester, to which the student was admitted, shall not exceed the maximum period (Clause 5.1), regardless to the break-of-study (vide Clause 15) or period of prevention in order.

5.3 Each semester shall consist of minimum 90 working days. Head of the Department shall ensure that every faculty member teaches the subject / course as prescribed in the approved curriculum and syllabi.

5.4 Special Theory / Practical Sessions may be conducted for students who require additional inputs over and above the number of periods normally specified (Remedial Classes), as decided by the Head of the Department, within the specified duration of the Semester / Programme.

6. COURSE ENROLLMENT AND REGISTRATION

6.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 8) who shall advise / counsel the student about the details of the academic programme and the choice of course(s) considering the student's academic background and career objectives.

6.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the semester concerned.

6.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

6.3.1 Each student, on admission to the programme, shall register for **all the courses prescribed in the curriculum** in the **first Semester of study (III Semester** for students admitted under **lateral entry stream).**

6.3.2 The enrollment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the Semester II. In case, if a student fails to register in course(s), he/ she may be permitted to register the same, as specified in the Clause 6.5, in the subsequent semesters or when it is offered.

6.3.3 The enrollment for the courses of the Semesters III to VIII will commence 10 working days prior to the last working day of the preceding semester. The student shall enroll for the courses with the guidance of the student's Faculty Advisor. If a student wishes, the student may drop or add courses (vide Clause 6.4) within **five** working days after the commencement of the

semester concerned and complete the registration process duly authorized by the Faculty Advisor.

6.4 Flexibility to Add or Drop courses

6.4.1 A student has to earn the total number of credits specified in the Curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum by opting for one- credit courses, self study electives or additional courses.

6.4.2 From the III to VIII semesters (from IV to VIII Semesters in case of lateral entry students), the student has the option of registering for additional courses or dropping existing courses. The total number of credits that a student can add or drop is limited to 8, subject to a maximum of 2 courses in a given Semester. In such cases, the attendance requirement as stated in Clause 7 is mandatory.

6.4.3 The student shall register Project work I in semester VII and Project work II in semester VIII only.

6.5 Reappearance Registration

6.5.1 If a student fails in a theory course, the student shall do reappearance registration (Examination) for that course in the subsequent semesters or when it is offered next.

6.5.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes, and the attendance requirement (vide Clause 7) is not compulsory for such courses.

6.5.3 However, if a student wishes to improve his/ her continuous assessment, in the second attempt during reappearance, he/she shall satisfy the Clause 6.5.5 and appear for continuous assessment as given for that particular course.

6.5.4 If the theory course, in which the student has failed, is either a professional elective or an open elective, the student may register for the same or any other professional elective or open elective course, respectively in the subsequent semesters. However, the change of elective courses is permitted only once.

6.5.5 In this case (Clause 6.5.4), the student shall attend the classes, satisfy the attendance requirements (vide Clause 7), earn Continuous Assessment marks and appear for the End Semester Examination.

6.5.6 The student who fails in any continuous assessment courses (Laboratory/ Project work / Seminar or any other HSS/EEC courses) shall register for the same in the subsequent semesters or when offered next, and **repeat** the course as per Clause 6.5.5.

6.5.7 If a student is prevented from writing the end semester examination of a course or several courses due to lack of attendance, the student has to register for that / those course(s) again, when offered next, attend the classes and fulfill the requirements as per Clause 6.5.5 & 6.5.6. If the course, in which the student has 'lack of attendance', is a Core Elective or an Open Elective, the student may register for the same or any other Core Elective or Open Elective course(s) respectively in the subsequent semesters and appear in the examination as per Clause 6.5.5.

6.5.8 If a student fails to secure a pass in any theory courses (including elective) he/she is given a maximum of three arrear attempts to complete the courses. If the student still fails to secure a pass, he/she shall register for the same when offered next and repeat the course.

7. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide Clause 7.1 and 7.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

7.1 Every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance course wise taking into account the number of periods required for that course as specified in the curriculum.

7.2 If a student, secures attendance between 70% and 79% in any course(s) in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/

International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department (along with Condonation form). Such certificates along with the condonation forms shall be forwarded to the Controller of Examinations for verification and permission to attend the examinations. However during the entire programme of study, a student can avail such Condonation in any two semesters only (regardless the number of courses).

7.3 A student shall normally be permitted to appear for End Semester Examination of the course(s) if the student has satisfied the attendance requirements (vide Clause 7.1 – 7.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

7.4 Students who do not satisfy Clause 7.1 and 7.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semesters or when it is offered next (vide Clause 6.5).

7.5 If a student has shortage of attendance in all the registered courses, he/she would not be permitted to move to the higher semester and has to repeat the current semester in the subsequent year.

7.6 In the case of reappearance (Arrear) registration for a course, the attendance requirement as mentioned in Clauses 7.1 - 7.3 is not applicable. However, the student has to register for examination in that course by paying the prescribed fee.

7.7 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades.

8. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor

for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. The Faculty Advisor also discusses with or informs the parents about the progress / performance of the students concerned.

The responsibilities of the faculty advisor shall be:

- To inform the students about the various facilities and activities available to enhance the student's curricular and co-curricular activities.
- To guide student enrollment and registration of the courses.
- To authorize the final registration of the courses at the beginning of each semester.
- To monitor the academic and general performance of the students including attendance and to counsel them accordingly.

9. COMMITTEES

9.1 Common Course Committee

9.1.1 A theory course handled by more than one faculty including the discipline with multiple divisions (greater than or equal to 2) shall have a "Common Course Committee" comprising of all members of faculty teaching that course with one of the members as the Course Coordinator, nominated by the Head of the Institution (Head of the Department in the case of multiple divisions of a discipline) and student representatives (one per specialization or division) registered for that course in the current semester.

First meeting of the Common Course Committee shall be held within fifteen days from the date of commencement of the semester. Two subsequent meetings in a semester may be held at suitable intervals. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all the students.

9.1.2 In addition, Common Course Committee (without the student representatives) shall meet to ensure uniform evaluation through the common question papers during Continuous Assessment and End Semester Examinations.

9.2 Class Committee Meeting

For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened thrice in a semester (first meeting within 15 days from the commencement of the semester and other two meetings at equal interval after the first meeting) comprising members of the faculty handling all the courses and two student representatives from the class.

One of the members of the faculty (preferably not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of the Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

10. SYSTEM OF EXAMINATION

10.1 Performance in each course of study shall be evaluated based on (i) Continuous Assessment throughout the semester and (ii) End Semester examination at the end of the semester for the regular courses or as given in the Clause 16. However, the final examination in the case of certificate / value added courses may be conducted, as and when the course is completed, through the office of the Controller of Examinations.

10.2 Each course, both theory and laboratory including project work, shall be evaluated as per the Scheme of Assessment given in Clause 16.

10.3 The End Semester Examinations shall normally be conducted after satisfying the Clause 5.2.

10.4 For the End Semester examinations, both theory and project work, the internal and external examiners (from Academia or Industry) shall be appointed by the Controller of Examinations as per the guidelines given by the Examination cum Evaluation committee of the Institute.

11. PASSING REQUIREMENTS AND PROVISIONS

11.1 The Passing requirement for a student in a course is determined based on the marks obtained both in Continuous Assessment and End Semester Examinations. If the student gets <50% of marks in End Semester Examination, then the student will be awarded only RA (Reappearance) grade.

11.1.1 If a student fails to secure a pass in a particular course, i.e., failing to obtain minimum marks, as stated above, it is mandatory that he/she shall reappear for the examination in that course in the subsequent semester(s) whenever the examinations are conducted for that course, till he / she secures a 'Pass'.

Continuous Assessment (CA) marks obtained by the student in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 6.5.4, 6.5.5, 6.5.6 and 6.5.7. However, from the third attempt onwards, the student shall be declared to have passed the course if he/she secures a minimum of 6 Grade Points (B Grade) in the course prescribed during the End Semester Examinations.

11.2 If a candidate fails in the seventh semester examinations of Project work I, he/she has to resubmit the Project Report within 30 days from the date of declaration of the results. If he / she fails in the End semester examination of Project work II, he/she shall resubmit the Project Report within 60 days from the date of declaration of the results. The resubmission of the project report and the subsequent viva-voce examination will be considered as reappearance with payment of exam fee. In case a student fails in the resubmission of a project report and subsequent viva-voce examination, the student shall register for the course again, when offered next.

11.3 The passing requirement for the courses which are assessed only through continuous assessment (Laboratory and EEC courses except project work), shall be fixed as minimum 50% and the remaining grades are decided as per clause 12.4. If a candidate fails in EEC courses (Except Project work), he/she has to register and repeat the course within 30 days from the date of declaration of the

results. In case a student fails to register within 30 days, he/she shall register for the course again, when offered next.

11.4 The minimum number of total credits to be earned by a student to qualify for the award of Degree in the various branches of study as prescribed by the respective Boards of Studies is given below:

Branch of Study	Minimum Credits	
	Regular Admission	Lateral Entry
B.E. Programmes		
Aeronautical Engineering	172	135
Agricultural Engineering	172	134
Automobile Engineering	170	133
Civil Engineering	171	133
Computer Science and Engineering	171	133
Electronics and Communication Engineering	172	131
Electrical and Electronics Engineering	170	131
Electronics and Instrumentation Engineering	170	131
Mechanical Engineering	170	131
Mechatronics	170	132
B.Tech. Programmes		
Biotechnology	172	134
Fashion Technology	172	134
Food Technology	170	132
Information Technology	170	132
Textile Technology	171	133

11.5 Student Migration and Credit Transfer: Normalization of the Credits will be carried out in consultation with the Board of Studies of the programme concerned and approved by the Head of Institution, if a student migrates from other Autonomous institutions to Bannari Amman Institution of Technology or rejoins from previous regulation to this regulation.

11.6 A student shall be declared to have qualified for award of B.E/B.Tech. Degree if he/she successfully completes the course requirements (vide Clause 7, 10 and 11) and passed all the prescribed courses of study of the respective programme (listed in Clause 2), within the duration specified in Clause 5.1.

12. ASSESSMENT AND AWARD OF LETTER GRADES

12.1 The assessment shall be based on the performance in the End Semester Examinations and / or Continuous Assessment, carrying marks as specified in Clause 16. Letter Grades (based on Credit Point and Grade Point) are awarded to the students based on the performance in the evaluation process.

12.2 Credit Point is the product of Grade Point and number of credits for a course and Grade Point is a numerical weight allotted to each letter grade on a 10-point scale (as specified in the Clause 12.4), while the Letter Grade is an index of the performance of a student in a said course.

12.3 Condition for Relative Grading

The minimum number of students for applying relative grading system is 30. If the students' strength is less than 30 then absolute grading system will be applied. The relative grading system shall not be applied for laboratory and EEC courses.

12.4 The performance of a student will be reported using Letter Grades in absolute grading, each carrying certain points as detailed below: In relative grading, grades will be decided by the faculty concerned. A student who earns a minimum of 6 grade points in a course is declared to have successfully passed the course.

Range of Total Marks (as specified in Clause 16) / Specific Reason	**Grade Points**	**Letter Grade**
91 to 100	10	O (Outstanding)
81 to 90	9	A + (Excellent)
71 to 80	8	A (Very Good)
61 to 70	7	B + (Good)
50 to 60	6	B (Above average)
0 to 49	0	RA (Reappearance Registration)
Incomplete	0	I
Withdrawal	0	W
Absent	0	AB
Shortage of Attendance	0	SA

'RA' ---Reappearance registration is required for that particular course

'I' --- Continuous evaluation is required for that particular course in the subsequent examinations.

'SA' --- shortage of attendance (Clause 7) and hence prevented from writing end semester examination.

12.5 After completion of the evaluation process, Semester Grade Point Average (SGPA), and the Cumulative Grade Point Average (CGPA) is calculated using the formula:

$$SGPA/CGPA = \frac{\sum_{1}^{n} C_i * g_i}{\sum_{1}^{n} C_i}$$

Where

C_i : Credit allotted to the course.

g_i : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of SGPA and all the semesters, under consideration, in the case CGPA.

12.6 A student who does not appear for the End Semester Examinations in a course, after registering for the same, shall be deemed to have appeared for that examination for the purpose of classification (Subject to Clause 14 and 15).

12.7 For the non credit courses grades shall be indicated as given in the Clause 16 and shall not be counted for the computation of SGPA/CGPA.

For the Co-curricular activities such as NCC / NSS / NSO / YRC, a satisfactory / not satisfactory grading will appear in the mark sheet. Every student shall put in a minimum of 75% attendance in the training and attend the camp compulsorily. The training and camp shall be completed during the first year of the programme. However, for valid reasons, the Head of the Institution may permit a student to complete this requirement in the second year. A satisfactory grade in the above co-curricular activities is compulsory for the award of degree.

12.8 **Revaluation:** A student, who seeks the re-valuation of the answer script, is directed to apply through proper application to the Controller of Examinations in the prescribed format through the Head of the Department. The Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted to the courses other than theory courses. In the case of theory courses with laboratory component, a student can seek revaluation for the theory component only, following the procedure stated above.

12.9 **Supplementary Examinations**: If a student fails to secure a pass in theory course(s) of VIII semester examination, he/she is eligible to appear for a one time Supplementary Examination which shall be conducted at the end of VIII semester, for the subjects of VIII semester alone within 30 days from the date of declaration of the results.

12.10 Eligibility for the Award of Degree

A student shall be declared to be eligible for the award of the B.E. / B.Tech. Degree provided the student has

i. Successfully gained the required number of total credits as specified in the curriculum corresponding to the student's programme within the stipulated time.
ii. Successfully completed the course requirements, appeared for the End-Semester examinations and passed all the courses prescribed in all the 8 semesters within a maximum period of 7 years reckoned from the commencement of the first semester to which the candidate was admitted.
iii. Successfully completed the NCC / NSS / NSO / YRC / Extra-curricular/ Co-curricular requirements.
iv. No disciplinary action is pending against the student.
v. The award of Degree must have been approved by the Syndicate of the University.

13. CLASSIFICATION OF THE DEGREE AWARDED

For the purpose of the 'Award of Degree', the duration of completion of the programme shall be the total duration taken by a student for completing first time registration of all the required courses and satisfying Clause 11, regardless to the period of Break-of-study as per Clause 15 and satisfy any one of the conditions required as given below.

13.1 **First Class with Distinction**: A student who satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction**:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry students) in the student's First Appearance within five years, which includes authorized break of study of one year. Withdrawal from examination (vide Clause 15) will not be considered as an appearance.
- Should have secured a CGPA of **not less than 8.50**
- Should **NOT** have been prevented from writing end semester examination due to lack of attendance in any of the courses.

13.2 **First Class**: A student who satisfies the following conditions shall be declared to have passed the examination in **First class**:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry students) within five years, which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of **not less than 7.00**

13.3 Second Class: All other students (not covered in clauses 13.1 and 13.2) who qualify for the award of the degree shall be declared to have passed the examination in **Second Class.**

14. WITHDRAWAL FROM THE EXAMINATION

14.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) only once during the entire duration of the degree programme.

14.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 7 and, if it is made within TEN working days before the commencement of the end semester examination in that course or courses and also recommended by the Head of the Department.

14.3 Notwithstanding the requirement of mandatory TEN working days' notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

14.4 If a student withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examination(s).

14.5 Withdrawal shall not be considered as an appearance in the examination for the eligibility of a student for First Class with Distinction or First Class.

14.6 Withdrawal is permitted for the end semester examinations in the final semester, only if the period of study of the student concerned does not exceed 5 years as per clause 13.1 & 13.2.

15. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

15.1 A student is permitted to go on break of study for a fixed period of one year as a single break in the entire course of study.

15.2 A student is normally not permitted to break the period of study temporarily. However, if a student happens to discontinue the programme temporarily during the middle of programme of study, for reasons such as personal accident or hospitalization due to ill health or in need of health care, he/she shall apply to the Head of the Institution in advance, in any case, not later than the last date for registering for the semester examination, through the Head of the Department stating the reasons for the break-of-study (for one academic semester or 6 months, whichever is earlier). However, a student detained for want of minimum attendance

requirement as per Clause 7 shall not be considered as permitted 'Break of Study' and Clause 15.3 is not applicable for such case.

15.3 The student is permitted to rejoin the programme after the break / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of rejoining. The students rejoining in new Regulations shall apply to the Dean Academics in the prescribed format through the Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

15.4 Authorized break of study will be counted towards the duration specified for passing all the courses (vide Clause 5.1 and 5.2) and for the purpose of classification of Degree (vide Clause 13).

15.5 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in Clause 5.1, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 13).

15.6 In case of valid reasons (as stated in Clause 15.2) extended break-of-study may be granted by the Head of the Institution for a period not more than one year in addition to the earlier authorized break of study.

15.7 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrollment. Such students are not entitled to seek readmission under any circumstances.

16. SCHEME OF ASSESSMENT

Courses offered under B.E. / B.Tech. Programmes are assessed as given below:

I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (10)	
	Periodical Test II (10)	
	Innovative Practices (30)	
	End Semester Examination	**50**
	Total Marks	**100**

II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (10)	
	Periodical Test II (10)	
	Innovative Practices (30)	
	(Laboratory Assessment & Report)	
	End Semester Examination (QP pattern as per (I))	**50**
	Total Marks	**100**

III	**LABORATORY COURSES**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (20)	
	ii. Experiment and Analysis of Results (20)	
	iii. Record (10)	
	Test – Cycle I (25)	
	Test – Cycle II (25)	
	Total Marks	**100**

IV	**PROJECT WORK I**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	<u>Review I</u>	
	Literature Survey (5)	
	Identification of topic and Justification (5)	
	Work plan (10)	
	<u>Review II</u>	
	Approach & Results (15)	
	Conclusion (15)	

	End Semester Examination	**50**
	Report[#] (20)	
	Presentation (20)	
	Viva voce (10)	
	Total Marks	**100**

V	**PROJECT WORK II**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Progress (10)	
	Review II	
	Approach & Results (10)	
	Review III	
	Conclusion & Final Presentation (10)	
	Report (15)	
	Publication of Paper in Conferences / Journals (5)	
	End Semester Examination	
	Presentation (30)	**50**
	Viva voce (20)	
	Total Marks	**100**

VI	**LANGUAGE ELECTIVE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test 1	
	Listening (5)	
	Speaking (10)	**25**
	Reading (5)	
	Writing (5)	
	Test 2	
	Listening (5)	
	Speaking (10)	**25**
	Reading (5)	
	Writing (5)	
	Oral Exam	**50**
	Total Marks	**100**

VII	**ONE-CREDIT COURSE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test I	**50**
	Quiz/ Assignment	**50**
	Total Marks	**100**

[#] *Reports / Record Note / Integrated Lab Manual to be retained for 1 year for Academic Audit, by respective Department*

VIII	**INDUSTRIAL TRAINING/ INTERNSHIP (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Assessment by Industry	**30**
	Viva-voce	**20**
	Presentation	**30**
	Case Study / Report	**20**
	Total Marks	**100**

IX	**SOFT SKILLS (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test I	**25**
	Test II	**25**
	Final Examination	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory)	

X	**VALUE ADDED / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test I	**25**
	Test II	**25**
	Final Evaluation / Test	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory)	

XI	**ENGINEERING GRAPHICS**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Exercise (Minimum 10 Exercises/Modelling)	**60**
	Model Examination	**40**
	Total Marks	**100**

Optional Test: *A student becomes eligible to appear for an optional test conducted after the Periodical Test II, only under the following circumstances: (i) absent for Test I or Test II or both on account of medical reasons (hospitalization / accident / specific illness), or (ii) participation in the College / University / State / National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned member of faculty who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII, VIII, IX, X and XI listed above.*

17. FIELD / INDUSTRIAL VISIT / INTERNSHIP

In order to provide the experiential learning to the students, Head of the Department shall take efforts to arrange at least two industrial visits / field visits. The students may also undergo in-plant training / internship during summer / winter vacation between III and VII semesters.

18. PERSONALITY AND CHARACTER DEVELOPMENT

Every student shall be required to undergo a minimum of 40 hours of Personality Development Programmes viz, NSS / NCC / YRC / YOGA / Sports and Games / Technical and Non-technical Club activities during the first year. The attendance of the personality and character development courses / events shall be maintained on the regular basis by the concerned First Year Co-ordinators and made available in the Office of the Controller of Examinations before the commencement of Semester examinations of Semester I or Semester II.

19. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

20. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI

The Institution reserves the right to revise/amend/change the Regulations, Curriculum, Syllabi, Scheme of Examinations and date of implementation and to introduce Additional Electives, Open Electives, One Credit Courses and Value Added Courses through the Academic Council.

VISION OF THE DEPARTMENT

To offer world-class education by providing academic and professional competence in tune with technological and societal aspirations.

MISSION OF THE DEPARTMENT

- To provide a state-of-art infrastructure for a professional environment through standard academic practices, co-curricular and extra-curricular activities in-line with National and International paradigms.
- To facilitate a platform for student and faculty members towards qualitative interdisciplinary research for developing sustainable circular bioeconomy.
- To establish collaborations with biotech ventures and research institutes to inculcate professional and leadership qualities for students career advancements and faculty competency enhancement.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To maintain high standards of teaching through innovative pedagogy for enabling students to be lifelong learners and globally competent professionals.

II. To foster creativity through innovation based research activities for upliftment of self and society promoting socio-economic growth.

III. To inculcate professional ethics and skills amongst the graduates and empowering them to have career advancement through placements, higher studies, and entrepreneurship.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

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

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

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

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

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

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

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Program Specific Outcome (PSOs)

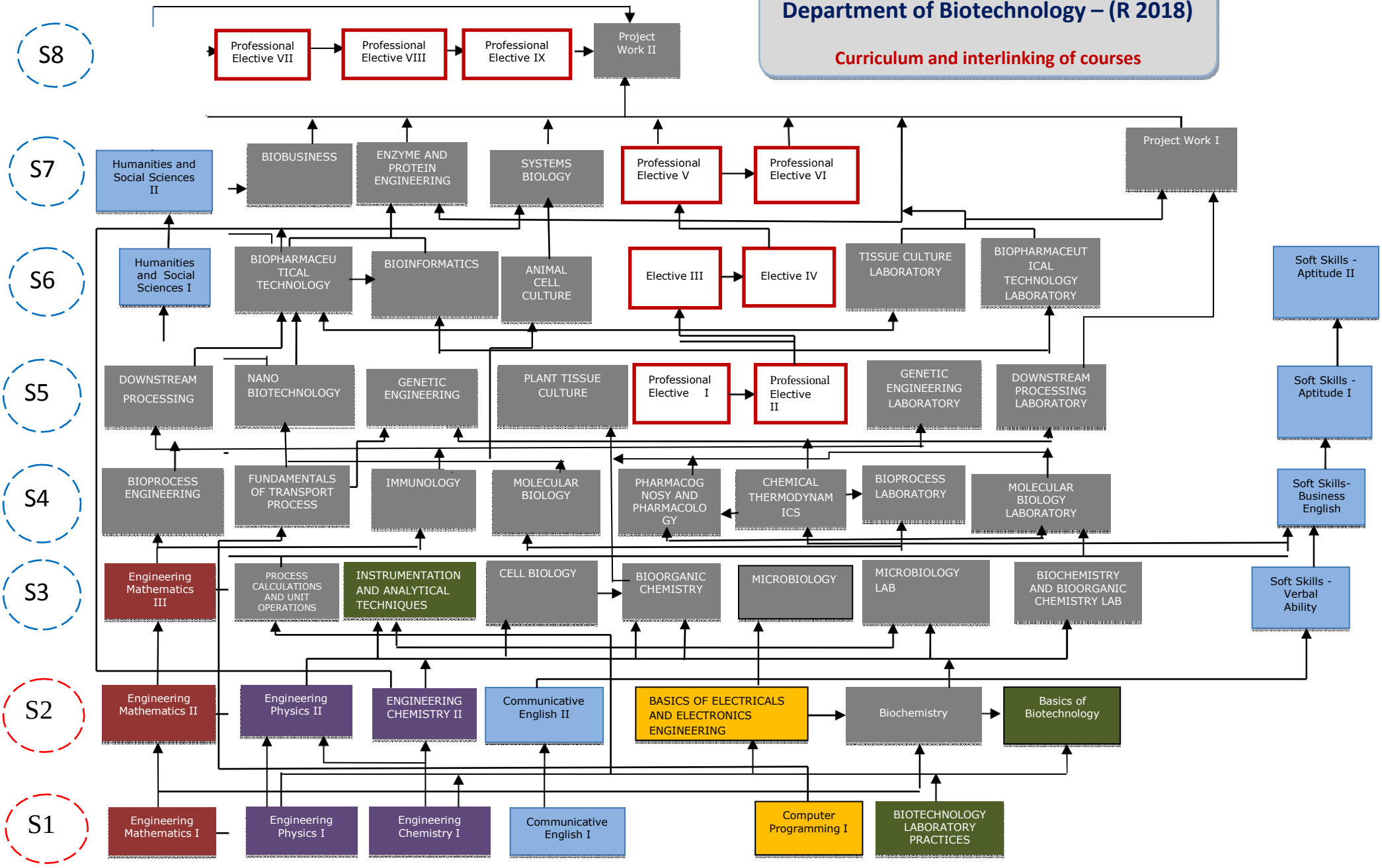
1. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
2. Design and synthesis of the novel biomolecule for the agriculture and healthcare sectors
3. Conceive, Plan and Deploy societal projects for environmental protection using Bioresources.

MAPING OF PEOs & POs

POs	1	2	3	4	5	6	7	8	9	10	11	12
PEO I	X	X	X		X	X				X	X	
PEO II		X	X	X		X		X		X	X	X
PEO III						X	X		X		X	X

Department of Biotechnology – (R 2018)

Curriculum and interlinking of courses



General Electives (I to IX) are the courses offered by the department.

DEPARTMENT OF BIOTECHNOLOGY
Minimum Credits to be Earned : 172

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18BT101	ENGINEERING MATHEMATICS I	3	1	0	**4**	4	50	50	100	BS
18BT102	ENGINEERING PHYSICS I	2	0	2	**3**	4	50	50	100	BS
18BT103	ENGINEERING CHEMISTRY I	2	0	2	**3**	4	50	50	100	BS
18BT104	COMPUTER PROGRAMMING	2	0	2	**3**	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	**2**	3	100	0	100	HSS
18BT106	BIOTECHNOLOGY LABORATORY PRACTICES	0	0	4	**2**	4	100	0	100	BS
Total		**10**	**1**	**12**	**17**	**23**				**-**

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18BT201	ENGINEERING MATHEMATICS II	3	1	0	**4**	4	50	50	100	BS
18BT202	ENGINEERING PHYSICS II	2	0	2	**3**	4	50	50	100	BS
18BT203	ENGINEERING CHEMISTRY II	2	0	2	**3**	4	50	50	100	BS
18BT204	BASICS OF ELECTRICALS AND ELECTRONICS ENGINEERING	2	0	2	**3**	4	50	50	100	ES
	LANGUAGE ELECTIVE	-	-	-	**2**	3	100	0	100	HSS
18BT206	BIOCHEMISTRY	3	0	0	**3**	3	50	50	100	ES
18BT207	BASICS OF BIOTECHNOLOGY	3	0	0	**3**	3	50	50	100	ES
Total		**15**	**1**	**6**	**21**	**25**				**-**

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT301	ENGINEERING MATHEMATICS III	3	1	0	**4**	4	50	50	100	BS
18BT302	PROCESS CALCULATIONS AND UNIT OPERATIONS	3	0	2	**4**	5	50	50	100	ES
18BT303	INSTRUMENTATION AND ANALYTICAL TECHNIQUES	3	0	0	**3**	3	50	50	100	ES
18BT304	CELL BIOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT305	BIOORGANIC CHEMISTRY	3	0	0	**3**	3	50	50	100	PC
18BT306	MICROBIOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT307	MICROBIOLOGY LAB	0	0	4	**2**	4	100	0	100	PC
18BT308	BIOCHEMISTRY AND BIOORGANIC CHEMISTRY LAB	0	0	4	**2**	4	100	0	100	ES
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**12**	**24**	**31**				-
IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT401	BIOPROCESS ENGINEERING	3	1	0	**4**	4	50	50	100	PC
18BT402	FUNDAMENTALS OF TRANSPORT PROCESS	3	1	0	**4**	4	50	50	100	ES
18BT403	IMMUNOLOGY	3	0	2	**4**	5	50	50	100	PC
18BT404	MOLECULAR BIOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT405	PHARMACOGNOSY AND PHARMACOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT406	CHEMICAL THERMODYNAMICS	3	1	0	**4**	4	50	50	100	ES
18BT407	BIOPROCESS LABORATORY	0	0	4	**2**	4	100	0	100	PC
18BT408	MOLECULAR BIOLOGY LABORATORY	0	0	4	**2**	4	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HSS
18GE401	SOFT SKILLS– BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		**20**	**3**	**12**	**26**	**35**				-

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT501	DOWNSTREAM PROCESSING	3	1	0	**4**	4	50	50	100	PC
18BT502	NANO BIOTECHNOLOGY	3	0	2	**4**	5	50	50	100	PC
18BT503	GENETIC ENGINEERING	3	0	0	**3**	3	50	50	100	PC
18BT504	PLANT TISSUE CULTURE	3	0	0	**3**	3	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	**3**	3	50	50	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	**3**	3	50	50	100	PE
18BT507	GENETIC ENGINEERING LABORATORY	0	0	4	**2**	4	100	0	100	PC
18BT508	DOWNSTREAM PROCESSING LABORATORY	0	0	4	**2**	4	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**12**	**24**	**31**				-
VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HS002	PROFESSIONAL ETHICS IN ENGINEERING	2	0	0	**2**	2	50	50	100	HSS
18BT602	BIOPHARMACEUTICAL TECHNOLOGY	3	0	0	**3**	3	50	50	100	EEC
18BT603	BIOINFORMATICS	3	0	2	**4**	5	50	50	100	PC
18BT604	ANIMAL CELL CULTURE	3	0	0	**3**	3	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	**3**	3	50	50	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	**3**	3	50	50	100	PE
18BT607	TISSUE CULTURE LABORATORY	0	0	4	**2**	4	100	0	100	PC
18BT608	BIOPHARMACEUTICAL TECHNOLOGY LABORATORY	0	0	4	**2**	4	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		**17**	**0**	**12**	**22**	**29**				-

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HS003	PRINCIPLES OF MANAGEMENT	2	0	0	**2**	2	50	50	100	HSS
18BT702	BIOBUSINESS	3	0	0	**3**	3	50	50	100	PC
18BT703	ENZYME AND PROTEIN ENGINEERING	3	0	0	**3**	3	50	50	100	PC
18BT704	SYSTEMS BIOLOGY	3	0	0	**3**	3	50	50	100	PC
	PROFESSIONAL ELECTIVE V	3	0	0	**3**	3	50	50	100	PE
	PROFESSIONAL ELECTIVE VI	3	0	0	**3**	3	50	50	100	PE
18BT707	PROJECT WORK I	0	0	6	**3**	6	100	0	100	EEC
Total		**17**	**0**	**6**	**20**	**23**				**-**
VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
	PROFESSIONAL ELECTIVE VII	3	0	0	**3**	3	50	50	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	**3**	3	50	50	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	**3**	3	50	50	100	PE
18BT804	PROJECT WORK II	0	0	18	**9**	18	100	0	100	EEC
Total		**9**	**0**	**18**	**18**	**27**				**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HSH01	HINDI	1	0	2	**2**	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	**2**	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	**2**	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	**2**	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	**2**	3	100	0	100	HSS
PHYSICS ELECTIVES										
18GE0P1	NANOMATERIALS SCIENCE	3	0	0	**3**	3	50	50	100	BS
18GE0P2	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	**3**	3	50	50	100	BS
18GE0P3	APPLIED LASER SCIENCE	3	0	0	**3**	3	50	50	100	BS
CHEMISTRY ELECTIVES										
18GE0C1	CORROSION SCIENCE AND ENGINEERING	3	0	0	**3**	3	50	50	100	BS
18GE0C2	ENERGY STORING DEVICES	3	0	0	**3**	3	50	50	100	BS
18GE0C3	POLYMER SCIENCE	3	0	0	**3**	3	50	50	100	BS
MATHEMATICS ELECTIVES										
18GE0M1	GRAPH THEORY AND COMBINATORICS	3	0	0	**3**	3	50	50	100	BS
18GE0M2	ALGEBRA AND NUMBER THEORY	3	0	0	**3**	3	50	50	100	BS
18GE0M3	MATHEMATICAL FINANCE AND QUEUEING THEORY	3	0	0	**3**	3	50	50	100	BS
ENTREPRENEURSHIP ELECTIVES										
18GE0E1	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	**3**	3	50	50	100	PE
18GE0E2	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	**3**	3	50	50	100	PE

