SCHEME OF COURSES - B.E. BIOTECHNOLOGY

UNIVERSITY OF DELHI

NETAJI SUBHAS INSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM

SCHEME OF COURSES

for

Bachelor of Engineering

in

Biotechnology

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

TABLE OF CONTENTS

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

PREAMBLE

I. INTRODUCTION

Higher education is very important for the growth and development of any country. It is a living organ and requires continuous changes to ensure the quality of education. National Knowledge Commission and University Grants Commission have recommended many academic reforms to address the challenges of today's networked globalized world. People are coming together with the help of new technologies which is resulting towards new aspirations, expectations, collaborations and associations. The concept of "work in isolation" may not be relevant and significant anymore. The UGC guidelines on adoption of Choice Based Credit System may be an important step to revamp the processes, systems and methodologies of Higher Educational Institutions (HEIs). The teacher centric mode be changed to learner centric mode. Class room teaching and learning be made effective, relevant and interesting. Concepts and theories be explained with examples, experimentation and related applications.

A culture of discussions, arguments, interpretations, counter-interpretations, re-interpretations and opposing interpretations must be established. Research should not be confined only to redefinition, extension and incremental change. Innovation and creativity should become an epicenter for all research initiatives. The most important capital is the human capital and thus the ultimate objective is to develop good human beings with utmost integrity and professionalism for this new world.

The Choice Based Credit System supports the grading system which is considered to be better than conventional marking system. It is followed in many reputed institutions in India and abroad. The uniform grading system facilitates student mobility across institutions within and across countries and also enables potential employers to assess the performance of students. The Choice Based Credit System makes the curriculum interdisciplinary and bridges the gap between professional and liberal education.

II. CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions have been moving from the conventional annual system to semester system. Currently many of the institutions have already introduced the Choice Based Credit System. The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the COURSE CONTENT and hours of teaching. The Choice Based Credit System provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses to acquire more than the required credits and adopt an interdisciplinary approach to learning.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

A. Programme Educational Objectives:

This scheme and courses are related to four year Biotechnology programme with following Programme Educational Objectives (PEOs).

1. To impart extensive and updated knowledge in the basic and advanced aspects of modern biotechnology to create well-trained human resource

2. To create a group of young professionals with skills to investigate and solve the industrial and environmental problems of the present day Biotechnology industry.

3. To create professionals able to conceptualize as well as achieve modern tools, products and applications in various sectors of Biotechnology

4. To create graduates aware of the financial, social, ethical and intellectual property related issues and is able to effectively communicate and address societal concerns in these regards

5. To be able to recognize the need for and have the preparation and ability to engage in independent life-long learning in the broadest context of technological changes

B. Types of Courses

Courses are the subjects that comprise the Biotechnology programme.

1. A course may be designed to comprise lectures, tutorials, laboratory work, field work, outreach activities, project work, vocational training, viva, seminars, term papers, assignments, presentations, self-study etc. or a combination of some of these components.

2. The learning outcomes of each course will be defined before the start of a semester.

3. Courses are of three kinds: Core, Elective and Foundation.

   i. **Core Course (CC)**: This is a course which is to be compulsorily studied by a student as a core requirement to complete the requirement of B.E. Biotechnology.

   ii. **Elective Course**: An elective course is a course which can be chosen from a pool of courses. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency and skill. An elective may be of following types:

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

a) **Discipline Centric Elective (ED)**: It is an elective course that adds proficiency to the students in the discipline.

b) **Generic Elective (EG):** It is an elective course taken from other engineering disciplines and enhances the generic proficiency and interdisciplinary perspective of students.

c) **Open Elective (EO):** It is an elective course taken from non-engineering disciplines that broadens the perspective of an engineering student.

iii. **Foundation Course**: A Foundation course leads to knowledge enhancement and provides value based training. Foundation courses may be of two kinds:

a) **Compulsory Foundation (FC):** It is based upon content that leads to fundamental knowledge enhancement in sciences, humanities, social sciences and basic engineering principles. They are mandatory for all disciplines.

b) **Elective Foundation (FE):** It can be taken from among a pool of foundation courses which aim at value-based education. They may provide hands-on training to improve competencies and skills or provide education on human, societal, environmental and national values.

4. Each course contributes certain credits to the programme. A course can be offered either as a full course (4 credits) or as a half course (2 credits). A full course is conducted with 3 hours of lectures and either 1 hour of tutorial or 2 hours of practical work per week. A half course is conducted with 2 hours of lectures.

5. A student of undergraduate programme has to accumulate about 50% credits from Core courses, about 20% credits from Foundation courses, and the remaining credits from Elective courses to become eligible for award of the degree.

6. A course (full/half) may also be designed without lectures or tutorials. However, such courses may comprise of field work, workshop, engineering drawing, outreach activities, project work, vocational training, seminars, self-study, sports, skills enhancement etc. or a combination of some of these.

7. A project work/dissertation is considered as a special course involving application of the knowledge gained during the course of study in exploring, analyzing and solving complex problems in real life applications. A candidate completes such a course with an advisory support by a faculty member.

8. Apart from the above courses Audit courses may be offered. They do not carry credit but aim at expanding knowledge, bridging deficiency in knowledge and skills.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

C. Examination and Assessment

The following system will be implemented in awarding grades and CGPA under the CBCS system.

1. **Letter Grades and Grade Points:** A 10-point grading system shall be used with the letter grades as given in Table 1 below.

Table1: Grades and Grade Points

Letter Grade	Grade point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (absent)	0

2. **Fail grade:** A student obtaining Grade F shall be considered fail and will be required to reappear in the examination. If the student does not want to reappear in an **elective course** (that is, EG, ED, EO, FE *but not* CC or FC courses) then he/she can re-register afresh for a new elective course.
3. **Audit course:** For audit courses, 'Satisfactory' or 'Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.
4. **Fairness in assessment:** The CBCS promotes continuous evaluation system where the weightage of end semester examinations should not be more than 60%. The departments shall design its own methods for continuous evaluation. It shall have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching-learning methods. In this regard, checks and balances will be implemented to ensure fair and effective assessment and examination process.
5. **Computation of SGPA and CGPA:** The following procedure shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):
    i. The SGPA is the ratio of sum of the product of the number of credits and the grade points scored in all the courses of a semester, to the sum of the number of credits of all the courses taken by a student, that is:

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

$$SGPA(S_i) = \frac{\sum C_j \times G_j}{\sum C_j}$$

Where S_i is the i^{th} semester, C_j is the number of credits of the j^{th} course of that semester and G_j is the grade point scored by the student in the j^{th} course.

ii. The CGPA is also calculated in the same manner taking into account all the courses taken by a student over all the semesters of a programme, that is:

$$CGPA = \frac{\sum C_i \times SGPA(S_i)}{\sum C_i}$$

where SPGA(S_i) is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

iv. CGPA shall be converted into percentage of marks if required, by multiplying CGPA with 10.

III. PROGRAMME STRUCTURE

1. The B.E. Biotechnology programme consists of 8 semesters, normally completed in 4 years. The total span period cannot exceed 8 years.

2. The courses offered in each semester are given in the Semester-wise Course Allocation scheme for B.E. Biotechnology.

3. The courses under FC and common pool of electives offered for students of all disciplines under FE, EG and EO categories are listed under separate tables in the scheme. The discipline centric courses under CC and ED categories are listed separately.

4. A course may have pre-requisite course(s) that are given in the Semester-wise Course Allocation scheme.

5. A student can opt for a course only if he/she has successfully passed its pre-requisite(s).

6. A student has to register for all courses before the start of a semester.

7. After second year a student may register for courses leading to a minimum number of credits as prescribed in the scheme and a maximum of 28 credits. Normally, a student registers for courses leading to 22 credits.

8. B.E. Biotechnology programme consists of 176 credits. A student shall be awarded the degree if he / she has earned 168 or more credits.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

IV. COURSE CODIFICATION

1. Programme Code

The codes for various undergraduate programmes are as follows:

i. Biotechnology: BT
ii. Computer Engineering: CE
iii. Electronics and Communication Engineering: EC
iv. Instrumentation and Control Engineering: IC
v. Information Technology: IT
vi. Manufacturing Processes and Automation Engineering: MA
vii. Mechanical Engineering: ME

2. Departmental Course Code

The codes for departmental core courses and discipline-specific electives are specific to each discipline. The first two characters are derived from departmental codes listed above. The third character is 'C' for core courses and 'D' for discipline-specific courses. This is followed by a 2-digit sequence number:

i. BTCyy: Core Course
ii. BTDyy: Discipline-centric Elective Course

3. Common Course

There are common lists for courses offered under Compulsory Foundation (FC), Foundation Electives (FE) and Open Electives (EO) will follow a common code as shown below. The 3-digit sequence number 'yyy' is taken from the respective tables of different types of courses.

i. FCyyy: Foundation Compulsory Course
ii. FEyyy: Foundation Elective Course
iii. EOyyy: Open Elective Course

4. Generic Elective

A student may take a course under the category of Generic Elective (EG) offered by any other department of the Institute under the category of Core Course (CC) and Discipline-centric Elective Course (ED). However, such options shall be offered to a student as per prescribed guidelines of the Institute.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

V. EVALUATION SCHEME

The courses are evaluated on the basis of continuous assessment, mid-semester examinations and end-semester examinations. The weightage of each of these modes of evaluation for the different types of courses are as follows:

Type of Course	Continuous Assessment (CA), Theory	Mid-Semester Exam (MS), Theory	End-Semester Exam (ES), Theory	Continuous Assessment (CA), Lab	End-Semester Exam (ES), Lab
FE courses	As specified in Table 3 of Foundation Electives				
CC/FC/ED/EG/EO Theory with Tutorial	25	25	50	Nil	Nil
CC/FC/ED/EG/EO Theory with Practical	15	15	40	15	15
Project I and Project II	Nil	Nil	Nil	40	60
Training	Nil	Nil	Nil	40	60
Audit Courses 1*	-	-	-	-	-
1*: The distribution of marks and the minimum marks required for getting "Satisfactory" for Audit courses will be determined by the Department.					

VI. EVALUATION AND REVIEW COMMITTEE

The Committee of Courses and Studies in each department shall appoint one or more Evaluation-cum-Review Committees (ERC), each committee dealing with one course or a group of courses. This ERC consists of all faculty members who are likely to teach such course(s) in the group.

The ERC has the following functions-

(i) To recommend appointment of paper setters/examiners of various examinations at the start of each semester.

(ii) To prepare quizzes, assignments, test papers etc. for Continuous Assessment (CA), Mid-Semester examination (MS) and End Semester (ES) examination and to evaluate them. Normally, each concerned faculty member, who is also a member of ERC, will do this job for his/her class. However, in exceptional circumstances any part of the work may be entrusted to some other member of the ERC.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

(iii) To consider the individual representation of students about evaluation and take remedial action if needed. After scrutinizing, ERC may alter the grades awarded upward/downward. The decision of the ERC shall be final.

(iv) To moderate assignments, quizzes etc. for courses given by each of the concerned faculty members for his/her class with a view to maintain uniformity of standards.

(v) To review and moderate the MS and ES results of each course with a view to maintain uniformity of standards.

(vi) To lay guidelines for teaching a course.

VII. ATTENDANCE, PROMOTION AND DETENTION RULES

1. A student should normally attend all the classes. However, a student will be allowed to appear in the examination if he/ she has put in a minimum of 75% attendance separately in each course for which he / she has registered. A relaxation up to a maximum of 25% may be given on the production of satisfactory evidence that (a) the student was busy in authorized activities, (b) the student was ill.
2. A student should submit the evidence to the fact 1(a) and / or 1(b) above within seven working days of resuming the studies. Certificates submitted later will not be considered.
3. No relaxation in attendance beyond 25% is permitted in any case.
4. A student with satisfactory attendance will be promoted to the even semester irrespective of his/ her results in the odd semester examinations.
5. If a student fails to secure a minimum of 22 credits after the completion of second semester, he/ she will not be allowed to register in the third semester till he / she secures a minimum of 22 credits.
6. If a student fails to secure a minimum of 44 credits after the completion of fourth semester, he / she will not be allowed to register in the fifth semester till he / she secures a minimum of 44 credits.
7. There shall be no supplementary examinations. A student who has failed in a course will have to re-register for the course in a subsequent year.
8. If a student fails in any core course during the first four semesters (without repeating a year), he/she will have to re-register for such courses after the fourth semester.
9. If the student does not want to reappear in an **elective course** (that is, EG, ED, EO, FE *but not* CC or FC courses) then he/she can re-register afresh for a new elective course.
10. After second year a student may register for courses leading to a minimum of credits as prescribed in the scheme and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

VIII. DECLARATION OF RESULTS

1. The B.E. Biotechnology programme consists of 176 credits. A student will be awarded the degree if he/she has earned 168 or more credits.
2. CGPA will be calculated on the basis of the best 168 credits earned by the student.
3. The candidate seeking re-evaluation of a course shall apply for the same on a prescribed proforma along with the evaluation fee prescribed by the University from time to time only for the End Semester Examination within seven days from the date of declaration of result.
4. The Institution/University may cancel the registration of all the courses in a given semester if
   i. The student has not cleared the dues to the institution/hostel.
   ii. A punishment is awarded leading to cancellation of the student's registration.