DISCIPLINE ELECTIVES										
18BT001	CANCER BIOLOGY	3	0	0	**3**	3	50	50	100	PE
18BT002	CELLULAR BIOPHYSICS	3	0	0	**3**	3	50	50	100	PE
18BT003	METABOLIC ENGINEERING	3	0	0	**3**	3	50	50	100	PE
18BT004	BIOPOLYMERS	3	0	0	**3**	3	50	50	100	PE
18BT005	BIOSENSORS	3	0	0	**3**	3	50	50	100	PE
18BT006	BIOMATERIALS	3	0	0	**3**	3	50	50	100	PE
18BT007	STEM CELL TECHNOLOGY	3	0	0	**3**	3	50	50	100	PE
18BT008	GENOMICS AND PROTEOMICS	3	0	0	**3**	3	50	50	100	PE
18BT009	PHARMACOVIGILANCE	3	0	0	**3**	3	50	50	100	PE
18BT010	VACCINE TECHNOLOGY	3	0	0	**3**	3	50	50	100	PE
18BT011	MOLECULAR MODELLING AND DRUG DESIGN	3	0	0	**3**	3	50	50	100	PE
18BT012	MOLECULAR PATHOGENESIS AND DISEASE DIAGNOSIS	3	0	0	**3**	3	50	50	100	PE
18BT013	BIOLOGICAL SPECTROSCOPY	3	0	0	**3**	3	50	50	100	PE
18BT014	BIOPROCESS MODELLING AND SIMULATION	3	0	0	**3**	3	50	50	100	PE
18BT015	INTELLECTUAL PROPERTY RIGHTS AND TECHNOLOGY TRANSFER	3	0	0	**3**	3	50	50	100	PE
18BT016	BIOETHICS AND BIOSAFETY	3	0	0	**3**	3	50	50	100	PE
18BT017	BIOREMEDIATION	3	0	0	**3**	3	50	50	100	PE
18BT018	BIOMASS AND BIOENERGY	3	0	0	**3**	3	50	50	100	PE
18BT019	WASTE MANAGEMENT AND UTILIZATION	3	0	0	**3**	3	50	50	100	PE
18BT020	BIODIVERSITY AND BIOPROSPECTING	3	0	0	**3**	3	50	50	100	PE
18BT021	GENETICS	3	0	0	**3**	3	50	50	100	PE
OPEN ELECTIVES										
18BT0YA	BIOFUELS	3	0	0	**3**	3	50	50	100	PE
18BT0YB	MUSHROOM CULTIVATION AND VERMICOMPOSTING	3	0	0	**3**	3	50	50	100	PE
18BT0YC	FORENSIC TECHNOLOGY	3	0	0	**3**	3	50	50	100	PE

ONE CREDIT COURSES										
18BT0XA	MOLECULAR MARKER TECHNOLOGIES	0	0	0	**1**	-	100	0	100	EEC
18BT0XB	TRANSLATIONAL RESEARCH AND TECHNOLOGY TRANSFER	0	0	0	**1**	-	100	0	100	EEC
18BT0XC	MARINE FOOD TECHNOLOGY	0	0	0	**1**	-	100	0	100	EEC
18BT0XD	BEVERAGE, BAKING AND CONFECTIONERY TECHNOLOGY	0	0	0	**1**	-	100	0	100	EEC
18BT0XE	APPLIED SYSTEMS BIOLOGY	0	0	0	**1**	-	100	0	100	EEC
18BT0XF	FUNDAMENTALS OF LIQUID CHROMATOGRAPHY	0	0	0	**1**	-	100	0	100	EEC
18BT0XG	PROCESS VALIDATION AND QUALITY ASSURANCE FOR BIOPRODUCTS	0	0	0	**1**	-	100	0	100	EEC
18BT0XH	DIAGNOSTICS AND HEALTH CARE	0	0	0	**1**	-	100	0	100	EEC
18BT0XI	CLINICAL RESEARCH	0	0	0	**1**	-	100	0	100	EEC
ADDITIONAL ONE CREDIT COURSE										
18GE0XA	ETYMOLOGY	1	0	0	1	-	100	0	100	EEC
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	1	-	100	0	100	EEC
18GE0XC	NEURO BEHAVIORAL SCIENCE	1	0	0	1	-	100	0	100	EEC
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	1	-	100	0	100	EEC
18GE0XE	YOGA FOR HUMAN EXCELLENCE	1	0	0	1	-	100	0	100	EEC
18GE0XF	VEDIC MATHEMATICS	1	0	0	1	-	100	0	100	EEC
18GE0XG	HEALTH AND FITNESS	1	0	0	1	-	100	0	100	EEC
18GE0XH	CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING	1	0	0	1	-	100	0	100	EEC
18GE0XI	BLOG WRITING	1	0	0	1	-	100	0	100	EEC
18GE0XJ	INTERPERSONAL SKILLS	1	0	0	1	-	100	0	100	EEC
18GE0XK	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1	-	100	0	100	EEC
18GE0XL	NATIONAL CADET CORPS	1	0	0	1	-	100	0	100	EEC
18GE0XM	COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	1	0	0	1	-	100	0	100	EEC
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1	-	100	0	100	EEC
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1	-	100	0	100	EEC

S. No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	**BS**	12	10	4	-	-	-	-	-	26	15%	15%	20%
2	**ES**	3	9	9	8	-	-	-	-	29	17%	15%	20%
3	**HSS**	2	2	-	-	-	2	2	-	8	5%	5%	10%
4	**PC**	-	-	11	18	18	14	9	-	70	40%	30%	40%
5	**PE**	-	-	-	-	6	6	6	9	27	15%	10%	15%
6	**EEC**	-	-	-	-	-	-	3	9	12	7%	7%	10%
Total		17	21	24	26	24	22	20	18	**172**	100%	-	-

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

18BT101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems
- Explain the concepts of analytic functions in complex domains to predict the nature of different engineering systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the different forms of coordinate systems in complex planes and characteristics of linear systems by Eigen values and Eigenvectors.
2. Apply the various types of functions and their differentiation techniques involved in engineering fields.
3. Analyze the different methods of integration used in engineering problems.
4. Analyze the suitable integration technique to calculate the area and volume of different surfaces.
5. Evaluate the concept of analytic function to estimate the integral in the complex plane.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2		2													
3		2													
4	1	2													
5	1	2													

UNIT I **9 Hours**

COMPLEX NUMBERS, VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices : Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III **9 Hours**

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolls Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchys Residue Theorem

FOR FURTHER READING

mass spring system in

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaum's Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.

18BT102 ENGINEERING PHYSICS I 2 0 2 3

Course Objectives

- Illustrate the Newton's laws of motion and wave motion with applications
- Understand the basic properties of electricity, magnetism and optics
- Differentiate the special theory of relativity and quantum physics from classical physics

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Apply the Newton's three laws of motion and apply the same to solve the real world problems involving elevator, atwood machine and acceleration of objects
2. Apply the physical characteristics of simple harmonic motion, wave motion and find the solutions for wave equations
3. Analyze the fundamental laws, properties of electricity and magnetism and apply the same to electric and magnetic elements
4. Analyze the principles of physical and geometrical optics in the mirrors, lenses, microscopes and diffraction gratings
5. Evaluate the importance of special theory of relativity, quantum physics and analyse the wave and particle nature of matter

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1							2						
2	2	1							2						
3	2	2													
4	2	2							2						
5	2	1							2						

UNIT I **6 Hours**

MECHANICS

Newtons laws of motion: Concept of force and its nature - Newtons first law and inertial frames - definition of mass - Newtons second law-gravitational force and weight - Newtons third law. Applications of Newtons laws: particle in equilibrium, particle under net force - weighing a mass in an elevator, the atwood machine and acceleration of two objects connected by a cord

UNIT II **6 Hours**

OSCILLATIONS AND WAVES

Fundamentals of simple harmonic motion - energy of simple harmonic oscillator - spring mass system - time period of simple pendulum, compound pendulum and torsional pendulum - Damped oscillations. Travelling wave motion - sinusoidal waves on strings - speed of a wave - reflection and transmission - rate of energy transfer in wave motion

UNIT III **6 Hours**

ELECTRICITY AND MAGNETISM

Point charges - electric fields - Gausss law and its applications - electric potential - capacitance - energy stored in a capacitor. Concept and source of magnetic fields - Amperes theorem - determination of magnetic field due to different current distributions - Faradays law - self-induction and mutual induction - energy stored in an inductor

UNIT IV **6 Hours**

LIGHT AND OPTICS

Nature of light - laws of reflection and refraction - refractive index and Snells law - dispersion of light - total internal reflection - image formation: concave mirrors - convex mirrors - thin lenses - compound microscope - human eye.

Conditions of interference - Youngs double slit experiment - intensity distribution of interference -phase change due to reflection - diffraction-narrow slit diffraction - single slit and two slit - intensity distribution - diffraction grating - applications

UNIT V **6 Hours**

MODERN PHYSICS

Special theory of relativity - simultaneity and time dilation - twin paradox - length contraction -relativistic mass variation - space time graph.Black body radiation and Planck hypothesis - allowed energy levels - thermal radiation from different objects - photoelectric and Compton Effect. Matter waves - de-Broglie hypothesis - wave nature of particles - Davission-Germer experiment

1 **5 Hours**

EXPERIMENT 1

Determination of resultant of system of concurrent coplanar forces-Parallelogram law of forces

2 **5 Hours**

EXPERIMENT 2

Determination of moment of inertia-Torsional pendulum

3 **5 Hours**

EXPERIMENT 3

Determination of wavelength of mercury spectral lines-spectrometer

4 **4 Hours**

EXPERIMENT 4

Determination of refractive index of solid and liquid-travelling microscope

5 **3 Hours**

EXPERIMENT 5

Determination of wavelength of laser-diffraction grating

6 **4 Hours**

EXPERIMENT 6

Determination of frequency of a tuning fork-Meldes apparatus

7 **4 Hours**

EXPERIMENT 7

Thickness of a thin wire using interference of light-Air wedge method

Total: 60 Hours

Reference(s)

1. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2011
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011
3. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017
4. H D Young and R A Freedman, Sears and Zemansky's University Physics with Modern Physics, Pearson education, 2016
5. R K Gaur and S L Gupta, Engineering Physics, Dhanpat Rai Publications, 2012

18BT103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- Outline the bonding and arrangements of atoms in biomolecules and their interactions.
- Interpret the molecules three dimensional orientation and its optical rotations.
- Identify the different organic reaction intermediates and reaction mechanisms

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the bonding interactions of biomolecules and its three dimensional orientations
2. Apply the drug molecular interactions and reactions in biological species
3. Analyze the basic biological reaction and its organic mechanisms
4. Analyze a polymer material for the different biological applications
5. Evaluate a suitable analytical method for the identification of functional groups in organic compounds and estimation of metal/metal ions in solution

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2	3	2													
3	2														
4	2	3													
5	1	2													

UNIT I **6 Hours**

CHEMICAL BONDING

Bonding: Classification of bonds - primary bonds (covalent, electrovalent, dative and metallic bonds) - secondary bonds (dipole-dipole, ionic, H-bonding, Vander Waals and hydrophobic interactions) - theories of chemical bonding - valence bond and molecular orbital theory. Thermodynamics of chemical reactions - Reaction isotherm.

UNIT II **6 Hours**

STEREOCHEMISTRY

Isomerism - classification - tautomersim. Stereochemistry- chirality - prochirality- CIP sequence rules - optical isomers (R & S) - types. re and si faces. Geometrical isomerism (E & Z). Types of strains in molecules - Bayers strain theory. Conformational analysis of alkanes and cycloalkanes - reactivity of cycloalkanes.

UNIT III **6 Hours**

ORGANIC REACTIONS AND MECHANISMS

Functional groups - bond cleavage - reactive species. Types of organic reactions. Substitution - nucleophilic substitution SN1 and SN2 mechanism - stereochemistry. Reactivity of alkyl halides - nucleophilicity - elimination. Esterification & hydrolysis - condensation - cyclisation - Rearrangement - isomerisation.

UNIT IV **6 Hours**

POLYMERS

Polymers - classification - polymerization - polymer characterizations - molecular weight - thermal stability physico-mechanical property - applications. Biopolymers - classifications - biodegradability and compatibility - Uses.

UNIT V **6 Hours**

ANALYTICAL INSTRUMENTATION TECHNIQUES

Chromatograpy - adsorption isotherms - classification. Spectroscopy- Jablonski diagram - UV-Visible, IR, NMR (1H and 13C) and Raman spectroscopy - theory and applications. Mass spectrometry: Principle, instrumentation and applications.

FURTHER READING

Paper battery, Carbon nanotubes with a conventional sheet of cellulose based paper Polymers used in biomedical devices

1 **6 Hours**

EXPERIMENT 1

Construction of adsorption isotherm for equilibrium dye adsorption on cotton fibers

2 **6 Hours**

EXPERIMENT 2

Determination of specific rotation and purity of sucrose using Polarimeter

3 **6 Hours**

EXPERIMENT 3

Preparation of ethyl acetate by esterification and ester hydrolysis via saponification reactions

4 **6 Hours**

EXPERIMENT 4

Preparation of polystyrene polymer from styrene monomer by thermal polymerization

5 **6 Hours**

EXPERIMENT 5

Estimation of iron(Fe II) present in the given solution by spectrophotometry using thiocyanate reagent

Total: 60 Hours

Reference(s)

1. J. D. Lee, Concise Inorganic Chemistry, 5th Edition, John Wiley & Sons, 2008.
2. P.S. Kalsi, Stereochemistry Conformation and Mechanism, New Age International, 2005.
3. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013.
4. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, 1st Edition, New age International Publishers, New Delhi, 2014.
5. Padma L Nayak, Polymer Science, 1st Edition, Kalyani Publishers, New Delhi, 2005.
6. P.H. Rieger, Electrochemistry, Springer, Netherland, Second Edition (Reprint) 2012;S. Vairam, Engineering Chemistry, John Wiley & sons, 2014; B. H. Mahan, University Chemistry, Addison-wesley, 2013.

18BT104 COMPUTER PROGRAMMING 2 0 2 3

Course Objectives

- To learn the basics of computer organisation.
- To study the basics of C primitives, operators and expressions.
- To understand the different primitive and user defined data types.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the solutions using problem solving techniques and number system conversions
2. Apply the programs using operators, type conversion and input-output functions
3. Analyze decision making and looping statements in writing C programs
4. Analyze the concepts of arrays and strings in developing C programs
5. Evaluate applications using structures and functions in C

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		3												
2	1	2			3										
3	1	3			3										
4	1	3			3										
5	1	2	3		3										

UNIT I **6 Hours**

INTRODUCTION TO COMPUTERS

Introduction to computers - Characteristics of Computers - Evolution of Computers - Computer Generations - Basic Computer Organization - Number System - Problem Solving Techniques - Features of a Good Programming Language.

UNIT II **6 Hours**

INTRODUCTION TO C PROGRAMMING

Overview of C-Structure of C program-Keywords-Constants- Variables-Data types-Type conversion Operators and Expressions: Arithmetic-Relational-Logical-Assignment- Increment and Decrement-Conditional-Bitwise - Precedence of operators-Managing I/O operations-Formatted I/O-Unformatted I/O.

UNIT III **6 Hours**

CONTROL STATEMENTS

Decision Making and Branching: simple if statement-if else statement-nesting of if else Statement-Switch Statement.Decision Making and Looping: while statement-do while statement-for statement-Nested for statement Jump Statements: goto-break-continue-return statement

UNIT IV **6 Hours**

ARRAYS AND STRINGS

Arrays: Introduction, one dimensional array, declaration - Initialization of one dimensional array, two-dimensional arrays, initializing two dimensional arrays, multi dimensional arrays. Strings: Declaring and initializing string variables- Reading strings from terminal - writing string to screen - String handling functions.

UNIT V **6 Hours**

STRUCTURES AND FUNCTIONS

Structures and Unions: Introduction-defining a structure- declaring structure variables-accessing structure members- structure initialization-Unions-Enumerated data type User Defined Functions: Elements of user defined functions -Definition of functions-return values and their types- function calls-function declaration-categories of function -call by value and call by reference-recursion-Preprocessor directives and macros.

FOR FURTHER READING

Creating and manipulating document using word - Mail merge - Creating spread sheet with charts and formula using excel - developing power point presentation with Animations - C graphics using built in functions

1 **2 Hours**

EXPERIMENT 1

Write a C program to perform arithmetic operations on integers and floating point numbers.

2 **2 Hours**

EXPERIMENT 2

Write a C program to implement ternary operator and relational operators.

3 **2 Hours**

EXPERIMENT 3

Write a C program to find the greatest of three numbers using if-else statement.

4 **2 Hours**

EXPERIMENT 4

Write a C program to display the roots of a quadratic equation with their types using switch case.

5 **2 Hours**

EXPERIMENT 5

Write a C program to generate pyramid of numbers using for loop.

6 **2 Hours**

EXPERIMENT 6

Write a C program to perform Matrix Multiplication

7 **2 Hours**

EXPERIMENT 7

Write a C program to check whether the given string is Palindrome or not.

8 **2 Hours**

EXPERIMENT 8

Write a C program to find the factorial of given number.

9 **3 Hours**

EXPERIMENT 9

Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student
details: rollno, name, branch, year, section, cgpa.
****

NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:

10 **3 Hours**

EXPERIMENT 10

Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student
details: rollno, name, branch, year, section, cgpa.
****

NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:

11 **3 Hours**

EXPERIMENT 11

Design a union to hold the following details of a Employee. Read the details of an employee and display them in the following format
details: Name, Employee Id, Address, Salary, Designation
****

NAME:
EMPLOYEE ID:
ADDRESS:
SALARY:
DESIGNATION:

12 **3 Hours**

EXPERIMENT 12

Write a C program to print the Fibonacci series using recursive function

13 **2 Hours**

EXPERIMENT 13

Write a c program to swap two numbers using call by value and call by reference.

Total: 60 Hours

Reference(s)

1. 1. Pradeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB publications, 2008
2. 2. Ashok. N. Kamthane, Computer Programming, Second Edition, Pearson Education, 2012
3. 3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. 4. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
5. 5. Byron Gottfried, Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013

18HS101 COMMUNICATIVE ENGLISH I 1 0 2 2

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Use appropriate grammar & vocabulary that is expected at the BEC Preliminary exam level
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature
3. Write straightforward, routine letters of a factual nature, and make notes on routine matters, such as taking/placing orders
4. Follow simple presentations/demonstrations
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									1						
2									2						
3									3						
4										1					
5										2					

UNIT I **9 Hours**

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III **9 Hours**

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

1. Goodbye party for Miss Pushpa T S - Nissim Ezekiel
2. Our Casuarina Tree - Toru Dutt
3. Palanquin Bearers - Sarojini Naidu
4. The Tyger - William Blake
5. Ode on a Grecian Urn - John Keats

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

18BT106 BIOTECHNOLOGY LABORATORY PRACTICES **0 0 4 2**

Course Objectives

- To provide hands on training for the performance of sterilization and aseptic maintenance.
- To gain the skills for making buffers and reagents.
- To develop the skills for preparing the equipment through standard calibration protocol.

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply and prepare solutions of varying concentrations and pH adjustment
2. Analyze laboratory document preparation, reports, observe results and interpret the results
3. Analyze and measure biological samples using colorimeter and spectrophotometer
4. Evaluate the environmental remediation techniques including soil treatment and microbial consortia preparation
5. Create aseptic media and maintain during the inoculation period

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1					2					3					
2				3					2						
3			3	2										1	
4			2						2		2			1	
5			3	2					3						1

1 **7 Hours**

EXPERIMENT 1

Names of glasswares and their use and handling; Cleaning and Washing of laboratory wares (Sterilization and Aseptic maintenance)

2 **7 Hours**

EXPERIMENT 2

Current Good Manufacturing Practices (cGMP) (Laboratory maintenance, safety and security)

3 **7 Hours**

EXPERIMENT 3

Solution/ Reagent preparation: Concentration - Molarity, Normality, Molality, Mole fraction, weight percentage, volume percentage, pH - buffers and their preparation, Basic mathematical skills for laboratory/ calibration curve - linear-curve fitting, least square method

4 **7 Hours**

EXPERIMENT 4

Simple laboratory processes: Distillation, Extraction, Filtration and Oven drying.

5 **8 Hours**

EXPERIMENT 5

Calibration and Measurement: weighing balance, pH meter (with pH adjustment), Thermometer, Pipette and Micropipette

6 **8 Hours**

EXPERIMENT 6

Measurement and Usage of Colorimeter and Spectrophotometer [Beer-Lambertz law, DNS/ Lowry assay]

7 **8 Hours**

EXPERIMENT 7

Media preparation and Microbial inoculation techniques

8 **8 Hours**

EXPERIMENT 8

Preparation, Maintenance of Lab Notebook/ record and Interpretation of results/observations

Total: 60 Hours

18BT201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply the multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyze the convergence and divergence of sequences and series by various tests.
4. Analyze first order differential equations from real time phenomena and solve it by suitable method.
5. Evaluate the appropriate method to solve the second order differential equations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	2	1													
3	2	2													
4	2	1													
5	2	1													

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only- Greens theorem and Gauss Divergence theorem).

UNIT III **9 Hours**

SEQUENCES AND SERIES

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

UNIT IV **9 Hours**

FIRST ORDER DIFFERENTIAL EQUATIONS LEX FUNCTIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

FOR FURTHER READING

Applications to Electrostatic and Fluid Flow.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, ThomasCalculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

18BT202 ENGINEERING PHYSICS II 2 0 2 3

Course Objectives

- To probe impact of physics in biomolecular structure and dynamics
- To exemplify the thermal and magnetic properties of smart materials
- To familiarize emerging trends in laser technology and crystalline materials

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Apply the heat transfer mechanism in the thermodynamic system using thermodynamic laws and apply the same in heat pumps and refrigerators.
2. Apply the properties of magnetic materials for biomedical applications such as drug delivery and radionuclide delivery.
3. Analyze the principle, characteristics, and different types of lasers and explain the types of optical fiber for endoscope application.
4. Analyze the seven crystal systems, crystal planes and the characteristics of metallic crystal structures
5. EValuate the structure and dynamics of bio-molecules by different techniques for bio-instrumental applications of X-ray, MRI, CT and PET scans

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1							2						
2	2	1							2						
3	2	1							2						
4	2	1							2						
5	2								2						

UNIT I **6 Hours**

THERMODYNAMICS

Temperature-thermodynamic system - zeroth law of thermodynamics - heat and internal energy - work and heat in thermodynamic processes - first law of thermodynamics - applications of the first law - heat engines and the second law of thermodynamics - heat pumps and refrigerators

UNIT II **7 Hours**

MAGNETIC MATERIALS

Magnetism - origin of magnetic moment - classification of magnetic materials - ferromagnetism: magnetic domains - hysteresis curve - soft and hard magnetic materials - antiferro and ferrimagnetic materials - ferrites - applications: drug delivery for cancer therapy - radionuclide delivery.

UNIT III **6 Hours**

LASER AND FIBER OPTICS

Laser: Principle of laser - characteristics of laser- types - construction and working of semiconductor laser - excimer laser - medical applications: LASIK - photocoagulation.
Fiber optics: principle of light transmission through fiber- structure of optical fiber - types of optical fibers (refractive index profile and mode) - medical application: endoscope.

UNIT IV **5 Hours**

CRYSTAL PHYSICS

Crystalline and amorphous solids - unit cell - bravais lattice - miller indices - crystal structure: simple cubic, body centered cubic, face-centered cubic, hexagonal close-packed structure - diamond structure - crystal defects: point defects and line defects

UNIT V **6 Hours**

BIO PHYSICS

Introduction - structure: configuration versus conformation of biomolecules -protein and nucleic acid -internal rotation and rotational isomerism - biomolecular free energy, biomolecular structures and dynamics - luminescence methods - radio spectroscopy methods - nuclear magnetic resonance methods -applications: X-ray imaging, MRI, CT scans, and PET scans

1 **5 Hours**

EXPERIMENT 1

Using Lees disc apparatus,
(i) find the thickness of bad conductor and lees disc.
(ii) determine the coefficient of thermal conductivity of a bad conductor.

2 **5 Hours**

EXPERIMENT 2

Determine the Hall coefficient and the carrier concentration of semiconducting material.

3 **5 Hours**

EXPERIMENT 3

(i) Calculate the wavelength of laser using diffraction.
(ii) Determine the average particle size of lycopodium powder using laser source.

4 **5 Hours**

EXPERIMENT 4

Determination of acceptance angle and numerical aperture of a given fiber

5 **5 Hours**

EXPERIMENT 5

To study different crystals structures using interfacial angles and intercepts values

6 **5 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material

Total: 60 Hours

Reference(s)

1. Fundamental of Biophysics, Andrey B. Rubin, Scrivener publishing, 2014
2. Physics for scientists and engineers, Raymond A. Serway and John W. Jewett, Jr. Seventh edition, Thomson books, 2008
3. Introduction to Magnetic Materials B. D. Cullrty, C. D. Graham, second edition, 2009.
4. Optoelectronic properties of semiconductors and superlattices, M.O. Manasreh (editor), Vol. 10, Julian cheng and niloy K. Dutta, Gordon and Breach Science Publishers, 2012
5. Solid State Physics: Structure and Properties of Materials, Wahab, M.A., Alpha Science International Ltd., 2017

18BT203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Recall the terminologies of heterocyclic compounds and identify their role in biomolecules
- Interpret the role of catalyst and its mechanism in chemical reactions
- Summarize the structure, preparation and industrial applications of commonly used polymers

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the structure and functions biomolecules DNA and RNA
2. Analyze the enzyme catalysed biological reactions
3. Analyze commercially available polymers and list its applications
4. Evaluate electrodes used in the electrochemical cells and use the concept for corrosion protection
5. Evaluate the fuels, based on calorific values for selected applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		1		1										
2	3	2													
3	2	1	2		1										
4	3	2													
5	2	2	1												

UNIT I **6 Hours**

AMINO ACIDS AND HETEROCYCLICS

Heterocyclics - classification. Aromaticity- pyrrole, furan, thiophene, pyridine, indole, imidazole, triazole, piperidine - structure and properties. Purine and pyrimidines bases in DNA and RNA - structure and properties - alpha-amino acids - stereochemistry, classification, structure, chemical synthesis and properties. Asymmetric synthesis of amino acids.

UNIT II **6 Hours**

CATALYSIS AND MECHANISM

Classification and mechanism with examples - acid base concepts. Reaction rates - Arrhenius equation - collision theory - transition state (or absolute reaction rate) theory - progress of reaction - graphical representation - potential energy diagram - Hammond principle - Hammond effect - Bronsted beta value - transition state - analogue - Paulis concept - design of transition state analogues.

UNIT III **6 Hours**

POLYMER MATERIALS

Fibre, plastic, elastomer, hydrogels - examples and characterizations - thermoplastics and thermosets - paints, bio-adhesive and biosealants - surfactants and emulsifiers. Plastics - additives - fillers, stabilizers, plasticizers, pigments, flame retardants - compounding and molding. Polymer for tissue engineering, orthopedic, ophthalmic and drug delivery applications. Biocomposites.

UNIT IV **6 Hours**

ELECTROCHEMISTRY

Redox reaction - electrode potential and Nernst equation - electrodes and electrochemical cells - classifications - enzyme electrodes - electrochemical biosensor. Potentiometry and voltametry - principles and applications - electro-synthesis - electrolytic splitting of water. pH-meter and measurements. Butler-Volmer equation - rate of electrochemical reaction. Corrosion - types - electrochemical corrosion and biochemical corrosion.

UNIT V **6 Hours**

FUELS AND ENERGY

Fuel - classification - characterization - biomass carbonization - types. Petroleum - refining of crude oil - properties - liquefaction of coal. Gaseous fuels. Biofuel - biodiesel. Energy storage devices - fuel cells - classification - microbial fuel cell. Batteries - classification, applications and their electrochemistry.

FURTHER READINGS

Recent developments in polymer degradation (Bacteria, Enzymes etc.,) Industrial enzyme catalysis, Pharmaceutical molecules from biomass

1 **6 Hours**

EXPERIMENT 1

Identification of different amino acids by qualitative tests.

2 **6 Hours**

EXPERIMENT 2

Determination of the rate of a typical chemical reaction and its activation energy using Arrhenius equation.

3 **6 Hours**

EXPERIMENT 3

Preparation of super absorbent polymers (hydrogels) from acrylic monomers.

4 **6 Hours**

EXPERIMENT 4

Determination of strength of Fe2 ion and HCl by potentiometry and pH meter.

5 **6 Hours**

EXPERIMENT 5

Determination of voltage and current outputs in lab model microbial fuel cell.

Total: 60 Hours

Reference(s)

1. B S Bahl, Arun Bahl, Advanced Organic Chemistry, S.Chand, 5th Edition, 2012.
2. M.B. Smith, J. March, Advanced Organic Chemistry, Wiley, 6th edition, 2015.
3. P Atkins, J de Paula, and J. Keeler, Physical Chemistry, Oxford University Press, 11th Edition, 2017.
4. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, 1st Edition, New age International Publishers, New Delhi, 2014.
5. Padma L Nayak, Polymer Science, 1st Edition, Kalyani Publishers, New Delhi, 2005.
6. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013; 7. S. Vairam, Engineering Chemistry, John Wiley & sons, 2014; 8. Robert M. Silverstein, Francis X. Webster and David J. Kiemle, Spectrometric Identification of Organic Compounds (7th edition), Wiley, 2007.

18BT204 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

2 0 2 3

Course Objectives

- To understand the basic concepts of dc electrical circuits and machines
- To examine the speed control methods of DC motor
- To illustrate the construction and operation of various semiconductor devices

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Apply the concept of current and voltage law for DC circuits
2. Apply the constructional details and working of DC machines
3. Analyze the construction, working principle and applications of different AC machines
4. Analyze the different speed control methods of DC motors and special machines
5. Evaluate the performance characteristics and applications of semiconductor devices and transducers

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3													
2		2													
3	2		3												
4				2											
5		2													

UNIT I **6 Hours**

DC CIRCUITS

Definition of Voltage, Current, Power, Energy - Ohm's law -statement, Illustration and limitation - Kirchoff's Laws statement and Illustration - Resistance in series and voltage division technique - Resistance in parallel and current division technique-Simple problems

UNIT II **6 Hours**

DC MACHINES

Constructional details of DC Machines - Principle of operation of D.C. generator - EMF equation - Methods of excitation - Principle of operation of D.C. motor - Back EMF and torque equation - Types and Applications of DC machines

UNIT III **6 Hours**

AC MACHINES

Single Phase Transformer - Single Phase Induction motor - Three Phase induction motor - Construction and Working Principle – Applications

UNIT IV **6 Hours**

ELECTRICAL DRIVES

Speed control of dc shunt motor - Armature Control - Flux Control - Construction and operation of Variable Reluctance and Permanent Magnet stepper motor

UNIT V **6 Hours**

ELECTRON DEVICES AND TRANSDUCERS

Characteristics of PN Junction diode - Half wave and Full wave Rectifiers - Bipolar Junction Transistor - Operation of NPN and PNP transistors - Construction and working of FET, Operational amplifiers- Inverting & Non inverting amplifiers and Introduction to transducers, Classification and its applications

FOR FURTHER READING

Voltage Regulator - BLDC Motor -SMPS - Autotransformer - Alternator

1 **6 Hours**

EXPERIMENT 1

Verification of Ohms law, KCL and KVL

2 **6 Hours**

EXPERIMENT 2

Load test on DC Shunt motor

3 **6 Hours**

EXPERIMENT 3

Load test on single phase transformer

4 **6 Hours**

EXPERIMENT 4

Speed control of dc shunt motor

5 **6 Hours**

EXPERIMENT 5

Diode as a switch

Total: 60 Hours

Reference(s)

1. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010
2. R. Muthusubramanian, S. Salivahanan, - Basic Electrical and Electronics Engineering, Tata McGraw-Hill Education, Reprint 2012
3. R. S. Sedha, A Textbook of Applied Electronics, S.Chand & Company Ltd, 2013
4. Jacob. Millman, Christos C.Halkias, Electronic Devices and Circuits, 3rd Edition ,Tata McGraw Hill Publishing Limited, New Delhi, 2010
5. A.Anand kumar, Fundamentals of digital circuits, 3rd Edition, PHI Learning Pvt Ltd, 2014

LANGUAGE ELECTIVE **1 0 2 2**

Course Objectives

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialization
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Use appropriate grammar & vocabulary that is expected at the BEC Vantage exam level.
2. Understand the general meaning of non-routine letters, and of a report of predictable / unpredictable topic
3. Write simple reports of factual nature and factual non-routine letters
4. Ask for factual information and understand the answer; and take/pass on workplace messages
5. Express opinions and present arguments to a limited extent; and give simple, prepared presentations on familiar topics

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									1						
2									2						
3									3						
4										1					
5										2					

UNIT I **9 Hours**

GRAMMAR3

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

UNIT II **9 Hours**

READING

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

UNIT III **9 Hours**

WRITING

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

UNIT IV **9 Hours**

LISTENING

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

UNIT V **9 Hours**

SPEAKING

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

1. A Horse and Two Goats - R K Narayan
2. My Lord the Baby - Rabindranath Tagore
3. Twist in the Tale - Jeffery Archer
4. The Third and Final Continent - Jhumpa Lahiri
5. The Gift of the Magi - O Henry

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage- Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

18BT206 BIOCHEMISTRY 3 0 0 3

Course Objectives

- To learn the bio molecules in the biological system
- To study the mechanism and role of enzymes in metabolism
- To understand the metabolic pathways of biomolecules

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the classification, structure, function and properties carbohydrates and lipids
2. Apply the structures , functions and classification of proteins and nucleic acids
3. Analyze the concepts of buffers, and principles and energetics of chemical reactions in metabolic pathways
4. Analyze the metabolism and energetic of carbohydrates and lipids in human system
5. Evaluate the metabolism of proteins, amino acids, nucleic acids, pyrimidines and purines in human body

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3													
2	2	2												1	
3		3	3				1								
4			2				2		1		2			2	
5			2				2		2		1				

UNIT I **9 Hours**

CARBOHYDRATES AND LIPIDS

Biomolecules-Introduction. Classification, structure, nomenclature, properties, functions and qualitative analysis of carbohydrates and lipids

UNIT II **9 Hours**

PROTEINS AND NUCLEIC ACIDS

Amino acids- classification, structure and configuration. Pyrimidines , Purines, nucleosides, nucleotides- Structures. Classification, structure, properties and functions of proteins and nucleic acids . Lipoproteins-types and function. - Higher order structures of proteins and nucleic acids and their importance

UNIT III **9 Hours**

REACTIONS AND ENERGETICS OF METABOLISM

Buffering system , biological buffers. Metabolism - anabolism, catabolism and amphibolism; Chemistry of metabolism; coenzymes and their roles in metabolism- concepts of bioenergetics.