IX. CURRICULUM MODIFICATION

The curriculum will be updated regularly within a period of 5 to 10 years since last revision, to keep pace with the advancements in the field of Biotechnology.

X. CENTRAL ADVISORY COMMITTEE

There shall be a Central Advisory Committee consisting of the following:

a) Dean, Faculty of Technology, Chairman
b) Head of Institution
c) Dean, Under Graduate Studies
d) Dean, Post Graduate Studies
e) Heads of Departments

This Committee shall have the following functions-

1. Lay guidelines for executing all the provisions and stipulations of the programme.
2. Give an interpretation of the rules in case of differences of opinion, which shall be binding on all.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY - PROGRAMME OUTCOMES (POs)

1. Students will gain knowledge about basic concepts of Biotechnology, Science and Engineering to solve complex problems related to field of Biotechnology.

2. Students will be able to identify, analyze and understand problems related to biotechnology and will be able to find valid solutions related to field of Biotechnology.

3. Students will be able to design and develop solutions to biotechnological problems by applying appropriate tools.

4. Students will be able to design, perform experiments, analyze and interpret data for investigating complex problems related to biotechnology.

5. Students will be able to apply recombinant DNA tools and techniques for biotechnological manipulation.

6. Students will be able to justify societal, health, safety and legal issues and understand their responsibilities in lifelong learning.

7. Students will be able to understand the need and impact of biotechnological solutions on environment and societies keeping in mind the need for sustainable solution.

8. Students will have knowledge and understanding of norms and ethics required for biotechnology product/technique development.

9. Students will have good oral and written communication skills and will emerge as an individual and as a team member in a multidisciplinary environment.

10. Students will be able to demonstrate knowledge of project and finance management when dealing with biotechnology projects.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SEMESTER-WISE COURSE ALLOCATION

B.E. BIOTECHNOLOGY - SEMESTER I												
Course Code	**Type**	**Courses**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
FC001	FC	Mathematics-I	3	1	0	4	25	25	50	-	-	None
FC002	FC	Computer Programming	3	0	2	4	15	15	40	15	15	None
FC003	FC	Electrical and Electronics Engineering	3	0	2	4	15	15	40	15	15	None
FC004	FC	Physics	3	0	2	4	15	15	40	15	15	None
FC005	FC	English – I	2	0	0	2	25	25	50	-	-	None
FExxx 1*	FE	Foundation Elective	-	-	-	2	-	-	-	-	-	-
			23/25 2*			**20**						

1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.

2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3)

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY - SEMESTER II												
Course Code	**Type**	**Course**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
FC006	FC	Mathematics-II	3	1	0	4	25	25	50	-	-	None
FC007	FC	English – II	2	0	0	2	25	25	50	-	-	None
BTC01	CC	Physics of Materials	3	0	2	4	15	15	40	15	15	None
BTC02	CC	Advance Chemistry	3	0	2	4	15	15	40	15	15	None
BTC03	CC	Biostatistics	3	1	0	4	25	25	50	-	-	None
BTC04	CC	Introduction to Biotechnology	3	1	0	4	25	25	50	-	-	None
FExx 1*	FE	Elective Foundation	-	-	-	2	-	-	-	-	-	-
			26/28 2*			**24**						

1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.

2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3)

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY AUDIT COURSE AFTER SEMESTER II					Evaluation Scheme	
Course Code	**Type**	**Course**	**LTP**	**Credits**	**Theory CA-MS-ES**	**Practical CA-ES**
ACxxx	**Audit**	Audit Courses can be floated during summer break after 2nd semesters on: (I) Courses for improvement: These will not be shown on the degree. (II) Courses on new themes: These will be shown on the degree.	-	NIL	The evaluation scheme and minimum grades for getting "Satisfactory" level, will be decided by the Department. Student has to achieve the minimum grades prescribed for getting "Satisfactory" level.	

AC: Audit Course

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY-SEMESTER III													
Course No.	**Type**	**Subject**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
BTC05	CC	Biochemistry	3	0	2	4	15	15	40	15	15	None
BTC06	CC	Microbiology	3	0	2	4	15	15	40	15	15	None
BTC07	CC	Cell Biology	3	0	2	4	15	15	40	15	15	None
BTC08	CC	Data Structure and Algorithms	3	0	2	4	15	15	40	15	15	None
BTC09	CC	Chemical Engg. Principles	3	1	0	4	25	25	50	-	-	None
FExxx 1*	FE	Elective Foundation	-	-	-	2	-	-	-	-	-	-
			26/28 2*			**22**						

1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.

2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3).

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY-SEMESTER IV												
Course No.	**Type**	**Subject**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
BTC10	CC	Methods & Instrumentation in Biotechnology	3	1	0	4	25	25	50	-	-	None
BTC11	CC	Molecular Biology	3	0	2	4	15	15	40	15	15	None
BTC12	CC	Immunology	3	0	2	4	15	15	40	15	15	None
BTC13	CC	Database Management Systems	3	0	2	4	15	15	40	15	15	None
BTC14	CC	Genetics	3	0	2	4	15	15	40	15	15	None
FExx 1*	FE	Elective Foundation	-	-	-	2	-	-	-	-	-	-
			26/28 2*			**22**						

1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.

2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3).

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY AUDIT COURSES AFTER SEMESTER IV					Evaluation Scheme	
Course No.	**Type**	**Course**	**LTP**	**Credits**	**Theory CA-MS-ES**	**Practical CA-ES**
ACxxx	**Audit**	Audit Courses can be floated during summer break after 4th semester on: (i) Courses for improvement: These will not be shown on the degree. (ii) Courses on new themes : These will be shown on the degree.	-	NIL	The evaluation scheme and minimum grades for getting "Satisfactory' level, will be decided by the Department. Student has to achieve the minimum grades prescribed for getting "Satisfactory" level.	

AC: Audit Course

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY-SEMESTER V												
Course No.	**Type**	**Subject**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
BTC15	CC	Recombinant DNA Technology	3	0	2	4	15	15	40	15	15	None
BTC16	CC	Structural Biology	3	0	2	4	15	15	40	15	15	None
BTC17	CC	Fundamentals of Biochemical Engineering	3	0	2	4	15	15	40	15	15	None
BTC18	CC	Enzymology	3	0	2	4	15	15	40	15	15	None
1*	ED/G /O	Elective(s)	-	-	-	-	-	-	-	-	-	-
			2*			**16 – 28 3***						

1*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4 - 6.
The course code will depend upon student's choice of elective(s).
The actual weakly load will depend upon the electives chosen by the student.
2*: The actual weekly load will depend upon the elective(s) chosen by the student.
3*: A student may register for courses leading to a minimum of 16 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY-SEMESTER VI												
Course No.	**Type**	**Subject**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
BTC19	CC	Bioprocess Technology	3	0	2	4	15	15	40	15	15	None
BTC20	CC	Plant & Animal Biotechnology	3	0	2	4	15	15	40	15	15	None
BTC21	CC	Downstream Processing	3	0	2	4	15	15	40	15	15	None
1*	ED/EG /EO	Elective(s)	-	-	-	-	-	-	-	-	-	-
			2*			**12 – 28 3***						

1*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4 - 6.
The course code will depend upon student's choice of elective(s).
2*: The actual weekly load will depend upon the elective(s) chosen by the student.
3*: A student may register for courses leading to a minimum of 12 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY- TRAINING AFTER SEMESTER VI												
Course No.	**Type**	**Subject**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
BTC22 *1	**CC**	Training	-	-	-	2	-	-	-	40	60	-

*1: Students will undergo Training at Industry/Research organizations/ reputed institutions during the summer vacation after VI Semester. This will be evaluated as a VII Semester subject during end-semester examination.

Training gives an exposure to students on the working on practical applications of Biotechnology and on work ethics.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY-SEMESTER VII												
Course No.	**Type**	**Subject**	**L**	**T**	**P**	**Credits**	**Evaluation Scheme (Percentage weights)**					**Pre-requisites**
							Theory			**Practical**		
							CA	**MS**	**ES**	**CA**	**ES**	
BTC221*	CC	Training	-	-	-	2	-	-	-	40	60	None
BTC232*	CC	Project-I	0	0	4	4	0	0	0	40	60	None
3*	ED/EG/EO	Elective(s)	-	-	-	-	-	-	-	-	-	-
			4*			**6 – 28 5***						

1*: The Training undertaken by students during the Summer vacation after VI Semester will be evaluated as a VII Semester subject during end-semester examination.

2*: Project work is based on the students' ability to understand, design and implement the fundamental concepts of the basic sciences, mathematics, engineering subjects and human values.

3*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4-6. The course code will depend upon student's choice of elective.

4*: The actual weekly load will depend upon the elective choices of the student.

5*: A student may register for courses leading to a minimum of 6 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

B.E. BIOTECHNOLOGY-SEMESTER VIII												
Course No.	Type	Subject	L	T	P	Credits	Evaluation Scheme (Percentage weights)					Pre-requisites
							Theory			Practical		
							CA	MS	ES	CA	ES	
BTC241*	CC	Project-II	0	0	4	4	0	0	0	40	60	None
2*	ED/EG/EO	Elective(s)	-	-	-	-	-	-	-	-	-	-
			3*			4 – 28						

1*: Project work is based on the students' ability to understand, design and implement the fundamental concepts of various basic sciences, mathematics, human values and engineering subjects.
2*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4-6. The course code will depend upon student's choice of elective.
3*: The actual weekly load will depend upon the elective choices of the student.
4*: A student may register for courses leading to a minimum of 4 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

TABLE - 3 LIST OF FOUNDATION ELECTIVES

Code	Name of Foundation Elective	LTP Allocation			Evaluation Scheme					Pre-Requisites
					Theory			Practical		
		L	T	P	CA	MS	ES	CA	ES	
FE001	Sports-I	0	0	4	-	-	-	60	40	None
FE002	Sports-II	0	0	4	-	-	-	60	40	FE001
FE003	NSS	0	0	4	-	-	-	60	40	None
FE004	NCC	0	0	4	-	-	-	60	40	None
FE005	Corporate Social Responsibility	2	0	0	25	25	50	-	-	None
FE006	Environmental Sciences	2	0	0	25	25	50	-	-	None
FE007	Environment development and Society	2	0	0	25	25	50	-	-	None
FE008	Spoken Skills in English	2	0	0	25	25	50	-	-	None
FE009	Financial Literacy	2	0	0	25	25	50	-	-	None
FE010	Introduction to Indian society	2	0	0	25	25	50	-	-	None
FE011	Soft Skills and Personality Development	1	0	2	-	-	-	60	40	None
FE012	Business Communication and Presentation Skills	1	0	2	-	-	-	60	40	None

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

FE013	Theatre	0	0	4	-	-	-	60	40	None
FE014	Dance	0	0	4	-	-	-	60	40	None
FE015	Yoga	0	0	4	-	-	-	60	40	None
FE016	Digital Film Making	0	0	4	-	-	-	60	40	None
FE017	Workshop (Electrical and Mechanical)	0	0	4	-	-	-	60	40	None
FE018	Music	0	0	4	-	-	-	60	40	None
FE019	Sociology of development	2	0	0	25	25	25	-	-	None
FE020	Universal Human Values 1: Self and Family	2	0	0	25	25	50	-	-	None
FE021	Universal Human Values 2: Self Society and Nature	2	0	0	25	25	50	-	-	FE020

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

TABLE 4A: LIST OF DISCPLINE CENTRIC ELECTIVES WITH PRACTICAL							
LTP Allocation			**Evaluation Scheme**				
			Theory			**Practical**	
L	**T**	**P**	**CA**	**MS**	**ES**	**CA**	**ES**
3	**0**	**2**	**15**	**15**	**40**	**15**	**15**
Code	**Name of Elective**		**Pre-Requisites**				
BTD01	Biology of Infectious Diseases		BTC05, BTC07, BTC12				
BTD02	Microbiome and Metagenome		BTC05, BTC14				
BTD03	Nanobiotechnology		BTC01, BTC04, BTC10				
BTD04	Cell & Tissue Engineering		BTC07,BTC20				
BTD05	Molecular & Cellular Diagnostics		BTC05, BTC10				
BTD06	Anatomy and Physiology		BTC05, BTC07				
BTD07	Fuel Cell Technology		BTC09, BTC10,				
BTD08	Computational Biology		BTC05, BTC08, BTC16				
BTD09	Environmental Biotechnology		BTC04, BTC06				
BTD10	Bioremediation & Waste Management		BTC06, BTC19				

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

TABLE 4B: DISCPLINE CENTRIC ELECTIVES WITH TUTORIAL							
LTP Allocation			Evaluation Scheme				
L	T	P	CA	MS	ES	CA	ES
3	1	0	25	25	50	-	-
Code	Name of Elective		Pre-Requisites				
BTD31	Neurobiology		BTC05, BTC07				
BTD32	Chemical Reaction Engineering		BTC09, BTC17				
BTD33	Bioelectronics		BTC01, BTC07				
BTD34	Pharmaceutical Chemistry		BTC02, BTC05				
BTD35	Drug Design, Development & Delivery		BTC02, BTC05				
BTD36	Metagenomics and Metabolomics		BTC05, BTC14				
BTD37	Biosafety & Hazard Management		BTC06, BTC07				
BTD38	Bioenergy Fundamentals		BTC06, BTC09				
BTD39	Epigenetics		BTC11, BTC14				
BTD40	Biomechanics		BTC05, BTC07, BTC10				
BTD41	Systems Biology		BTC11, BTC16				
BTD42	Bioprocess Plant Design		BTC17, BTC19				

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

TABLE 5 : GENERIC ELECTIVES (EG)
A STUDENT MAY TAKE ANY COURSE OFFERED BY ANY DEPARTMENT OF THE INSTITUTE UNDER THE CATEGORIES OF CORE COURSE (CC) AND DISCIPLINE CENTRIC ELECTIVE (ED). HOWEVER, SUCH OPTIONS SHALL BE OFFERED TO A STUDENT AS PER PRESCRIBED GUIDELINES OF THE INSTITUTE

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

TABLE 6 : LIST OF OPEN ELECTIVES

Code	Name of Open Elective	LTP Allocation			Evaluation Scheme					Pre-Requisites
					Theory			Practical		
		L	T	P	CA	MS	ES	CA	ES	
EO001	Technical Communication	3	1	0	25	25	50	-	-	None
EO002	Disaster Management	3	1	0	25	25	50	-	-	None
EO003	Basics of Finance Management	3	1	0	25	25	50	-	-	None
EO004	Basics of Human Resources Management	3	1	0	25	25	50	-	-	None
EO005	Project Management	3	1	0	25	25	50	-	-	None
EO006	Basics of Corporate Law	3	1	0	25	25	50	-	-	None
EO007	Biological computing	3	1	0	25	25	50	-	-	None
EO008	Basic of social sciences	3	1	0	25	25	50	-	-	None
EO009	Entrepreneurship	3	1	0	25	25	50	-	-	None
EO010	Social work	3	1	0	25	25	50	-	-	None
EO011	Intellectual Property and Patenting	3	1	0	25	25	50	-	-	None
EO012	Supply Chain Management-Planning and logistics	3	1	0	25	25	50	-	-	None
EO013	Organization Development	3	1	0	25	25	50	-	-	None
EO014	Industrial Organisation and Managerial Economics	3	1	0	25	25	50	-	-	None

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

EO015	Global Strategies and Technology	3	1	0	25	25	50	-	-	None
EO016	Engineering System Analysis and Design	3	1	0	25	25	50	-	-	None
EO017	Biology for Engineers	3	1	0	25	25	50	-	-	None
EO018	Energy, Environment and Society	3	1	0	25	25	50	-	-	None
EO019	Public Policy and Governance	3	1	0	25	25	50	-	-	None
EO020	Mathematics –IV, Numerical Methods	3	0	2	15	15	40	15	15	None
EO021	Mathematics –V, Mathematical Statistics	3	1	0	25	25	50	-	-	None
EO022	Mathematics – VI, Abstract and Linear Algebra	3	1	0	25	25	50	-	-	None
EO023	Mathematics – VII, Optimization Techniques	3	1	0	25	25	50	-	-	None
EO024	Mathematics – VIII, Introduction to Mathematical Software and Programming Languages	3	0	2	15	15	40	15	15	None
EO025	Mathematics – IX, Mathematical Finance	3	1	0	25	25	50	-	-	None
EO026	Quantum Electronics	3	0	2	15	15	40	15	15	None
EO027	Laser Systems and Applications	3	0	2	15	15	40	15	15	None
EO028	Optoelectronics and Photonics	3	0	2	15	15	40	15	15	None
EO029	Electromagnetic Theory and Waveguide	3	0	2	15	15	40	15	15	None

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

EO030	Polymer Science and Technology	3	0	2	15	15	40	15	15	None
EO031	Semiconductor Physics and Devices	3	0	2	15	15	40	15	15	None
EO032	Elements of Fibre Optics	3	0	2	15	15	40	15	15	None
EO033	Material Physics	3	0	2	15	15	40	15	15	None
EO034	Advanced Electromagnetic Theory and Relativity	3	0	2	15	15	40	15	15	None
EO035	Fibre and Integrated Optics	3	0	2	15	15	40	15	15	None
EO036	Condensed Matter Physics	3	0	2	15	15	40	15	15	None
EO037	Microwave	3	0	2	15	15	40	15	15	None
EO038	Fundamentals of Instrumentation and experimental techniques in Physics	3	0	2	15	15	40	15	15	None
EO039	Lasers and Photonics	3	0	2	15	15	40	15	15	None

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SYLLABUS OF FOUNDATION CORE COURSES

Course No.	Title of the Course	Course Structure	Pre-requisite
FC001	Mathematics - I	3L - 1T - 0P	None

COURSE OUTCOMES (COs):

By the end of this course, the student will be able to

1. Analyze and test infinite series for its convergence.
2. Find Taylor's series expansion, maxima & minima of functions of one and more variables.
3. Calculate length, area, radius of curvature, surface of revolution and volume of revolution.
4. Calculate area of a given region and volume enclosed by a surface.

COURSE CONTENT:

Infinite Series: Tests for convergence of series (Comparison, Integral, Ratio's, Raabe's, Logarithmic and nth root,), Alternating series, Absolute convergence, Conditional convergence.

Function of Single Variable: Hyperbolic functions, Taylor's and Maclaurin's theorems with remainder terms, Polar Curves, Angle between tangent and radius vector, Curvature and Radius of Curvature, Asymptotes, Curve tracing, Applications of definite integral to area, arc length, surface area and volume of revolution (in Cartesian, parametric and polar co-ordinates).

Function of Several Variables: Partial Derivatives, Differentiability, Total differential, Euler's theorem, Jacobian, Taylor's theorem, Maxima and Minima for functions of two or more variables, Extreme values, Lagrange's method of undetermined multipliers, Differentiation under the integral sign.

Multiple Integrals: Evaluation of double integral (in Cartesian and polar co-ordinates) change of order of integration, integration by change of variables and its applications in area, mass, and volume. Triple integral (in Cartesian, cylindrical and spherical co-ordinates) and its application in volume.

SUGGESTED READINGS:

1. G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", Pearson Education.
2. R. K. Jain and S. R. K. Iyenger, "Advanced Engineering Mathematics", Narosa.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley.
4. Michael Greenberg, Advanced Engineering Mathematics", Pearson Education.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
FC002	Computer Programming	3L - 0T - 2P	None

COURSE OUTCOMES (COs):

1. To understand the basic terminology program structures used in computer programming to solve real world problems.
2. To learn the process of representing problems and writing, compiling and debugging programs.
3. To develop programming skills in using different types of data, decision structures, loops functions, pointers, data files and dynamic memory allocation/de-allocation.
4. To understand the need for continuing to learn new languages to solve complex problems in different domains.

COURSE CONTENT:

C Programming Language

Thinking like a programmer: problem solving. Components of a problem, algorithm, checking for errors and inconsistencies, writing a pseudocode.

Boolean Logic: Binary Number systems and codes and operations.

Introduction to programming& Basics of C: Concepts of Algorithm and Flowcharts, Process of compilation, Basic features of C Language like Identifier, Keywords, Variable, data types, Operators and Expression, basic screen and keyboard I/O, Control Statements, iteration, nested loops, Enumerated data types, bitwise operators, C Preprocessor statements.

Arrays and Pointers: One and multidimensional dimensional arrays, strings arrays, operations on strings, Array and Pointers, Pointers and strings, Pointer to Pointer, other aspect of pointers,User Defined Data Types: Structures, Unions, bit fields.

Functions: Concept of modular programming, Using functions, Scope of data, Recursive functions, Pointers and functions, Command line arguments.

Linked List: Dynamic memory allocation, singly link list, traversing, searching, insertion, and deletion.

Files: Types of files, working with files, usage of file management functions.

C++ Programming Language

Moving from C to C++: Concepts of Object Orientation, Objects, classes, encapsulation, data abstraction, inheritance, delegation, and software reuse. Inheritance visibility rules using public, private, protected, member functions: Constructors / destructors, operator (::), accessing member functions within a class, new, delete.

Friend functions and classes, static data and functions, function templates, pointers within a class, passing / returning objects as arguments.

Functions Polymorphism – virtual functions, function overloading, variable definition at the point of use, reference variables, strict type checking, default arguments, type conversion.

Exception handling, streams based I/O.

Trends: Kinds of programming languages.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Guidelines for practical work based on programming concepts:

Programs for temperature conversion, area of triangle, counting frequencies of letters, words to understand the basic data types, input-output, control flags.

Programs for decision making using selection, looping, processing of arrays for sorting, searching, string manipulations, matrix operations.

Programs for parameter passing to functions, returning values, interactions among functions, pointer with arrays, strings, call by reference.

Programs using structure, pointers and files for linked lists, inventory management etc.

Program using bit wise operators to simulate the combinational circuits.

Program showing the concept of objects, access specifiers and inheritance.

SUGGESTED READINGS:

1. B. W. Kernighan and D.M. Ritchie, "The C programming language", Prentice Hall.
2. Herbert Schildt, "C: The Complete Reference", Tata McGraw Hill.
3. Yashwant Kanitkar, "Let us C", BPB Publication.
4. Byron Gottfried, "Schaum's Outline of Programming with C", Tata McGraw Hill.
5. Budd, "Object Oriented Programming", Addison Wesley.
6. D Samantha, "Object oriented Programming in C++ and Java", PHI.
7. Stroustrup, "Programming in C++", Special Edition, Addison Wesley.

Course No.	Title of the Course	Course Structure	Pre-requisite
FC003	**Electrical and Electronics Engineering**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To understand the basic concepts of magnetic, AC & DC circuits
2. To learn the basics of semiconductor diodes, BJTs
3. Will be able to analyze basic electrical and electronic circuits

COURSE CONTENT:

D.C. Circuits and Theorems: Ohm's Law, KCL, KVL Mesh and Nodal Analysis, Circuit parameters, energy storage aspects, Superposition, Thevenin's, Norton's, Reciprocity, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta Transformation. Application of theorem to the Analysis of dc circuits.

A.C.Circuits: R-L, R-C, R-L-C circuits (series and parallel), Time Constant, Phasor representation, Response of R-L, R-C and R-L-C circuit to sinusoidal input Resonance-series and parallel R-L-C Circuits, Q-factor, Bandwidth.