UNIT IV **9 Hours**

CARBOHYDRATES AND LIPID METABOLISM

Glycolysis and Krebs cycle, Pentose Phosphate Pathway (HMP Shunt), Cori cycle.Glycogen synthesis and breakdown, Electron transport chain and oxidative phosphorylation. Biosynthesis and degradation of lipids- fatty acids, phospholipids, cholesterol and lipoproteins.

UNIT V **9 Hours**

NITROGEN METABOLISM

Catabolism of Proteins , amino acids, nucleotides, pyrimidines and purines. Glucose-Alanine cycle. Biosynthesis of nucleotides-de novo and salvage pathways for purines and pyrimidines. Health disorders in nitrogen metabolism

FOR FURTHER READING

Electron transport chain and oxidative phosphorylation, concepts of bioenergetics

Total: 45 Hours

Reference(s)

1. D. L. Nelson and M. M. Cox, Lehninger's Principles of Biochemistry, 6 th edition WH Freeman &Co., 2012.
2. J. Tymoczko, J. Berg and L. Stryer, Biochemistry- A Short Course, Freeman and Company, 2009.
3. D. Voet and J. G. Voet, Biochemistry, John Wiley and Sons Inc., 2010.
4. C. K. Mathews, K. E. Van Holde and K. G. Ahern, Biochemistry, Pearson Education Private Ltd., 2000.
5. www.ocw.mit.edu

18BT207 BASICS OF BIOTECHNOLOGY 3 0 0 3

Course Objectives

- To introduce various streams of Biotechnology
- To expose students to industrial bioproducts/ process
- To create deeper understanding of Biotechnology application in the modern world

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the importance of Biotechnology
2. Apply the knowledge of fermentation technology for product development
3. Analyze the nature of enzymes and its industrial applications
4. Analyze the role of transgenics in agriculture and environment
5. Evaluate the fermentation process in food industry and biofuel production

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1												
2	2	2	1							2				1	
3	2	2	1		1							2			
4	1	2	1		2		2				2				2
5	1	2	1							2					

UNIT I **9 Hours**

INTRODUCTION TO BIOTECHNOLOGY

Biotechnology - definition and historical development , Biotechnology - an Interdisciplinary and a three component core, product safety, main areas of applications of Biotechnology , substrates for Biotechnology - biomass, natural raw materials, by-products , chemical and petrochemical feedstocks

UNIT II **9 Hours**

BIOPROCESS / FERMENTATION TECHNOLOGY

Introduction of Bioprocess technology , principles of microbial growth , Bioreactor / fermenter and upstream, bioprocess and downstream and scale up , solid substrate fermentation

UNIT III **9 Hours**

ENZYME TECHNOLOGY

Nature of enzymes , industrial applications of enzymes , genetic engineering of enzymes , technology of enzyme production , immobilized enzymes

UNIT IV **9 Hours**

AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY

Transgenic plants for pest and weed resistance , biocontrol agents , genetic engineering of transgenic animals, genetically engineered hormones and vaccines , microbes in wastewater treatment , composting , bioremediation

UNIT V **9 Hours**

BIOTECHNOLOGY IN FOOD AND ENERGY

Food and beverage fermentations, alcoholic beverages, dairy fermented products , vegetable fermentation-sauerkraut , conversion of biomass to energy , production of ethanol and methane from biomass , safety aspects in Biotechnology

FOR FURTHER READING

Wastewater treatment, composting, bioremediation

Total: 45 Hours

Reference(s)

1. John E Smith, Biotechnology, Cambridge University Press, 5th Edition, 2006
2. W.Crueger, and Anneliese Crueger, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2003
3. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology, Cambridge University Press, 2001
4. L.E.Casida, Industrial Microbiology, New Age International (P) Ltd, 2005

18BT301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Develop the knowledge of periodic and non periodic functions and their representations using Fourier analysis
- Understand the Laplace Transform to solve real world problems
- Predict the changes in the testing process using the concepts of statistics

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Apply the properties of periodic and non-periodic vibrations with the help of Fourier analysis in biotechnology.
2. Apply a function in frequency domain for which the function defined in time domain through the techniques of Laplace transforms
3. Analyze the position of a particle that depends on more than one parameter, using partial differential equations
4. Analyze the outcome of bio technology problem using the concepts of probability and its distributions
5. Evaluate and validate the mathematical model for a bio technology problems with the help of hypothesis testing

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1														
2		2										3			
3	1	2										1			
4	1	2										2			
5	2	1													

UNIT I **9 Hours**

FOURIER ANALYSIS

Fourier series for periodic functions. Orthogonal functions. The Euler coefficients. Fourier transforms. Properties of Fourier transform. Applications of Fourier series and transform analysis

UNIT II **9 Hours**

LAPLACE TRANSFORM

Properties and theorems of Laplace transform. Shifting theorems. Convolution. Applications to ordinary differential equations. Applications to linear system analysis.

UNIT III **9 Hours**

PARTIAL DIFFERENTIAL EQUATION

Introduction to partial differential equations. One-dimensional wave equation. Method of separation of variables. D'Alembert's solution of the wave equation. Heat equation. Laplaces equation. Telegraph equations. Laplace transform method of solution.

UNIT IV **9 Hours**

PROBABILITY THEORY

Probability. Random variables, probability densities and distributions, mean and variance of a distribution. Conditional probability. Bayes theorem. Binomial, Poisson and normal distributions.

UNIT V **9 Hours**

MATHEMATICAL STATISTICS

Sample mean and variance. Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses, one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

Total: 60 Hours

Reference(s)

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
2. Johnson Richard A. and Bhaltacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996.
3. O Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995.
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993.
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995.

18BT302 PROCESS CALCULATIONS AND UNIT OPERATIONS **3 0 2 4**

Course Objectives

- To provide students the basic knowledge on chemical calculations and its application for material balance
- To impart the basic concepts of unit operation
- To understand the different unit operations and processes carried out in the chemical and biochemical industries

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

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

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

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

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

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

o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the various basic chemical calculations and its application
2. Apply the quantification of the process using material and energy balance
3. Analyze various size reduction equipment and measurement of the particle size
4. Analyze various types of mixers, flow patterns and scale up criteria for mixing and agitation
5. Evaluate the various types of equipments for filtration and sedimentation operation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3					2									
2		2	3												3
3		2	3												
4	3										2	3			
5	3		2				3					3			

UNIT I **9 Hours**

BASICS OF CHEMICAL CALCULATION

Stoichiometry & chemical equations; Units,dimensions & conversions; Basic chemical calculations - mole, weight & volume%, Henry's law,Raoult's law and their applications to different systems

UNIT II **9 Hours**

MATERIAL AND ENERGY BALANCE

Material Balance without Chemical reaction-distillation, evaporation, drying& fermenter, recycle, bypass and purging operations; Energy balance- Sensible heat, latent heat

UNIT III **9 Hours**

MECHANICAL OPERATIONS - SOLIDS HANDLING, SIZING AND SCREENING

Properties of particulate solids, Screening- Determination of particle size, Screen analysis, Surface area measurements, Size reduction of solids- laws, stages of reduction, operating variables, intermediate and fine size reduction, Sieve analysis, Power driven machines - Crushers, ball mills, conveyers

UNIT IV **9 Hours**

MIXING AND AGITATION

Introduction to agitation and mixing of liquids, Mixing - types of mixers- ribbon and muller mixer, Mixing and bioreaction interactions-flow regimes with and without baffles, Agitation equipment, flow patterns in agitator, Power required for agitated vessels- power number and power number calculation, Scale up criteria for mixing and agitation equipment

UNIT V **9 Hours**

FILTRATION AND SEDIMENTATION

Filtration- Principles of cake filtration, Filter medium and filter aids, Constant rate filtration and constant pressure filtration. Batch and continuous filtration, Filtration equipments- plate and frame, leaf filter, rotary drum, Sedimentation and Settling theory, Equipment for sedimentation- thickeners, clarifiers centrifugation,

1 **8 Hours**

EXPERIMENT 1

Flow Measurement using Orifice and Venturi

2 **6 Hours**

EXPERIMENT 2

Calculation of overall Heat Transfer Coefficient in Double Pipe Heat Exchanger

3 **8 Hours**

EXPERIMENT 3

Calculation of Cake and Medium Resistance in Plate and Frame filter

4 **8 Hours**

EXPERIMENT 4

Liquid Liquid Extraction - Single and Multi stage

Total: 75 Hours

Reference(s)

1. N. Anantharaman and V. Venkataramani, Process Calculation, Prentice Hall of India, 2005
2. C. J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall of India, 2007
3. W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations in Chemical Engineering, Tata McGraw-Hill Professional, 2005
4. M. Coulson and J. F. Richardson, Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth Heineman, 2004
5. G. K. Roy, Fundamentals of Heat and Mass Transfer, Kanna Publications, 2004.

18BT303 INSTRUMENTATION AND ANALYTICAL TECHNIQUES **3 0 0 3**

Course Objectives

- To expose students with electrical and electronic components used in the analytical instruments
- To learn and understand the principles and operation of different instrumentation techniques
- To know the different molecular spectroscopic techniques and their analytical applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the function of electrical and optical component in analytical instruments and their calibration
2. Apply the spectroscopic techniques to identify, estimate and characterize analytes
3. Analyze the thermal behavior of materials using thermal analysis
4. Analyze chromatographic and electrophoretic techniques to separate, purify and quantify molecules
5. Evaluate different types of electrodes and electroanalytical techniques for sensing and quantifying analytes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1										3		
2	3	2	3	2	2							3	2		
3	3	2	2	1	2								2		
4	3	3	3	2	2							3	2		
5	3	1	2	1	1		2						1		

UNIT I **9 Hours**

BASICS OF MEASUREMENT AND OPTICAL METHODS

Classification of instrumental methods - calibration methods for instruments - electrical components in circuits and their function - signal to noise ratio - signal - noise enhancement-software and hardware techniques. General design of optical instruments - sources of radiation - wavelength selectors - materials for optical components and sample holders. Radiation transducers

UNIT II **9 Hours**

MOLECULAR SPECTROSCOPY

Types of optical instruments- Fourier transform measurements-Theory and advantages. Measurement of transmittance and absorbance- Beer's law - Derivation and types of Deviation. Spectrophotometer analysis - qualitative and quantitative absorption measurements - types of spectrometers - UV - visible, IR , Raman and NMR-theory, instrumentation and applications

UNIT III **9 Hours**

THERMAL METHODS

Thermo-gravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC) theory, instrumentation and applications

UNIT IV **9 Hours**

SEPARATION METHODS

Introduction to chromatography - models - ideal separation - retention parameters - van - deemter equation - GC-MS - stationary phases - detectors - kovats indices- HPLC - pumps - columns- Detectors and instrumentation. Size exclusion, hydrophobic interaction, supercritical chromatographic techniques. Ion exchange, affinity - theory,instrumentation and applications. Capillary electrophoresis.

UNIT V **9 Hours**

ELECTRO -ANALYTICAL TECHNIQUES

Electrodes, reference electrodes, ion selective electrodes and pH meter. Potentiometry, Voltametry, coulometry and amperometry- theory, instrumentation and applications in life sciences.

FOR FURTHER READING

Advanced chromatographic techniques

Total: 45 Hours

Reference(s)

1. H. H. Willard, and L. L. Merrit, Instrumental Methods of Analysis, Prentice Hall of India, 2005.
2. D. A. Skoog, J. F. Holler and T. A. Nieman, Principles ofInstrumental Analysis, Thomson, 2006.
3. G. W. Ewing, Instrumental Methods of Chemical Analysis, Mc Graw Hill, 1985.
4. R. D. Braun, Introduction to Instrumental Analysis, Pharma Book Syndicate, Adithiya Art Printers, 1987.

18BT304 CELL BIOLOGY 3 0 0 3

Course Objectives

- To understand the basic structure and function of an organelle
- To understand the transportations through cell membrane
- To understand the concept of the cell division and signalling pathways

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Understand the structure of cells, its division, and multiplication and explain how it leads to formation of cancer cells in our body.
2. Understand and Apply the knowledge of cell structure to demonstrate the mechanism of transport across cell membrane
3. Apply the cell transport mechanism to assess the role of cell bound receptors and signaling process.
4. Analyze the role of ion channels and justify the mechanism of neurotransmitters.
5. Evaluate the different models of signal amplification and secondary messengers involved in cell-to-cell Interaction

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		2							3			1	
2	3	2		3											
3	2	3		2										1	
4	3	3		2			2							1	
5	3	3		3										1	

UNIT I **9 Hours**

CELL STRUCTURE AND FUNCTIONS AND CELL CYCLE

History of cell biology; Comparison of eukaryotic and prokaryotic cells; biological membrane organization-membrane proteins; cytoskeletal proteins; Types of cell division - mitosis and meiosis; cell cycle and molecules that control cell cycle; cell cycle and cancer, oncogenes; growth hormones and their roles.

UNIT II **9 Hours**

TRANSPORT ACROSS CELL MEMBRANES AND RECEPTORS

Passive and Active transport, permeases, sodium potassium pump, Ca2+ ATPase pumps, lysosomal and vacuolar membrane ATP dependent proton pumps, co-transport (symport, antiport), endocytosis and exocytosis; receptor-mediated endocytosis.

UNIT III **9 Hours**

RECEPTORS AND CELL SIGNALING

Cytosolic; Nuclear and membrane bound receptors; Examples of receptors; Autocrine, paracrine and endocrine models of action.

UNIT IV **9 Hours**

ION CHANNELS

Types of Ion-channels; Ligand-gated and Voltage-gated ion channels; Neurotransmitters- mechanism of action, nerve conduction.Ion-channel agonists and antagonists.

UNIT V **9 Hours**

SIGNAL TRANSDUCTION

Signal amplifications; different models of signal amplification; Second messengers - cAMP, Inositol phosphates, DAG, cGMP, G proteins, Ca; Protein kinases, serine threonine kinases.

FOR FURTHER READING

Apoptosis and programmed cell death;Entry of virus and toxins into cells;Quantification and characterization of receptors;Ion channel defects;TNF receptor families

Total: 45 Hours

Reference(s)

1. H. Lodish, A. Berk, S. L. Zipurursky, P. Matsudaria, D. Baltimore and J. Darnell, Molecular Cell Biology, W. H. Free Man and Company, 2000.
2. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter, Molecular Biology of the Cell, Garland Science, 2002.
3. S. C. Rastogi, Cell Biology, India: New Age International Pub. Ltd., 2001.
4. E. D. P. Robertis De and E. M. F. Robertis De, Cell and Molecular Biology, B.I. Publications, Pvt. Ltd., 2005.
5. Gerald Karp and Nancy L. Puritt, Cell and Molecular Biology, Concepts and experiments, John Wiley and Sons Inc., 2004

18BT305 BIOORGANIC CHEMISTRY 3 0 0 3

Course Objectives

- To provide students with a basic understanding of weak interaction, stereo chemistry and structures of simple biomolecules, proteins and nucleic acids
- To introduce and understand the mechanism of enzyme action ,protein folding and unfolding and their biological significances
- To acquire/ demonstrate their basic knowledge and skill on the kinetics, mechanism and function of proteins/ enzyme action and improve their self learning and understanding skills on biochemical engineering and promote employability in biotech research areas

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the weak interactions in biomolecules with mathematical models, stereochemistry of nucleophilic substitution reactions and types of catalysis to understand the structure, properties and function of biomolecules.
2. Analyze the enzyme structure and their stereo specificity of action
3. Analyze the kinetics and mechanism for enzymatic reaction and understand allosteric regulation.
4. Evaluate higher order structural level, stability and sequencing in protein and nucleic acids and their chemical method of synthesis
5. Evaluate the protein folding-unfolding kinetics and know the importance of molecular chaperons.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2	2			1							
2	2	3		2	1										
3	2	3		1	1		2							2	
4	2	3		1	2			2						2	
5	2	3		1	3			2			2			2	

UNIT I **9 Hours**

INTRODUCTION TO BIOORGANIC CHEMISTRY

Historical connection between organic and biological chemistry , nonbonding interactions and simplified equations representing these energies- stereochemistry of nucleophilic substitution reactions- ester formation and hydrolysis, analogy between chemical and biochemical reactions, chemistry of living cells, Types of Catalysis - mechanisms for elctrophilic, nucleophilic and covalent catalysis with typical examples. Potential energy diagram- Hammonds postulate

UNIT II **9 Hours**

ENZYMES: STRUCTURE, STEREOCHEMISTRY AND MECHANISM

Stereospecific enzymatic reactions - fumarase catalysed reactions - NAD dependent oxidation and reduction reactions - chiral methyl group .The dehydrogenases - the proteases - lysozyme-ribonucleases.

UNIT III **9 Hours**

ENZYME KINETICS

Transition state analogues - reaction rates . Michaelis-Menton Kinetics. Derivation of rate equation for equilibrium and non-equilibrium models. Mechanism of enzyme action. Energetics of enzyme catalysed reaction . Significances of change in enthapy, free energy, entropy in enzyme kinetics. Kinetics of multisite co-operative enzymes-sequential (Koshland-Nemethy-Filmer (KNF) and Concerted (Monod - Changeux -Wyman model) models.

UNIT IV **9 Hours**

PROTEINS AND NUCLEIC ACIDS

Chemical synthesis of proteins , different types of secondary structural elements in proteins, stability of proteins - stability - activity trade off. Chemical synthesis of nucleotides and poly nucleotides . Chemical and enzymatic methods for sequencing of proteins and nucleic acids.

UNIT V **9 Hours**

PROTEIN FOLDING

Protein folding pathways, folding kinetics-basic methods - two state kinetics - multistate kinetics, transition states in protein folding-1H-2H exchange studies in protein-Linderstrom-Lang model- folding of peptides- CI2 folding. Molecular chaperons-heat shock proteins-GroEL -GroES- mechanism of action.

FOR FURTHER READING

Structures of aromatic heterocyclic and polycyclic aromatic compounds, structural levels in proteins and nucleic acids, functions of proteins and nucleic acids, types of DNA and RNA, ribozyme- classification, mechanism of catalysis and uses

Total: 45 Hours

Reference(s)

1. A. Fersht, Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding, New York: W. H. Freeman and company, 1999.
2. H. Dugas, Bioorganic Chemistry, Springer Verlag, 1999.
3. D. L. Nelson and C. M. M. Lehninger, Principles of Biochemistry, W.H. Freeman & Co., 2005.
4. C. K. Mathews, K. E. Van Holde, and K. G. Ahern, Biochemistry, Pearson Education, Indian Reprint, 2003.
5. F. Campbell, Biochemistry, Thomson Books, Indian Reprint, 2007

18BT306 MICROBIOLOGY 3 0 0 3

Course Objectives

- This course aims to develop skills of the Students in the identification of microbes, structure, metabolism and their industrial applications
- To understand the interaction of host and pathogen
- To acquire prerequisite knowledge for all Bioprocess Technology processes

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Understand how the microbes are classified and usage of microscopic techniques to study the microbial staining procedures.
2. Understand and apply the structure of Microbes and assess its way of multiplication.
3. Analyze the level of nutrient requirement to study the microbial growth and its metabolism.
4. Analyze the role of antimicrobial drugs in microbial control and outline the mechanism of pathogenicity and host defense.
5. Evaluate the microbial involvement in synthesis of economically important products.
6.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2				2		1				1		
2	2		2				3		2				1		
3	1		3				1		2						
4	2		3				2		2						
5	2		2				1		2						2

UNIT I **9 Hours**

INTRODUCTION

Classification and nomenclature of microbes; Principle and applications of Microscopy - Light, dark field, phase contrast and fluorescence microscope; Staining techniques: Principles and application- Gram, Acid fast, Capsule, Flagella, Endospore and Lacto phenol cotton blue.

UNIT II **9 Hours**

STRUCTURE AND MULTIPLICATION OF MICROBES

Colony morphology and arrangement of bacterial cells; Structure and multiplication of bacteria, fungi (Rhizopus) and viruses (TMV); life history of mycoplasma, actinomycetes (Streptomyces), yeast, and bacteriophages.

UNIT III **9 Hours**

MICROBIAL NUTRITION, GROWTH AND METABOLISM

Nutritional requirements and media for bacterial growth; Bacterial growth curve, nutritional classification of organisms; methods to quantitate bacterial growth, preservation techniques; Bacterial metabolism - respiration and fermentation (lactic acid and ethanol).

UNIT IV **9 Hours**

MICROBIAL CONTROL AND HOST INTERACTION

Physical and chemical methods of microbial control; Antimicrobial drugs - mode of action and drug resistance, Antibacterial, Antifungal and Antiviral agents; mechanisms of pathogenicity - mode of entry, penetration of host defences and damage.

UNIT V **9 Hours**

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

Biofertilizers, Biopesticides, Production of alcohol, amoxicillin; bioremediation; leaching of ores by microbes; microbial treatment of wastewater - aerobic and anaerobic methods.

FOR FURTHER READING

Microbial diseases - source, mode of infection and treatment of Candidiasis, Rabies, Chikungunya, Dengue, Malaria and Typhoid

Total: 45 Hours

Reference(s)

1. L. M. Prescott, J. P. Harley and D. A. Klein, Microbiology, Wm. C. Brown Publishers, 2004.
2. M. J. Pelczar, E. C. S. Chan and N. R. Krein, Microbiology, Tata McGraw-Hill, 2002.
3. G. J. Tortora, B. R. Funke and C. L. Case, Microbiology, Addison Wesley Longman, Inc. 2001.
4. R. M. Atlas and Renk, Principles of Microbiology, McGraw-Hill Higher Education, 1995.

18BT307 MICROBIOLOGY LAB 0 0 4 2

Course Objectives

- Imparts hands on training in the aseptic techniques and operation of equipment
- Develops skills in the isolation and identification of microbes
- To study the metabolites and its antagonistic effects on other organisms

Programme Outcomes (POs)

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

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

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

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the identification mechanism of microorganisms from various sources
2. Apply the preservation of microorganisms
3. Analyze the role of microbes for producing bioproducts and biomass
4. Analyze the growth characteristics of bacteria
5. Evaluate the microbes present in environmental samples

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2				2	3		2		2	1		
2	2		2				2			2			1		
3	3		1				1			2			1		
4	3		3				2								
5	3		2				2				2				

1 **10 Hours**

EXPERIMENT 1

Microscopic observation of microorganisms

2 **10 Hours**

EXPERIMENT 2

Culturing of microorganisms - in broth, plates (pour plate and streak plate)and slant

3 **10 Hours**

EXPERIMENT 3

Staining techniques - Gram staining - Endospore staining,

4 **10 Hours**

EXPERIMENT 4

Determination of Bacterial growth curve

5 **10 Hours**

EXPERIMENT 5

Antibiotic sensitivity assay by Kirby-Bauer Test

6 **10 Hours**

EXPERIMENT 6

Enumeration of microbial population from soil and water

Total: 60 Hours

Reference(s)

1. Microbiology Laboratory Manual

18BT308 BIOCHEMISTRY AND BIOORGANIC CHEMISTRY LAB

0 0 4 2

Course Objectives

- To provide hands on training for the analysis of biomolecules qualitatively
- To develop the skills for preparing the equipment through standard calibration protocol
- To provide hands on training for quantitative analysis of spectrophotometer

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the biomolecules using different parameters Qualitatively
2. Apply the methodologies involved in the laboratory document preparation, reports, observe results and interpret the results
3. Apply the calibration and measure biological samples using colorimeter and spectrophotometer
4. Analyze organic molecules , purify them and identify using their properties
5. Evaluate the organic molecules for medicine and pharma industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			2	2						2			1		
2			3	3					2	2			1		
3			3	2	3				2	1			1		
4			2	2					2	2				2	
5			3	2					3	2				2	

1 **6 Hours**

EXPERIMENT 1

Qualitative analysis of carbohydrates

2 **6 Hours**

EXPERIMENT 2

Qualitative analysis of aminoacids

3 **8 Hours**

EXPERIMENT 3

Estimation of amino acids by ninhydrin method

4 **8 Hours**

EXPERIMENT 4

Determination of saponification /acid number of lipids

5 **8 Hours**

EXPERIMENT 5

Quantitative analysis of DNA and RNA by UV spectrophotometer

6 **8 Hours**

EXPERIMENT 6

Synthesis, purification by crystallization and identification (melting point) of aspirin

7 **8 Hours**

EXPERIMENT 7

Preparation of 5, 10, 15, 20-tetrakisphenyl porphyrin

8 **8 Hours**

EXPERIMENT 8

Synthesis of ethyl acetate by Fischer esterification and its purification by distillation

Total: 60 Hours

Reference(s)

1. A. Manickam , S. Sadasivam, Biochemical Methods, 3 rd Edition, New Age International Pvt Ltd Publishers, 2009

18GE301 SOFT SKILLS - VERBAL ABILITY 0 0 2 0

Course Objectives

- To help students gain adequate proficiency in vocabulary
- To help students become proficient in basic writing skills related to workplace communication
- To read and understand unabridged text

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2		2			
2										2		2			
3										2		3			

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

Total: 30 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use a Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books. 1991.
3. Baron"s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

18BT401 BIOPROCESS ENGINEERING 3 1 0 4

Course Objectives

- To understand the role of biotechnologists in bioprocess industry.
- To apply the engineering concepts for biological conversion of raw materials
- To perform simulations of reactors and model the kinetics of product formation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Understand the fermentation process and sterilization kinetics.
2. Apply the cellular Stoichiometry and energy balance to study the fermentation process.
3. Analyze the mass transfer coefficient parameters and medium optimization techniques.
4. Analyze the bioreactor types, selection and scale-up for industrial application
5. Evaluate the structured models and metabolic pathways in product formation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	1		2			3							
2	3	3								2					
3	3	3	3	3	2										
4			2	3	3			1			2	2		3	2
5	1	3		3	2										

UNIT I **9 Hours**

STERILIZATION TECHNIQUES AND FERMENTATION PROCESS

Overview of fermentation process and industry; Basic configuration of fermentor and its ancillaries; Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization; Design of sterilization equipment.

UNIT II **9 Hours**

CELLULAR STOICHIOMETRY IN BIOPROCESS

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT III **9 Hours**

MEDIUM REQUIREMENTS AND MASS TRANSFER IN BIOREACTORS

Medium requirements for fermentation process; Medium formulation; Medium optimization methods; Mass transfer by diffusion and convection, Methods for the measurement of kLa, oxygen mass transfer methodology in bioreactors - microbial oxygen demands; Factors affecting oxygen transfer rate.

UNIT IV **9 Hours**

BIOREACTOR TYPES, ANAYSIS AND SCALE-UP

Bioreactor classification: Stirred Tank reactor, Packed bed reactor, Airlift reactor, Fluidized Bed Reactor and Bubble column reactor; Various accessories of bioreactors. Cultivation mode of organisms: batch, continuous and fed-batch systems; Online and Offline Monitoring and control of Bioreactor; Scale up and selection of bioreactors.

UNIT V **9 Hours**

MODELLING, SIMULATION AND BIOENERGETICS OF BIOPROCESSES

Study of structured models for analysis of various bioprocesses: compartmental models, single cell models and plasmid replication/ stability model, Dynamic simulation of batch, fed batch, steady and transient culture metabolism. Bioenergetics, Control sites of major metabolic pathway.

Total: 60 Hours

Reference(s)

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering - Basic Concepts, Prentice Hall, 2002.
2. M. Pauline Doran, Bioprocess Engineering Principles, Academic Press Limited, 1995.
3. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, Butterworth Heinemann publications, 1995.
4. Harvey W. Blanch, S. Douglas and Clark, Biochemical Engineering, New York: Marcel Dekker Inc., 1997.

18BT402 FUNDAMENTALS OF TRANSPORT PROCESS **3 1 0 4**

Course Objectives

- To impart the significance of mass transfer principles used in bioprocess.
- To develop knowledge for application of mass transfer equipments
- To assess the principles of measuring the fluid flow

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the principle of liquid liquid diffusion and methods of distillation.
2. Analyse the principles of extraction, drying and adsorption with industrial applications
3. Analyze the principles of conductive and convective modes of heat transfer
4. Evaluate the principle and working method of heat exchangers and evaporators
5. Evaluate the types of fluids and demonstrate the method to estimate fluid flowrate

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3												1		
2		2	3		3							2	1		
3		2	3				1								
4	3														
5	3		2												

UNIT I **9 Hours**

DIFFUSION AND DISTILLATION

Introduction to mass transfer operations; Ficks Law of Diffusion, one component transferring to non diffusing component and equimolar diffusivity estimation; Basic concepts of distillation , VLE, Relative volatility; Methods of distillation - Simple, steam, flash distillation, azeotropic, extractive and molecular distillation, Continuous fractionation- McCabe-Thiele method.

UNIT II **9 Hours**

EXTRACTION AND DRYING

Liquid liquid extraction applications, Solvent selection,Design calculations for stage wise extraction, single stage and multi stage operation, crosscurrent and countercurrent operations; liquid extraction equipments. Solid liquid extraction, Drying of wet solids; Classification of drying equipment and its

UNIT III **9 Hours**

CONDUCTIVE AND CONVECTIVE HEAT TRANSFER

Modes of heat transfer- Principles of Conduction, convection and radiation; Fourier law of heat conduction, Conduction - Steady state heat conduction through unilayer and multilayer walls, Convective heat transferprinciple. Adsorption -adsorption Isotherm, freudlich, langmuir and BET equation.

UNIT IV **9 Hours**

HEAT EXCHANGERS AND EVAPORATORS

Heat exchangers-, Parallel and counter flow heat exchangers, Principle and Working of double pipe, shell and tube heat exchanger, Overall & Individual heat transfer co-efficient, LMTD, Evaporators-single effect and multiple effect evaporators

UNIT V **9 Hours**

FLUID MECHANICS

Nature of fluids, properties of fluids, classification of fluids, hydrostatic equilibrium;Manometers;Measurement of fluid flow-orifice meter, venturimeter, pilot tube and Rota meter. Flow controls-gate valve, globe valve, butterfly valve, globe and ball valve Pumps- Classification, Principle, Characteristics and working of centrifugal pump and reciprocating pump, Peristaltic pump. Continuity equation,Bernoulli equation;

FOR FURTHER READING

HETP calculations - Vapour liquid equilibrium

Total: 60 Hours

Reference(s)

1. R. E. Treybal,Mass Transfer Operations, New York: McGraw-Hill, 2002.
2. J. M. Coulson and J. F. Richardson, Chemical Engineering,Vol.I&II, Pergamon Press, 1998
3. W. L. Mc-Cabe, J. C. Smith and P. Harriot, Unit Operations in Chemical Engineering, New York: McGraw-Hill Inc., 2005
4. G. K. Roy, Fundamentals of Heat and Mass Transfer, Kanna Publishers, 2006.
5. C. J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall of India, 2007.

18BT403 IMMUNOLOGY 3 0 2 4

Course Objectives

- To understand the concepts of immune system and the structure, functions and properties of different cell types and organs that comprise the immune system
- To comprehend the range of immunological agents and the strategies that may be used to prevent and combat infectious diseases
- To understand transplantation and autoimmunity

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the basics of immune system and its components
2. Analyze the various antigen antibody reactions
3. Analyze the mechanism of cell mediated immunity
4. Evaluate the immune response related to microbial infection, allergy and hypersensitivity
5. Evaluate about organ transplantation and immunological anomalies related to autoimmune disorders and tumor

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2													
2	1	2	3											2	
3	1	2	3											2	
4		2	3	2			2							2	
5			3			2		1						2	

UNIT I **9 Hours**

INTRODUCTION TO IMMUNE SYSTEM

Cells of immune system - B-Lymphocytes, T-Lymphocytes, Macrophages, Dendrite cells, Natural Killer, Eosinophils, Neutrophils, Mast cells; innate and acquired immunity; Organization and structure of lymphoid organs, Types of immunity and immune responses. Antigens ÃƒÂ¢?? epitopes, antigenicity, factors influencing antigenicity.

UNIT II **9 Hours**

HUMORAL RESPONSE

Development, maturation, activation and differentiation of B-cells, Theory of clonal selection, Antibodies: structure, function and classification; Monoclonal and polyclonal antibodies - principles and production.

UNIT III **9 Hours**

CELLULAR RESPONSE

Development, maturation, activation and differentiation of T-cells. T Cell Receptor, APC, Processing and presentation of antigen for immune response, Major histocompatibility complex.