Magnetic Circuits: Magnetomotive Force, Magnetic Field Strength, Permeability, Reluctance, Permeance, Analogy between Electric and Magnetic Circuits.

Semiconductor Diodes and Rectifiers: Introduction, general characteristics, energy levels, extrinsic materials n & p type, ideal diode, basic construction and characteristics, DC & AC

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

resistance, equivalent circuits, drift & diffusion currents, transition & diffusion capacitance reverse recovery times, temperature effects, diode specifications, different types of diodes (Zener, Varactor, Schouky, Power, Tunnel, Photodiode & LED), Half wave & full wave rectifiers. Switched Mode Power Supply.

Bipolar junction transistor: Introduction, Transistor, construction, transistor operations, BIP characteristics, load line, operating point, leakage currents, saturation and cut off mode of operations, Eber-Moll's model.

Bias Stabilization: Need for stabilization, fixed bias, emitter bias, self bias, bias stability with respect to variation in I_{co} V_{BE} & β, Stabilization factors, thermal stability.

SUGGESTED READINGS:

1. Vincent Del Toro, "Electrical Engineering Fundamentals"
2. Mittle and Mittal, "Basic Electrical Engineering", TMH.
3. Boylestad and Nashelsky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson.
4. Millman & Grabel, "Microelectronics", TMH.

Course No.	Title of the Course	Course Structure	Pre-requisite
FC004	Physics	3L - 0T - 2P	None

COURSE OUTCOMES (COs):

1. Knowing important concepts and phenomena linked to relativity, waves and oscillations and be able to do analytical and numerical calculations for faithful measurements, observations and gravitational wave communications.
2. The course is helpful to the students in understanding various optical wave phenomena which are required for optical & electromagnetic wave communications and in optical devices.
3. Concepts of Laser and Optical Fiber for modern developments in physics which are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics.

COURSE CONTENT:

Relativity: Special Relativity**,** Lorentz Transformations, Velocity addition, Time dilation, Length Contraction, Variation of mass with velocity, Mass and energy, Relativistic momentum and relativistic energy, General theory of relativity, Einstein's theory of Gravitation, Gravitational waves, Gravity and Light.

Oscillations and Waves: Damped and forced oscillations, Sharpness of resonance, Q-factor, Application in resonance, Acoustic waves, Pressure wave equations, Intensity pressure relation, Acoustic impedance, Reflection and transmission of acoustic waves, Impedance matching, Ultrasonics and its applications.

Optics: Interference: Interference due to thin films, Newton's rings, and determination of the wavelength of sodium light, Interference due to wedge shaped film. Diffraction: Fraunhofer diffraction due to single slit and N Slits, Plane transmission grating, Rayleigh criterion of resolution, Resolving power of a grating, Polarization: Polarization in light, Birefringence, Nicol

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

prism, Quarter and half wave plates, Production and analysis of plane, Circularly and elliptically polarized light, Optical rotation, specific rotation, Polarimeter.

Quantum Theory of Light: Hertz's Experiments- Light as an Electromagnetic Wave, Blackbody radiation, Light Quantization, Compton Effect, X-rays.

LASERS : Absorption and emission of radiation, Main features of a laser, Spatial and temporal coherence, Einstein Coefficients, condition for light amplification, Basic requirement for Laser, Population Inversion - Threshold Condition, Line shape function , Optical Resonators , Three level and four level systems. Classification of Lasers: Solid State Laser-Ruby laser and Gas Laser-He-Ne laser (Principle, Construction and working), Optical properties of semiconductor, Semiconductor laser (Principle, Construction and working), Applications of lasers in the field of medicine, Industry, Environment and Communication.

Fibre Optics : Need for fiber Optic Communication, Physical nature of Optical fiber, Theory of Light propagation in optical fiber, Acceptance angle and numerical aperture, Step index and graded index fibers, Single mode and multimode fibers, Losses in optical fiber, Optical Fiber cables and bundles, Dispersion in optical fibers: Intermodal and Intramodal dispersion.

TERM WORK Experiments: Any ten experiments based on the theory course or related subject as above. For examples : Wavelength by diffraction grating, Newton's rings experiments and bi-prism assembly, resolving power of a Telescope, Nodal-Slide assembly , specific rotation of cane sugar by Polarimeter, dispersive power of Prism, Wavelength of He-Ne laser by diffraction, refractive index for O-ray and E-ray, Brewester's law, Ultrasonic interferometer, numerial aperture of an optical fibre, other experiments based on LASER and optical fiber.

SUGGESTED READINGS:

1. Arthur Beiser and Shobhit Mahajan, "Concepts of Modern Physics", McGraw Hill.
2. Serwey, Moses, and Moyer, "Modern Physics", Cengage Learning
3. D S Mathur, "Mechanics", S Chand & Co.
4. Jenkins and White, "Fundamentals of Optics", McGraw Hill.
5. N. Subramaniam and Brij Lal, "A Text Book of Optics", S Chand.
6. Indu Prakash, "A Text Book of Practical Physics, Volume-1", Kitab Mahal Publication.

Course No.	Title of the Course	Course Structure	Pre-requisite
FC005	English – I	2L - 0T - 0P	None

COURSE OUTCOMES (COs):

1. The course will focus on the four integral skills of language, improving the proficiency levels in all of them and to learn to use language as a tool for effective communication.
2. This course will widen the understanding of the learners in all genres of literature (short stories, poetry, autobiographies..) with the help of expository pieces .
3. The course will strive to equip the learner with the ability to express oneself and be understood by others with clarity and precision, in both written and spoken forms.
4. This course will encourage creative use of language through translation, paraphrasing and paragraph writing.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Along with the above, the course will also build confidence and encourage the students to use a standard spoken form of English in order to prepare them to face job interviews, workplace and in higher studies.

COURSE CONTENT:

- Practice in dictation, punctuation and spellings, listening and reading comprehension.
- Practice with well formed sentences with stress on remedial grammar.
- Exercises in unseen comprehension, paraphrasing, paragraph writing & summarizing.
- Reinforcement in letter writing, preparing CVs, writing book reviews.
- Exposure to the nuances and usages of the language through newspapers and magazines as an exercise to be in line with current form of language used.
- Proficiency in spoken English with focus on confidence building and standard pronunciation through language lab sessions.

1. Sadat Hasan Manto: Toba Tek Singh,
2. Abdul Kalam: Wings of Fire (excerpts)
3. Jhumpa Lahiri: The Namesake (excerpts)
4. Khaled Hosseini: The Kite Runner (excerpts)
5. Mohan Rakesh: Halfway House

Language Skills

1. Dictation, punctuation and spellings, listening and reading comprehension.
2. Correspondence(formal & informal)
3. Reading editorials, columns, speeches & essays

SUGGESTED READINGS:

1. Margaret M Maison, “Examine Your English”

Course No.	Title of the Course	Course Structure	Pre-requisite
FC006	Mathematics – II	3L - 1T - 0P	None

COURSE OUTCOMES (COs):

By the end of this course, the student will be able to

1. Solve system of equations and know the concepts of eigenvalue and eigenvector.
2. Know the concepts of Ordinary Differential Equations and its applications.
3. Know the concepts of Special Functions.
4. Know the concepts of Laplace Transforms and its application to solve Differential Equations

COURSE CONTENT:

Matrices: Rank, inverse and normal form of a matrix using elementary transformations, consistency of linear system of equations, linear dependence/ independence, linear transformations, eigenvalues and eigenvectors of a matrix, Cayley-Hamilton theorem, diagonalization.

Ordinary Differential Equations: Second & higher order linear differential equation with constant coefficients, general solution of homogenous and non- homogenous equations, Euler-Cauchy equation, Application to mass- spring system and electrical circuits. Power series

method.

Special Functions: Beta and Gamma functions, Dirichlet's Integral. Legendre equation, Legendre polynomials and its properties, Bessel equation, and Bessel function of first kind and its properties, ber and bei functions.

Laplace Transforms: Basic properties, Laplace transform of derivatives and integrals. Laplace of periodic functions. Laplace transforms solution of IVP and simultaneous linear differential equations, unit step function, Dirac-Delta function. Inverse Laplace transform, Convolution theorem.

SUGGESTED READINGS:

1. 1. G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", Pearson Education.
2. R. K. Jain and S. R. K. Iyenger, "Advanced Engineering Mathematics", Narosa.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley.
4. Michael Greenberg, Advanced Engineering Mathematics", Pearson Education.

Course No.	Title of the Course	Course Structure	Pre-requisite
FC007	English – II	2L - 0T - 0P	None

COURSE OUTCOMES (COs):

1. The course will focus on the four integral skills of language, improving the proficiency levels in all of them and to learn to use language as a tool for effective communication.
2. This course will widen the understanding of the learners in all genres of literature (short stories, poetry, and autobiographies.) with the help of expository pieces.
3. The course will strive to equip the learner with the ability to express oneself and be understood by others with clarity and precision, in both written and spoken forms.
4. This course will encourage creative use of language through translation, paraphrasing and paragraph writing.
5. Along with the above, the course will also build confidence and encourage the students to use a standard spoken form of English in order to prepare them to face job interviews, workplace and in higher studies.

COURSE CONTENT:

Literature

1. Anton Chekov: The Bet
2. Guy de Maupassant: The Necklace
3. D H Lawrence: Odour of Chrysanthemums
4. R K Narayan: Malgudi Days
5. Sarojini Naidu: Bangle Sellers
6. Rupert Brooke: The Soldier/Siegfried Sassoon: Suicide in the Trenches

Language Skills

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

1. Translation, paragraph writing, paraphrasing, summarizing,
2. Comprehension
3. Presentations/book reviews/reading exercises

SUGGESTED READINGS:

1. Martin Hewing, “Advanced English Grammar”
2. Meenakshi Raman & Sangeeta Sharma, “Technical Communication”
3. Renu Gupta, “A Course in Academic Writing”

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SYLLABUS OF CORE COURSES

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC01	Physics of Material	3L - 0T - 2P	None

COURSE OUTCOMES (COs):

1. Students will know the fundamental science and engineering principles relevant to materials.
2. Students will understand the relationship between nano/microstructure, characterization, properties and processing and design of materials.
3. Students will have the experimental and computational skills for a professional career or graduate study in materials.
4. Students will possess knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.

COURSE CONTENT:

Crystal Structures, Imperfections and Bonding in Solids - Bravais lattice, Miller indices, Simple crystal structures, Packing fraction, Different kinds of bondings, Types of imperfections, Effect of imperfections, Point defects, Edge and Screw dislocations, Berger's vector, Crystal growth-Introduction.

Fundamental of Quantum Mechanics:

Matter Waves and de-Broglie Hypothesis, Uncertainty Principle, Wave Packets, Interpretation of Wave function, Schroedinger's Wave Equation, Simple Eigen value Problems and degeneracy.

Classical and Quantum Theory of Metals: Free electron model, Energy distribution of electrons in a metal, Fermi Dirac Probability function, Fermi level, Conduction process,

Band Theory of Solids : Isolated- Atom Approach to Band Theory, Bloch theorem, Kronig - Penney Model, Effective mass of an electron, conduction in metals, semiconductors and insulators , Energy band diagram.

Semiconductors: Carrier concentration in intrinsic and extrinsic semiconductors, effect of temperature and impurity on conductivity, life time, recombination process, Hall Effect, drift and diffusion, compensated semi conductors. Semiconductor devices: junction transistor, FET and IC.

Dielectric Materials: Dielectric polarization, types of polarization, local electric field, Clausius-Mossotti relation, Debye's equation and molecular structure, dielectric breakdown, piezoelectricity, ferroelectricity, electrats, ceramics, effect of frequency and temperature on polarization.

Magnetic Materials: Ferromagnetism, Antiferro, Ferri-ferro magnetism, ferrites, magnetic storage,

Superconductors: Types of superconductors, Meissner effect, BCS theory, Josephson's effect, London penetration depth, high temperature superconductors, future applications.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Introduction to Nanoscience and Nanotechnology: Basic principles, Preparation of nano-materials, Properties of nanoparticles, Types of nanomaterials, quantum well, quantum wire and quantum dots, carbon nanotubes–structure, properties and uses, applications of nanotechnology.