UNIT IV **9 Hours**

INFECTION AND IMMUNITY

Injury and inflammation, Immune responses to infections - immunity to viruses, bacteria, fungi and parasites, Cytokines, Complement, Immunosuppression, Immunotolerance, resistance and immunization; Allergy and hypersensitivity. Basics of vaccine, types of vaccine and vaccinations chart.

UNIT V **9 Hours**

TRANSPLANTATION, AUTOIMMUNITY AND TUMOR IMMUNOLOGY

Transplantation of organ and tissue transplantation, laws of transplantation, genetics of transplantation - HLA system, mechanism and prevention of graft rejection, immunosuppressive drugs, autoimmune disorders, treatment of autoimmune disorders, tumor immunology: tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy.

FOR FURTHER READING

Types of antigen antibody reactions - agglutination, precipitation, Immunodiffusion - single, double, radial, immunoelectrophoresis.

1 **3 Hours**

EXPERIMENT 1

Blood grouping and Blood Typing (ABO)

2 **3 Hours**

EXPERIMENT 2

Detection of Salmonella antibody in serum (Widal test)

3 **3 Hours**

EXPERIMENT 3

Ouchterlony double immunodiffusion (ODD)

4 **3 Hours**

EXPERIMENT 4

Radial immunodiffusion (RID)

5 **3 Hours**

EXPERIMENT 5

Rocket immunoelectrophoresis (RIE)

6 **5 Hours**

EXPERIMENT 6

Enzyme-linked Immunosorbent assay (ELISA)

7 **10 Hours**

EXPERIMENT 7

SDS PAGE and Western Blotting

Total: 75 Hours

Text Book(s)

1. Judith A Owen, Jenni Punt, Sharon A Stranford, Patricia P Jones, Janis Kuby, Kuby Immunology 7th Edition,New York : W.H. Freeman, 2013.

Reference(s)

1. A David Male, Jonathan Brostoff, David Roth and Ivan Roitt, Immunology, Mosby Publication, 2006.
2. Ashim K. Chakravarty, Immunology and Immunotechnology, Oxford University Press India Publication, 2006.
3. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, Kuby Immunology, W.H. Freeman & Company, 2006.
4. P. M. Lydyard, A. Whelan and M. W. Fanger, BIOS Instant Notes in Immunology, Taylor & Francis Publication, 2011
5. P. M. Lydyard, A. Whelan and M. W. Fanger, BIOS Instant Notes in Immunology, Taylor & Francis Publication, 2011

18BT404 MOLECULAR BIOLOGY 3 0 0 3

Course Objectives

- To familiarize students on macromolecule's properties, structures and functions
- To expose students to various molecular events in prokaryotes
- To create deeper understanding on regulation of genes activities

Programme Outcomes (POs)

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the three major macromolecules and their properties in living organisms.
2. Apply the mechanism of DNA replication in prokaryotes.
3. Analyze the mechanism of transcription and universal genetic code in prokaryotes.
4. Analyze the process of translation and DNA repair system in prokaryotes.
5. Evaluate the concept of gene regulation and its significance in prokaryotes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3				1							3	1		
2	3			1			1					1	1		
3	3			1	2							1		2	
4	3			1			1				3			2	
5	3			1	3									1	

UNIT I **9 Hours**

MACROMOLECULES

Macromolecules major classes - chemical structures and properties; Physical and chemical structure of DNA; Alternative structure of DNA; RNA molecules- classes, structure and functions.

UNIT II **9 Hours**

DNA REPLICATION

Properties of genetic material; DNA replication in prokaryotes- untwisting of highly coiled DNA, de novo and covalent extension initiations, elongation and termination; Prokaryotic and eukaryotic DNA polymerases; Plasmids- characteristics, types and applications.

UNIT III **9 Hours**

TRANSCRIPTION AND GENETIC CODE

Bacterial and eukaryotic RNA polymerases; Transcription in prokaryotes - initiation, elongation and termination; The genetic code- salient features, RNA and DNA codon tables; Wobble base pair; Aminoacyl-tRNA synthetases; Posttranscriptional modification - mRNA processing.

UNIT IV **9 Hours**

TRANSLATION AND DNA REPAIR

Translation in prokaryotes- initiation, elongation and termination; DNA damage - sources and types; DNA repair mechanisms - direct reversal, excision repair, recombinational repair and SOS response; Inhibitors of translation - antimicrobial agents that bind with 30S and 50S ribosomal subunits.

UNIT V **9 Hours**

REGULATION OF GENE ACTIVITY

Principles of gene regulation and operon concept; Transcriptional regulation - lac operon, galactose operon, arabinose operon, tryptophan operon, attenuation, autoregulation; Feedback inhibition and allosteric control.

FOR FURTHER READING

Hydrolysis of nucleic acids; Conformations of plasmid DNA; DNA replication in eukaryotes- initiation, elongation and termination; DNA transcription and translation in eukaryotes.

Total: 45 Hours

Reference(s)

1. G. M. Malacinski, Freifelder's Essentials of Molecular Biology,Narosa Publishing House, 2005
2. J. K. Pal and S. S. Ghaskadbi, Fundamentals of Molecular Biology, Oxford University Press, New Delhi, 2011
3. J. Watson, T. Baker, S. Bell, A. Gann, M. Levine and R. Losick, Molecular Biology of the Gene, Pearson Education, Inc., 2008
4. J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick, LewinÃƒÂ¢??s Genes X, Sudbury, MA: Jones & Bartlett Publishers, 2009
5. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter, Molecular Biology of the Cell, Garland Science, 2008
6. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, M. P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, Molecular Cell Biology, W. H. Freeman & Co., 2007

18BT405 PHARMACOGNOSY AND PHARMACOLOGY **3 0 0 3**

Course Objectives

- To introduce concepts of essential medicines
- To expose students to foresee, prevent and manage adverse drug events and drug interactions
- To build deeper understanding of basic concepts of drug screening and testing from natural sources

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Understand the mechanism of drug action and its relevance in the treatment of different diseases.
2. Apply the fundamental knowledge on various aspects of drugs acting on different systems of the body.
3. Analyze the principles and method of testing of various drugs.
4. Analyze the techniques in production and evaluation of crude drugs.
5. Evaluate the rate and mechanism of drug action.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	2										2	
2	1	2	3	3	1			3						2	
3	3	1	2	1				3						3	
4	2	1	3	2	2		2				3	3		3	1
5	2	1	2	2	2									2	1

UNIT I **9 Hours**

INTRODUCTION

Pharmacognosy and Pharmacology - definition and historical perspective, sources of drugs, adulteration and evaluation of crude drugs, nomenclature and classification of drugs, routes of drug administration, types of dosage forms, significance of pharmacopoeial standards

UNIT II **9 Hours**

PHYTOPHARMACEUTICALS

Occurrence, chemical nature, medicinal uses and health benefits of Saponins - Diosgenins and Shatavarins, Flavonoids - Hesperidin and Quercetin, Carotenoids - Carotene (Alpha & Beta)) and Xanthophyll (Lutein), Limonoids - Limonene and alpha Terpineol, Vitamins - Cholecalciferol and Tocopherols

UNIT III **9 Hours**

SCREENING, TESTING AND PHARMACOVIGILANCE OF NATURAL DRUGS

Phytopharmacological screening of anti-inflammatory, antiulcer and anti-diabetic drugs, stability testing of natural products, toxicity studies as per OECD guidelines, WHO and AYUSH guidelines for safety monitoring of natural drugs, spontaneous reporting schemes for bio-drug adverse reactions, bio drug-drug and bio drug-food interactions

UNIT IV **9 Hours**

SYSTEMIC PHARMACOLOGY

Drugs Affecting Autonomic Nervous System - Cholinergic and Anticholingergic, Peripheral Nervous System - Local anaesthetics and Skeletal muscle relaxants, Central Nervous system - Antianxiety, Cardiovascular System - Anti-anginal and Antihypertensive, Respiratory System - Expectorants, Kidney Function - Diuretics and Antidiuretics

UNIT V **9 Hours**

PHARMACOKINETICS AND PHARMACODYNAMICS

Basics of clinical and population pharmacokinetics, toxicokinetics, pharmacokinetic and pharmacodynamics parameters, order of a reaction - Zero order, first order and mixed order kinetics, principles of drug action (stimulation, depression, irritation , replacement and cytotoxic action)

FOR FURTHER READING

Peripheral Nervous System - toxicity studies as per OECD guidelines

Total: 45 Hours

Reference(s)

1. W. C. Evans, Trease and Evans Pharmacognosy, W.B. Sounders & Co., London, 16th Edition, 2009
2. C. K. Kokate, Purohit and Gokhlae, Text book of Pharmacognosy, Nirali Prakashan, 37th Edition, 2007
3. S. H. Ansari, Essentials of Pharmacognosy, Birla publications, 2nd edition, 2007
4. R. A. Harvey, M. A. Clark, and R. Finkle, Pharmacology, LWW Publishers, 5th Edition, 2011
5. B. Katzung, S. Masters, and A. Trevor, Basic and Clinical Pharmacology, McGraw-Hill Medical, 11th Edition, 2009
6. Richard D. Howland, Lippincott's illustrated reviews: Pharmacology, Lippincott Williams & Wilkins, 7th Edition, 2007

18BT406 CHEMICAL THERMODYNAMICS 3 1 0 4

Course Objectives

- To get familiar with the process, system and free energy which are essential for Biochemical engineering
- To understand the physiological conditions such as pressure and temperature which are essential for any process or product development
- To perform calculations and estimate the necessary conditions for an industrial process

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the law of thermodynamics and non-ideality to assess the thermodynamic properties of fluids
2. Analyze the thermodynamic property of mixtures
3. Analyze the phase equilibrium behavior using VLE calculations
4. Evaluate the equilibrium constant and equilibrium conversion using chemical reaction equilibria
5. Evaluate the thermodynamic concepts and principles for various industrial processes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2													
2	2	3					2								
3	2	3													
4	2	3	1										1		
5	3	3	1									2	1		

UNIT I **9 Hours**

INTRODUCTION AND BASIC CONCEPTS

Definitions and fundamental concepts, Laws of thermodynamics; First law of thermodynamics for Flow and non flow Process; Internal energy, Enthalpy, Heat capacity, P-V-T behavior of Pure fluids; Processes involving ideal gases, calculation of Heat effects accompanying chemical reactions, Hess law. second law of thermodynamics, Entropy concepts and calculation of entropy changes

UNIT II **9 Hours**

THERMODYNAMIC PROPERTIES OF MIXTURES

Classification of thermodynamic properties, work function , Gibbs free energy , Maxwell relations and applications, Relationship among thermodynamic properties , Partial molar properties; concepts of chemical potential and fugacity; activity and activity coefficient; Gibbs Duhem equations.

UNIT III **9 Hours**

PHASE EQUILIBRIA

Criteria for phase equilibria and stability; phase equilibria for binary and multi component systems; Phase rule and Duhem theorem.VLE Equilibrium, VLE for ideal solutions, Phase diagrams for binary solutions and ternary mixtures.

UNIT IV **9 Hours**

CHEMICAL REACTION EQUILIBRIA

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yield for single and multiple reactions

UNIT V **9 Hours**

APPLICATION OF THERMODYNAMICS

Refrigeration, coefficient of performance, Carnot cycle for ideal refrigeration, Choice of refrigerant, Liquefaction Processes, Ideal Steam power cycles

FOR FURTHER READING

Basic statistical mechanical concept, ensemble and partition function,

Total: 60 Hours

Reference(s)

1. S.I.Sandler, Chemical, Biochemical, and Engineering Thermodynamics, John Wiley publications, 2006
2. K. V. Narayanan, A Text Book of Chemical Engineering Thermodynamics, Prentice Hall of India, 2001.
3. J. M. Smith, H. C. Van Ness and M. M. Abbot, Chemical Engineering Thermodynamics, McGraw-Hill Inc., 2001.
4. P. Atkins, J. D. Paula, Physical chemistry, Oxford University Press, 2002.
5. Terrell L. Hill. An Introduction to Statistical Thermodynamics, Dover Publications

18BT407 BIOPROCESS LABORATORY 0 0 4 2

Course Objectives

- To provide hands on training for the performance of sterilization and aseptic maintenance.
- To gain the skills on analyzing substrate and product kinetics of bioreactor.
- To develop the skills in line with industry oriented biochemical experiments.
- To provide hands on training for studying different modes of bioreactor
- To develop the skills in the mass transfer analysis for the production of metabolites.

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the methodology involved in the aseptic media preparation and calculate del factor of reactors
2. Apply and determine commercially important bioproducts
3. Analyze the physical and environmental parameters involved in optimization process of reactors
4. Analyze mass transfer coefficients and rheological properties of bioreactor
5. Evaluate the fermentation process through modern software/tools

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1					2					3			1		
2				3					2				1		
3			3	2											
4			2						2				1		
5			3	2					3				1		

1 **10 Hours**

EXPERIMENT 1

Batch Sterilization techniques in bioreactor

2 **10 Hours**

EXPERIMENT 2

Growth and Product kinetics from microorganisms in BATCH and FED-BATCH mode

3 **10 Hours**

EXPERIMENT 3

Medium Optimization techniques for Bioprocess systems (Plackett Burman Design)

4 **10 Hours**

EXPERIMENT 4

Effects of pH, Temperature and Substrate on free/ immobilzed Enzyme activity. Use of MATLAB for determnation of Enzyme kinetic parameters

5 **10 Hours**

EXPERIMENT 5

Estimation of qO2 and kLa by dynamic gassing out method

6 **10 Hours**

EXPERIMENT 6

Rheological studies of Fermentation Broth

Total: 60 Hours

Reference(s)

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering - Basic Concepts, Prentice Hall, 2002.
2. M. Pauline Doran, Bioprocess Engineering Principles, Academic Press Limited, 1995.
3. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, Butterworth Heinemann publications, 1995.
4. Harvey W. Blanch, S. Douglas and Clark, Biochemical Engineering, New York: Marcel Dekker Inc., 1997.

18BT408 MOLECULAR BIOLOGY LABORATORY 0 0 4 2

Course Objectives

- To make wider practical dexterity in the area of molecular biology tools and techniques
- To acquire practical skill in isolating and analyzing nucleic acid from living cells

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the process involved in the isolation of genomic DNA from bacteria, plant and animal tissues
2. Apply the concept of gene regulation and its significance in prokaryotes
3. Analyze the quantification of DNA using analytical techniques
4. Analyze the restriction digestion and molecular weight determination of DNA
5. Evaluate the three major macromolecules and their properties in living organisms.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1		2	3			2	1	2				2	
2	1	2		3	2				1			3		2	
3	1	3		2	1				1	2				1	
4	1	1		1	1				1					1	
5	1	1		1	1				1	2		2		1	

1 **10 Hours**

EXPERIMENT 1

To isolate genomic DNA from Bacteria

2 **10 Hours**

EXPERIMENT 2

To isolate genomic DNA from plant tissue

3 **10 Hours**

EXPERIMENT 3

To isolate genomic DNA from animal tissue

4 **10 Hours**

EXPERIMENT 4

To quantify DNA using UV spectrophotometer / DNA nano drop

5 **10 Hours**

EXPERIMENT 5

To digest DNA using restriction enzymes

6 **10 Hours**

EXPERIMENT 6

To identify DNA molecule using agarose gel electrophoresis

Total: 60 Hours

Reference(s)

1. J. Sambrook, D. Russell, and D. W. Russell, Molecular cloning-A laboratory Manual (A set of Volume 1, 2 and 3), USA: Cold Spring Harbor Laboratory Press, 2000

18HS001 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Apply Suitable strategies for sustainable management of components of environmental science
3. Analyze the existing environmental challenges related to pollution and its management
4. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
5. Evaluate the impacts of population and human activities on environment

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2													
2	1	1													
3	2	2					1								
4	1														
5	2														

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - landslides

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act.

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - women and child welfare programmes - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

FOR FURTHER READING

Human rights: E - waste and biomedical waste -Identification of adulterants in food materials

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

18GE401 SOFT SKILLS-REASONING 2 0 0 0

Course Objectives

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2		3			
2										2		3			

UNIT I **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information

Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

1 **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information - Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

2 **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 60 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

18BT501 DOWNSTREAM PROCESSING 3 1 0 4

Course Objectives

- To introduce the methods of separation technology
- To expose students to techniques of product fractionation
- To create deeper understanding of final product purification

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Understand the separation techniques used in downstream processes for the purification of biomolecules.
2. Apply the techniques of insoluble removal and predict the parameters for large scale operations.
3. Analyze various downstream techniques for bulk product isolation.
4. Analyze the high-resolution product purification based on product characteristics and cost effectiveness.
5. Evaluate the application of equipment utilizing downstream techniques in final product formulation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2			2							1		2	
2	1	2	2		3	3						2		2	
3	1	2	2		3		1			1		2		3	
4	2				3						3	2		2	
5	2		2		3	3					3	2		1	

UNIT I **9 Hours**

DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

Scope and importance of Downstream Processing in Biotechnology; need for bioproduct purification; characteristics of biomolecules and bioprocesses; criteria for selection of bio-separation techniques; Role of DSP methods in bioprocess economics; Pretreatment of cells; Cell disruption methods

UNIT II **9 Hours**

PHYSICAL METHODS OF SEPARATION

Pretreatment and removal of insolubles; Unit operations for solid - liquid separation; Flocculation and sedimentation; Centrifugation - basket, tubular bowl, disk and ultra centrifugation; Filtration - conventional and cross flow filtration, Pervaporation, Kinetics, design and economic consideration

UNIT III **9 Hours**

ISOLATION OF PRODUCTS

Adsorption - Types and applications; liquid-liquid extraction - Reversed micellar and aqueous two-phase extraction; Membrane separation - micro, ultra filtration, reverse osmosis, dialysis; criteria for selection of membranes; Precipitation - Types and scale up

UNIT IV **9 Hours**

PRODUCT RESOLUTION AND FRACTIONATION

Chromatography - principles, instrumentation and types - adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, Bioaffinity chromatography and Pseudo affinity chromatography; Electrophoresis and the methodologies.

UNIT V **9 Hours**

FINISHING OPERATIONS FOR FINAL PRODUCT

Crystallization - principles, practices and equipments; Drying - principles, practices, and equipments; Lyophilization - principles, practices and equipments

FOR FURTHER READING

Criteria for scale up; Vacuum extraction; Recrystallization

Total: 60 Hours

Reference(s)

1. P. A. Belter, E. L. Cussler and Wei-Shou Hu, Bioseparations - Downstream Processing for Biotechnology, Wiley Interscience, 1988
2. B. Sivasankar, Bioseparations - Principles and Techniques, Prentice Hall of India Pvt. Ltd., 2007
3. R. G. Harrison, P. Todd, S. R. Rudger and D. P. Petrides, Bioseparation Science and Engineering, Oxford University Press, 2003
4. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth Heinemann, 2006

18BT502 NANO BIOTECHNOLOGY 3 0 2 4

Course Objectives

- To develop the skills of the student in the area of nano biotechnology and its application
- To familiarize student with different techniques for synthesizing and characterizing of various nanoparticles
- To motivate and facilitate student to undertake the project and research work in nanobiotechnology

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the synthesis and characterization of nanoparticles
2. Apply the suitable methods in the preparation of DNA and peptide nanostructures
3. Analyze the usage of analytical tools in nanobiotechnology
4. Analyze the applications of nanoparticles in drug delivery
5. Evaluate the strategies in the preparation of biomaterials in nanomedicine

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1												2	
2	2	1	3									2		2	
3		1	2	2	3								3		
4	2		3	1				3					2		
5	2	1	3					1				3		2	

UNIT I **9 Hours**

INTRODUCTION TO NANOBIOTECHNOLOGY

Synthesis and Characteristics of nanoparticles; Characterization of Nanoscale materials, Strategies for Nano architecture- bottom up, top down and functional approaches; Quantum dots, Carbon nanotubes- properties, synthesis and application.

UNIT II **9 Hours**

DNA AND PROTEIN BASED NANOSTRUCTURES

DNA-gold particle conjugates; DNA nanostructrures for mechanics and computing; Polymer nanocontainers; Peptide nanotubes and their applications electronics, antibacterial agents, DNA microarrays; Nanobiosensors.

UNIT III **9 Hours**

NANOANALYTICS AND NANO-STRUCTURED MATERIALS

UV-visible spectrophotometer; Particle size analyzer; Zeta sizer; X-Ray Diffractometer, Transmission electron microscopy, Scanning electron microscopy; Energy-dispersive X-ray spectroscopy; Atomic force microscopy; Mass spectroscopy; Fourier transform infrared spectroscopy; X-ray photoelectron spectroscopy.

UNIT IV **9 Hours**

NANOPARTICLES IN DRUG DELIVERY

Applications of Nanobiotechnology in drug delivery; Polymeric nanoparticles for drug and gene delivery; Liposomes; Micelles for drug delivery; Nanotoxicology- Cyto-toxicity, Geno-toxicity In vivo tests/assays etc.

UNIT V **9 Hours**

NANOMATERIALS AND NANOMEDICINE

Cardiavascular implants,Biomaterials for optamology,Structure, property of Biological Materials: tissues, bones and teeth, collagen rich,tissues, elastic tissues, nanostructured collagen mimics in tissue Engineering. Biopolymers: Preparation of nanobiomaterials Polymeric scaffolds collagen, Elastins:Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans; Alginates;Pectins; Chitin, nanosurgery.

FOR FURTHER READING

Synthesis of nanoparticles bacteria, fungi, yeast and plants, chemical Transformation of Biomaterials. protein self-assembly,nanochips, nanopolymers.instruments

1 **4 Hours**

EXPERIMENT 1

Synthesis of metal nanoparticles by chemical reduction method (Ag, Cu, Au and Fe NPs).

2 **4 Hours**

EXPERIMENT 2

Synthesis of metal nanoparticles by biological method

3 **4 Hours**

EXPERIMENT 3

Synthesis of metal oxide nanoparticles (ZnO, Fe3O4, CuO, CdO and Al2O3 NPs)

4 **5 Hours**

EXPERIMENT 4

Characterization of NPs by UV-visible spectrophotometer, fluorescent spectrophotometer and FTIR Analysis

5 **4 Hours**

EXPERIMENT 5

Evaluation of antimicrobial property of NPs.

6 **4 Hours**

EXPERIMENT 6

Preparation of drug carrier by nanoemulsion technique.

7 **5 Hours**

EXPERIMENT 7

Preparation of polymer containers for controlled drug release application

Total: 75 Hours

Reference(s)

1. C. M. Niemeyer and C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, Weiheim: Wiley-VCH Verlag GmbH and Co. KGaA, 2004
2. T. Pradeep, Nano: The Essentials Understanding Nanoscience and Nanotechnology, New Delhi: Tata McGraw- Hill, 2008.
3. H. S. Nalwa, Encyclopedia of Nanoscience & Nanotechnology, California: American Scientific Publishers, 2004
4. Bhusan, Handbook of Nanotechnology,Berlin, Heidelberg, Germany: Springer-Verlag, 2004
5. P. M. Ajayan, L. S. Schadler, and P. V. Braun, Nanocomposite Science and Technology, Weiheim: Wiley-VCH Verlag, GmbH & Co. KGaA, 2003

18BT503 GENETIC ENGINEERING 3 0 0 3

Course Objectives

- To familiarize students on various enzymes and vectors used in genetic engineering
- To give exposure on cloning techniques and their applications
- To create deeper understanding on various techniques of gene manipulation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the microbial enzymes for constructing recombinant DNA
2. Apply the vectors for cloning and expression of gene of interest
3. Analyze the mechanism of construction of DNA libraries
4. Analyze the molecular techniques used in genetic engineering
5. Evaluate the applications of genetic engineering in biotechnology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1			2								1		
2	2				3			1					1		
3	3				2			1						2	
4	2	1			3									2	
5	2					3		1						2	

UNIT I **9 Hours**

ENZYMES USED IN GENETIC ENGINEERING

Nuclease- exonucleases and endonucleases; Restriction enzymes- nomenclature, types, applications; Restriction endonuclease- blunt and sticky ends; RNases, DNA Ligase, Polymerases; DNA Modifying enzymes- alkaline phosphatase, polynucleotide kinase and terminal deoxynucleotidyl transferase.

UNIT II **9 Hours**

VECTORS FOR GENE CLONING AND EXPRESSION

Characteristics of cloning and expression vectors; Plasmids-pSC101, pBR322, pSF2124, colE1, pUC, pGEM, pMUTIN, pGEX-3X, pET and pTrcHis, Ti plasmid; Bacteriophage vector- lambda; Yeast vectors- plasmids and YAC; Shuttle vectors; Cosmid and phagemid vectors.

UNIT III **9 Hours**

CONSTRUCTION OF LIBRARIES

Linkers, adaptors and homopolymer tailing; Construction of genomic library; cDNA construction- hairpin loop strategies; Directional and non directional cDNA synthesis; Construction of full length cDNA library- Oligo capping; Okayama and Berg method of cDNA cloning; Screening of libraries.

UNIT IV **9 Hours**

TECHNIQUES FOR GENETIC ENGINEERING

Polymerase chain reactions; RAPD; RFLP; Molecular beacons and Taqman assay; Nucleic acid sequencing; Southern and northern blotting; Gene transfer technologies

UNIT V **9 Hours**

APPLICATIONS OF GENETIC ENGINEERING

Gene therapy- ex vivo and in vivo; Genetic engineering in medicine- recombinant therapeutics and biopharmaceuticals, antibiotics, vaccines; Genetic engineering in agriculture- bio pesticides, herbicides; Applications in environment-bioremediation or environment clean-up

FOR FURTHER READING

Mammalian and plant expression vectors; In-situ hybridization; Site-directed mutagenesis; Primer designing; DNA fingerprinting; National regulatory mechanism for implementation of Biosafety guidelines for handling GMOs; Regulation for GM plants, Hybridization and labeling.

Total: 45 Hours

Reference(s)

1. Smita Rastogi and Neelam Pathak, Genetic Engineering, Oxford University Press, 2009
2. T.A.Brown, Gene Cloning an Introduction, U.K: Blackwell Publishers, 2001
3. R.W.Old and S.B.Primrose, Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell Science Publications, 2001
4. B.D.Singh, Biotechnology, Kalyani Publishers, 2010

18BT504 PLANT TISSUE CULTURE 3 0 0 3

Course Objectives

- To gain ample knowledge on different plant culture types involved
- To learn the techniques involved in plant tissue culturing
- To have an exposure on the various real time applications of culturing techniques in GM crop production and sustainability.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Understand the media composition and explants requirement for culturing plants *in vitro* under aseptic condition
2. Apply the varied types of explants for successful propagation of plant tissues *in vitro*.
3. Analyze how shoots and roots can be induced from other plant tissues without any infection and apply the learned technique for production of artificial seeds and complete regeneration of whole crops.
4. Analyze the genetic modifications used for large scale production of commercially important crops using tissue culture.
5. Evaluate the production of industrially important plant products through application of plant tissue culture.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1										1		
2		3	1			2							2		
3		3	2			1							1		
4			1			1	3	3					2		
5			3					2			1		1		

UNIT I **9 Hours**

INTRODUCTION TO PLANT TISSUE CULTURE

History of plant tissue culture, Laboratory requirements and organization; Types of media and its composition - inorganic nutrients, organic supplements, carbon source, vitamins, gelling agents,, Explants and sterilization techniques- filter, heat, wet and chemical, Plant Growth hormones; Commonly used culture media.

UNIT II **9 Hours**

BASICS OF CULTURE TYPES AND TECHNIQUES

Suspension culture - Batch and continuous, Synchronisation of suspension culture, Micro propagation - Factors affecting morphogenesis and proliferation rate, technical problems in micropropagation; Protoplast isolation and fusion technology and its Viability test

UNIT III **9 Hours**

CELL CULTURE TECHNIQUES FOR REGENERATION OF CROPS

Organogenesis -formation of shoots and roots, production of virus free plants by Meristem and shoot-tip culture , Embryogenesis - Process of somatic embryogenesis, structure, stages of embryo development, factors affecting embryogenesis; production of artificial seeds; Cryopreservation

UNIT IV **9 Hours**

COMMERCIAL CROPS USING PLANT TISSUE CULTURE

Herbicide resistance; Pest resistance - BT Crops; Genetic engineering for male sterility- Barnase-Barstar; Delay of fruit ripening - Polygalacturanase, ACC synthase, ACC oxidase

UNIT V **9 Hours**

APPLICATIONS OF TISSUE CULTURE

Application of plant tissue culture in mutant selection, Secondary metabolite production and clonal propagation. Plant products of industrial importance, Recent advances in plant tissue culture.

FOR FURTHER READING

Hybrid plants - Embryo transfer techniques

Total: 45 Hours

Reference(s)

1. M. K. Razdon, Introduction to Plant Tissue Culture, Oxford &IBH Publishing Company, 2006.
2. S. Narayanaswamy, Plant Cell & Tissue Culture, Tata Mc Graw-Hill, 2008
3. A. Slater, N. Scott and M. Fowler, Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, 2003

18BT507 GENETIC ENGINEERING LABORATORY 0 0 4 2

Course Objectives

- To build sound practical knowledge in gene amplification using genetic engineering tools
- To acquire practical skills in gene cloning techniques
- To create deeper understanding on various techniques of gene manipulation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the bacterial gene amplification using PCR
2. Apply and demonstrate the gene cloning using genetic engineering tools and techniques
3. Analyze the Plasmid profiling using chemical lysis method
4. Analyze and construct recombinant DNA for microbial enzymes
5. Create the vectors for cloning and expression of gene of interest

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1		2	3				1					2	
2	1	2		3	2				1	2		2		1	
3	1	3		2	1				1	3	1			1	
4	1	1		1	1			3	1	2					
5	1	1		1	1				1						

1 **10 Hours**

EXPERIMENT 1

Isolation of iapA gene of Listeria monocytogenes by PCR and its confirmation by agarose gel electrophoresis.

2 **10 Hours**

EXPERIMENT 2

Purification of amplified iapA DNA and ligation in pGMT easy vector system

3 **10 Hours**

EXPERIMENT 3

Preparation of E. coli DH5a competent cells by glycerol methods

4 **10 Hours**

EXPERIMENT 4

Transformation of recombinant pGMT easy vector into E. coli DH5a by electroporation method

5 **10 Hours**

EXPERIMENT 5

Confirmation of recombinant transformed clones using Blue White screening

6 **10 Hours**

EXPERIMENT 6

Isolation of recombinant plasmid DNA using alkaline lysis method

Total: 60 Hours

Reference(s)

1. J. Sambrook, D. Russell, and D. W. Russell, Molecular cloning-A laboratory Manual (A set of Volume 1, 2 and 3), USA: Cold Spring Harbor Laboratory Press, 2000

18BT508 DOWNSTREAM PROCESSING LABORATORY **0 0 4 2**

Course Objectives

- To implement the techniques of bioseparation.
- To expose students to the techniques of final product purification
- To create deeper understanding of final product purification

Programme Outcomes (POs)

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

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

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

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

n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the separation techniques for the recovery of biomolecules from fermentation broth.
2. Apply the chromatography techniques in biomolecules separation
3. Analyze techniques of insoluble removal and predict the parameters for large scale operations
4. Analyze the techniques used for final purification and product formulation
5. Evaluate the techniques of high-resolution product purification based on product characteristics and cost effectiveness

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			2	3	3		2					2		2	
2			2	3	3				2	2		2		1	
3			2	3	3					2		2		1	
4			1	1	1				2	2		1		1	
5			1	1	1						2	1		1	

1 **10 Hours**

EXPERIMENT 1

Cell disruption techniques - Physical, Chemical and Mechanical

2 **10 Hours**

EXPERIMENT 2

Aqueous two phase extraction of biological molecules

3 **10 Hours**

EXPERIMENT 3

Microfiltration using tangential flow separation

4 **10 Hours**

EXPERIMENT 4

Precipitation and Electrophoresis of proteins

5 **10 Hours**

EXPERIMENT 5

Purification of biomolecules using chromatographic techniques

6 **10 Hours**

EXPERIMENT 6

Crystallization of metabolites

Total: 60 Hours

Reference(s)

1. P. A. Belter, E. L. Cussler and Wei-Shou Hu, Bioseparations - Downstream Processing for Biotechnology, Wiley Interscience, 1988
2. B. Sivasankar, Bioseparations - Principles and Techniques, Prentice Hall of India Pvt. Ltd., 2007

18GE501 SOFT SKILLS - APTITUDE I 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2												3			
3										2		3			
4										2		3			

1 **2 Hours**

NUMBER SYSTEMS

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility- Number of zeros in an expression.

2 **2 Hours**

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations- Concept of percentage values through additions-Fraction to percentage conversion table.

3 **3 Hours**

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average- Replacement of some of the items.

4 **3 Hours**

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios-Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

5 **2 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

6 **2 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

7 **2 Hours**

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

8 **3 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

9 **2 Hours**

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

10 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

11 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

12 **3 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

18HS002 PROFESSIONAL ETHICS IN ENGINEERING 2 0 0 2

Course Objectives

- To understand Human Values and ethical theory.
- To understand codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural ethics and engineers responsibility.