PRACTICAL:

1. Spectroscopic analysis of microstructures.
2. Thermal analysis
3. Electronic and magnetic measurements
4. Tensile strength
5. Thermal activation.
6. Semiconductor in equilibrium
7. Nonequilibrium excess carriers in semiconductors
8. PN junction and PN junction diode

SUGGESTED READINGS:

1. A. Bieser, "Concepts of Modern Physics", McGraw Hill.
2. John Allison, "Electronic Engineering Materials and Devices", Tata McGraw Hill.
3. C Kittel, "Solid State Physics", Wiley.
4. A J Dekker, "Electronic Engineering Materials", Prentice Hall.
5. LH Van Vlack, "Elements of Material Science and Engg.", Addision Wesley.
6. A.S. Vasudeva, "Modern Engineering Physics", S Chand.
7. CP Poole and FJ Owens, "Introduction to Nanotechnology", Wiley.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC02	**Advance Chemistry**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To learn organic reaction mechanism
2. To understand the stereochemistry of organic compounds
3. To know about tautomerism, pericyclic reactions, etc.
4. To get an idea of non-benzenoid aromatic system
5. To perform organic analysis experimentally to learn detection of elements, functional groups, etc.
6. To determine melting and boiling points of organic compounds, preparation of derivatives.

COURSE CONTENT:

Reaction mechanisms – Nucleophilic and electrophilic aliphatic and aromatic substitution reactions, elimination reactions, inductive effect, electromeric effect, mesomeric effect, hyperconjugation

Reaction Intermediates- biradicals, enamines, carbenes, nitrenes, benzyne and their reactions, energetics of organic reactions.

Alicyclic compounds –classification, synthesis of alicyclic compounds, physical and chemical

properties, Baeyer's strain theory, strainless or puckered theory, relative stability of chair and boat form, relative stability of cycloalkanes in terms of M.O. theory, medium ring compounds, large ring compounds, natural compounds with large rings (civetone and muscone)

Stereochemistry – Enantiomers, diastereomers, fischer projection formula, optical isomerism in compounds containing no chiral carbon atom, racemic modification, resolution of racemic modification, asymmetric synthesis, stereochemistry and reaction mechanism, relative and absolute configuration, modern interpretation of geometrical isomerism, interconversion of geometrical isomers, stereochemistry of cycloparaffins, stereochemistry of nitrogen, phosphorous, sulphur and arsenic compounds.

Tautomerism- Classification, dyad system, triad system, ring chain tautomerism, valence tautomerism.

Conformational analysis –Conformations, conformations of ethane, substituted ethanes, cyclohexane, substituted cyclohexanes, cyclohexene, cyclohexanone, fused ring compounds, other ring systems, conformations and chemical reactivity of acyclic compounds and cyclic compounds.

Pericyclic reactions -Mechanism and stereochemistry of pericyclic reactions, types of pericyclic reactions (cycloadditions, electrocyclic reactions, sigmatropic rearrangements), (4+2) cycloadditions, (2+2) cycloadditions, electrocyclic reactions, woodward Hoffmann rule and orbital symmetry, sigmatropic rearrangement.

Non benzenoid aromatic system-Ferrocene, fulvene, tropylium cation, tropone and tropolone, azulene, annulenes, heterocyclic compounds, sydnones.

PRACTICAL:

1. Qualitative organic analysis - Analysis of binary organic mixtures- Tests with the mixture, Separation of the mixture, Purification of the separated compounds, Identification of components.
2. Qualitative organic analysis - Element detection, Detection of functional groups, Determination of melting and boiling points, Specific or confirmatory tests, Preparation of suitable derivatives.
3. Quantitative organic analysis - Estimation of sulphur, nitrogen, halogens, aniline, glycine, phenol, glucose, determination of molecular weight.
4. Chemical hydrolysis of a protein, carbohydrate, lipid and characterization of the products.

SUGGESTED READINGS:

1. A. Zlatkis, "A Concise Introduction to Organic Chemistry", McGraw Hill.
2. P. Sykes, "A Guide Book to Mechanism in Organic Chemistry", Longmans.
3. J. March, "Advanced Organic Chemistry-Reactions, Mechanisms and Structure", McGraw Hill.
4. D.E. Applequist, C.H. Depuy and K.L.Rinehart, Jr., "Introduction to Organic Chemistry by Publisher", John Wiley and Sons Inc.
5. F.A. Carey and R.J. Sundberg, "Organic Chemistry", Plenum Publishing Corporation.
6. J. B. Hendrickson, S.H. Pine, D.J. Cram and G.S. Hammond, "Organic Chemistry", McGraw Hill.
7. R.T. Morrison and R.N. Boyd, "Organic Chemistry", Prentice Hall College Division.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

8. B. Miller, "Organic Chemistry: The Basis of Life", Addison-Wesley Publishing Company.
9. F.G. Mann and B.C. Saunders, "Practical Organic Chemistry", Longman.
10. A.I. Vogel, B.S. Furniss, and A.R. Tatchell, "Vogel's Textbook of Practical Organic Chemistry", Addison-Wesley Publishing Company.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC03	**Biostatistics**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To understand the application of probability and statistics in biology
2. To know about different distribution
3. To understand the concept of least square method
4. To understand the correlation and regression analysis
5. To understand about sampling theory

COURSE CONTENT:

Random Variable, Moments, Rectangular distribution, Exponential distribution, Beta distribution of first and second kind, Gamma distribution, Marginal and Conditional probabilities, Tchebycheff's and Markov's inequalities, Important theoretical Distributions: Binomial, Poisson, Normal and Multinomial distributions and their properties, Fitting of Normal Distribution by Method of ordinates and Method of areas, Dirichlet distribution, Moment Generating Functions and Cumulants, Weak Law of Large Numbers, Central Limit Theorem.
Method of least square: Fitting a straight line, Parabola and Exponential Curves.
Bivariate distribution: Correlation and Regression, Probable Error, Rank Correlation.
Simple sampling of Attributes: Large samples, Mean and S.D. in simple sampling of attributes, Test of significance for large samples, Standard error, Null Hypothesis, Confidence Limits, Chi-Square Distribution, Degree of Freedom, m. g. f. of Chi square distribution, Level of Significance, Test of Goodness of Fit, Test of Independence, Coefficient of Contingency, Yate's Correction for Continuity.
Sampling of Variables: Small samples, t-Distribution, Test of significance of the mean of random sample from Normal population, F-Distribution, ANOVA: Analysis of variance, meaning and definition, Variance within and between classes, One criterion of Classification and problems based on it.

SUGGESTED READINGS:

1. Walpole, et al., "Probability and Statistics for Engineers and Scientists", Prentice Hall, Inc.
2. Ross, S.M "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press.
3. Curtis, F. et al., "Applied Numerical Analysis", Pearson Education Ltd.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC04	**Introduction to Biotechnology**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To gather an idea of biotechnology from historical practices as well as day to day activities
2. To be able to appreciate the highly sophisticated nature of science and engineering involved in designing a living system
3. To be able to understand immense potential of biological information for generating innovative products and services for varied applications
4. Learning the concepts in manipulation of biological information or engineering new / novel information for novel applications
5. Understanding the nature's way of doing genetic engineering
6. To be able to use biotechnology in various fields, like, health, food, agriculture and medicine
7. Learning the importance of ethics and regulatory issues while practicing biotechnology

COURSE CONTENT:

History and Scope: Historical perspectives, Biotechnology as an integrated discipline, its applications and future directions.

Overview of Living Systems: Cell as unit of life, organization and function, source for biomaterials.

Understanding Biological Information: Nature of biological information, its storage, maintenance and propagation, engineering of biological information

Biological variation: Mutation, recombination and adaptation, Concept of evolution.

Commercial applications: Biotechnology in industry, food & agriculture, health & medicine and environment

Ethical and regulatory issues

SUGGESTED READINGS:

1. B.L. DeVere, "Agriscience and Technology", Delmar Publishers.
2. Walter and York, "Agriscience Fundamentals and Applications", Delmar Publishers.
3. E.S. Grace, "Biotechnology Unzipped", Joseph Henry Press/ National Academy Press.
4. S. R. Barnum, "Biotechnology: An Introduction", Wadsworth Publishing Company.
5. D. Bourgaize, T.R. Jewell and R.G. Buiser, "Biotechnology-Demystifying the Concepts" Addison-Wesley Longman.
6 H.F. Judson, "Eighth Day of Creation: Makers of the Revolution in Biology", Cold Spring Harbor Laboratory.
7. R. L. Montalcini, "In Praise of Imperfection", Basic Books.
8. J.D. Watson and J. Steitz, "Molecular Biology of the Gene", Addison-Wesley Publishing.
9. Principles of Biotechnology - http://www.biotech.iastate.edu/biotech_info_series/bio1.html
10. J. D. Watson, "The Double Helix: A Personal Account of the Discovery of the Structure of DNA", Touchstone Books.
11. L. Thomas, "The Lives of a Cell: Notes of a biology watcher", Penguin USA.
12. R. V. Herren, "The Science of Agriculture, A Biological Approach", Delmar Publishers.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

13. K. R. Miller and J. Levine, "Biology", Prentice Hall.
14. K. Drlica, "Understanding DNA and Gene Cloning", Wiley and Sons Company.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC05	**Biochemistry**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To develop the concept of chemical basis for the working of biomolecules
2. To develop an understanding of types and properties of biomolecules
3. To develop an understanding of structure and function of various biomolecules
4. To learn basic concepts in enzyme structure and function
5. To learn structure and properties of nucleic acids
6. Understanding the scientific basis and techniques for separation of biomolecules
7. The students will have an understanding of the laws of thermodynamics and the nature of energy transactions in biological systems.
8. The students will learn about the catabolic and anabolic pathways of carbohydrate metabolism and will be able to understand the cause of metabolic disorders associated with carbohydrate metabolism.

COURSE CONTENT:

Chemical foundations of Biology – Properties of water, acids, bases and buffers**,** covalent bonds, Non-covalent interactions in biological systems.

Introduction to biomolecules -

Carbohydrates – Sugars, Polysaccharides, Glycoproteins - structure and function

Vitamins and Coenzymes

Lipids – classification, structure and function. Lipids and biological membranes Transport across cell membranes, Lipid linked proteins and lipoproteins.

Proteins - Amino acids and peptides – classification, chemical reactions and physical properties. Introduction to protein structure and function. Enzymes - Introduction to kinetic and catalytic mechanisms of enzymes, Regulation of enzyme activity, Effects of physical parameters on enzyme activity.

Nucleic acids – nitrogenous bases, nucleotides, types, structure and properties of nucleic acids Separation techniques for biomolecules.

Metabolism and bioenergetics - First and second law, free energy and chemical equilibrium, Organic reaction mechanisms, Design of metabolism - concept of ΔGO, ATP-ADP cycle. Cellular energy transactions – role of mitochondria and chloroplast

Carbohydrate metabolism – glycolysis pathway and reactions, Glycogen breakdown and synthesis, control of glycogen metabolism, glycogen storage and its disease

Citric acid cycle – Overview, Metabolic sources of Acetyl Co-A, enzymes and regulation, The amphibolic nature of the Citric acid cycle

Electron transport chain and oxidative photophosphorylation – mitochondrion and electron transport, phosphorylation and control of ATP production

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Gluconeogenesis, The glyoxylate pathway, Biosynthesis of Oligosaccharides and glycoproteins, Pentose phosphate pathway

PRACTICALS:

1. Preparation of solutions based on molarity, normality, percentage, dilutions etc.
2. Estimation of Mohr's salt/ oxalic acid by titrating with KMNO4.
3. Preparation and properties of different buffers.
4. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Mohlisch, Barfoed, Fehling, Tollen, Benedict, Selvinoff, Osazone, Bial'stests.
5. To determine the Iodine number of the given oil sample.
6. To find pKa value of given amino acid
7. Principles of Colorimetry**: (i)** Beer-Lambert law, (**ii)**. Estimation of protein concentration **(iii)** Estimation of nucleic acids concentration
8. Determination of p*I* of a given protein
9. Separation of Amino acids by paper chromatography.
10. Separation of Sugars and Bases by TLC.