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Apply the engineering ethics theory with sustained lifelong learning.
2. Apply a good character and follow high professional ethical life.
3. Analyze and contribute to shape a better character by following ethical actions.
4. Analyze and resolve moral issues occurred during technological activities.
5. Evaluate the moral and ethical problems through exploration and assessment by established experiments.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
1								3			2				
2								2		2	2				
3											3				
4								2		2	2				
5								2			2				

UNIT I **6 Hours**

HUMAN VALUES

Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others - Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy

UNIT II **6 Hours**

ENGINEERING ETHICS AND PROFESSIONALISM

Scope of Engineering Ethics- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy – Kohlberg's and Gilligan's theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance - justification - limitation - Abuse

UNIT III **6 Hours**

ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as experimentation - Engineers as responsible experimenters - Balanced outlook on law - Cautious optimism - Safety and risk - Assessing and reducing risk - Safe exits - The Challenger case study- Bhopal Gas Tragedy - The Three Mile Island and Chernobyl

UNIT IV **6 Hours**

WORKPLACE RESPONSIBILITIES AND RIGHTS

Fundamental Rights - Responsibilities and Duties of Indian Citizens - Teamwork - Ethical corporate climate- Collegiality and loyalty - Managing conflict - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights

UNIT V **6 Hours**

GLOBAL ISSUES

Multinational corporations: Technology transfer and appropriate technology - International rights - promoting morally just measures - Environmental ethics: Engineering, ecology - economics - Human and sentient centered - and bio and eco centric ethics - Computer ethics and internet - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership

FOR FURTHER READING

Sample code of ethics like IETE,ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

Total: 30 Hours

Reference(s)

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
3. R S Naagarazan, A text book on professional ethics and human values, New age international (P)limited, New Delhi,2006.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics - Concepts and Cases, Wadsworth Thompson Learning, United States, 2005.
6. http://www.slideworld.org/slidestag.aspx/human-values-and- Professional-ethics

18BT602 BIOPHARMACEUTICAL TECHNOLOGY 3 0 0 3

Course Objectives

- Introduce diverse sources and classes of biopharmaceuticals
- Expose students to various modes of drug delivery
- Build deeper understanding of application of biotechnology tools in the world of medicine

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Understand the difference between chemical and bio-based pharmaceuticals
2. Apply the knowledge of biological effects of bioactive substances for their use as therapeutics
3. Analyze the need for formulation of biopharmaceuticals
4. Analyze various criteria for selection of drug carriers that result in effective drug delivery
5. Evaluate drug action based on the difference in physiological functions of a host

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1			2		2						2	
2	1	2	3					2		1				2	
3	3	1	2		2			3	3					3	
4	2	1	3					2		1			1	2	
5	2	1	2		2			2				3	1	2	

UNIT I **9 Hours**

INTRODUCTION

Biopharmaceuticals - definition, classification, current status and future prospects. traditional pharmaceuticals of biological origin, generic and branded biopharmaceuticals, biosimilars - global and Indian scenario, advantages and issues concern with the use of biosimilars

UNIT II **9 Hours**

PRODUCTION AND THERAPEUTIC APPLICATIONS OF BIOPHARMACEUTICALS

Cytokines - IFN-, IL-2; Hormones - Insulin, Human growth hormone; Antibodies - Monoclonal and Polyclonal, Vaccines - hepatitis B, Porcilis pesti; Anticoagulant - Hirudin

UNIT III **9 Hours**

FORMULATION OF BIOPHARMACEUTICALS

Rational for formulation of biotherapeutics, formulation excipients - solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants, methods to enhance shelf- life of protein based therapeutics, preservatives and packaging techniques

UNIT IV **9 Hours**

CONVENTIONAL DOSAGE FORMS AND NOVEL DRUG DELIVERY SYSTEMS (NDDS)

Liquid dosage forms - Suspensions, emulsions; Semisolid dosage forms - Ointments, creams; Soild dosage forms - Tablets, Capsules; modes of NDDS - targeted, controlled and modulated, advantages and factors affecting NDDS

UNIT V **9 Hours**

MECHANISM OF ACTION OF BIOPHARMACEUTICALS

Mechanisms of drug absorption, distribution and metabolism, factors governing absorption, distribution and metabolism of a drug, Pharmacokinetics and Pharmacodynamics of therapeutic peptides, Bioavailability and Bioequivalence

Total: 45 Hours

Reference(s)

1. Daan J A Crommelin, Pharmaceutical Biotechnology, Taylor &Francis Group, 2nd Edition, 2010
2. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, Inc., 2nd Edition, 2003
3. Rodney J. Y. Ho, Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, John Wiley & Sons, Inc., 2ndEdition, 2013
4. Gary Walsh, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons, Inc., 2007
5. Oliver Kayser and Heribert Warzecha, Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, John Wiley & Sons, Inc., 2nd Edition, 2012

18BT603 BIOINFORMATICS 3 0 2 4

Course Objectives

- To understand the theory and background of commonly available bioinformatics tools
- To navigate through internet-based biological databases and genomic browsers
- To use online resources for biological applications

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

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

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

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Understand the importance of biological databases and their usage
2. Apply the knowledge of bioinformatics in analysis of biological information
3. Analyze the evolutionary concepts to build phylogenetic tree
4. Analyze the concepts of systems biology for its application in metabolic engineering and synthetic biology
5. Evaluate the importance of advanced bioinformatic techniques for drug designing and high throughput analysis

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1		1								2		
2	2	2	1		2					1	2		2		
3	2	2	1		3		2		2	2			2		
4	3	2	1		2							2	2		
5	3	2	1		3					2		2	1		

UNIT I **9 Hours**

INTRODUCTION TO BIOINFORMATICS

Introduction to bioinformatics, Basics of database, Biological databases, Protein and Nucleic Acid Databases, PDB, NCBI, Swissprot, KEGG, Uniprot

UNIT II **9 Hours**

SEQUENCE ALIGNMENT

Pairwise sequence alignments - basic concepts of sequence alignment, local and global alignments, Dot Plot, scoring matrices, Multiple Sequence Alignment - CLUSTALW, Genetic Algorithm, HMM

UNIT III **9 Hours**

PHYLOGENETIC ANALYSIS

Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees.

UNIT IV **9 Hours**

INTRODUCTION TO SYSTEMS BIOLOGY

Introduction to systems biology, Systems theory, Advantages over reductionist approach, Biological networks - metabolic, signaling & regulatory network, Flux analysis MFA & FBA, Bottom-up approach, Top-down approach, Applications - Metabolic engineering, Synthetic biology.

UNIT V **9 Hours**

ADVANCED BIOINFORMATICS

Data mining, Clustering & Classification, Next Generation Sequence Analysis, High Throughput databases, Computer aided drug design, Quantitative structure activity relationship (QSAR) for drug designing.

FOR FURTHER READING

Online Tools, open source databases

1 **6 Hours**

EXPERIMENT 1

Retrieving files and information from biological databases (NCBI, PDB, PubChem)

2 **4 Hours**

EXPERIMENT 2

Sequence alignment -BLAST, FASTA, Clustal Omega

3 **4 Hours**

EXPERIMENT 3

Molecular phylogenetic analysis

4 **6 Hours**

EXPERIMENT 4

Gene annotation and gene finding

5 **6 Hours**

EXPERIMENT 5

Molecular modeling of protein and its visualization

6 **4 Hours**

EXPERIMENT 6

Computer aided drug design with online tools

Total: 75 Hours

Reference(s)

1. David B. Mount: Bioinformatics. Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York, 2001
2. Andreas D. Baxevanis, B. F. Francis Ouellette: Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Volume 39, John Wiley, 1998
3. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall, 2006
4. James Tisdall, Beginning Perl for Bioinformatics. O'Reilly & Associates, 2000

18BT604 ANIMAL CELL CULTURE 3 0 0 3

Course Objectives

- To impart the knowledge on basic tissue culture techniques
- To train students on theoretical and practical aspects of animal cell culture
- To demonstrate knowledge of cell lines used in mammalian tissue culture, their origins and applications

Programme Outcomes (POs)

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

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

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

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

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

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

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

n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the concepts of the cell culture techniques and their competence in laboratory techniques
2. Apply the knowledge of cell isolation, maintenance and characterization in organ culture
3. Analyze the proficiency in establishing and maintaining of cell lines
4. Analyze cell cytotoxicity in regard to cell proliferation and viability
5. Evaluate the potential benefits of cell culture techniques in disease management

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3		2			2		3						2	
2	2		3			2	2	2							
3	3		2			3		3				3		1	
4	2		3			2		2				3		1	
5	2		2			3		3			2			2	

UNIT I **9 Hours**

INTRODUCTION TO CELL CULTURE

Introduction, importance, history of cell culture development, Equipments for cell culture, Aseptic techniques, Layout of animal tissue culture laboratory, Safety protocols and sterilization techniques.

UNIT II **9 Hours**

CELL CULTURE MEDIA AND REAGENTS

Different type of cell culture media, Growth supplements, Serum free media, Balanced salt solution, and Advantages, disadvantages and their applications

UNIT III **9 Hours**

CELL CULTURE TECHNIQUES

Different cell culture techniques including primary and secondary culture, Continuous cell lines, suspension culture and organ culture, Subculture and propagation, Cell lines, nomenclature, cell line designations, Routine maintenance and immortalization of cell lines

UNIT IV **9 Hours**

DEVELOPMENT AND MAINTENANCE OF CELL LINES

Development of cell lines, Characterization and maintenance of cell lines, Cryopreservation, Common cell culture contaminants, Measurement of viability and cytotoxicity

UNIT V **9 Hours**

APPLICATIONS OF CELL CULTURE

Gene transfer techniques in mammalian cells, Viral and non-viral methods, Production of transgenic animals, ES and microinjection, retroviral method, applications of transgenic animal technology

FURTHER READING

Animal cell staining: Histological and Immunohistochemical analysis, Adaptation of virus in cell culture

Total: 45 Hours

Reference(s)

1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
3. Ed. Martin Clynes, Animal Cell Culture Techniques. Springer, 1998.

18BT607 TISSUE CULTURE LABORATORY 0 0 4 2

Course Objectives

- To impart hands on training in the aseptic techniques and operation of equipment
- To study the different culturing techniques involved in plant and animal tissue culture.
- To learn about different origins and types of contamination in a cell culture environment

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the various concepts in plant and animal tissue culture experiments.
2. Apply the knowledge to optimize media for the in vitro culturing of plant and animal cells
3. Analyze the different methods that are suitable for plant and animal cells culturing
4. Analyze the different nutritional and environmental requirements for growing cells
5. Evaluate different factors that affects cell growth in culture

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2					3	3		2	2		1		
2	2	3	2				3	3	2	2		2	1		
3	2	3					2	3	2	2		2	2		
4	2		2				2	3				2	2		
5	2		2				2	3				2	1		

1 **8 Hours**

EXPERIMENT 1

Organizing plant tissue culture laboratory

2 **8 Hours**

EXPERIMENT 2

Preparation of plant tissue culture medium

3 **8 Hours**

EXPERIMENT 3

Preparation of explants (Callus and shoot induction)

4 **8 Hours**

EXPERIMENT 4

Organizing animal tissue culture laboratory

5 **14 Hours**

EXPERIMENT 5

Culturing of chick embryo and primary cell isolation

6 **14 Hours**

EXPERIMENT 6

Media preparation, cell counting, staining and preservation techniques

Total: 60 Hours

Reference(s)

1. M. K. Razdon, Introduction to Plant Tissue Culture, Oxford & IBH Publishing Company, 2006
2. U. Satyanarayana, Biotechnology, Book & Allied Pvt. Ltd., 2007.
3. Readings in Mammalian cell culture. R. Pollack., Cold Spring Harbour Laboratory (198)
4. Culture of Animal Cells. R. Ian Freshney and R. Alan., Liss. Inc. (1987).

18BT608 BIOPHARMACEUTICAL TECHNOLOGY LABORATORY **0 0 4 2**

Course Objectives

- To provide hands on training good laboratory practices
- To impart the skills for ensuring sterility of biopharmaceuticals
- To acquire skills in preparing various pharmaceutical dosage forms

Programme Outcomes (POs)

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

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

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

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

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

n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply good laboratory practices in biopharmaceutical manufacturing facilities
2. Analyze biopharmaceuticals for their sterility
3. Evaluate the efficiency of different carrier molecules used for drug delivery
4. Evaluate the pharmacological functions of bioactive compounds isolated from natural source
5. Create novel dosage forms for effective drug delivery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			1	2	2			3	3					2	
2			3	1	2				1					2	
3			2	3	1				3	3				2	
4			3	2	1				2					1	
5			2	2	1		2	3	3	3	2	2		2	

1 **7 Hours**

EXPERIMENT 1

Good Laboratory Practice (GLP) protocols for cleaning, decontamination and sanitization

2 **7 Hours**

EXPERIMENT 2

Sterility testing of injectables by membrane filtration

3 **7 Hours**

EXPERIMENT 3

Sterility testing of freeze dried formulation by direct inoculation

4 **7 Hours**

EXPERIMENT 4

Preparation of blank and loaded liposome for drug delivery

5 **8 Hours**

EXPERIMENT 5

Preparation of controlled release formulation

6 **8 Hours**

EXPERIMENT 6

Isolation, screening and quantification of bioactive compounds from natural source

7 **8 Hours**

EXPERIMENT 7

Determination of bacterial endo-toxins by Limulus Amebocyte Lysate (LAL) Test

8 **8 Hours**

EXPERIMENT 8

Anti Lipid Peroxidation (Thiobarbituric Acid Reactive Substances) assay

Total: 60 Hours

Reference(s)

1. S. B. Bhise, R. J. Dias, S. C. Dhawale and K. K. Mali, Laboratory Manual of Biopharmaceutics and Pharmacokinetics, Trinity Publishing House, 2010
2. H. C. Ansel, Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams & Wilkins, 7th Edition, 2000

18GE601 SOFT SKILLS-APTITUDE II 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sides colored.
4. Interpret various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2						
2											3				
3									2		3				
4									2		3				
5											2				

1 **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

2 **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

3 **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

4 **4 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

5 **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

6 **4 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

7 **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

8 **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

9 **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

10 **2 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

11 **2 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

12 **2 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

13 **2 Hours**

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

18HS003 PRINCIPLES OF MANAGEMENT 2 0 0 2

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
1								3		3	2				
2								2			2				
3										3	3				
4								2			2				
5								2		3	2				

UNIT I **6 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management - Science or Art - Manager Vs Entrepreneur-types of managers- Managerial roles and skills -Evolution of Management - Scientific, Human Relations, System and Contingency approaches - Types of Business organization- Sole proprietorship, partnership, Company-public and private sector enterprises-Organization culture and Environment - Current Trends and issues in Management.

UNIT II **6 Hours**

PLANNING

Nature and purpose of planning-Planning process-Types of planning-Objectives-Setting objectives- Policies-Planning premises - Strategic Management- Planning Tools and Techniques-Decision making steps and process.

UNIT III **6 Hours**

ORGANISING

Nature and purpose - Formal and informal organization - Organization chart - Organization Structure – Types - Line and staff authority – Departmentalization - delegation of authority - Centralization and decentralization - Job Design-Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV **6 Hours**

DIRECTING

Foundations of individual and group behavior - Motivation- Motivation theories- Motivational techniques-Job satisfaction- Job enrichment- Leadership- types and theories of leadership- Communication- Process of communication - Barrier in communication - Effective communication - Communication and IT.

UNIT V **6 Hours**

CONTROLLING

System and process of controlling- Budgetary and non-Budgetary control techniques- Use of Computers and IT in Management control- Productivity problems and management- Control and Performance- Direct and preventive control-Reporting.

Total: 30 Hours

Reference(s)

1. 1. Robbins, S. (2017). Management, (13th ed.), Pearson Education, New Delhi.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education,7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007..
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008

18BT702 BIOBUSINESS 3 0 0 3

Course Objectives

- To inculcate the spark of creating bio business
- To explore the entrepreneurial skills for Bio startups
- To create the entrepreneurship ecosystem

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Understand the basics of bio business and correlate it with development of biotech industries.
2. Apply specific business strategies for successful initiation of business startups.
3. Analyze the significance of legal protection of Bio inventions and commercialization.
4. Analyze the recent business schemes and funding opportunities for starting bio ventures.
5. Evaluate the scope of export business and legal procedures for exporting value added commercially significant bio products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1					2				3					3
2		1	2							2					2
3		1	1						2	2					2
4	1		2							3				1	3
5	1		2								2			2	2

UNIT I **9 Hours**

INTRODUCTION TO BIO BUSINESS

Need and scope of Bio business, Bio Business boom and Indian economy, Industry - academia collaboration, Role of entrepreneurs in economic development,Growth of biotechnology and biopharmaceutical industries, Market share of biotechnology industry at global level.

UNIT II **9 Hours**

BIO BUSINESS STRATEGIES

Self-Discovery,Customer Discovery, Design Thinking for Customer Delight, Market survey, Value chain and value proposition, business model canvas, Business plan, break-even point, bootstrapping, Iterating the Minimum viable product, Capstone Project Presentation, Mentoring and Venture Support, Blue Ocean Strategy, Return on Investment (ROI) and Return on Equity (ROE), Digital presence of entrepreneurs and online marketing.

UNIT III **9 Hours**

BIO BUSINESS AND PROTECTION

Technological Innovation and Entrepreneurship, Design-Driven Innovation, Intellectual property rights, technology licensing, financial assistance for Patent filing systems in India and other countries, benchmarking, IP protection & commercialization strategies, relevance of cost theories in business decision-making,

UNIT IV **9 Hours**

BIO BUSINESS SCHEMES AND FUNDING OPPORTUNITIES

Resource Mobilization-Angel Investor, funds from Government agencies - MSME, DBT, BIRAC, Startup & Make in India, private agencies like venture capitalists:/angel investors and bank for bio entrepreneurship.

UNIT V **9 Hours**

BIO STARTUPS ANDEXPORTS

scope of export business and Legal procedures and registration -Company, bank accounts,IE code and export promotion council, Supply Chain and Shipping Logistics, Statutory and legal requirements for starting a company/venture, Cash flow management, Estimation of income, expenditure, profit, income tax.

FOR FURTHER READING

Government funded start up schemes in india

Total: 45 Hours

Reference(s)

1. Dr. Craig Shimasaki ,Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press; 1 edition, 2014
2. Anas Rasheed , Ipr in Biotechnology, Createspace Independent Pub, 2017.
3. Team PrabhatPrakashan, Government Schemes, Missions, Campaigns and Programmes In India, PrabhatPrakashan; 1 edition, 2018
4. I C Dhingra, MAKE IN INDIA, Cosmos Book Hive; 1 edition, 2016
5. Allen McCarthy, Freight Broker Business Startup: How to Start, Run & Grow a Successful Freight Brokerage Business, CreateSpace Independent Publishing Platform; 1 edition, 2017
6. Yann Aubinand Arnaud Idiart, Export Control Law and Regulations Handbook (Global Trade Law), Wolters Kluwer; 3 edition3rd Edition

18BT703 ENZYME AND PROTEIN ENGINEERING 3 0 0 3

Course Objectives

- To provide students with a basic understanding of classification, nomenclature, mechanism and specificity of enzyme-coenzyme action, extraction, purification and characterization of enzymes
- To understand enzyme immobilization methods , kinetics of free, immobilized and allosteric enzymes
- To learn the stability, dynamics, structure/function relationships, folding of proteins and rational drug design

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Understand and gain knowledge on enzyme, coenzyme and their classification
2. Apply the basic downstream techniques for processing, Production and Purification of enzymes from various sources at an industrial scale
3. Analyze the theoretical and practical aspects of enzyme kinetics for promoting research
4. Analyze the tertiary and quaternary structure of proteins
5. Evaluate the role of structure function relationship of proteins

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3				1								2	
2	1	2	3	2					2		2	2		1	
3	3	3	1											2	
4	2	3	1	1							2	2		1	
5	2	3	3								2	2		1	

UNIT I **9 Hours**

INTRODUCTION TO ENZYMES AND PROTEIN

Nomenclature and Classification of enzymes. Mechanism and specificity of enzyme action - Units for enzyme activity - Coenzymes-Classification, Coenzymes in metabolic pathways, metal-activated enzyme and metalloenzyme; enzymes without cofactors, Abzymes, synzymes, non-protein enzymes and thermophilic enzymes. pH and temperature effect on enzyme activity.

UNIT II **9 Hours**

ENZYMES: EXTRACTION, PURIFICATION AND IMMOBILIZATION

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays, Physical and chemical techniques for enzyme immobilization adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding.

UNIT III **9 Hours**

KINETICS OF ENZYME

Single and multisubstrate enzyme catalysed reaction- MM kinetics-turnover number-catalytic efficiency- ping-pong bi-bi mechanism, random - order mechanism and compulsory order mechanisms; Types of inhibition & models for substrate and product inhibition. Immobilized enzyme kinetics - Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized Enzyme Reactions,

UNIT IV **9 Hours**

PROTEIN ARCHITECTURE AND STRUCTURE

Primary structure: peptide mapping, peptide sequencing -automated Edman method. Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structures, topology diagrams, prediction of substrate binding sites. Tertiary structure: Domains, folding, denaturation and renaturation, Quaternary structure: Modular nature, formation of complexes.

UNIT V **9 Hours**

STRUCTURE-FUNCTION RELATIONSHIP

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors - Membrane proteins: General characteristics, Transmembrane segments, prediction - Immunoglobulins: IgG Light chain and heavy chain architecture - Abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase,

FOR FURTHER READING

TIM barrel structures nucleotide binding folds, prediction of substrate binding sites

Total: 45 Hours

Reference(s)

1. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 1995
2. Chaplin and Bucke, Enzyme Technology, Cambridge University Press, 1990
3. Price and Stevens, Fundamentals of Enzymology, Oxford University Press,
4. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
5. Branden C. and Tooze J., Introduction to Protein Structured 2ndEdition, Garland Publishing, 1999.
6. Creighton T.E. Proteins, 2ndEdition. W.H. Freeman, 1993

18BT704 SYSTEMS BIOLOGY **3 0 0 3**

Course Objectives

- To introduce the bottom-up and top-down design and analysis strategies for systems and synthetic biology
- To expose students to biological networks in cellular process
- To create deeper understanding of systems biological applications and work in computational and wet-lab projects

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the basic concepts and correlate the importance of Systems biology
2. Apply the knowledge of biological molecules in network analysis
3. Analyze the genes and regulatory networks to understand systems biology
4. Analyze the concepts of systems biology with various tools
5. Evaluate systems biology modelling and simulation in biological applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1										1		
2	2	2	1										1		
3	2	2	1					3				2			
4	3	2	1		3							3	1		
5	3	2	1									3	1		

UNIT I **9 Hours**

INTRODUCTION TO SYSTEMS BIOLOGY

Overview of System Biology, Mechanisms of gene expression, Metabolic and signal transduction pathways, enzyme kinetics and thermodynamics, Networks and Motifs, Signaling& Experimental methods in systems biology, Robustness and optimality in Biology

UNIT II **9 Hours**

BIOLOGICAL NETWORKS

Biological networks: metabolic, signaling, regulatory,Network alignment and comparisons, network organization, Designing, simulating and building gene circuits, Genome design and synthesis

UNIT III **9 Hours**

GENE REGULATORY NETWORK

Clustering Coordinately Regulated Genes, Discovering Gene Regulatory Signals, Gene Regulatory Modules and Networks, MicroRNA Regulatory Networks, Gene networks

UNIT IV **9 Hours**

TOOLS IN SYSTEMS BIOLOGY

Flux analysis MFA & FBA, Bottom-up approach, Top-down approach, Computer aided design tools for metabolic engineering (lenera programs, retrosynthesis), Development of a flux theoretical model, correlation of the model with experimental data

UNIT V **9 Hours**

MODELLING AND APPLICATIONS OF SYSTEMS BIOLOGY

Modelling and simulation of biological cells, Stochastic modelling for systems biology, Applications of systems biology in various platforms.

FOR FURTHER READING

Modelling tools - Artificial neural networks

Total: 45 Hours

Reference(s)

1. Uri Alon, an Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall, 2006.
2. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill, 1986

18BT707 PROJECT WORK I 0 0 6 3

Course Objectives

- To extend knowledge to devise a real time problem and project goals
- To identify the various tasks of the project to determine standard procedures
- To recognize the various procedures for validation of the product and cost effectiveness

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions
2. Improve technical presentation and communication skills
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	2			3					2	1		3
2			2			2					2		1	2	
3			3		2						2		2	2	2
4				2	3	2	2	3					1	1	3
5									3	2			2		

Total: 90 Hours

18BT804 PROJECT WORK II **0 0 18 9**

Course Objectives

- To extend knowledge to devise a real time problem and project goals.
- To identify the various tasks of the project to determine standard procedures
- To recognize the various procedures for validation of the product and cost effectiveness

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions
2. Improve technical presentation and communication skills
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	2			3					2	1		3
2			2			2					2		1	2	
3			3		2						2		2	2	2
4				2	3	2	2	3					1	1	3
5									3	2			2		

Total: 180 Hours

DISCIPLINE ELECTIVES

18BT001 CANCER BIOLOGY 3 0 0 3

Course Objectives

- To Develop in depth knowledge in molecular biology of cancer and to Identify different cancer causing agents in our day to day life
- To Compute about the diagnosis and prevention of cancer and to Assess the recent techniques in cancer treatment
- To Develop new techniques in identification and mitigation of cancer based on high throughput screening

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the fundamentals of cell cycle in cancer formation
2. Analyze the signaling pathways in cancer causing genes
3. Analyze the relationship between genes and cancer
4. Evaluate the recent advancements in cancer diagnosis
5. Create new strategies for the treatment of cancer

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2						2							
2	1	3						2						1	
3	1			3				2						1	
4					3		2	2				2			1
5					3			2				2			1

UNIT I **9 Hours**

FUNDAMENTALS OF CELL CYCLE AND CANCER

Mitosis, Regulation of cell cycle - Check points, Cell proliferation and Apoptosis, Theory and mechanism of carcinogenesis- Chemical, physical & radiation carcinogenesis, Causes of cancer - Radiation, Stress, Tobacco, alcohol & coffee/Tea

UNIT II **9 Hours**

BIOLOGY OF CANCER

Effects on receptor, signal switches, signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, mechanism of oncogenes activation, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity; tumor suppressor genes - Rb, p53, APC, BRCA paradigms; Telomerases

UNIT III **9 Hours**

PRINCIPLES OF CANCER METASTASIS

Mechanism of spread; Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion; Angiogenesis

UNIT IV **9 Hours**

CANCER DETECTION

Cancer detection: Detection using biochemical assays and molecular; Different types of tumour markers, tumour imaging and molecular imaging, Gene expression profiling, Diagnostics- Imaging (MRI, PET) & Biopsy.

UNIT V **9 Hours**

CANCER THERAPY

Therapy forms surgery, chemotherapy & radiation, Hyperthermia and magnetic hyperthermia: basic principle with examples, advantages and limitations New approaches of cancer therapy: Monoclonal antibodies, vaccines, gene therapy, Stem cell therapy

FOR FURTHER READING

Survival rate of different cancer, Life style and its consequences for cancer, Growth factors related to transformation, Recent approaches to identify key factors controlling metastasis

Total: 45 Hours

Reference(s)

1. Pelengaris S and Khan M., The Molecular Biology of cancer, Blackwell Scientific Publications, Oxford, 2006
2. Robin Hesketh, Introduction to Cancer Biology, Cambridge University Press, 2013
3. Kufe, DW, Pollock, RE, Weichselbaum, RR, Bast R.C., Gansler TS., Holland JF Frei, E, Cancer medicine, 6th Edn, BC Deckker Inc., Toranto, Canada, 2003

18BT002 CELLULAR BIOPHYSICS 3 0 0 3

Course Objectives

- To expose students to the basics of membrane biophysics and molecular electrophysiology
- To learn the mechanism involved in activation and inactivation of ion channels
- To make students learn about the patch clamping technique

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the fundamentals of electrophysiology in cellular biophysics.
2. Analyze the electrophysiology in cellular behavior.
3. Analyze ion channel behavior and its characterization.
4. Evaluate the role of ion channels in cell communication.
5. Create the techniques in the electrophysiology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1												
2	2	3	3										1		
3	2	2	3										1		
4	2	3	3										1		
5	3	3	3										1		

UNIT I **9 Hours**

INTRODUCTION

Basic structure and composition of membrane, The resting membrane potential, Donnan equilibrium, GHK, Ohm's law, electric fields, potentials, I-V curves, Ion transport system overview

UNIT II **9 Hours**

ION CHANNEL STRUCTURE AND GATING FUNCTION

Structure of Ion Channels, Common elements organized to make specific function, Protein structure and pore formation, Control of channel function, voltage activation, ligand activation, signaling, gating kinetics, Ion selectivity

UNIT III **9 Hours**

ION CHANNEL TYPES AND CHARACTERIZATION

Channel types, structure and function, same channels in different cell types, Molecular biology in ion channels, Channelopathies

UNIT IV **9 Hours**

NEURON SYNAPSE, SYNAPTIC PLASTICITY

Structure of the synapse, electrochemical transduction, Postsynaptic integration and information processing, cardiac cell-to-cell communication, Gap junction structure and function.

UNIT V **9 Hours**

EXPERIMENTAL METHODS IN ELECTROPHYSIOLOGY

Voltage Clamp, Patch Clamp, Current Clamp, EKG, Single channel and whole cell experiments

FOR FURTHER READING

Molecular structure of biological systems, Energetics & Dynamics of Biological systems

Total: 45 Hours

Reference(s)

1. Antonio Zaza and Michael R. Rosen An Introduction to Cardiac Electrophysiology, Harwood Academic Publishers, 2000
2. Berul C and Towbin Jeffrey A, Molecular Genetics of Cardiac Electrophysiology, Springer, 2000.
3. BertiHille, Ion channel of Excitable Membranes, Sinauer Associates, 3rd edition edition, 2001

18BT003 METABOLIC ENGINEERING 3 0 0 3

Course Objectives

- To introduce the basic concepts of metabolic engineering
- To expose transport mechanisms and models to regulate enzymes
- To utilize the tools used for metabolic pathway manipulation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instruction**s.**
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the cellular metabolism in growth regulation.
2. Analyze the metabolic engineering in field of biotechnology.
3. Analyze the scheme of regulatory pathways.
4. Evaluate the tools used in metabolic engineering.
5. Evaluate the strategies used in metabolic pathway manipulation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3									3				1	
2	2		2							3				2	
3	1		2							3				1	
4			2	2		3	2	2						2	
5				2		3	2	2							

UNIT I **9 Hours**

OVERVIEW OF CELLULAR METABOLISM

Transport processes, Fueling Reactions, Biosynthetic reactions, Polymerisation, growth energetics.

UNIT II **9 Hours**

INTRODUCTION TO METABOLIC ENGINEERING

Importance of metabolic engineering; Concept of metabolic pathway synthesis; Central Metabolism: Fueling metabolism, Supply of biomass precursors, Anabolism, Anaplerosis. Need for pathway synthesis, Paradigm shift; Information resources; Scope and future of metabolic engineering; Methods for metabolic characterization.

UNIT III **9 Hours**

REGULATION OF METABOLIC PATHWAY

Regulation of Enzymatic Activity, Regulation of Enzyme concentration, Regulation at whole cell level, Regulation of Metabolic networks, Transport mechanisms and their models, Mechanisms and their dynamic representation

UNIT IV **9 Hours**

TOOLS IN METABOLIC ENGINEERING

Metabolic flux analysis (MFA), Methods for MFA - Metabolite Balancing, Tracer Experiments, MS and NMR in labelling measurement, Metabolic control analysis (MCA), Determination of Flux control coefficients, MCA of Linear and Branched pathways.

UNIT V **9 Hours**

METABOLIC PATHWAY MANIPULATION

Enhancement of product yield and productivity, Extension of substrate range, Extension of product spectrum and novel products, Improved cellular properties, metabolic pathway synthesis - case study: lysine biosynthesis, Synthetic biology in metabolic engineering - heterologous pathway modification yeast, genome-wide analysis and engineering.

FOR FURTHER READING

Thermodynamic principles; Productivity; Enzyme kinetics; Applications of MFA and MCA; Xenobiotics degradation.

Total: 45 Hours

Reference(s)

1. G.N. Stephanopoulos, A.A. Aristidou, J. Nielsen: Metabolic Engineering. Principles and Methodologies. Academic Press, 1998
2. S. Y. Lee & E.T. Papoutsakis, Metabolic Engineering, Marcel Dekker, New York, 1999.
3. R.Heinrich and S. Schuster, The Regulation of Cellular Systems, Chapman & Hall, 1996
4. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill, 1986

18BT004 BIOPOLYMERS 3 0 0 3

Course Objectives

- To know what are biopolymers, their classification and potential applications
- To expose how biopolymers help in the development of the next generation of materials, products, and processes
- To facilitate the students to undertake research work both for improving /modifying their functional properties and to develop new products and processes

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
c.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the properties and structure to classify the biopolymers
2. Analyze the synthesis of nucleic acid, proteins and polysaccharides in bioploymers
3. Analyze the synthesis and compare the uses of polyesters and polyisoprenoids
4. Evaluate the synthetic biodegradable polymers for various applications
5. Create animal and plant fibers for textile and composite applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2		3	2								3	
2	2	3		3		3								2	
3	1	3		2	3									2	
4	2	3		2	2									3	
5	2		1	2			3							1	

UNIT I **9 Hours**

CLASSIFICATION AND STRUCTURE

Biopolymer/bio-macromolecule-definition and history, different methods of classification, structure, formation, modification-blending, grafting -properties, characterization- molecular weight, glass transition , amorphous and crystalline behavior, mechanical properties, thermal, bio and photo-degradation and applications, Confirmations and Dynamics of biopolymers

UNIT II **9 Hours**

POLYNUCLEOTIDES, POLYAMIDES AND POLYSACCHARIDES

Polynucleotides- DNA, RNA, protein- chemical synthesis-Collagen, casein, pectin, albumin and polysaccharides-synthesis/biosynthesis, structure and applications of important members under each class

UNIT III **9 Hours**

POLYESTER, POLYISOPRENOIDS AND POLYPHOSPHATES

Poly(hydroxyalkanoates), cutan, cutin, poly(hydroxyl butyrate-co-hydroxy valerate) , polyisoprenoids and polyphosphate-Structure, synthesis and specific uses with example

UNIT IV **9 Hours**

SYNTHETIC BIOPOLYMERS AND POLYMER HYDROGELS

Synthetic biodegradable polymers-Introduction, applications, and chemical synthesis of important members, biopolymer membrane preparation, characterization and copolymers of lactic, glycolic acid etc, poly (alpha amino acids), polyethylene glycol, polycaprolactone

UNIT V **9 Hours**

NATURAL FIBERS AND THEIR COMPOSITES

Silk, wool, flax, jute, linen, cotton,sisal, bamboo, pineapple leaf and oil palm fibers, kneaf, and industrial hemp, properties, applications , property improvement by biochemical treatment . Wood a composite material, Biocomposites- formation, properties and applications

FURTHER READING

Polymerization methods, molecular weight by GPC, Lignin, gums , resins, environmental effects of biopolymers, sugar based biopolymers

Total: 45 Hours

Reference(s)

1. R.M. Johnson, R. M. Mwaikambo, L. Y., Tucker, N. Biopolymers, Rapra Technology 2003
2. Richard Wool., and Susan Sun, X (Eds)., Biobased polymers and composites, Academic Press 2005
3. Alexander Steinbucghel (Ed.)Encyclopedia of Biopolymers, Vols.1-10, Wiley-VCH 2004
4. Platt K., Biodegradable polymers, Rapra Technology 2006
5. Biopolymers(New Materials for Sustainable Films and Coatings), Wiley, 2011

18BT005 BIOSENSORS 3 0 0 3

Course Objectives

- To understand the principle, operations and classification of biosensors
- To introduce transducers and physiological property measurement using biosensor
- To investigate the applications of biosensors in various fields

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the electrode system to create a biosensor.
2. Analyze the design of transducer for construction of biosensor.
3. Analyze the bio selective materials and its application for construction of biosensor.
4. Evaluate the bio membrane for biosensor fabrications.
5. Create the biosensor for the Industrial, analytical, medical and environmental applicationn

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	1	2			2						2		
2		2	1	2			2	2					3		
3		3	2	2			3		2				2		
4		3	2	2			3			2			1		
5		3	2	2			3								

UNIT I **9 Hours**

ELECTROCHEMISTRY - CLASSIFICATION AND OPERATION

Electrochemistry single electrode potential- Nernst equation Tafel plot. Desired characteristics of biosensors: reliability, simplicity, cost, and related parameters. Classification and components of Biosensor. Types of enzyme electrodes. Advantages and limitations, biocatalysis based biosensors.

UNIT II **9 Hours**

TRANSDUCERS IN BIOSENSORS

Types of transducers, principles and applications - Calorimetric, acoustic, optical (absorption, fluorescence, bio/chemiluminescence, surface Plasmon resonance (SPR)), potentiometric / amperometric, conductrometric / resistor metric, piezoelectric, semiconductor - ion sensitive field effect transistor (ISFET), enzyme field effect transistor (ENFET)

UNIT III **9 Hours**

BIOSELECTIVE LAYERS

Bioselective layers: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Microbial metabolism; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors

UNIT IV **9 Hours**

BIO MEMBRANES FABRICATION

Design of micro fluid flow systems that interface with biosensors. Different assay types (Displacement, competitive, sandwich, and direct). Biosensor fabrication methods: self-assembled monolayers, Screen printing, photolithography, micro contact printing; Micro-electromechanical system (MEMS).

UNIT V **9 Hours**

BIOSENSOR ENGINEERING AND APPLICATIONS

Applications- Case studies Glucose, urea and cholesterol biosensors. Implantable sensors for long-term monitoring, Drug development and detection; Industrial on-line monitoring, Environmental monitoring; Technological process control; veterinary, agriculture, Food quality control

FOR FURTHER READING

Biochips and biosensor arrays; Problems and limitations. Ink-jet dispensing and micro stamp printing, engineering concepts for mass production

Total: 45 Hours

Reference(s)

1. Ursula Spichiger-Keller, Chemical Sensors and Biosensors for Medical and Biological Applications, Wiley-VCH, 1998
2. D. A. Skoog, F. J. Holler and Nieman A. Timorthy, Principles of Instrumental analysis, 6th edition, 2006.
3. D. G. Buerk, Biosensors: Theory and Applications, Technomic, Lancaster, 1993.
4. Jon Cooper and Tony cass, Biosensors, Oxford University Press, 2004.

18BT006 BIOMATERIALS 3 0 0 3

Course Objectives

- Summarize the classification of biomaterial, their bulk and surface properties and characterization to prepare the students to find a place in biomedical field
- Interpret the various manufacturing processes and testing, cost, sterilization, packaging and regulatory issues of biomaterials.
- Motivate and facilitate students to undertake projects and research work in Biomaterials.

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds.

Course Outcomes (COs)

1. Apply the fundamental principals in biomedical engineering, material science and chemistry, and how they contribute to biomaterial development and performance.
2. Analyze the knowledge of different characterization techniques in biomaterial fabrication..
3. Analyze the math, science, and engineering knowledge gained in the course to biomaterial selection and design.
4. Evaluate the need of tissue replacement implants in organ regeneration.
5. Create the need of different tissue replacement substitutes in regenerative medicine .

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		1	2	2						2			2		
2		2	3	3			2		2	2			2		
3		2	2	2						2			1		
4		1	2	2				2		2			2		

5		2	3	3				3		2			1		

UNIT I **9 Hours**

INTRODUCTION

Basic concepts: General overview of components in the human body used to construct tissue. Implantable materials: temporary or permanent implants, biodegradable materials, cell substrates, tailored tissue.

UNIT II **9 Hours**

CLASSIFICATION OF BIOMATERIALS

Metals: different types, properties and interaction with the tissue, Polymers: classification and properties, Ceramics: Types, properties and interactions with the tissue, Composites: matrix and reinforcing agents/fillers and properties

UNIT III **9 Hours**

BIOMATERIAL CHARACTERIZATION

Bulk Characterization: XRD, FT-IR, SEM, X-ray (EDX), DSC, TGA, AFM, Surface modifications, Sterilization of biomedical implants. Cell-biomaterial interactions: ECM components, cellular interaction with non-cellular substrates

UNIT IV **9 Hours**

BIOMATERIAL COMPATIBILITY

Biocompatibility: blood and tissue compatibility; degradation of biomaterials in biological environment, toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests; In vitro and In vivo testing, implant associated infections.

UNIT V **9 Hours**

BIOMATERIALS IN MEDICINE

Tissue replacements, wound dressings and sutures, surgical tapes, adhesives and sealants, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, Joint replacements, implants for bone regeneration, Artificial heart, prosthetic cardiac valves

Total: 45 Hours

Reference(s)

1. D. Shi , Ed., Biomaterials and Tissue Engineering, Berlin, New York: Springer, 2004
2. B. Joon Park, D.B. Joseph and Boca Ration, Biomaterials: principles and applications, CRC, press, 2003.
3. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering, Woodhead Publishing in Materials, 2002.
4. Ratner, B. D., et al, (eds.), Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2004

18BT007 STEM CELL TECHNOLOGY 3 0 0 3

Course Objectives

- To gain knowledge on the basics of stem cells and their origin
- To learn the methods of stem cell identification and various sources
- To give way to the therapeutic treatment using stem cells

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the characteristics of different types of stem cells and their origin in field of biotechnology.
2. Analyze the differentiation process of premature stem cells.
3. Analyze the characteristic features of Embryonic and adult stem cells.
4. Evaluate the methods of stem cell identification and various sources.
5. Create the therapeutic applications of stem cells in human diseases.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1			2		1							1		
2	2			2		2				1	2				2
3	2			2	2	2				2	2		2		2
4	2			1	2					1	1		1		2
5	1			1	1	1				2	2		1		

UNIT I **9 Hours**

INTRODUCTION TO STEM CELL

Introduction to stem cells; Stem cell niche - embroyonic stem cells, hematepoitic stem cells, bone marrow stem cells, germline stem cells, cancer stem cells, neural stem cells, adult stem cells, muscle and cardiac stem cell; Properties potency and self renewal Epigenetics

UNIT II **9 Hours**

DIFFERENTIATION OF STEM CELLS

Differentiation status of cells - Primordial germ cell, Skin cell, Gastrointestinal cells; Embryonic stem cell differentiation as a model to study haematopoetic cell development. Endothelial cell development

UNIT III **9 Hours**

GENERATION OF STEM CELLS

Testing and generation of embryonic stem cells; testing for adult stem cells and differentiation. Animal models of regeneration

UNIT IV **9 Hours**

MANIPULATION OF EMBRYONIC STEM CELLS

Integration of transgenes into a defined locus in human embryonic stem cells; Genetic manipulation of embryonic stem cells; Genetic manipulation through DNA delivery by electroporation, , chemical-based reagents and viruses Nucleofection

UNIT V **9 Hours**

APPLICATIONS OF STEM CELLS

Uses of Stem cells; Human stem cells; Renewal of stem cells; Stem cells and Tissue engineering; Embryonic stem cells and Gene therapy; Therapeutic Cloning

FOR FURTHER READING

Ethical issues associated with stem cell research

Total: 45 Hours

Reference(s)

1. MD. Steward Sell, Stem cells, Human Press Inc., 2004
2. Ariff Bongso and Eng Hin Lee, Stem cells, World Scientific Publication Co. Pvt. Ltd., 2005.
3. Robert Paul Lanza, Essentials of stem cell biology, Academic Press, 2006
4. Harvey F. Lodish, Arnold Berk and Chris A. Kaiser, Molecular cell Biology, W. H. Freeman and Co., 2008.

18BT008 GENOMICS AND PROTEOMICS 3 0 0 3

Course Objectives

- To understand the background of genomes and proteomes used in providing new insights in biotechnologytools
- To explore the genome and protein sequence analysis and determination.
- To formulate genome-related hypothesis and design an experimental plan for testing and analysis.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the concepts of genomes and proteomes in Biotechnology..
2. Apply the knowledge of genomic approaches in Biotechnology.
3. Analyze the proteomic approaches for Biotechnology applications.
4. Evaluate the advanced genome-proteome based concepts.
5. Create genome and proteomic approaches in systems biology and other medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1										1		
2	2	2	1										2		
3	2	2	1										1		
4	3	2	1										2		
5	3	2	1												

UNIT I **9 Hours**

INTRODUCTION

Introduction to genomes, transcriptomes and proteomes; Organisation and structure of genomes; DNA sequencing methods; Recombinant DNA technology; Human genome project; Overview of Protein structure; Introduction to omics: Genomics, Proteomics, Transcriptomics, Metabolomics, Fluxomics

UNIT II **9 Hours**

GENOMICS

Introduction and scope of genomics, Next generation sequencing methods, Genetic Mapping, Physical Mapping, Integration of mapping methods, Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), Gene-disease association, Polymorphism, Social, Legal and Ethical Implications of Human Genome Research

UNIT III **9 Hours**

PROTEOMICS

Introduction and scope of proteomics, Protein separation techniques: ion-exchange, size-exclusion and affinity chromatography techniques, Polyacrylamide gel electrophoresis, Isoelectric focusing (IEF), Two dimensional PAGE for proteome analysis, Introduction to mass spectrometry, Protein sequencing, Protein modifications and proteomics

UNIT IV **9 Hours**

ADVANCED PROTEOMICS AND GEMOMICS

Comparative genomics, Functional genomics, Structural genomics, Personal Genomics, Protein engineering, DNA and Protein chips, Functional proteomics, Quantitative proteomics, Structural proteomics, DNA Protein interactions, Protein Protein interactions, HTP Analysis

UNIT V **9 Hours**

APPLICATIONS OF GENOMICS AND PROTEOMICS

Systems and Synthetic biology, Genomics based drug design, Predictive Medicine, Cytogenomics, Clinical and biomedical application of proteomics, Applications of proteome analysis to drug

FOR FURTHER READING

Protein chip technologies - drug designing

Total: 45 Hours

Reference(s)

1. T.A. Brown, Genomes 3, Garland Science, 2007.
2. D.C. Libeler, Introduction to Proteomics: Tools for the New Biology, Humana Press, 2006
3. Arthur M. Lesk, Introduction to Protein Science- Architecture, Function and Genomics, Oxford University Press, 2004.
4. Peter Sudbery, Human Molecular genetics, Benjamin-Cummings Publishing Company, 2010
5. S. R Pennington, and M.J. Dunn, Proteomics: from Protein Sequence to Function First, Viva Books Private Limited, 2002
6. S.B Primrose and R.M Twyman, Principles of Genome Analysis and Genomics, Blackwell Publishing Co., 2005

18BT009 PHARMACOVIGILANCE 3 0 0 3

Course Objectives

- To understand the basic terms used in pharmacovigilance
- To apply the basic concepts and methods to generate safety data during pre clinical, clinical and post approval phases of drugs' life cycle
- To analyze case studies and the differences in Indian and global pharmacovigilance requirements.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the basic concepts and principles of pharmacovigilance in pharmaceutical products.
2. Apply the international guidance, legal and regulatory principles applicable to safety surveillance regulatory requirements in production of drugs.
3. Analyze the international classification of disease and drugs.
4. Evaluate the methods involved in pharmacovigilance investigation.
5. Create the Indian and global pharmacovigilance programmes Articulation Matrix

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3			1											
2	2			3				3		1				2	
3	1			3	1			3						2	
4				2	2							1		1	
5					3					2					

UNIT I **9 Hours**

BASIC CONCEPTS OF PHARMACOVIGILANCE

History and development of Pharmacovigilance, Importance of safety monitoring of Medicine, WHO international drug monitoring programme, Definitions and classification of ADRs,Detection and reporting, Methods in Causality assessment, Severity and seriousness assessment, Predictability and preventability assessment, Management of adverse drug reactions.

UNIT II **9 Hours**

LAWS, REGULATIONS AND GUIDELINES OF PHARMACOVIGILANCE

ICH guidelines, FDA regulations and guidelines, EU regulations and guidelines, laws, legal cases and legislations on drug safety, role of preclinical safety studies in drug development, non-clinical safety evaluation and adverse events in phase I trials, safety reporting requirements in pre-marketing phase, ethical and societal considerations.

UNIT III **9 Hours**

DRUG DICTIONARIES AND CODING IN PHARMACOVIGILANCE

Anatomical, therapeutic and chemical classification of drugs, International classification of diseases, Daily defined doses, International Non proprietary Names for drugs, WHO adverse reaction terminologies, MedDRA and Standardised MedDRAqueries, WHO drug dictionary, Eudravigilance medicinal product dictionary, Basic drug information resources, Specialised resources for ADRs.

UNIT IV **9 Hours**

PHARMACOVIGILANCE METHODS

Passive surveillance-Spontaneous reports and case series Stimulated reporting, Active surveillance- Sentinel sites, drug event monitoring and registries, Comparative observational studies- Cross sectional study, case control study and cohort study Targeted clinical investigations.

UNIT V **9 Hours**

PHARMACOGENOMICS AND PHARMACOVIGILANCE

Pharmacogenomics of adverse drug reactions, genetics related ADR with example focusing PK parameters, drug safety evaluation in special population - Paediatrics, Pregnancy and lactation, geriatrics, CIOMS working groups, CIOMS form, CDSCO (India) and Pharmacovigilance, D&C Act and Schedule Y, differences in Indian and global pharmacovigilance requirements.

FOR FURTHER READING

Safety risks in new technologies and products - Biosimilars, biomarkers, combination products, etc.

Total: 45 Hours

Reference(s)

1. Elizabeth B. Andrews and Nicholas Moore (eds.). Mann's Pharmacovigilance, 3rd Edition, Wiley-Blackwell, 2014.
2. Klepper M. J. and Barton Cobert, Drug Safety Data: How to Analyze, Summarize and Interpret to Determine Risk, Jones & Bartlett Publishers, 2011
3. Waller P, An Introduction to Pharmacovigilance, 1st Edition, Wiley-Blackwell, 2009.
4. Gupta S. K (eds). Textbook of Pharmacovigilance, 1st Edition, Jaypee Brothers Medical Publishers (P) Ltd., 2011.
5. Mohanta G. P. and P. K. Manna. A Textbook of Pharmacovigilance: Concept and Practice, PharmaMed Press, 2015.

18BT010 VACCINE TECHNOLOGY 3 0 0 3

Course Objectives

- To study the various forms of vaccines
- To learn the techniques of vaccine production and their delivery methods
- To give an exposure on the regulatory and biosafety measures of vaccine

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the principle of vaccination in the immunization processes
2. Analyze the types of vaccines and their applications.
3. Analyze the vaccine purification, preservation and formulation techniques.
4. Evaluate the advanced methods of vaccine delivery
5. Create the quality measures and regulatory issues concerned with vaccine production

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1					2							
2		1	2	3								3		2	
3				3	2							3		1	
4				2	3										1
5			2			3		3				3			1

UNIT I **9 Hours**

INTRODUCTION

Vaccines - definition, History of vaccine development, requirements for immunity, Basics of immunization- Epitopes, linear and conformational epitopes, characterisation and location of APC, MHC and immunogenicity; immunization programs and role of WHO in immunization programs

UNIT II **9 Hours**

TYPES AND METHODS OF APPLICATION

Active and passive immunization; Viral/bacterial/parasite vaccine differences, methods of vaccine preparation - Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, edible vaccines, reverse vaccinology, combination vaccines, therapeutic vaccines; Peptide vaccines,conjugate vaccines; Cell based vaccines. Uses of nanoparticles in vaccine application. Reverse Vaccinology.

UNIT III **9 Hours**

TECHNIQUES IN VACCINE PRODUCTION

Purification, preservation and formulation techniques. Commercial production of DPT, TT, polio, rabies and hepatitis vaccines.

UNIT IV **9 Hours**

DELIVERY METHODS

Needle free Vaccine delivery, ISCOMS, Adjuvant delivery systems, Intranasal and inhaled vaccine delivery, liquid jet and solid dose injectors, development of gene-based vectors.

UNIT V **9 Hours**

REGULATORY AND BIOSAFETY MEASURES

Quality assurance in vaccine production. Regulatory issues - Environmental concerns with the use of recombinant vaccines - Disease security and biosecurity principles and OIE guidelines.

FOR FURTHER READING

Principles of vaccination, Peptide vaccines, Commercial production of malarial vaccine, Delivery of immunogens through microsperes, Biosafety aspects of vaccine production.

Total: 45 Hours

Reference(s)

1. P. Ramadass, Animal Biotechnology - Recent concepts and Developments, MJP Publications, 2008.
2. T. J. Kindt, R. A. Goldsby, B. A. Osborne and J. Kuby, Kuby Immunology, W.H. Freeman & company, 2007.
3. S. A. Plotkin, W. A. Orenstein and P. A. Offit, Vaccines, W B Saunders Company, 2012.
4. Cheryl Barton, Advances in Vaccine Technology and Delivery, Espicom Business Intelligence, 2009.
5. Ronald W. Ellis, New Vaccine Technologies, Landes Bioscience, 2001.

18BT011 MOLECULAR MODELLING AND DRUG DESIGN **3 0 0 3**

Course Objectives

- Interpret the basic concepts in the field of drug design followed by advanced methodology in the molecular aspects of drug design.
- Apply modelling tools and docking programme for predicting the three- dimensional structure of biomolecules
- Analyze how drugs interact with macromolecules and strategies used in designing novel drugs and prodrugs

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the molecular pathways in modeling and drug design.
2. Apply the various computational simulation methods to analyze the result of simulation and estimating errors
3. Analyze the new molecules with therapeutic values.
4. Evaluate the development of new biomolecules by modification.
5. Create new lead molecules in drug design.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3		2	1						2				2	
2	2		2	1	3					2				2	
3	2		2	2	3			3						3	
4	1		2	1	3				3					3	
5	1		2	1	3	2			3	2				1	

UNIT I **9 Hours**

EMPIRICAL FORCE FIELDS MOLECULAR MECHANISM

Bond Stretching -Angle Bending- Torsional terms - Out plane bonding motions - Electrostatic interactions - Van der Waals interactions - Effective pair Potentials -Hydrogen Bonding - Simulation of liquid water.

UNIT II **9 Hours**

COMPUTER SIMULATION METHODS

Calculation of thermodynamic properties - Phase space -Practical aspects pf computer simulation - Boundaries monitoring Equilibrium - Long range Process - Analyzing result of simulation and estimating errors.

UNIT III **9 Hours**

MOLECULAR DYNAMICS SIMULATION METHODS

Molecular Dynamics using simple modules - Molecular Dynamics with continuous potentials - Running Molecular Dynamics simulation -Constant dynamics - Time dependent properties - Molecular Dynamics at constant temperature and pressure - Monte Carlo simulation methods.

UNIT IV **9 Hours**

METROPOLIS METHODS

Monte Carlo simulation of molecules - Monte Carlo simulation of polymers - Calculating chemical potentials - Monte Carlo or Molecular Dynamics, Molecular modeling to discover and design new molecules.

UNIT V **9 Hours**

MOLECULAR MODELING IN DRUG DISCOVERY

Deriving and using 3D Pharmacophores - Molecular docking -Structure Based methods to identify lead components- De novo ligand design.

FOR FURTHER READING

Database searching, Simulations for conformational analysis, Comparative Modeling

Total: 45 Hours

Reference(s)

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001
2. R.Leach - Molecular Modeling Principles and Application, 2nd edition, Longman Publications, 1996
3. Burkert U and Allinger NL, Molecular Mechanics, ACS Monograph 177. Washington D.C., American Chemical Society, 1982
4. McCammon J A. and Harvey S C, Dynamics of Proteins and Nucleic Acids, Cambridge University Press, 1987
5. Hans Pieter H and Folkens G, Molecular Modelling, VCH, 1999

18BT012 MOLECULAR PATHOGENESIS AND DISEASE DIAGNOSIS

3 0 0 3

Course Objectives

- To familiarize students about pathogen and zoonotic diseases
- To attain fundamental knowledge on host defense mechanism and host pathogen interaction
- To explain the methods involved in diagnosis of diseases.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Apply molecular techniques to identify various pathogens and zoonotic diseases.
2. Apply the host defense mechanisms against pathogens.
3. Analyze the virulence factors and toxins in pathogenicity.
4. Evaluate the host pathogen interaction.
5. Create modern approaches of disease diagnosis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1			1				2		2				2	
2	1			2				2						1	
3	2			3				2							
4	2			3				2		2				2	
5	1			3				2	3						

UNIT I **9 Hours**

PATHOGEN AND ZOONOTIC DISEASES

Pathogens; Attributes and component of microbial pathogenicity; Pathogen types and mode of entry; Robert Koch postulates; General disease symptoms; Microbial Zoonosis and diseases- HUS, MRSA, Leptospirosis, Salmonellosis; Swine flu (H1N1), Avian flu (H5N1).

UNIT II **9 Hours**

HOST DEFENSE MECHANISM AGAINST PATHOGENS

Host natural defense mechanism - humoral and cellular defense mechanisms; Components of host surface defense systems- skin, mucosa, eye, mouth, respiratory tract; Components of systemic defense- tissues and blood; Complements and inflammation process.

UNIT III **9 Hours**

VIRULENCE FACTOR AND TOXIN

Virulence factors; Endo and exo toxins; Colonizing and invasion virulence factors; E. coli pathogens - ETEC, EPEC, EIEC, EHEC, EAEC; Salmonella enterica toxin; Shigella toxin; Vibrio cholerae toxin; Clostridial toxins- C. perfringens, C. botulinum

UNIT IV **9 Hours**

HOST-PATHOGEN INTERACTION

Virulence gene and their regulation; Virulence assays; Cytopathic vs cytotoxic effects; Criteria and tests in identifying virulence factors; Serotyping

UNIT V **9 Hours**

DISEASE DIAGNOSIS

Influenza virus; Diagnosis of disease using immunological methods-EIA, ELISA, Ouchterlony double diffusion, Immunobloting; Diagnosis of disease using molecular methods- PCR, Hybridization, DNA sequencing.

FOR FURTHER READING

Methods to detect genetic diversity and structure in nature population; Emerging microbial diseases; Fungal toxins; Real time PCR, DNA microarray; Recent trends in disease diagnosis, Vaccines

Total: 45 Hours

Reference(s)

1. K. Talaro and A. Talaro, Foundations in Microbiology, W.C. Brown Publishers, 2006.
2. C.A. Janeway and P. T. Travers, Immunobiology, Blackwell J Scientific Publishers, 2004
3. Iglewski B.H and Clark V.L -Molecular basis of Bacterial Pathogenesis, Academic Press, 1990.
4. Peter Williams, Julian Ketley & George Salmond, Methods in Microbiology: Bacterial Pathogenesis, Vol. 27, Academic Press, 1998
5. C.L. Gyles, F.P. John, G. Songer and C. O. Theon, Pathogenesis of Bacterial Infections in Animals, Blackwell Publishers, 2010.
6. Paul Digard, Anthony Nash and R. E. Randall, Molecular Pathogenesis of Virus Infections, Cambridge University Press, 2005

18BT013 BIOLOGICAL SPECTROSCOPY 3 0 0 3

Course Objectives

- To learn the various spectroscopic techniques, the physical principles, experimental and instrumentation techniques
- To use the various atomic and molecular spectroscopic techniques to estimate and analyze the structure and dynamics of biomacromolecules
- The applications of X-ray crystallography, x-ray spectroscopy, mass spectrometry, electron spectroscopy etc in analysis of chemical and crystalline structure, molecular weight of biomolecules.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the concepts of different electronic spectroscopy in biomolecular characterisation.
2. Analyze the basic principles in spectral characterization of biomlecules.
3. Analyze the role of different resonance spectroscopy and its application to biomolecules.
4. Evaluate the role of mass spectroscopy and its application in protein analysis.
5. Create the importance of X ray spectroscopy and electron spectroscopy applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		2	3								2		
2	2	2		3	3								3		
3	2	3		2	3						2	2	2		
4	1	2		3	3						2	2	2		
5	2	2		2	3						2		1		

UNIT I **9 Hours**

ELECTRONIC SPECTROSCOPY

Electronic Energy levels in atoms and molecules- Electronic transitions- Selection rule, properties associated with the transition dipole moments and interaction between them. Absorption range of biological chromophores.d-d transition in transition metals-charge transfer spectra- UV-Vis absoption (atomic & molecular) spectroscopy-Fluorescence spectroscopy-physical basis and biological applications. Atomic Emission spectroscopy (AES) - Polarized light - optical rotation - circular dichroism - Optical rotator dispersion-theory and applications to bimolecules

UNIT II **9 Hours**

INFRA-RED AND RAMAN SPECTROSCOPY

Measurement of Fourier - Transform Infrared spectrum - Physical basis of infrared spectra, Infrared of Polyatomic molecules, biological examples, infrared of oriented samples. Raman spectroscopy- Physical principle, polarization ratio and biological applications.

UNIT III **9 Hours**

RESONANCE SPECTROSCOPY

Nuclear Magnetic Resonance Spectroscopy: Spectral parameters-Intensity-Chemical shifts - spin - spin coupling - line widths, T1 and T2 relaxation mechanisms - nuclear overhauser effect(NOE) - multidimensional nmr spectroscopy - determination of macromolecular structure by NMR - magnetic resonance imaging , NOE in biology , assignment of NMR peaks, studies of Macromolecules, ligand binding, ionisation studies and pH kinetics, molecular motion. Electron Spin Resonance Spectroscopy: Introduction-Resonance condition-measurement-spectral parameters, intensity, g values-spectral anisotropy, time scale of EPR-spin labels, transition metal ions, spins trapping, and applications to biomolecules.

UNIT IV **9 Hours**

MASS SPECTROMETRY

Ion sources- sample introduction - mass analyzers and ion detectors - biomolecule mass sepctrometry - peptide and protein analysis - carbohydrates and small molecules - specific applications., TOF mass spectrometry.

UNIT V **9 Hours**

X-RAY ANALYSIS AND ELECTRON SPECTROSCOPY

Scattering by x- rays - diffraction by a crystal - measuring diffraction pattern - bragg reflection - unit cell - phase problem - anomalous diffraction - determination of crystal structure - X-ray fluorescence, photoelectron spectroscopy (XPS), ultraviolet photo electron spectroscopy (UPS), electron impact spectroscopy and auger electron spectroscopy -physical basis and applications.

FOR FURTHER READING

NMR - magnetic resonance imaging , NOE in biology

Total: 45 Hours

Reference(s)

1. D. Campbell and R. A. Dwek, Biological Spectroscopy, Benjamin Cummins and Company. 1986.
2. P. W. Atkins , Physical Chemistry, Oxford : Oxford University press, 2001
3. G. W. Ewing, Instrumental methods of chemical analysis, McGraw-Hill Book Company, 1985.
4. Jag Mohan., Organic spectroscopy: Principles and Applications, Narosa Publishing House, 2007.
5. P.S. Kalsi , Spectroscopy of organic compounds, New age International Publishers, 2016.

18BT014 BIOPROCESS MODELLING AND SIMULATION

3 0 0 3

Course Objectives

- To introduce the importance of modelling and simulation in bioprocess
- To expose students to mathematical model for modelling a bioprocess
- To create models and simulate bioprocess for improving the quality of process

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

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

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

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

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the principles of bioprocess modeling and simulation in production of bioproducts.
2. Apply the knowledge of mathematical models in biochemical engineering systems.
3. Analyze the modelling for reactors.
4. Analyze the modelling for fermenters
5. Evaluate the application of Superpro Designer, MATLAB and SIMULINK in the bioprocess systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1												
2	2	3	3										1		
3	2	2	3			2			2				1		
4	2	3	3			2			2				1		
5	2	3	3		3	2			2		2		1		

UNIT I **9 Hours**

INTRODUCTION TO MODELING AND SIMULATION

Basic principles of Modeling, definition of Modeling and simulation, Fundamental lawsContinuity equation, energy equation, equation of motion, transport equation, equation of state, Phaseand chemical equilibrium, chemical kinetics, Model building, application of mathematical modeling,scope of coverage

UNIT II **9 Hours**

MODELS FOR BIOCHEMICALENGINEERING SYSTEMS

Models based on Mass, component, energy and force balance: Batch reactors, PFR, CSTR, Gravity flow systems, Reactors in series, Concept of Heated tanks

UNIT III **9 Hours**

MODELING OF REACTORS

Modeling of fermentation Batch reactor, Fed batch reactor, Modeling a continuous culture: Chemostat, Chemostat with recycles, substrate limited growth in Chemostat

UNIT IV **9 Hours**

MODELING OF FERMENTERS

Modeling of suspended growth reactors, activated sludge systems, theory onagitated and sparged bioreactor, tower-aerobic and anaerobic bioreactors

UNIT V **9 Hours**

SUPERPRO DESIGNER, MATLAB AND SIMULINK: APPLICATION INBIOPROCESS SYSTEMS

Introduction to SuperPro Designer for Material and Energy Balance with andwithout reaction. Solving problems using MATLAB by numerical integration, Euler and fourth order RungeKutta methods. Simulation - Simulation of gravity flow tank - Simulation of CSTR in series.

Total: 45 Hours

Reference(s)

1. Luben W.L. Process Modelling Simulation and Control for ChemicalEngineers, McGrawHill, International New York, 1990
2. Franks RGE. Mathematical Modeling in Chemical Engineering, JohnWiley and Sons, Inc., New York, 2004
3. Biquette W.B. Process Dynamics- Modeling analysis with simulation,Prentice Hall; 1 edition January 15, 1998
4. William J. Palm. Introduction to Matlab 7 for Engineers, III, McGrawHill 2005
5. Kenneth J. Beers. Numerical Methods for Chemical Engineering Applications in MATLAB, Massachusetts Institute of Technology,Cambridge University press 2007 edition

18BT015 INTELLECTUAL PROPERTY RIGHTS AND TECHNOLOGY TRANSFER **3 0 0 3**

Course Objectives

- To expose students to the concepts of IPR
- To create proper understanding on patent filing and application
- To make students understand the guidelines involved in technology transfer

Programme Outcomes (POs)

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

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

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

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

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

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the fundamentals of IPR in biotechnology.
2. Analyze the importance of IPR in various aspects of biotechnology..
3. Analyze the procedures involved in patent filing and application.
4. Evaluate the role of agencies involved in technology transfer.
5. Evaluate the funding sources for commercialization of technology.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			3			1		1						1	
2						1	3	2							2
3										3	2			1	
4			2								3				2
5										2	3				1

UNIT I **9 Hours**

INTELLECTUAL PROPERTY

Concepts and fundamentals; Concepts regarding intellectual property (IP), intellectual property protection (IPP) and intellectual property rights (IPR); Economic importance, mechanisms for protection of intellectual property-patents, copyrights, trademark; Factors effecting choice of IP protection; Penalties for violation; Role of IP in pharmaceutical industry; Global ramifications and financial implications.