SUGGESTED READINGS:

1. K. Wilson and K. H. Goulding, "A Biologist's Guide to Principles and Techniques of Practical Biochemistry", Print India.
2. I. H. Segal, "Biochemical Calculations", John Wiley and Sons.
3. C. K. Mathews, K. E. Van Holde and K.G. Ahern, "Biochemistry", Benjamin/Cummings.
4. L. Stryer, "Biochemistry", W.H. Freeman and Company.
5. "Devlin's Textbook of Biochemistry with Clinical correlations", John Wiley and SonsInc.
6. K. Robert, M. D. Murray, D. K. Granner, P. A. Mayes and V. I. Rodwell, "Harper's Biochemistry", McGraw-Hill/Appleton and Lange.
7. Work and Work, "Laboratory Techniques in Biochemistry and Molecular Biology", Elsevier Science.
8. A. L. Lehninger, D. L. Nelson, and M. M. Cox, "Principles of Biochemistry", Worth Publishing.
9. K. E. Van Holde and W. C. Johnson "Principles of Physical Biochemistry", Prentice Hall.
10. T. G. Cooper, "Tools of Biochemistry", John Wiley and Sons Inc.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC06	**Microbiology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To be able to appreciate the importance of thinking and working with an out-of-box approach in achieving scientific and technological breakthroughs
2. To gain knowledge and skills to innovate and design low-cost medium for microbial growth
3. To realize immense potential of microbes as a source for novel products and services to the society

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

4. To be able to gain knowledge and skills for characterization of microbes and recognizing their potential applications
5. Understanding interaction of the microbes with human, plants and environment to gain a better understanding of such processes so as to determine how these could be useful for the society

COURSE CONTENT:

Introduction and historical perspectives

Methods in Microbiology: Theory and practice of sterilization, Pure culture techniques, Enrichment culture techniques, methods of maintenance and preservation of pure cultures

Microbial nutrition and growth: Principles of microbial nutrition, Culture media, definition of growth, mathematical expression of growth, growth curve, measurement of microbial growth, synchronous growth, continuous culture, influences of environmental factors on growth, culture collection and maintenance of cultures

Prokaryotic structure and function – functional anatomy of bacteria: cell envelope, cell wall, cytoplasmic membrane, capsule, surface appendages, cytoplasm and cytoplasmic inclusions.

Microbial metabolism and Metabolic diversity: Role of ATP, reducing power and precursor metabolites in metabolism, biochemical mechanisms generating ATP, Fuelling reactions in aerobic heterotrophs, Fermentation, Photosynthesis, Chemolithotrophy, methanogenesis and acetogenesis, nitrogen fixation, hydrocarbon transformation

Microbial taxonomy: Introduction to microbial taxonomy, taxonomic ranks, techniques for determining microbial taxonomy and phylogeny, Bergey's manual of systematic bacteriology

Microbial diversity: Bacteria, Archaea, Eukarya: Algae, fungi, slime molds and protozoa. Viruses, viriods and prions

Microbial Interactions: Human Microbiome, Plant – Microbe interactions and plant microbiome, Microbes in Environment

Microbial applications: in medicine, food, agriculture and energy

PRACTICAL:

1. Microbiology Laboratory Practices and Biosafety.
2. Preparation and sterilization of culture media for bacterial cultivation
3. Aseptic techniques: preparation of plates, slants and stabs, inoculation techniques
4. Study of Cell morphology by using different staining techniques
5. Study of microbial diversity in samples from soil, air and water
6. Isolation of pure culture and study of colony characteristics
7. Biochemical Characterization and identification of pure cultures
8. Estimation of microbial growth and determination of growth rate
9. Factors affecting microbial growth

SUGGESTED READINGS:

1. M.T. Madigan, J.M. Martinko and J. Parker, "Brock Biology of Microorganisms", Prentice-Hall, Inc.
2. R.Y. Stanier, J.L. Ingraham, M.L. Wheelis and P.R. Painter "General Microbiology", Macmillan.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

3. S.R. Maloy, J.E. Cronan and J.D. Freifelder, "Microbial Genetics", Bartlett Publishers.
4. J.G. Cappuccino and N. Sherman, "Microbiology – A Laboratory Manual", Addison-Wesley.
5. H.J. Benson, "Microbiology Applications – A Laboratory Manual in General Microbiology", Wm C Brown Publishers.
6. M.J. Pelczar, E.C.S. Chan and N.R. Kreig, "Microbiology", Tata McGraw Hill.
7. R.M. Atlas, "Principles of Microbiology", Wm C. Brown Publishers.
8. P.V. Vandenmark and B.L. Batzing, "The Microbes – An Introduction to their Nature and Importance", Benjamin Cummings.
9. Roger Y. Stanier, "The Microbial World", Prentice Hall.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC07	Cell Biology	3L - 0T - 2P	None

COURSE OUTCOMES (COs):

1. Students will observe the cell doctrine and will understand that the cell is the basic structural and functional unit of life.
2. Students will learn that cells functions similarly in all living organisms and that the life is an orchestrated event of cellular organelles.
3. Students will understand the metabolic concepts and requirements for growth and reproduction.
4. The students will learn the implication of cell motility in physiology and different cellular processes such as growth, division, transport and metabolism.
5. Students will learn the biogenesis of various organs and cellular types including hematopoietic cells and will learn the concepts of stem cell biology for its application as regenerative medicine.
6. Students will learn different mechanisms of cell interaction and will understand the implication of defects in signal transduction pathways leading to several diseases such as diabetes, heart disease, inflammation and cancer.
7. The students will learn many aspects of tumour cell biology and programmed cell death and will learn the concepts which could be manipulated to obtain the cure for cancer.

COURSE CONTENT:

Introduction to Cell Biology: Historical developments, microscopy, cell theory, cell size shape and architecture

Cellular Organelles: Biogenesis of cellular organelles, cell wall and their structural organization, nucleus, endoplasmic reticulum, golgi bodies, lysosomes, mitochondria, chloroplasts, microbodies - organization, structure and function.

Cell Division: Cell Cycle, Mitosis, Meiosis, Regulation of cell cycle

Membrane Transport: Plasma membrane – Structure and function, Transport of small molecules and ions, bulk transport

Cell Signaling and Signal Transduction: General principles of cell signaling, receptors, types of receptors, cell to cell signalling: signaling via G-Protein-linked cell surface receptors, signaling

via Enzyme-linked cell-surface receptors, ion and voltage gated channels, Second messengers, Intracellular signaling

Cytoskeleton and Cell motility: Cytoskeleton proteins, Microtubules, Intermediate Filaments and Microfilaments – structure, composition and function. Cell motility, cilia, flagella of prokaryotes and eukaryotes

Apoptosis: Death domains, Direct Signal transduction, Caspases, mitochondrial regulation, apoptosome, Apoptosis in health and disease.

Cancer: Oncogenes, tumor suppressor genes, types of cancer, prevention and cure.

Recent developments in cell biology

PRACTICAL:

1. Development of a Working Knowledge of the Microscope and its Applications.
2. To study differential centrifugation for isolation of cellular organelles and their charactrization
3. To isolate chloroplast and confirm its identity using *in vitro* photosynthesis
4. To carry out vital staining of mitochondria in epithelial cells
5. To carry out differential staining of DNA and RNA in epithelial cells
6. To study different stages of Mitotic and Meiotic cell divisions
7. To prepare chromosome spread from kidney of a fish
8. To carry out amoeba culture as a model organism for studying membrane transport
9. To demonstrate the principle of pinocytosis using amoeba culture
10. To differentiate between apoptotic and necrotic cells
11. To carry out chromosomal analysis of neoplastic cells/tissue
12. To study characteristics of a cancer cell using cancerous cell line

SUGGESTED READINGS:

1. E.B. Wilson, “Cell in Development and Inheritance”, Macmilan.
2. S.F. Gilbert, “Developmental Biology”, Sinauer Associates Inc.
3. B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, “Essential Cell Biology: An Introduction to the Molecular Biology of the Cell”, Garland Publishers.
4. F.T. Longo, “Fertilization”, Chapman and Hall.
5. L.P. Freedman, “Molecular Biology of Steroid and Nuclear Hormone Receptors”, Birkhuser.
6. B. Alberts, D. Bray, J. Lewis, M. Roff, K. Roberts and J.D. Watson, “Molecular Biology of the Cell”, Garland Publishing Company.
7. H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore and J. Darnell, “Molecular Cell Biology”, W H Freeman and Company.
8. D.M Prescott, “Reproduction in Eukaryotic Cells”, Academic press.
9. Ethan Bier, “The Coiled Spring by. Publisher”, Cold Spring Harbor Press.
10. URL: http://www.cellbio.com

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC08	**Data Structure And Algorithms**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. Students will be able to understand the concepts of data structure, data type and array data structure.
2. Students will be able to analyze algorithms and determine their time complexity.
3. Students will be able to implement linked list data structure to solve various problems.
4. Students will be able to understand and apply various data structure such as stacks, queues, trees and graphs to solve various computing problems using C-programming language.
5. Students will be able to implement and know when to apply standard algorithms for searching and sorting.
6. Students will be able to effectively choose the data structures that efficiently model the information in a problem.

COURSE CONTENT:

Programming strategies – Objects and ADTs with example, Constructors and destructors, Data structure, methods, Pre and post conditions, C conventions, Error handling, Some programming language notes.

Data structures – Arrays, lists, stacks and stack frames, Recursion – Recursive functions with example of factorial.

Searching – Sequential and binary search, Trees, **Complexity** - Complexity (PS)

Queues – Priority queues and heaps, **Sorting** – Bubble, Heap, Quick, Bin, Radix

Searching revisited – Red-Black trees, AVL trees, General n-ary trees, hash tables,

Dynamic algorithm – Fibonacci numbers, binomial coefficients, optimal binary search trees, matrix chain multiplication, longest common subsequence, optimal triangulation.

Graphs – Minimum spanning tree and Djkstra's algorithm.

Huffman encoding FFT

Hard or intractable problems – Eulerian or Hamiltonian paths, Travelling salesman problem

PRACTICALS:

1. Stack implementation through arrays, link list
2. Programs for recursion functions
3. Implementation of queues and leap structures
4. Application of binary trees in pre-order, post-order and in-order evaluation
5. Implementation of hash tables in strings and sequences
6. AVL tree implementation
7. Implementation of optimal binary search
8. Optimal matrix multiplication
9. Computation of binary coefficients of an expression.
10. Finding the minimum spanning graph – depth first and breadth first.

SUGGESTED READINGS:

1. A.V. Aho, J.E. Hopcroft and J. Ullman, "Data Structures and Algorithms", Addison-Wesley

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Publishing.
2. P. Rob and E. Semaan, "Database Design, Development and Deployment with Student CD", McGraw-Hill/Irwin.
3. A. Silberschatz, P.B. Galvin and G. Gagne, "Database system concepts", John Wiley and Sons Inc.
4. J. Tremblay and P.G.Sorensen, "Introduction to Data Structures and Application", McGraw Hill College Division.
5. J.R. Hubbard, "Schaum's Outline of Data Structures with C++", McGrawHill Trade.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC09	**Chemical Enggineering Principles**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To understand the basic concepts of chemical engineering calculations
2. To learn the application of energy and mass balance in bioprocess
3. To become familiar with the concept of heat and mass transfer and their application in biotechnology
4. To learn the chemical reaction engineering principles
5. To understand the application of the various process techniques in the industrial scale bioprocess

COURSE CONTENT:

Engineering Calculations – Variables, Dimensions, Units and their conversions, Dimensional Homegeneity in Equations, Stoichiometry

Material and Energy Balances – General Mass balance equation, Different problems of material balance, Calculations involving unit processes and reactive systems, General Energy balance equation, enthalpy changes in chemical / biochemical reactions and in non-reactive processes, Energy balance calculations, Use of Steam tables, Heat of reaction and energy balance for microbial processes.

Chemical reaction engineering – Kinetics of homogenous reactions: Concepts of reaction rate, order of reaction and molecularity, Analysis of batch reactors for kinetic interpretation of data, Design equations for CSTR and plug flow reactors.

Instrumentation and process control – Principles of measurement: error, accuracy and sensitivity, Measurement of flow, pressure, temperature, level, pH, viscosity and chemical composition.

Basic concepts of feedback control, Controller hardware, Choice of controllers and settings. Introduction to advanced control systems

SUGGESTED READINGS:

1. D.M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering".
2. E.I. Shaheen, "Basic Principles of Chemical Engineering".

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

3. G. Stephanopoulos, "Chemical Process Control, An introduction to Theory and Practice".
4. O. Levenspiel, "Chemical Reaction Engineering".
5. J.F. Richardson and D.G. Peacock, "Coulson's and Richardson's Chemical Engineering".
6. R.M. Felder and R.W. Rousseau, "Elementary Principles of Chemical Processes"
7. C.D Holland and R.G.Anthony, "Fundamentals of Chemical Reaction Engineering".
8. W.L. Luyben, "Process Modelling, Simulation and Control for Chemical Engineers".

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC10	**Methods & Instrumentation In Biotechnology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To learn and apply the concept of modern analytical techniques in qualitative and quantitative biochemical analyses
2. To learn the experimental design and the application of statistical methods in the data analysis and interpretation of their significance
3. To be able to do the selection of an appropriate bioanalytical technique as per the experimental requirement and to justify the same
4. To be able to apply the bioanalytical techniques in multidisciplinary research as well as industrial operations
5. To become able to critically evaluate the merits and limitations of any analytical techniques

COURSE CONTENT:

Cell disruption Techniques, Dialysis and ultra filtration

Centrifugation Techniques: Viscosity and diffusion, Sedimentation equilibrium and sedimentation velocity methods, Analytical and Preparative centrifuges, application of density gradient and differential centrifugation.

Electrophoresis: Paper and gel electrophoresis, Immuno electrophoresis, isoelectric focussing, two - dimensional electrophoresis, capillary electrophoresis.

Chromatography: Paper, TLC gas chromatography, gel filtration, ion-exchange chromatography, affinity chromatography and HPLC, FPLC, adsorption and desorption.

Spectroscopies : UV and visible, spectrofluorimetry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Mossbauer, MALDITOF, ORD and Circular Dichorism, Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy, Magnetic Resonance Imaging.

Microscopy : Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Polarization and Fluorescence microscopy

Diffraction techniques - X - Ray diffraction, Electron diffraction, Neutron Diffraction.

Radioisotope Techniques: Radio tracers, GM Counter, Proportional and Scintillation Counters,

autoradiography, radio - immunoassay.

SUGGESTED READINGS:

1. J.F. Van Impe, "Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes", Kluwer Academic.
2. C.R. Cantor and P.R. Schimmel, "Biophysical Chemistry: The conformation of Biological Macromolecules", W.H. Freeman.
3. J.P. Glusker and K.N. Trueblood, "Crystal Structure Analysis", Oxford University Press.
4. G. Rhodes, "Crystallography made Crystal Clear", Academic Press.
5. B.D. Cullity, S.R. Stock and S. Stock, "Elements of X-Ray Diffraction" Prentice Hall College Division.
6. P. Narayanan, "Essentials of Biophysics", New Age International Publishers.
7. D.L. Pavia, G.M. Lampman and G. S. Kriz, "Introduction to Spectroscopy" Brooks Cole.
8. J. M. Hollas, "Modern Spectroscopy", John Wiley and Son Ltd.
9. J. L. McHale, "Molecular Spectroscopy", Prentice Hall.
10. H. Günther, "NMR Spectroscopy: Basic Principles, Concepts, and Applications in Chemistry", John Wiley and Sons Ltd.
11. D. Freifelder, "Physical Chemistry", Freeman
12. C. Tanford, "Physical Chemistry of Macromolecules", John Wiley and Sons Inc.
13. L. Que, "Physical Methods In Bioinorganic Chemistry: Spectroscopy and Magnetism", Junior University Science Books.
14. D.E. McRee and P.R. David, "Practical Protein Crystallography", Academic Press.
15. K.E. Van Holde, "Principles of Physical Biochemistry", Prentice Hall.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC11	**Molecular Biology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To learn basic concepts of molecular biology including genome, DNA, RNA.
2. To have an in depth understanding of mechanisms of DNA replication in both prokaryotes and eukaryotes and differentiate between them.
3. To describe mechanisms by which DNA is damaged and molecular events in different types of DNA repair mechanisms.
4. To understand key features of homologous recombination.
5. To have an in depth understanding of mechanisms of DNA transcription in both prokaryotes and eukaryotes and differentiate between them.
6. To understand post transcriptional modifications of RNA and concepts of splicing and editing.
7. To have an in depth understanding of mechanisms of translation in both prokaryotes and eukaryotes and differentiate between them.
8. To understand molecular mechanisms behind different modes of gene regulation and fundamental concepts of transposons and retrotransposons.
9. To understand concepts of antisense and ribozyme technology.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

COURSE CONTENT:

Introduction to Molecular Biology: Structure of DNA and RNA, Genome organization: from nucleotide to chromatin, cot analysis, melting curve of DNA

DNA Replication: DNA Topology, Mechanism of DNA replication in prokaryotic and eukaryotic systems, DNA repair and recombination: Halliday Junction, FLP/FRT and Cre/Lox recombination, Rec A and other recombinases

Transcription: Mechanism of transcription in prokaryotic and eukaryotic systems, Regulation of Transcription, transcriptional and post-transcriptional gene silencing

Modifications in RNA: 5'-cap formation, transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability

Translation: Genetic code, Prokaryotic and Eukaryotic translation, Regulation of translation, Co- and post-translational modifications of proteins

Antisense technology: RNA interference, Molecular mechanism of antisense molecules, Inhibition of spilicing, polyadenylation and translation, Disruption of RNA structure and capping, Ribozyme

PRACTICAL:

1. Preparation of solutions for Molecular Biology experiments
2. Determination of size of linear double stranded DNA fragment
3. Isolation of genomic DNA from bacteria, plant and blood cells
4. Agarose gel electrophoresis to visualize genomic DNA isolated from different sources
5. G+C content and denaturation - renaturation analysis of DNA
6. Isolation of total RNA from bacteria, plant and animal
7. Gel electrophoresis for visualization of RNA from isolation of different sources
8. Quantification and purity determination of DNA /RNA using UV-Visible Spectroscopy
9. *In-vitro* double stranded cDNA synthesis by using PCR
10. Native gel-elctrophoresis for protein
11. Protein gel-electrophoresis under denaturing conditions
12. Western-blotting of proteins

SUGGESTED READINGS:

1. B. Lewin, "Gene IX", Oxford University Press.
2. T.A. Brown, "Genomes", John Wiley and Sons Inc.
3. P.D. Dabre, "Introduction to Practical Molecular Biology", John Wiley and Sons Inc.
4. T.A. Brown, "Molecular Biology LabFax", Bios Scientific Ltd. Oxford.
5. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson, "Molecular Biology of the Cell", Garland Publishing.
6. J.D. Watson, A.M. Weiner and N.H. Hopkins, "Molecular Biology of the Gene", Addison-Wesley Publishing.
7. H. Lodish, A. Berk, S. Zipursky, P. Matsudaira, D. Baltimore and J.E Darnell, "Molecular Cell Biology", W.H. Freeman and Company.
8. J. Sambrook, E.F. Fritsch and T. Maniatis, "Molecular Cloning: A Laboratory Manual (3-Volume Set)", Cold spring Harbor Laboratory Press.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC12	Immunology	3L - 0T - 2P	None

COURSE OUTCOMES (COs):

1. To understand the basic concepts of innate and adaptive immunity and differentiate between them.
2. To have an in-depth understanding of roles and functions of various cells, organs and molecules involved in mediating immunity.
3. To learn the molecular features of antigens recognized by B and T cells.
4. To have an in-depth understanding of the mechanisms of cell mediated and humoral immunity.
5. To learn how monoclonal antibodies are produced and their uses in therapy and diagnosis.
6. To become familiar with some immunological techniques and their clinical applications.
7. To have an understanding of cellular and molecular events involved in regulation of immune responses.
8. To understand the mechanisms of hypersensitive reactions and transplantation.
9. To understand some examples of autoimmune diseases and their target specificities.

COURSE CONTENT:

Introduction: Introduction to immunity, Innate and acquired immunity, clonal nature of immune response

Cells and organs of the immune system: hematopoiesis and differentiation, B-Lymphocytes, T-Lymphocytes, monocytes, macrophages, dendritic cells, natural killer cells, neutrophils, eosinophils, basophils, mast cells, primary and secondary lymphoid organs

Antigens: Immunogen, Epitope, Hapten, Adjuvants

Antibody: Structure, Function, BCR, Generation of antibody diversity, Hyridoma technology - Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their application. Antibody Phage Display, Xenomouse Technology, Immunotoxins

Antigen Antibody interactions and Immunological Techniques: Antigen antibody reactions, Crossreactivity, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, Immunofluorescence, FACS

Major Histocompatibilty Complex and Antigen Presentation: Structure and function of MHC molecules, Self MHC restriction, Exogenous and Endogenous pathways of antigen procesing and presentation, TCR, T & B cell maturation, activation and differentiation

Immune Effector Mechanisms: Cytokines, Complement system, Cell and Antibody mediated immunity: mechanism of T cell and NK cell mediated lysis, macrophage mediated cytotoxicity, antibody dependent cell mediated cytotoxicity,

Hypersensitivity, Autoimmunity, Tissue and Organ Transplant, Vaccines

PRACTICAL:

1. To study different organs of immune system.
2. To determine the blood group type and Rh factor of a blood sample.
3. To study the immunodiffusion technique by Single Radial Immunodiffusion.

4. To study the reaction pattern of an antigen with a set of antibodies by Ouchterlony Double Diffusion method.
5. To learn the technique of Immunoelectrophoresis.
6. To learn the method of Counter Current Immunoelectrophoresis to rapidly check any antisera for the presence and specificity of antibodies for a particular antigen.
7. To detect the presence of *Salmonella* genus which causes enteric or Typhoid Fever by using qualitative slide agglutination test.
8. To detect the presence of Rheumatoid Factors (RF) which are produced during Rheumatoid arthritis.
9. To learn the technique of Dot ELISA for the detection of an antigen.
10. To determine the antigen concentration by Antigen Capture ELISA method.
11. To prepare blood smear and identify various cells.
12. Isolation of PBMCs and Magnetic Cell Separation.

SUGGESTED READINGS:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne, "Immunology, 6th Edition", Freeman.
2. Janeway et al., "Immunobiology, 4th Edition", Current Biology Publications.
3. Paul, "Fundamental of Immunology, 4th edition", Lippencott Raven

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC13	**Database Management Systems**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. Students will be able to master the basic concepts and understand the applications of database systems.
2. Students will be able to construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures.
3. Students will be able to understand the basic database storage structures and access techniques.
4. Students will be able to distinguish between good and bad database design, apply data normalization principles, and be aware of the impact of data redundancy on database integrity and maintainability.
5. Students will be able to construct queries and maintain a simple database using SQL.
6. Students will be able to apply database transaction management and database recovery.

COURSE CONTENT:

Overview and historical perspective - file systems vs. DBMS, advantages of DBMS,
Describing and storing data in DBMS – levels of abstraction and data independence, Data models and their comparison, Entity relationship model – concepts, design, keys and features,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Relational model – introduction, structure of the relational databases, integrity constraints, Relational algebra and calculus – selection and projection, set operations, renaming, Joins, Division etc.

SQL and Perl

Database design – Pitfalls in database design, decomposition, functional dependencies, Normal forms, Concurrency control and database discovery – concept of transaction: atomicity, consistency, isolation and durability, transactions and schedules, concurrent execution of transactions, Lock based concurrency control, Database recovery

Current trends -Distributed databases and multimedia databases, Data warehousing – The evolution of Data management paradigms, Data warehouses, The data warehouse development lifecycle, Dimensional data modeling, Data Warehouse architecture and physical design, Data preparation and design

Data mining – Data mining primitives, languages and system architecture, Concept description-characterization and comparison, Mining complex types of data, Applications.

PRACTICAL:

1. Database creation using DDL and DML.
2. Defining the primary and secondary keys.
3. Implementation of selection, projection and joins (internal and external) with SQL and Perl
4. Normalization of databases with SQL and Perl
5. Implementation of transactions and schedules.
6. Detection of association rules and knowledge recovery.
7. Using genetic algorithm and neural networks for knowledge extraction
8. Implementation of anomaly detection/ knowledge detection algorithms.
9. Physical design of data warehouse.