UNIT II **9 Hours**

TRADE RELATED ASPECTS OF INTELLECTUAL PROPERTY RIGHTS

Intellectual property and international trade; Concept behind WTO, WIPO, GATT, TRIPs, TRIMS and GATS; Protection of plant and animal genetic resources; Biological materials; Gene patenting; Biotechnology / drug related IPR issues; Status in India and other developing countries; Case studies and examples; TRIPS issues on herbal drugs

UNIT III **9 Hours**

PATENT FILING AND PUBLICATION

Filing of a patent application; Precautions before patenting-disclosures / nondisclosures, publication-article / thesis; Patent application-forms and guidelines, fee structure, time frames, jurisdiction aspects; PCT and convention patent applications; International patenting requirement procedures and costs; Financial assistance for patenting- introduction to schemes by NRDC and TIFAC; Publication of patents-gazette of India, status in Europe and US

UNIT IV **9 Hours**

TECHNOLOGY DEVELOPMENT / TRANSFER / COMMERCIALISATION

Drug related technology development; Toxicological studies, bioequivalence (BU), clinical trials-phase-I, phase-II and phase-III; Approved bodies and agencies; Scale-up, semi-commercialization and commercialization-practical aspects and problems; Significance of transfer of technology (TOT), bottlenecks; Managing technology transfer-guidelines for research students, scientists and related personal; TOT agencies inIndia-APCTD, NRDC, TIFAC, BCIL, TBSE/SIDBI; TOT related documentation-confidentialityagreements, licensing, MOUs, legal issues; Challenges for Indian pharmaceutical industry in the context of globalisation of IP

UNIT V **9 Hours**

FUNDING SOURCES FOR COMMERCIALIZATION OF TECHNOLOGY

Preparation of a project report, financial appraisal, business models; GOI schemes and incentives; NRDC, TePP, HGT, TDB schemes. PATSER; Venture capitalists, banks. Incubator concept-case studies with respect to IIT, CCMB and BIT. Documentation and related aspects.

FOR FURTHER READING

IP and ethics-positive and negative aspects of IPP; Societal responsibility; Avoiding unethical practices; Echo-responsibility-economic, social and environmental benefits of modern biotechnology

Total: 45 Hours

Reference(s)

1. Law Relating to Intellectual Property by B.L.Wadhera
2. IPR Handbook for Pharma Students and Researchers by P.Bansal
3. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012)
4. Patent Agent Examination by Sheetal Chopra and Akash Taneja
5. Making Innovation Happen- A simple and Effective Guide to Turning Ideas into Reality by Michael Morgan

6. Making Breakthrough Innovation Happen by PorusMunshi

18BT016 BIOETHICS AND BIOSAFETY 3 0 0 3

Course Objectives

- To get acquainted to the principles of Biosafety and gain knowledge on laboratory safety
- To be aware of research guidelines and handling of microorganisms, plants and animals
- To understand the laws governing patents

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the bioethics with context to modern biotechnology laboratory practices.
2. Apply the concept of IPR in biotechnology products.
3. Analyze the principles of living organisms guidelines.
4. Analyze the process and patenting of biotechnological products.
5. Evaluate the role of international agencies of bioethics and biosafety.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			1			1	1	1							3
2			2			2	2	2							2
3			3			1	3	1							1
4			1			1	1	2							2
5			2			3	2	3							2

UNIT I **9 Hours**

INTERNATIONAL AGENCIES

Introduction. Definitions. General Agreement on Trade and Tariff (GATT) and World Trade Organizations. Establishment and functions of GATT, WTO and WIPO. WTO Guidelines and Summits. Physical and Intellectual Property. Tangible and Intangible property. Roles of IBSC, RCGM and GEAC

UNIT II **9 Hours**

INTELLECTUAL PROPERTY RIGHTS

TRIPS. Different types of intellectual property rights (IPR) - Patents, Trade mark, Trade secret, Copy right and Geographical Indications. Requirement of patentability. Compulsory licences.Biotechnological examples of patent, trademark, trade secret, copy right. Traditional Knowledge

UNIT III **9 Hours**

PATENT FILING

Patent application. Rules governing patents. Patent related cases. Licensing - Flavr Savr tomato as a model case. Biopiracy and case studies on patents (Basmati rice, Turmeric, and Neem). Indian Patent Act, 1970 and recent amendments

UNIT IV **9 Hours**

BIOSAFETY GUIDELINES

Biosafety-Introduction. Different levels of Biosafety. Guidelines for rDNA research activities. General guidelines for research in transgenic plants, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Containments- Types. Basic Laboratory and Maximum Containment Laboratory. Biological weapons. The Cartagena Biosafety protocol (CAB).Assessment of risks associated with GMO

UNIT V **9 Hours**

BIOETHICS GUIDLINES

Bioethics-Introduction. Animal Rights. General issues related to environmental release of transgenic plants, animals and microorganisms. Ethical issues related to research in embryonic stem cell cloning. Ethical, Legal and Social Implications (ELSI) of Human Genome Project.

FOR FURTHER READNG

Containments- Types. Basic Laboratory and Maximum Containment Laboratory. Biological weapons

Total: 45 Hours

Reference(s)

1. Patents (2003), N.Subbaram, Pharma Book Syndicate, Hyderabad
2. Bioethics and Biosafety in Biotechnology (2007), V.Sree Krishna, New Age International (P) Limited Publishers. ISBN (13): 978-81-224-2248-1
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010), 4th Edition, Glick, B.R., and Pasternack, J.J., ASM Press, Washington, DC
4. Introduction to Plant Biotechnology (2001), 3rd Edition, H.S.Chawla, Oxford & IBH Publishing Co. Pvt. Ltd
5. Bioethics and Biosafety (2008) M.K.Sateesh, I.K.International Pvt. Ltd, New Delhi, India

18BT017 BIOREMEDIATION 3 0 0 3

Course Objectives

- To develop fundamental understanding of problems in environment and preservation
- To expose students to ways of pollution and control methods
- To create deeper understanding of Bioremediation and its application

Programme Outcomes (POs)

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

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

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

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

o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the microbial techniques in remediating the environment.
2. Apply the knowledge in solving environmental problems.
3. Analyze the nature of environmental drawbacks.
4. Evaluate the role of biotechnology in nuclear waste management.
5. Create the technology for heavy metal reduction in environment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			1			1	1	1							
2			2			2	2	2							2
3			3			1	3	1							1
4			1			1	1	2							2
5			2			3	2	3							

UNIT I **9 Hours**

INTRODUCTION

Introduction to Bioremediation: Types of Bioremediation, Factors affection Bioremediation .Bioremediation Mechanisms.Limitations of Bioremediations. Microbes for Bioremediation :Essential Chararcteristics of Microbes for Bioremediation, Microbial Adapadation for Adverse conditions. Microbes involved in Bioremediation. Metabolic process involved in bioremediation. Bioremediation Techniques : Insitu & Exsitu bioremediation techniques. Phytoremediation

UNIT II **9 Hours**

SPECIFIC BIOREMEDIATION TECHNOLOGIES

Application, specific advantages and disadvantages of specific bioremediation technologies - land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wet lands, use of bioreactors for bioremediation

UNIT III **9 Hours**

MOLECULAR TECHNIQUES IN BIOREMEDIATION

Bioremediation of phenols, chlorinated phenols, chlorinated aliphatic compounds, heterocyclic compounds, cyanides, dyes; Rhizoremediation: a beneficial plant-microbe interaction; Molecular techniques in bioremediation- Enhanced biodegradation through pathway engineering; Biodegradation of polyhalogenated compounds by genetically engineered bacteria

UNIT IV **9 Hours**

NUCLEAR WASTE BIOREMEDIATION

Spent fuel characterisation, storage and disposal; Partitioning, transmutation and conditioning; Measurement of Radioactivity in the environment; Basic actinide research

UNIT V **9 Hours**

HEAVY METAL AND OIL SPILL BIOREMEDIATION

Heavy metal pollution & sources; Microbial interactions with heavy metals - resistance & tolerance; Microbial transformation; Accumulation and concentration of metals, Biosorption of heavy metals by microbial biomass and secondary metabolites, Biosurfactants. Advantages of biosurfactants over chemical surfactants; Biotechnology and oil spills; Improved oil recovery

FOR FURTHER READING

Microbial transformation; Accumulation and concentration of metals

Total: 45 Hours

Reference(s)

1. Bruce E. Rittmann, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, McGraw-Hill, 2001
2. Phillip L. Buckingham , Jeffrey C. Evans, Hazardous Waste Management, Waveland Pr Inc; Reissue edition 1, 2010
3. S. K. Agarwal, Environmental Biotechnology, APH Publishing, 2000
4. Martin Alexander, Biodegradation & Bioremediation, Academic press, 1999
5. Karrely D., Chakrabarty K., Omen G.S, Biotechnology and Biodegradation, Portfolio Pub. Co., 1990.
6. P. Rajendran, P. Guansekaran, Microbial Bioremediation, Mjp Publishers, 2011

18BT018 BIOMASS AND BIOENERGY 3 0 0 3

Course Objectives

- To introduce the basic concepts, principles, potentials and limitations of biological energy sources
- To introduce various form of energy derivation such as liquid, gas from biological sources
- To know and understand contemporary issues pertaining to the energy and environment

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Apply the composition, properties of biomass and its processing to derive energy.
2. Apply the technology in biogas production and its impact on environment sustainability.
3. Analyze the technology involved in liquid bio-fuels production and analysis their properties.
4. Analyze the various technologies involved in biomass processing.
5. Evaluate the concept of second and third generation of Bioenergy feed stocks and the conversion processes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2		1										
2	1		2		2						1				
3			2		2				2						
4			2		2		1				2				
5	2		3		2										

UNIT I **9 Hours**

BIOMASS TYPES, PROPERTIES AND CONVERSION

Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification. Chemical composition and properties of different biomass materials. Biomass conversion: Thermochemical (pyrolysis, reforming, gasification, hydrothermal conversion, biochemical conversion, combustion), biochemical (anaerobic digestion, fermentation etc) and mechano-chemical conversion. Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass, hydrogen production and biological fuel cell.

UNIT II **9 Hours**

BIOGAS TECHNOLOGY

Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues-. Microbial and biochemical aspects- Operating parameters for biogas production Kinetics and mechanism - Dry and wet fermentation. Digesters for rural application-High rate digesters for industrial waste water treatment

UNIT III **9 Hours**

BIO-ETHANOL AND BIO-DIESEL TECHNOLOGY

Bio- fuels -Production of Fuel Ethanol by Fermentation Of Sugars. Sugar cane molasses and other sources for fermentation ethanol-Sources and processing of oils and fats for liquid fuels. Gasohol as a Substitute for Leaded Petrol. - Trans-Esterification of Oils to Produce Bio-Diesel. Fuel properties - alcohol, biogas, producer gas, vegetable oil. Combustion - air requirement - Octane and Cetane numbers. Analysis of products of combustion. Fuel blending - fuel efficiency in dual fuel operation

UNIT IV **9 Hours**

PYROLYSIS AND GASIFICATION OF BIOMASS

Thermo-chemical conversion of ligno-cellulose biomass - Biomass processing for liquid fuel production - Pyrolysis of biomass-Pyrolysis regime, effect of particle size, temperature, and products obtained. Thermo-chemical gasification principles: Effect of pressure, temperature and of introducing steam and oxygen. Design and operation of Fixed and Fluidized Bed Gasifiers

UNIT V **9 Hours**

COMBUSTION OF BIOMASS AND COGENERATION SYSTEMS

Combustion of Woody Biomass: Theory, Calculations And Design Of Equipments. Cogeneration In Biomass Processing Industries. Case Studies: Combustion of Rice Husk, Use of Bagasse for Cogeneration

FOR FURTHER READING

Solar Energy, wind energy and hydro energy; Alcohol production - cellulose degradation;

Total: 45 Hours

Reference(s)

1. Sunggyu Lee and Y T Shah, Biofuels and Bioenergy- Process and Technology, CRC Press, 2014.
2. VV N Kishore, Renewable energy engineering and technology - principles and practice, TERI Press, New Delhi, 2010
3. Caye M. Drapcho, N.P. Nhuan and T. H. Walker, Biofuels Engineering Process Technology , Mc Graw Hill Publishers, New York, 2008
4. Jonathan R.M, Biofuels - Methods and Protocols (Methods in Molecular Biology Series), Humana Press, New York, 2009

18BT019 WASTE MANAGEMENT AND UTILIZATION 3 0 0 3

Course Objectives

- Understand and apply the basic scientific and sustainability principles behind waste management, for solving practical waste management challenges
- Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of value from waste
- Appreciate the increasing importance of waste and resource management in achieving environmental sustainability

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
o. Conceive, Plan and Deploy societal projects for environmental protection using bio-resources

Course Outcomes (COs)

1. Apply the properties of solid waste and its sources to regulate the waste management systems.
2. Analyze the collection, segregation and processing techniques for solid waste management.
3. Analyze various methods to minimize the waste and suitable treatment methods.
4. Evaluate the laws pertaining to the handling of hazardous waste and the technology for disposal.
5. Create the energy from waste and bio-conversion technologies of waste.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1												
2	2	1	3												1
3	1		2		3		2	2							2
4		1	3			2									1
5				3	2		2	2							2

UNIT I **9 Hours**

INTRODUCTION TO SOLID WASTE

Definition, Sources and engineering classification, characterization, generation and quantification; physical, chemical and biological Properties.Objectives, principles, functional elements of solid waste management system, Regulatory aspects of solid waste management.

UNIT II **9 Hours**

COLLECTION AND PROCESSING TECHNIQUES

Rate of generation, frequency, storage and refuse, collection, Types of waste collection methods, Handling and segregation of wastes at source, Collection (primary & secondary) and storage of municipal solid wastes, collection equipment, transfer stations.

UNIT III **9 Hours**

WASTE MINIMIZATION AND TREATMENT TECHNOLOGIES:

4 R- Refuse processing technologies, recovery, recycle and reuse, case study and guide lines.Refuse processing technologies, Mechanical and thermal volume reduction.Onsite handling,Incineration,pyrolysis, gasification,composting of solid wastes,Land Fill Method of Disposal, Impacts of open dumping, site investigation and selection, sanitary land filling.

UNIT IV **9 Hours**

HAZARDOUS AND BIOMEDICAL WASTE

Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment. Regulatory laws: RCRA, HSWA, CERCLA and SARA .Waste management techniques; land disposal of radioactive elements. Biomedical Waste Handling and management (Rules 2008), sources, treatment and disposal.

UNIT V **9 Hours**

ENERGY GENERATION FROM WASTE

Basics, types, working and typical conversion treatment technologies, Biological and chemical techniques for energy and other resource recovery: composting, vermicomposting, efficiencies of composting, vermin composting , fermentation, anaerobic digestion, factors affecting bio-digestion.bio-mass conversion technologies (wet and dry process), photosynthesis,agricultural waste derived energy, urban waste derived energy.

FOR FURTHER READING

Recent Developments in Solid Wastes Reuse and Disposal, Community based waste management, Waste as a Resource concept, Ground water contamination andremediation, Energy plantation

Total: 45 Hours

Reference(s)

1. L.D. Mackenzie and J.M. Susan, Principles of Environmental Engineering and Science, Mc Graw Hill,2004.
2. R.M. Forbes, R.W. Peter, F. Marina and H. Peter, Integrated Solid Waste Management: A Life CycleInventory, Mc Graw Hill, 2009.
3. Wilber, L.C., (1989), Handbook of Energy Systems Engineering, Wiley and Sons.
4. The Energy Research Institute (TERI), New Delhi, Publications.
5. Rai, G.D , Non-conventional Energy Sources , Khanna Publications.
6. Hazardous waste (management and handling) Rules, 2001 and Biomedical Rules 2008

18BT020 BIODIVERSITY AND BIOPROSPECTING 3 0 0 3

Course Objectives

- To recall the different types of biodiversity across the world.
- To identify the importance of population growth in each taxon and its respective diversity.
- To explain the basic concepts of Bioprospecting with respect to Biodiversity.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply biodiversity concepts in the environmental biotechnology.
2. Analyze the importance of the Population growth and effect of environment on the growth.
3. Analyze the concepts of animal and plant taxonomy.
4. Evaluate the microbial taxonomy and its classification.
5. Create the awareness of bioprospecting with respect to biodiversity.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3					1	2								
2	3					1	2							2	
3	2					1	2							1	
4	2					1	2							1	
5	3					3	2								

UNIT I **9 Hours**

INTRODUCTION

Biodiversity -Types of Biodiversity - Biodiversity as a natural resource - Vegetational Zones -Zones of Faunal distribution - Major Biodiversity areas of the world - Biodiversity Hot Spots - Basic Taxonomy - Types of classification - Classification of bacteria, algae, fungi and plants (major families only) - Classification of Protozoans - Non-chordates (major classes with insects up to orders) and Chordates (major orders).

UNIT II **9 Hours**

ECOLOGY AND EVOLUTIONARY BIOLOGY

Population growth: Growth types and growth models, exponential and logistic models, Effect of environment on population growth - diversity distribution, factors affecting diversity, impact of exotic species. Neo-Darwinism: spontaneous mutation controversy, effects of natural selection on populations, Levels of selection, group selection controversy, selfish gene theory.

UNIT III **9 Hours**

PLANT AND ANIMAL TAXONOMY AND DIVERSITY

Plant Taxonomy - Concept of species, variation - Introduction to major plant groups and evolutionary relationships - History of plant taxonomy - Code of nomenclature - Systems of classification. Animal Taxonomy- Introduction - Principles and rules of Taxonomy, Zoological nomenclature, ICZN regulations - Taxonomical hierarchy (Linnaean hierarchy) - Concepts of Taxon, holotype, paratype, topotype.

UNIT IV **9 Hours**

MICROBIAL TAXONOMY AND DIVERSITY

Microbial diversity: Outline classification of microorganisms. Fungi: Criteria for classification and identification - Types of vegetative forms, Types of spores, fruiting bodies and life cycles - Bacteria: Concept of species - Criteria for classification - Morphology in Actinomycetes, Cyanobacteria and Mycobacteria - Major classes of bacteria. Viruses: Outline classification.

UNIT V **9 Hours**

BIOPROSPECTING

Bioprospecting - Definition- Introduction - Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act- Introduction - Phases of Bioprospecting - Exemption to Act - Fields of Bioprospecting.

Total: 45 Hours

Reference(s)

1. V. N. Naik. Taxonomy of Angiosperms.
2. Heywood. Families of Flowering plants.
3. Pandey. Angiosperms: Taxonomy, Anatomy, Economic Botany & Embryology.
4. Ashlock., Principles of Animal Taxonomy
5. M. Gadgil., A methodology manual for scientific inventorying, monitoring and conservation of Biodiversity.
6. S Ram Reddy and M A Singara Charya -Microbial Diversity: Exploration and Bioprospecting

18BT021 GENETICS 3 0 0 3

Course Objectives

- Impart the principle and pattern of segregation of genes and its characters
- Gain knowledge about the mechanism of crossing over, linkage of genes and identification of genetic material
- Learn about genetic material and genetic transfer

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
n. Design and synthesis of novel bio-molecules for the agricultural and healthcare sectors

Course Outcomes (COs)

1. Apply the principles of Mendels experiment, pattern of segregation of genes and its characters.
2. Apply the mechanism of sex determination, linkages and crossing over.
3. Analyze the structure and function of genetic material.
4. Analyze the mutations and chromosomal Inheritance in life forms.
5. Evaluate the population and evolutionary Genetics.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	3									1		
2	3	1		3									1		
3	3	2		3										2	
4	3	2		3		2								1	
5	3	3		3											

UNIT I **9 Hours**

MENDELIAN GENETICS

Mendels experiment and principle of segregation, monohybrid crosses dominance and recessiveness; principle of independent assortment dihybrid crosses; multiple alleles ABO blood type, Rh factor alleles

UNIT II **9 Hours**

SEX DETERMINATION, LINKAGE AND CROSSING OVER

Mechanism of sex determination, sex differentiation, sex linked inheritance, linkage and crossing over

UNIT III **9 Hours**

GENETIC MATERIAL AND GENETIC TRANSFERTIC TRANSFER

Identification of genetic material by Hersey & Chase, Avery, Mcleod and Fraenkel - Singer experiments; chromosome structure in prokaryotes and eukaryotes, recombination in bacteria - transformation, transduction and conjugation

UNIT IV **9 Hours**

MUTATION AND CHROMOSOMAL INHERITANCE

Mutations - spontaneous, physical and induced; applications of mutation, organization of DNA in mitochondria and plastids, cytoplasmic male sterility in plants

UNIT V **9 Hours**

POPULATION AND EVOLUTIONARY GENETICS

Genetic variation, random mating and Hardy-Weinberg method, inbreeding, outbreeding and assortative mating, genetic equilibrium, evolutionary genetics

FOR FURTHER READING

Genetics in agriculture and medicine, Reverse Genetics, Genetics basis of cancer

Total: 45 Hours

Reference(s)

1. M.J. Simmons and. D.P. Snustad, Principles of Genetics, John Wiley, 2012
2. E.J. Gardner, M.J. Simmons and. D.P. Snustad, Principles of Genetics, John Wiley, 2006
3. H.T. Robert, Principles of Genetics, Tata McGraw Hill, 2002
4. L. Daniel, Hartl and W. Elizabeth, Essential Genetics, Jones and Bartlett publishers, Massachusetts, 2002

OPEN ELECTIVES

18BT0YA BIOFUELS 3 0 0 3

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more ecofriendly options.

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Understand the bio resources that can be used for the production of biofuels.
2. Apply the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Evaluate biofuel conversion technologies and their environmental attributes
5. Design major unit processes/operations of an integrated bio-refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1				2					3					
2	2				2					1					
3	1				1					3					
4	2									3					
5	1									1					

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Transesterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and

characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic .Production of biomethane and biohydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

FOR FURTHER READING

Edible and non-edible oils as fuels - their extraction; Purification - washing and drying options (bubble and mist washing), storage; Comparison of biodiesel with high speed diesel

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007

18BT0YB MUSHROOM CULTIVATION AND VERMICOMPOSTING

3 0 0 3

Course Objectives

- Understand the basic concepts, principles, potentials and limitations of mushroom cultivation and vermiculture techniques
- Apply the active compounds of mushroom for developing a solution for health care problems
- Develop mushroom cultivation and vermiculture skills for entrepreneurial activity

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Understand the active compounds of mushroom in food and pharmaceutical industry.
2. Apply the cultivation techniques for mushroom production.
3. Analyze post-harvest technology to preserve the quality of the product.
4. Evaluate the significance of earthworms in increasing the soil fertility.
5. Execute the techniques of vermicomposting for large scale production and marketing.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1									2					
2					2					3					
3					3					3					
4	3									2					
5	1				2					3					

UNIT I **9 Hours**

INTRODUCTION

Introduction and Importance of mushrooms; History of mushroom cultivation; Present status of mushroom industry in India; Cultivable edible mushroom; Biology of mushroom; Food value of edible mushrooms; Uses of mushrooms, Poisonous mushrooms, and Medicinal mushrooms.

UNIT II **9 Hours**

MUSHROOM CULTIVATION AND BIOLOGICAL IMPORTANCE

Mushrooms farm structure; design and layout; Spawn principles, techniques of spawn production; Principle and techniques of compost and compositing; Cultivation techniques of White button mushroom, oyster mushroom.

UNIT III **9 Hours**

DISEASE AND POST-HARVEST TECHNOLOGY

Management of fungal, bacterial and viral diseases in mushroom; Competitors, pests and nematodes in mushrooms. Post-harvest technology,: Freezing, Dry freezing , Drying, Canning.

UNIT IV **9 Hours**

VERIMICULTURE TECHNOLOGY

Permaculture Technology; organic farming, soil fertility; Distribution and Ecology of Earthworms Earthworm taxonomy -Morphological and Anatomical characteristics of Earthworm -Food habits, excretion and life cycle. Types of Earthworms -Exotic and native species

UNIT V **9 Hours**

METHODS OF VERMICOMPOSTING

Collection and preservation of earthworms for vermicomposting and culturing techniques of earthworms.Preparation of vermicomposting requirement, different methods of Vermicompositing (Heap method, Pot method, and Tray method).Changes during vermin compositing, Nutrient value of Vermicompositing; Problems in vermicomposting preparation; Earthworm as bioreactors. Influence of chemical inputs on earthworms activities. Large scale manufacture of Vermicomposting, packaging; financial supporting (Government and NGOs for vermi culture work)

FOR FURTHER READING

Nutritional value of mushrooms, South Indian and North Indian species used for vermin compositing, Vermicomposting and its marketin

Total: 45 Hours

Reference(s)

1. NPCS Board of Consultants & Engineers, The Complete Technology Book on Vermiculture and Vermicomposting, 2004
2. Keshav Singh, Textbook of Vermicompost: Vermiwash and Biopesticides, 2014
3. Robin Gogoi Yella Rathaiah T R Borah, Mushroom Cultivation Technology, Scientific Publishers, 2006
4. S.C. Tiwari & Pankaj Kapoor, Mushroom Cultivation, 2018

18BT0YC FORENSIC TECHNOLOGY 3 0 0 3

Course Objectives

- To prepare students for entry-level positions in the fields of forensic technology
- To create deeper understanding in forensic science
- To render knowledge of how to perform research in interdisciplinary fields like forensic studies

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Understand the forensic science and crime investigation process
2. Apply the principles and operation of analytical instruments in forensic analysis
3. Analyze various biological samples for forensic studies
4. Evaluate the non biological samples and characterize
5. Relate forensic examination in different levels and documentation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2	3	1								2		
2	2	2	1	2	1								1		
3	2		1	2	1								2		
4	1	2	2	2	3								1		
5	1			2											

UNIT I **9 Hours**

BASICS OF FORENSIC SCIENCE

History and Development; Crime Scene Management and Investigation- Collection, preservation, packing and forwarding of physical and trace evidence for analysis; Legal and Court procedure pertaining to Expert Testimony

UNIT II **9 Hours**

ANALYTICAL INSTRUMENTATION

Microscopy-Polarising, Fluorescent and Electron microscopes; Spectrophotometry- UV, Visible, IR atomic absorption; Chromatographic techniques(TLC, GLC, HPLC); Electrophoresis (Gel and Immunoelectrophoresis.)

UNIT III **9 Hours**

ANALYSIS OF BIOLOGICAL SAMPLES

Fresh Blood-Grouping and typing of fresh blood samples; Analysis of stains of blood and allied body fluids for their groups; Cases of disputed paternity and maternity problems; DNA profiling; Identification of hair, determination of species origin, sex, site and individual identification from hair; Examination and identification of saliva, Urine and Faecal matter.

UNIT IV **9 Hours**

CHARACTERIZATION OF NON BIOLOGICAL SAMPLE

Physical analysis - soil, glass, paints, lacquers, cement, inks, paper, tool marks, tyre marks, shoe prints, forensic examination of vehicles in cases of accident; Identification of individuals from bodily features; Examination and identification of deceased from skeletal remains

UNIT V **9 Hours**

FORENSIC EXAMINATION

Preliminary examination of documents-Identification of hand writing, signatures and detection of forgeries; Reproduction of documents (photographic , mechanical) and their examination; Physical and chemical erasures, obliterations, additions, alterations, indentations, secret writings and charred documents; Inks, papers and their scientific examinations including instrumental analysis

FOR FURTHER READING

Classification and identification of fibers; Identification and individualization from foot prints and teeth; Age of documents- Examination of typescripts; Lifting and examination of fingerprints; Crime records and computerization of fingerprints

Total: 45 Hours

Reference(s)

1. William G. Eckert,Introduction to Forensic Sciences, 2nd Ed. New York: CRC press, 2000.
2. S.H.James, and J.J. Nordby, Forensic Science An Introduction to Scientific and Investigative Techniques. London: CRC Press, 2003
3. B. D Alberts Bray, J. Lewis, K. Roberts and J.D. Watson. Molecular Biology of Cell., 2nd ed. New York: Garland Publishing, 1989
4. Simon, Ball. Environment Law: The Law and Policy Relating to Protection of Environment. Delhi: Universal Law Publishing, 1991

PHYSICS ELECTIVES

18GE0P1 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2													
2	2	1													
3	3	3													
4	2	2													
5	2	1													

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future -classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process - physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- fuel cells - quantum efficiency of semiconductor nanomaterials

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- organic LED: basic processes, carrier injection, excitons, optimization - organic photovoltaic cells- particulate and geometrical nanomagnets-magneto resistance.

Total: 45 Hours

Reference(s)

1. Willam A. Goddard, Donald W.Brenner, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, 2012
2. Charles P. Poole Jr and. Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2007
3. Guozhong Cao, Y. Wang, "Nanostructures and Nanomaterials-Synthesis, Properties & Applications", Imperials College Press, 2011.
4. T. Pradeep, "NANO: The Essentials Understanding Nanoscience and Nanotechnology", McGraw - Hill Education (India) Ltd, 2012
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley and Sons Ltd, 2006
6. Viswanathan B, Aulice Scibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

18GE0P2 SEMICONDUCTOR PHYSICS AND DEVICES 3 0 0 3

Course Objectives

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices
5. Represent the working mechanism of opto-electronic devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	3	2													
3	2	3													
4	2	2													
5	3	3													

UNIT I **9 Hours**

ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

UNIT II **9 Hours**

P-N JUNCTION

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

UNIT III **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor

UNIT IV **9 Hours**

MOSFET

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM

UNIT V **9 Hours**

PHOTONIC DEVICES

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells - efficiency

Total: 45 Hours

Reference(s)

1. Donald A Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, 2012
2. S. M. Sze and M. K. Lee, "Semiconductor Devices, Physics and Technology", John-Wiley & Sons, 2015
3. Ben. G. Streetman and S. K. Banerjee , "Solid State Electronic Devices", Pearson Education Ltd, 2015
4. C. Kittel, "Introduction to Solid State Physics", John-Wiley & Sons, 2012
5. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata McGraw Hill, 2010
6. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006

18GE0P3 APPLIED LASER SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Programme Outcomes (POs)

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

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3													
2	2	3													
3	3	1													
4	3	2													
5	2	1													

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion. Components of lasers - pumping methods - pumping mechanisms - optical resonator

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography.

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting. Lasers in electronics industry: information storage - bar code scanner. Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006.

CHEMISTRY ELECTIVES

18GE0C1 CORROSION SCIENCE AND ENGINEERING 3 0 0 3

Course Objectives

- Understand the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism.
- Apply various methods of corrosion control, corrosion testing and monitoring.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	2						1								
3	1	3													
4	2	2													
5	3	3					1								

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages.

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion. Catastrophic oxidation corrosion.

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filliform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces.

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing and eddy current testing.

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

FOR FURTHER READING

Corrosion issues in supercritical water reactor (SCWR) systems.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2008.
5. David E.J. Talbot (Author), James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.htm

18GE0C2 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Understand the concept, working of different types of batteries and analyze batteries used in electric vehicles.
- Identify the types of fuel cells and to relate the factors of energy and environment.
- Analyze various energy storage devices and fuel cells.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Explain the parameters required for operation of a cell to evaluate the capacity of energy storage devices
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications
3. Differentiate fuel cells based on its construction, production of current and applications
4. Compare different methods of storing hydrogen fuel and its environmental applications
5. Relate energy and environmental based on the importance and types of renewable energy for sustainable development

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1													
2	2	3													
3	3	1													
4	2	2					1								
5	3	3													

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid batery - charge efficiency- charge rate - charge retention - closed circuit voltage, open circuit voltage current density - cycle life - discharge rate-over charge-over discharge.

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries - zinc-carbon, magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries - introduction, cell reactions, cell representations and applications - lead acid, nickel-cadmium and lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide, lithium anode cell, photogalvanic cells. Battery specifications for cars and automobiles.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells - description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate and direct methanol fuel cells.

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen - electrolysis - photocatalytic water splitting - methods of hydrogen storage- high pressurized gas - liquid hydrogen type - metal hydride - hydrogen as engine fuel - features, application of hydrogen technologies in the future - limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second third and fourth generation solar cell - photobiochemical conversion cell.

FOR FURTHER READING

Energy conservation, over utilization, energy demanding activities.

Total: 45 Hours

Reference(s)

1. M. Aulice Scibioh and B. Viswanathan, Fuel Cells: Principles and Applications, University Press, India, 2009.
2. F. Barbir,PEM fuel cells: Theory and practice, Elsevier, Burlington, MA, Academic Press, 2013.
3. M. R. Dell Ronald and A. J. David, Understanding Batteries, Royal Society of Chemistry, 2001.
4. J. S. Newman and K. E. Thomas-Alyea, Electrochemical Systems, Wiley, Hoboken, NJ, 2012.
5. Shripad T. Revankar, Pradip Majumdar, Fuel Cells: Principles, Design, and Analysis, CRC Press, 2016.
6. Thomas B. Reddy, Linden's Handbook of Batteries, 4th Edition, McGraw Hill Professional, 2010

18GE0C3 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers and its processing
- identify suitable polymers for various industrial applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Characterize the polymers to identify the structural, thermal ,mechanical and electrical features for specific applications
4. Apply the polymer processing methods to design polymer products
5. Identify and analyze the polymers used in electronic and biomedical applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	1	2													
3	2	2													
4	1	1					1								
5	1	3					1								

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization – copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides.

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation.

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point. Test for electrical resistance, dielectric constant, dissipation factor, arc resistance and dielectric strength - water absorption.

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion.

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers. Polymer for biomedical applications: artificial organs, controlled drug delivery, hemodialysis and hemofiltration.

FOR FURTHER READING

Biodegradable polymers

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd., New Delhi, 2015.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2007
4. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008
5. George Odian , Principles of Polymerization, John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011

LANGUAGE ELECTIVES

18HSH01 HINDI **1 0 2 2**

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To teach them how to converse in Hindi on simple day- to -day situations

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Construct simple sentences and use vocabulary required for day- to -day cversaontion
2. Distinguish and understand the basic sounds of Hindi language
3. Appear for Hindi examinations conducted by Dakshina Bharat Hindi Prachar Sabha

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										3					

UNIT I **9 Hours**

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

Nouns: Genders (Masculine & Feminine Nouns)- Masculine & Feminine - Reading Exercises.

UNIT III **9 Hours**

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

Classified Vocabulary: Parts of body, Relatives, Spices, Eatables, Fruit & Vegetables - Clothes - Directions Seasons - Professions.

UNIT V **9 Hours**

Speaking: Model Sentences and Rhymes Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. Dakshin by Dakshin Bharat Hindi Prachar Sabha Chennai

1 0 2 2

18HSG01 GERMAN

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. listen and identify individual sounds of German
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										3					
4										2					
5										3					

UNIT I **9 Hours**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

UNIT II **9 Hours**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

UNIT III **9 Hours**

Regular & Irregular verbs - Personal pronouns - family - Introduction to types of sentences

UNIT IV **9 Hours**

Question words-Types of Questions - Nominative case- Verb Conjugation - country - nationalities

UNIT V **9 Hours**

Verbs - to be & to have - conjugation - Hobbys - Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015
2. Langenscheidt Eurodictionary - German - English / English - German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

1 0 2 2

18HSJ01 JAPANESE

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquettes

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Recognise and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										3					
4										2					
5										3					

UNIT I **9 Hours**

Introduction to Japanese , Japanese script, Pronunciation of Japanese(Hiragana), (Katakana) Long vowels , Pronunciation of in,tsu,ga Letters combined with ya,yu,yo Daily Greetings and Expressions Numerals. N1 wa N2 desu N1 wa N2 ja arimasen S ka N1mo N1 no N2 san Kore Sore Are Kono N Sono N Ano N Sou desu Souja Arimasen S1 ka S2 ka N1 no N2 Sou desu ka Koko Soko Asoko Kochira Sochira Achira Ni wa N2 (place) desu Doko Dochira N1 no N2 Ko So A Do (Demonstrative words) O kuni Kanji10 Technical Japanese Vocabulary (30 Numbers)

UNIT II **9 Hours**

Introduction to time Ji Fun Pun Introduction of verbs V Masu V Masu V Masen V Mashita V Masendeshita N (Time) Ni V N1 Kara N2 Made N1 to N2 S Ne N (Place) e Ikimasu Kimasu Kaerimasu Doko (e) Mo Ikimasen Ikimasendeshita N (Vechile) de Ikimase Kimasu Kaerimasu No (Person / Animal) to V Itsu S Yo N o (transitive) N o Shimasu Nani o Shimasuka Nan and Nani N (place) de V V Masenka V Mashou o Kanji 10 Technical Japanese Vocabulary (30 Numbers) .

UNIT III **9 Hours**

N (tool/means) de V Word/Sentence wa Go de Nani desu ka N (person) Ni Agemasu, etc N (person) Ni Moraimasu etc Mou V Mashita Introduction to Adjectives N wa Na adj (Na) desu N wa II adj (II) desu Na adj Na n II adj (II) N Totemo Amari N wa Dou desuka N1 wa Donna N2 desuka S1 Ga S2 Dore N ga Arimasu Wakarimasu N Ga Sukidesu Kiraidesu Jozu desu Heta desu Donna N Yoku Daitai Takusan Sukoshi Amari Zenzen Ã¢?? S1 kara S2 Doushite Kanji 10 Technical Japanese Vocabulary (30 Numbers)

UNIT IV **9 Hours**

N ga Arimasu Imasu N1 (place) Ni N2 ga Arimasu Imasu N1 (thing/person/place) no N2 (position) N1 ya N2 Word (s) desuka Chirisosu wa Arimasuka Saying numbers Quantifier (period) Ni kai V Quantifier Dake N dake Past tense of Noun sentences and Na adjective sentences Past tense of ii adjective sentences N1 wa N2 yori adjective desu N1 to N2 to dochira ga adjective desu ka N1/N2 no houga adjective desu Kanji 10 Technical Japanese Vocabulary (30 Numbers)

UNIT V **9 Hours**

N ga hoshi desu V masu form tai desu N (place) e V masu form N Ni ikimasu kimasu kaerimasu N ni V N o V dou ko ka nani ka go chuu mon Verb conjugation Verb groups Verb te form V te form kudasai V te form imasu V masu from mashouka S1 ga S2 N ga V V te form mo ii desu V te form wa ikemasen V te form imasu V te form imasu Shrimasen Kanji 10 Technical Japanese Vocabulary (30 Numbers)

Total: 45 Hours

Text Book(s)

1. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

Reference(s)

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

18HSC01 CHINESE **1 0 2 2**

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. listen and identify individual sounds of Chinese
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										3					
4										2					
5										3					

UNIT I **6 Hours**

Hello
Initials and Finals of Chinese
b,p,m,f,d,,n,l,g,k,h,j,q,x
Tones Four
Chinese Syllables
Tone S

UNIT II **6 Hours**

Thank you -
Initials and Finals of Chinese
The Neutral Tone
Rules of Tone Marking and Abbreviation

UNIT III **6 Hours**

What's your name - In the school; -In the classroom; -In the school
The Interrogative Pronoun
The Sentence
Interrogative Sentences with

UNIT IV **6 Hours**

She is my Chinese teacher -
In the library
The Interrogative Pronouns
The Structural Particle
The interrogative Particle

UNIT V **6 Hours**

Her daughter is 20 years old this year -
The Interrogative Pronoun
Numbers below 100
Indicating a Change
The Interrogative Phrase

Total: 30 Hours

18HSF01 FRENCH **1 0 2 2**

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. To help students acquire familiarity in the French alphabet & basic vocabulary
2. listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										3					
4										2					
5										3					

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue francaise, alphabets, les numeros, les jours, les mois.- Grammaire Les verbes s"appeler,etre, avoir, les articles definis, indefinis -Communication - Saluer, s"informer sur quelqu"un, demander de se presenter - Lexique - Les alphabets, les nationalites, l"age, les pays, les couleurs, les jours de la semaine, les mois de l"annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire - Verbes - Conjugaison : Present (Avoir / etre / ER, IR, RE : Regulier et Irregulier) - Adjectifs les propositions de lieu - Communication - Chercher un logement, d"ecrire son voisin, s"informer sur un logement - Lexique - L"habitat, les pieces, l"equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN

Grammaire - Articles contractes, verbes vouloir, pouvoir, devoir, adjective interrogative, future proche - Communication- Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique - le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT - OUVRIR LA CULTURE

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, l"imparfait Communication - Propose a quelqu'un de faire quelque chose, raconter une sortie au passe parler un film - Lexique - Les sorties, la famille, art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite - Communication Accepter et refuse rune invitation, donner des instructions, commander au restaurant - Lexique Les services et les commerces, les aliments, les ustensiles, argent

Total: 45 Hours

Reference(s)

1. Saison A1, Methode de francais
2. Hachette FLE

ONE CREDIT COURSE

18BT0XA MOLECULAR MARKER TECHNOLOGIES 1 0 0 1

Course Objectives

- To understand the role of molecular marker technology in breeding of animals and Plants
- To understand the sequencing and mapping techniques

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Build their carrier on DNA finger printing techniques
2. Work in genomics and bioinformatics research filed which is fast developing in the animal and agricultural science

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1								2						
2	2										1				

UNIT I **4 Hours**

MOLECULAR MARKERS INTRODUCTION

Organization & Molecular dissection of different genomes (Nuclear, Chloroplast and Mitochondrial)Morphological, Physiological and Genetic markers and their role in evolution and Taxonomy Merits and demerits

UNIT II **4 Hours**

HISTORY AND TYPES

-History of Molecular markers and Types of Molecular markers - Hybridization based markers RFLP and it's applications

UNIT III **4 Hours**

PCR BASED MARKERS

PCR based markers RAPD, AFLP, SSR and STS markers, new generation marker and their application - Development of new DNA markers - Principles of genetic linkage - Linkage relationship among different markers - Construction of linkage maps with different markers

UNIT IV **4 Hours**

MICROARRAY TECHNOLOGY

Microarray technology and application - Synteny among different genome with respect to markers - QTL mapping with molecular markers and related software - Finger printing of fungi, insects and other organisms - Tagging of economic importance using molecular markers MAS success story

UNIT V **4 Hours**

PRACTICAL SESSION

Demonstration of molecular marker usage in the laboratory

Total: 20 Hours

Reference(s):

1. Brown. T. A. Genomes, 3rd edition. University of Manchester, U.K. Garland Sciences. 2006
2. Phillips and I.K. Vasil. DNA based markers in plants. Second Edition, Klewer academic Publishers, and London. 2001.
3. Henry, R. J. Plant genotyping "The DNA finger printing of plants". CABI Publications. New York. 2001.
4. Patterson, Molecular dissection of complex traits. CRC Publication. Washigton. 1998
5. Rastogi, S.C. N. Mendiratta, and P. Rastogi. Bioinformatics "Methods and application Pretice" Hall Pvt. New Delhi. 2006.

18BT0XB TRANSLATIONAL RESEARCH AND TECHNOLOGY TRANSFER

1 0 0 1

Course Objectives

- To enable students to get an insight of translating Ideas and to evaluate and predict the role of technology in creating wealth or value
- To empower graduates and researchers to distinguish between Abrasive/Breakthrough technologies and lay a foundation for productive research for societal transformation.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Address the questions/challenges/problems/ pain statements of the society or demand area
2. Analyze the tools (Software and Legal instruments) for evaluating the technology
3. Build and stimulate a business model around ones idea/invention, which will enable to decide the best mode of translating idea/invention to value or wealth

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								1						
2	2								2						
3	2								1						

UNIT I **4 Hours**

TECHNOLOGY TRANSFER INTRODUCTON

Technology Transfer as a process Stages of Technology Transfer

UNIT II **4 Hours**

TRANSLATIONAL RESEARCH

Translational Research defined- Basic Components of Translational Research - Stages of invention and where does Translational research fit

UNIT III **4 Hours**

CLASSIFICATIONS OF INVENTIONS

Classifications of Inventions overview of protecting technology Strategies of Transferring technology Technology Valuation Methods Communication in Technology Transfer

UNIT IV **4 Hours**

MARKETING

Documentation for Technology Transfer Technology Landscaping- Technology Presentation for Marketing Legal Instruments Involved in Technology Transfer.

UNIT V **4 Hours**

PRACTICAL SESSION

Ability to write a model technology transfer/ translational document procedure

Total: 20 Hours

Reference(s):

1. Technology Transfer: A Communication Perspective (1990), Eds. Frederick Williams and DavidV. Gibson, SAGE Publications (ISBN:0-8039-3741-5
2. Biotechnology Intellectual Property Manual (2001) Spruson and Ferguson Patent Attorneys. (ISBN:0-642-72129-7)
3. Journal of Commercial Biotechnology http://www.palgrave-journals.com/jcb/index.html.
4. Intellectual Property in Health and Agricultural Innovations A Hand Book of Best Practices

18BT0XC MARINE FOOD TECHNOLOGY 1 0 0 1

Course Objectives

- To provide a concise and unified approach to marine flora, fauna and molecular properties
- To impart knowledge on various sea foods and its medicinal and nutritional values

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Explain about marine environment and marine organisms
2. Apply different techniques followed for marine resource assessment and evaluation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2	1								2						

UNIT I **4 Hours**

MARINE ENVIRONMENT

Marine environment -Marine Bioresources, Biodiversity-Marine Flora and fauna -Phytoplankton

UNIT II **4 Hours**

BIODIVERSITY

seaweeds, sea grasses and mangroves -Ocean Technology Tides,Currents and remote sensing techniques -Marine resource assessment and evaluation -Marine pharmacology“ Terms and definitions,

UNIT III **4 Hours**

MEDICINAL COMPOUNDS FROM MARINE FLORA

Medicinal compounds from marine flora and fauna, toxins, antiviral and antimicrobial agents -Sea foods shrimps, prawns, skewers, octopus, crabs, fish, squid and its processing with nutritional values

UNIT IV **4 Hours**

CERTIFICATIONS

Certifications like HACCP, EU, USFDA, ISO, BRC, ACC for sea foods

UNIT V **4 Hours**

PRACTICAL SESSION

Exposure to the marine biotechnology applications

Reference(s):

1. M. Fingerman, Recent advances in Marine Biotechnology, Science Publishers, 2000.
2. D. L. Krichman, Microbial Ecology of the Oceans,Wiley-Liss, 2000

Total: 20 Hours

18BT0XD BEVERAGE, BAKING AND CONFECTIONARY TECHNOLOGY

1 0 0 1

Course Objectives

- To impart knowledge to the students about food processing and various unit operations
- To apply the technology in processing, preservation, and packaging.
- To acquire practical knowledge on value addition of food products

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Explain about the process and products in a beverage industry
2. Apply different techniques followed in beverages., baking and confectionery technology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								1						
2	2								1						

UNIT I **4 Hours**

BASIC INDUSTRIAL CALCULATIONS

Basic industrial calculation and procedures, Entrepreneurship development

UNIT II **4 Hours**

METHODOLOGY IN FOOD PROCESSING

Methodology in Food Processing, Technologies in food processing - High Pressure Processing, Pulsed electric fields processing, Osmotic dehydration,

UNIT III **4 Hours**

FOOD PROCESSING

At hermal membrane concentration of liquid foods and colours, Ultrasound processing, Alternate thermal processing, Radiofrequency processing,

UNIT IV **4 Hours**

ADVANCE INDUSTRIAL TECHNOLOGY

Hybrid drying technologies. Value addition of fruit and vegetable products-squashes, pickles, jam, sauce, Ready to serve Beverages. Baking& Confectioner products- bread, rusk, cookies, chikkies.

UNIT V **4 Hours**

PRACTICAL SESSION

Making of beverage, baking and confectionery

Total: 20 Hours

References:

1. P. J. Fellows, Food Processing Technology: Principles and practice, Third Edition Woodhead Publishing limited, 2009.
2. Paul Singh, R and Dennis R. Heldman, Introduction to Food Engineering, Fourth Edition.Academic Press, 2009
3. M.Lewis and N.Heppell, Continuous Thermal Processing of Foods, Aspen Publisher,2000
4. V. A. Vaclavik and E. W. Christian, Essentials of Food Science, Springer, 2007
5. G. Campbell-platt, Food Science and Technology, Wiley-Blackwell, 2009
6. C.M.Weaver and J.R.Daniel, The Food Chemistry Laboratory: A Manual for Experimental foods, Dietetics, Food Scientists. CRC Press, 199

18BT0XE APPLIED SYSTEMS BIOLOGY 1 0 0 1

Course Objectives

- To provide students practical applications of system biology in biotechnology
- To understand the modeling theories, databases and tools

Programme Outcomes (POs)

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

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

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Explain about the process and Concepts in systems biology
2. Apply different techniques followed in genomics and bioinformatics research filed which is fast developing in the biotechnology.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								1						
2	1										2				

UNIT I **4 Hours**

INTRODUCTION TO SYSTEMS BIOLOGY

Systems biology - Systems level understanding of biological systems - Basic principles and concepts Applications, Scope and Future.

UNIT II **4 Hours**

MODELING THEORY

Linear Algebra - Ordinary differential equations - Difference Equations - Numerical Integration Graph and Network Theory Stochastic processes Statistics

UNIT III

CASE STUDIES:

Systems biology Approaches for Enhanced Biofuel Production,Models for Recombinant Protein Production, Systems approaches for Host Pathogen Interactions, Systems Biology Approaches for Drug Discovery,Systems Approaches for Personalized Health Care

UNIT IV

AVAILABLE DATABASES AND TOOLS FOR MODELLING:

Internet Databases Modelling-Pathway databases - Kinetics databases Model database Gene expression databases and other data resources.

UNIT V

PRACTICAL SESSION

Simulation Techniques and Tools-Petri nets - Mathematica -Matlab - Systems biology platforms: Copasi, CellDesigner, PyBioS, ScrumPy. Data formats for Modelling-Systems Biology Markup Language (SBML) BioPAX Systems Biology Graphical Notation Standards of Systems Biology Computer Practical-Mathematical modelling using Copasi (or) Matlab

Reference(s)

1. Systems Biology,EddaKlipp, Wolfram Liebermeister, ChristophWierling, Axel Kowald, Hans Lehrach, Ralf Herwig,ISBN: 978-3-527-31874-2,2009, Wiley-Blackwell
2. An Introduction to Systems Biology Design Principles of Biological Circuits,UriAlon,ISBN:1584886420, 2006, Chapman&Hall/CRC, Taylor and Francis Group
3. Foundations in Systems Biology,Kitano, H.(ed.), ISBN 0262112663,2001 The MIT Press
4. Systems Biology : Properties of Reconstruct
5. Stochastic Modelling for Systems Biology,Darren James Wilkinson ISBN:1-58488-540-8,2006, Chapman & Hall/CRC Press

18BT0XF FUNDAMENTALS OF LIQUID CHROMATOGRAPHY

1 0 0 1

Course Objectives

- To provide students practical applications of HPLC in biotechnology
- To understand the practical familiarization of HPLC

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Apply the industrial concepts of HPLC in advance purification process
2. Equip with the skills for analyzing the biotechnology products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								2						
2	1								1						

UNIT I **4 Hours**

BASICS OF HPLC

HPLC instrumentation, theory of chromatography, properties of stationary phase, selectivity, efficiency, Retention, resolution, Vandeemter equation, Isocratic/gradient mode of elution, mobile phase and importance of ion pairing reagent

UNIT II **4 Hours**

MODES OF CHROMATOGRAPHY

Reverse phase chromatography, hydrophobic interaction chromatography, Ion exchange chromatography, size exclusion chromatography, and affinity chromatography

UNIT III **4 Hours**

DETECTORS USED IN HPLC

UV-vis, PDA/DAD, CAD, refractive index, fluorescence

UNIT IV **4 Hours**

APPLICATION AND ADVANCEMENT OF LIQUID CHROMATOGRAPHY

Separation and quantification of proteins and related substances, process control, Advances application by using LCMS and 2D liquid chromatography

UNIT V **4 Hours**

PRACTICAL SECTION

Familiarization of HPLC setup

Total: 20 Hours

Reference(s)

1. Basic HPLC and CE of biomolecules by Robert L. Cunico, Karen M. Holding and Tim Wehr.

18BT0XG PROCESS VALIDATION AND QUALITY ASSURANCE FOR BIOPRODUCTS

1 0 0 1

Course Objectives

- To understand the importance of quality assurance and validation strategies in food and Pharmaceutical industries
- To appreciate the skills / devices / practices which assures the safety and quality of the finished products

Programme Outcomes (POs)

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain the HACCP principles and Validation in the Food and Pharmaceutical industries
2. Apply their knowledge in the arena of Quality Assurance

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1							2					1			
2							1		2	2	1				

UNIT I **8 Hours**

QUALITY ASSURANCE

Quality Assurance introduction, Regulatory compliance - FDA regulations, EU directives Certification systems - ISO 22000:2009 and BRC Global Standard for Food Safety Issue. The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP).

UNIT II **12 Hours**

PROCESS VALIDATION

Validation introduction, HACCP Principles and Hazard Analysis.Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation including the use of Statistical Process Control (SPC) Techniques.Audits - Requirements. Process Validation for pharmaceutical industries, Pilot Plant, Scale-Up Techniques.Analytical methods and tests for various drugs -Physicochemical and bioanalytical considerations. Validation of analytical methods. Product Development Strategies in food and Pharmaceutical industries. Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.

Total: 20 Hours

Reference(s)

1. Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker.
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker.
3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker
4. Handbook of Food science, Technology and Engineering, (Vol 1) Y.H. Hui, Taylor and Francis Publications

18BT0XI CLINICAL RESEARCH 1 0 0 1

Course Objectives

- To make the participants understand how the clinical research field develops useful products and methodologies
- To kindle the students to involve in clinical research for their research works

Programme Outcomes (POs)

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
m. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
n. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
o. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
p. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course outcomes

1. Understanding of clinical research practices
2. Aware of various guidelines and protocols of clinical research
3. Plan and design of Clinical trial managements
4. Clinical research Methods and data managements

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
1							2					1			
2							1		2	2	1				

Clinical Research: **15 Hours**

Definition, Types and Scope of Clinical Research, Good Clinical Practices, ethics in clinical research, Roles and Responsibilities of Clinical Research Professionals - Historical guidelines in Clinical Research: Nuremberg code, Declaration of Helsinki, Belmont report. Clinical Trial Protocol and Protocol Amendments, Essential Documents for Clinical Trial - History of Regulations in Clinical Research, INDIAN Regulatory system, Indian GCP guidelines (CDCSO guidelines), ICMR Guidelines - Project Management, Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure, Contract Research Organization, Site management organizations - Designing of Protocol, CRF, e-CRF, IB, ICF, SOP, CDM, CRF Design, Clinical Data Entry and Validation, Clinical Data Coding,

Total 15 Hours

Reference:

1. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
2. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
3. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes
4. Deborah Rosenbaum, Michelle Dresser. Clinical Research Coordinator Handbook Second Edition Practical Clinical Trials Series GCP Tools and Techniques Interpharm/CRC New York Washington, D.C.© 2002

ADDITIONAL ONE CREDIT COURSE

18GE0XA ETYMOLOGY 1 0 0 1

Course Objectives

- To increase vocabulary and enhance use, knowledge, and understanding of the English language.
- To stimulate an appreciation for the English language, including how it developed, how new wordsenter the language, and how it continues to be dynamic.
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication.

Course Outcomes (COs)

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events.

UNIT I **7 Hours**

CONVENTIONS

Acronyms, Abbreviations, Initialises, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms ; Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym Apheresis - Blend word Assimilation - Colloquial language Clipped word.

UNIT II **8 Hours**

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym.

Total: 15 Hours

Reference(s)

1. Norman, Lewis. Word Power Made Easy, Goyal Publisher. Edition 2. 2014.
2. C T Onions. The Oxford Dictionary of English Etymology, Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont, Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library. 1961.

18GE0XB GENERAL PSYCHOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of psychology.
- Defining Psychology and the subject matter of psychology.
- To provide an awareness of various methods and branches of psychology.
- To explain social and work psychology of people and the need for mental health.

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large.
2. Understand the different fields of psychology and its uses.
3. Deal people effectively in their personal and social life.

15 Hours

UNIT I

GENERAL PSYCOLOGY

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology -Motivation- Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation- social influence-social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude.

Total: 15 Hours

Reference(s)

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016.
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education. 2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

18GE0XC NEURO BEHAVIORAL SCIENCE 1 0 0 1

Course Objectives

- To provide an introduction to the Cognitive Neuro Science of languages.
- To provide an understanding of the Cognitive processes.

Course Outcomes (COs)

1. Identify the psychological problems that will impact mental health.
2. Value ethical conduct in professional and personal life.
3. Recognize the need for rationale and evidence in decision-making.

UNIT I **8 Hours**

INTRODUCTION TO PHYSIOLOGY

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science.

UNIT II **7 Hours**

PSYCHOLOGICAL BEHAVIOR

Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds.

Total: 15 Hours

Reference(s)

1. Beck. Robert. Handbook of Physiology. Vol I.
2. Horon C Philip. Sexology and Mind.

18GE0XD VISUAL MEDIA AND FILM MAKING 1 0 0 1

Course Objectives

- To acquire fundamental knowledge on development of filmmaking as an art
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Course Outcomes (COs)

1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

UNIT I **7 Hours**

INTRODUCTION

History of Cinema (Origin and Narrative). Cinema as a visual medium - Significance of Editing. Styles of Editing - Editing as a methodology (Hollywood"s Invisible Editing)-Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production)

UNIT II **8 Hours**

FUNDEMENTALS OF FILMMAKING

Different types of shots and angles-Film style and Narrative-(Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,)- Regional Cinema to National Cinema - Basics of Script Writing (Double and Single Column)- Basics of Video Production (script to screen)- Final submission of a script for five minutes short film.

Total: 15 Hours

Reference(s)

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009.
2. Belavadi, Vasuki, Video Production. India: OUP, 2013.

18GE0XE YOGA FOR HUMAN EXCELLENCE 1 0 0 1

Course Objectives

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

Course Outcomes (COs)

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

15 Hours

UNIT I

INTRODUCTION

What is Yoga? - History of Yoga- Yoga in todays scenario - Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga -Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar - Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas - Mudras-Relaxation - Pranayama? Meditation.

Total: 15 Hours

Reference(s)

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012.
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009.
3. Ramesh Partani, The Complete Secret, Ru Education, 2013.

18GE0XF VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills

Course Outcomes (COs)

1. Solve problems creatively in mathematics and its applications

UNIT I **15 Hours**

VEDIC MATHEMATICS

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

Total: 15 Hours

Reference(s)

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997

18GE0XG HEALTH AND FITNESS 1 0 0 1

Course Objectives

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

Course Outcomes (COs)

1. Acquire the knowledge and training of the individual physical, mental and social concepts
2. Understand the fundamental concepts of yogic practice and physical fitness
3. To acquire the knowledge about nutrition and health consciousness

UNIT I **5 Hours**

FITNESS

Meaning & Definition -Need & importance of Physical fitness - Types Physical fitness - Exercise, Training and Conditioning and it is important

UNIT II **5 Hours**

YOGA AND MEDITATION

Meaning and definition - Principles of practicing - Basic Asana and it important - Pranayama and Meditation - Relaxation Techniques

UNIT III **5 Hours**

NUTRITION AND BALANCE DIET

Nutrition and Balance Diet: Needs and Important - Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases - cause - prevention - First aid for common sports injuries.

Total: 15 Hours

Reference(s)

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited

18GE0XH CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING **1 0 0 1**

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact proceedures of biodegradation of unwanted solid residues

Course Outcomes (COs)

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment
2. Recognize the organic farming practices and production of healthy food products
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

VERMICOMPOSTING TECHNOLOGY **15 Hours**

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipments, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle) , vermicastings in organic farming/horticulture Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours

Reference (s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops

18GE0XI BLOG WRITING 1 0 0 1

Course Objectives

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

Course Outcomes (COs)

1. Understand the flow of language in natural manner.
2. Understand the elements of a blog and be able to use them effectively.
3. Find a niche for a long-term blog.
4. Gain insight into the strategies, methods and writing of successful bloggers.
5. Develop creative thinking.

UNIT I **7 Hours**

CONCEPT

What is blog writing? Types of blog posts personal experience, opinion, reviews, advice, news/updates. Focusing your blog concept, audience, uniqueness, posts. Company blogs. Structure: Types of structure inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

UNIT II **8 Hours**

VOICE RELIABILITY

Defining and achieving voice. Exploring various voices. Stylistic tips rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. Reliability - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

Total: 15 Hours

Reference(s)

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. $29.95 paperback.
2. Blogging Heroes, by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Complete Guide to Blogging, Huffinghton Post

18GE0XJ INTERPERSONAL SKILLS 1 0 0 1

Course Objectives

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage ones own and others emotions
- To define and solve problems by making decisions about the best course of action

Course Outcomes (COs)

1. Express themselves clearly and confidently
2. Listen to others completely and with empathy
3. Assert an opinion without diminishing others opinion
4. Be responsible and timely with a willingness to collaborate
5. Develop innate personality traits to handle certain social situations

UNIT I **7 Hours**

INTRODUCTION

Conversational Skills - Active Listening - Team working Empathy - Emotional Intelligence

UNIT II **8 Hours**

SKILLS

Conflict Resolution and Mediation skills - Decision making and Problem Solving - Negotiation and Persuasion skills

Total: 15 Hours

Reference(s)

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014

18GE0XK NEW AGE INNOVATION AND ENTREPRENEURSHIP

1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task of setting independent business units and on the various facets of running a business
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women
4. Overview of Indian trends in the start-up scene

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -MVPPositioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business PlanMentoring Session with Investors- Legal and Ethical Foundation for Startup. Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship - Intrapreneurship Sustainability - Exit strategies and Start-up trends in India.

Total: 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, publishedby the authors, 2010
3. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher, 2011

18GE0XL NATIONAL CADET CORPS 1 0 0 1

Course Objectives

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

Course Outcomes (COs)

1. Recall the motto and aim of NCC.
2. Implement synergy in disaster management.
3. Execute an example patriotic leader to serve nation

UNIT I **12 Hours**

NCC STRUCTURE AND TRAINING

NCC ORGANIZATION National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.DRILL AND WEAPON TRAINING: Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22 and INSAS - Stripping, Assembling and Cleaning of weapons. NATIONAL INTEGRATION AND SOCIAL AWARENESS:]National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGOs role and Contribution - Social Security schemes.

UNIT II **8 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

PERSONALITY DEVELOPMENT AND LEADERSHIP: Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader. DISASTER MANAGEMENT AND FIRST AID:Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defence: Civil defence measures - Civil defence services. First aid: First aid kits and Equipments - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

Total: 20 Hours

Reference(s)

1. Cadets Hand book Common subject, DG NCC, New Delhi.
2. Cadets Hand book Special subject, DG NCC, New Delhi
3. Misra R.C and Sanjaykumar Mishra, A HAND BOOK OF NCC(English), Kanti Prakashan, 2016
4. Gupta R. K, NCC: Handbook of NCC Cadets for A, B and C Certificate Examinations (English) RPH Editorial Board, 2018.

18GE0XM COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT **1 0 0 1**

Course Objectives

- understand the role of National Service Scheme in community
- identify the needs and problems of the community and involve in problem solving
- develop competence required for group living and acquire leadership qualities

Course Outcomes (COs)

1. Compare themselves in relation to their community and develop among themselves a sense of social and civic responsibility
2. Utilize their knowledge in finding practical solution to individual and community problems
3. Develop leadership qualities in working environment and during the time of emergency

COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT **15 Hours**

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS Emblem, flag, motto, song, badge- Organizational structure roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, Day Camps - Basisofadoption of village/slums-Methodology of conducting Survey -Financial pattern of the scheme -Coordination with different agencies-Maintenance of the Diary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community-Identifying methods of mobilization Youth-adult partnership. Health, Hygiene & Sanitation: Definition, needs and scope of health education Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.

Total: 15 Hours

Reference(s)

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. http://nss.nic.in/intro.asp
3. Delgado-Gaitn and Concha, The Power of Community: Mobilizing for Family and Schooling New York: Rowman & Littlefield Publishing, Inc. 2001
4. James Bailey, Guide to Hygiene and Sanitation in Aviation, World health organization, 2nd edition. 1980
5. Anuradha Basu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009

18GE0XN DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES **1 0 0 1**

Course Objectives

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

Course Outcomes (COs)

1. Understanding contemporary entrepreneurship as an important career option
2. Concept and methodology of creative disruption to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women with disruptive technology option
4. Overview of Indian trends with reference to disruptive innovation based start -ups

UNIT I **15 hours**

Creativity linked innovation Differences between Disruptive & incremental Innovations Historical, theoretical, and practical evolution of disruptive innovation (DI) - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new product s and services to the market? Investor preferences in core versus new or disruptive business models disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly Application of disruptive theories to complex problems and opportunities.

Total: 15 Hours

References

1. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x
2. http://www.brinq.com/workshop/archives/2005/01/08/what -is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

18GE0XO SOCIAL PSYCHOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of social psychology.
- Defining psychological & physical changes during puberty age.
- To provide an awareness of various psychological problems and social problems.
- To explain social and work psychology of people and the need for mental health.

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the various psychological, physical, social problems and management skills.
3. Deal people effectively in their personal and social life.

UNIT I **7 Hours**

INTRODUCTION

Introduction - Ice breaker - Time Line - Tasks and Challenges of the age(Erik Erikson)Physical changes - Introduction to Reproductive Health - Reproductive Organs - Menstruation - Changes during Puberty - Abortions - Contraception - Difference between Sex and Gender - Introduction to the origins of Patriarchy - Gender.

UNIT II **8 Hours**

PSYCHOLOGY

Developmental changes - Attraction - Friendship - Differences and Similarities - Images of Beauty and Body Image -Introduction to Media-Feedback - Sexuality - Boundaries Relationships - Marriage - Love - Emotional Health - Sexual Abuse and Safety - Role of Media.

Total: 15 Hours

Reference(s)

1. Baron, R. A., Branscombe. N.R. (2016).Social Psychology, 14th Ed. New Delhi; Pearson Education
2. Morgan, C.T., King, R.A.,Weisz, J.R., & Schopler,J.(1993). Introduction to Psychology, 7th Ed.New Dehi:Tata McGraw Hill.