SUGGESTED READINGS:

1. J. Han and M. Kamber, “Data Mining: Concept and techniques”, Morgan Kaufman.
2. A.K. Pujari, “Data Mining”, Sangam Books Ltd.
3. P.C. Desai, “Database Management”
4. C.J. Date, “Introduction to Database Systems”, Addison Wesley Publishing.
5. J.D. Ullman, “Principles of Database and Knowledge Based systems”, Computer Science Press.
6. “The Data Warehouse Lifecycle Toolkit”, John Wiley and Sons Inc.
7. R. Kimball et al., “The Data Warehouse Toolkit”, John Wiley and Sons Inc.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC14	**Genetics**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To understand various mechanisms that underline human inheritance
2. To understand the role of genetic factors in health and disease and to be able to utilize the knowledge of the same for human welfare

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

3. To enable them in identification of patients with, or at risk of, a genetic condition and to communicate genetic information in an explicable way with an awareness of its impact on individual, family and society
4. Students should be able to collect current information about scientific and clinical applications of genetics
5. Students should become aware of different parameters governing population genetics and must be well versed with the uses and limitations of genetic testing

COURSE CONTENT:

Science of genetics – Gene, introduction to genetics, chromosomes and cellular reproduction, model organisms: *E. coli,* inheritance and its applications, Sex Determination and Sex-Linked Characteristics, Extensions and Modifications of Basic Principles

Chromosomal basis of inheritance - sex linkage, linkage, crossing over and chromosome mapping in eukaryotes *yeast and drosophila*.

Mendelism –Mendelian

Molecular markers: RFLP, RAPD, AFLP, EST, SNP and SSR, Applications of molecular markers in forensic, disease prognosis, genetic counseling, pedigree, varietal etc.

Molecular mapping of the genome – Genetic and physical maps, physical mapping and map based cloning, choice of mapping population, simple sequence repeat loci,

Mechanism of genetic change – Mutation and mutagenesis, recombination and transposable elements, epigenetics

Microbial genetics – bacterial genetic system, mechanism of gene transfer in bacteria, recombination, plasmids and transposons, bacterial genetic map with reference to *E.coli*. Viruses and their genetic system, extrachromosomal inheritance in microbial systems.

Population genetics – Hardy Weinburg Law and its deviations

Extranuclear Inheritance - Overview of the mitochondrial and chloroplast Genome.

Application of Genetics: role of genetics in medicine, agriculture and society.

PRACTICAL:

1. Mendalian deviations in dihybrid crosses
2. Demonstration of - Barr Body - *Rhoeo* translocation.
3. Karyotyping with the help of photographs
4. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
5. To carry out mapping of genomic fragments.
6. To carry out population genetics study using sequence analysis.
7. To transfer foreign DNA in bacterial cells.
8. To prepare metaphase plate of onion root tip cells.
9. To carry out C-Banding in slide with good chromosome spread.
10. Recombination Experiments: Linkage analysis in Drosophila.
11. To carry out microsatellite analysis for polymorphism study.
12. Chi-Square Analysis.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SUGGESTED READINGS:

1. M.W. Strickberger, "Genetics by. Publisher", Prentice Hall College Division.
2. R. Levine, "Genetics", International Thomson Publishing.
3. U. Goodenough, "Genetics", International Thomson Publishing.
4. A.J.F. Griffiths, "Introduction to Genetic Analysis", W.H. Freeman and Company.
5. A.J. F. Griffiths, W.M. Gelbart, R.C. Lewontin and J.H. Miller, "Modern Genetic Analysis: Integrating Genes and Genomes", W.H. Freeman and Company.
6. D. Casey, "Primer on Molecular Genetics", http://www.genome.iastate.edu/edu/doe/.
7. D.P. Snustad and M.J. Simmons, "Principles of Genetics", John Wiley and Sons Inc.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC15	**Recombinant DNA Technology**	**3L - 0T - 2P**	BTC11

COURSE OUTCOMES (COs):

1. The students will have strong foundations in the basic concepts of recombinant DNA technology.
2. The students will have a Technical know-how on versatile techniques used in recombinant DNA technology.
3. The students will be able to explain how the polymerase chain reaction can be used to amplify DNA segments, and how it may be used to analyze DNA.
4. The students will explain the events involved in generating recombinant DNA molecules, to include cDNA generation, expression vectors and the choice of host cell.
5. The students will learn how manipulation of nucleic acids alters functions of proteins and subsequent cellular processes.
6. The students will be able to review cases wherein genetic disorders in humans have been treated using recombinant DNA technology.

COURSE CONTENT:

Milestones - Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression, cloning and patenting of life forms, genetic engineering guidelines

Tools used in r-DNA technology - Restriction endonucleases, Methytransferases, Ligases, Polymerases, Kinase, Phosphatase, Nucleases, DNA and RNA markers, Lambda and M13 phage - molecular Biology

Nucleic acid amplification and its applications

Gene cloning vectors – Plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes

Restriction mapping of DNA fragments and map construction

cDNA synthesis and cloning – mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Construction of cDNA and Genomic libraries

Alternative Cloning Strategies – cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid microarrays, Screening of recombinant

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

clones PCR.

Expression strategies for heterologous genes – vector engineering and codon optimization, host engineering, In vitro transcription and Translation, expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants

Gene therapy – vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing

PRACTICAL:

1. Preparation and Transformation of Competent Cells
2. Isolation of Plasmid
3. Construction of restriction map of plasmid DNA.
4. Cloning of GOI in plasmid vector.
5. Gene expression in *E.coli*
6. Analysis of gene product.
7. Optimization of cloned-gene expression.
8. Purification of the expressed product.
9. Reporter Gene assay (Gus/CAT/b-GAL).
10. PCR amplification.

SUGGESTED READINGS:

1. S.L. Berger and A.R. Kimmel, "A guide to Molecular cloning techniques in Methods in Enzymology – Vol 152", Academic Press Inc.
2. D.M. Glover and B.D. Hames, "DNA Cloning: A Practical Approach", IRL Press.
3. D. Micklos, "DNA Science: A First Course in Recombinant DNA Technology", Carolina Biological supply Company
4. D.V. Goeddel, "Gene expression Technology in Methods in Enzymology Vol. 185", Academic Press Inc.
5. M.V. Bloom, "Laboratory DNA Science: An Introduction to Recombinant DNA Techniques and Methods of Genome Analysis", Addison-Wesley Publication Company
6. J.A. Davies and W.S. Reznikoff, "Milestones in Biotechnolgy: Classic Papers on Genetic Engineering", Butterworth Heinemann.
7. P.B. Kaufman, W. Wu, D. Kim and C.J. Cseke, "Molecular and Cellular methods in Biology and Medicine", CRC Press.
8. B.R. Glick and J.J. Pasternak, "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC16	**Structural Biology**	**3L - 0T - 2P**	BTC05

COURSE OUTCOMES (COs):

1. Students will be able to understand the structure-activity and dynamics-activity

relationships of proteins
2. Students will be able to understand the reaction mechanism of protein-ligand interaction and its application in biological sciences
3. Students will understand the role of different factors involved in protein stability
4. Students will acquire the ability to purify protein and to predict its properties with bioinformatics tools
5. Students will acquire the ability to analyze experimental data obtained from spectrophotometric and crystallographic techniques.
6. Students will learn the structural organization of DNA and will understand to study its interaction with proteins using bioinformatic tools

COURSE CONTENT:

Chemistry of amino acids and peptides (side chain structure and function in protein folding and functionality)**:** Secondary structure of proteins - helices, sheets, loops and turns, Structural and functional proteins. Tertiary structure of proteins, homo and heterodimers, trimers and tetramers, forces governing protein-protein interactions, open tertiary structure, Classification of proteins, Structure and function of an antibody, structure of hemoglobin, muscle proteins, Sequence and structural motifs in proteins.

Protein-ligand interactions: Lock and key versus handshake mechanism of substrate recognition, structural basis of recognition, reaction mechanisms of enzymes, G-Protein coupled receptors.

Protein solubility, protein stability and stabilization: salting in and salting out, Parameters affecting, enthalpic and entropic stabilization, mutations increasing stability, helix capping, Native, partially denatured and denatured proteins, Protein denaturation, Physical and chemical denaturants, Refolding

DNA structure: covalent structure of DNA, base pairing, hydrogen bonding, DNA melting and annealing, difference between AT and GC pairing, DNA models, The Watson Crick model, Crystal structure of B-DNA, major and minor groves, dyad symmetry, base pair stacking, propellor twist, A and Z- DNA, triple stranded DNA, telomeric sequences and structure, G-quartets, palindromic and tandem sequences, Base pair flipping and DNA bulges, DNA methylation, Protein-DNA interactions, drug-DNAinteractions, Databases of sequences and structure for protein and DNA, public domain softwares for visualizing and modeling biomolecules – Rasmol, Deepview, Whatif.

PRACTICAL:

1. Chemical modification of proteins
2. Peptide mapping
3. Analysis of amino acid composition.
4. Analysis and interpretation of Spectrophotometric data for denaturation studies.
5. Analysis of CD data
6. Analysis and interpretation of NMR data
7. Crystallization of Lysozyme – pH driven and salt driven crystallization. Effect of

concentration- BMCD
8. Analysis and interpretation of X-Ray crystallographic data
9. Public domain software for structure modeling and visualization.

SUGGESTED READINGS:

1. R.H. Abeles, P.A. Frey and W.A. Jencks, "Biochemistry", Jones and Bartlett Publications
2. J. W. Mullin, "Crystallization", Butterworth Heinemann Publications
3. A. McPherson, "Crystallization of Biological Macromolecules", Cold Spring Harbor Laboratory Press.
4. D. Freifelder, "Essentials of Molecular Biology", Jones and Bartlett Publications.
5. B. Lewin, "Genes VII", Oxford University Press.
6. A.M. Lesk, "Introduction to Protein Architecture: The Structural Biology of Proteins", Oxford University Press.
6. C. Branden and J. Tooze, "Introduction to Protein Structure", Garland Publishing Company.
7. C.R. Cantor and P.R. Schimmel, "Physical Chemistry", W.H Freeman.
8. M. Perutz, "Protein Structure", Oxford University Press.
9. T.E. Creighton, "Proteins (Structures and Molecular Properties)", W.H. Freeman and Company.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC17	**Fundamentals of Biochemical Engg.**	**3L - 0T - 2P**	BTC05, BTC06, BTC09

COURSE OUTCOMES (COs):

1. To become familiar with biochemical engineering fundamentals and applications
2. To learn the microbial growth and kinetics of microbial processes
3. To learn upstream processing for bioprocess operations
4. To understand the basic principles of fluid flow and solid handling in bioreactors
5. To learn about the various modes of bioreactor operations

COURSE CONTENT:

Preparation and sterilization of media: Media design and optimization, Sterilization: concept and methods, Media sterilization, Thermal death kinetics, Batch sterilization, Continuous sterilization, Sterilization of air: Methods, filters and design of depth filters.

Transport phenomena in Biochemical Introduction: Definition and scope of biochemical engineering. Different biochemical unit operations and processes.

Metabolic stoichiometry: Stoichiometry of cell growth and product formation. Overall growth stoichiometry, elemental material balance for growth, heat generation and yield concepts etc. Primary and secondary metabolites.

Engineering: Fluid dynamics principles, Rheology of fermentation fluids, Aeration and agitation, power requirements in gassed and ungassed bioreactors, Oxygen transfer in microbial systems, oxygen demands, mass transfer theories, measurements of volumetric mass transfer coefficient

Microbial growth kinetics: Kinetics of microbial growth, metabolic heat and factors affecting

microbial growth, substrate utilization and product formation in batch reactors. Batch growth kinetics models, Ideal chemostat.

PRACTICAL:

1. To plot growth curve for shake flask culturing using cell dry weight and to estimate growth parameters of E. coli culture.
2. To get familiarized with the lab scale fermentor (bench top fermentor)
3. Thermal death kinetics
4. Estimation of Monod Parameters for microbial growth kinetics
5. To Determine the Oxygen transfer coefficient (KLa) in CSTR

SUGGESTED READINGS:

1. W.F. Veith, "Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression", John Wiley and Sons Inc.
2. S. Aiba, A.E. Humphrey and N.F. Millis, "Biochemical Engineering", University of Tokyo Press.
3. J.E. Baily and D.F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill.
4. M.L. Shuler and F. Kargi, "Bioprocess Engineering Basic Concepts", Prentice Hall.
5. P. Doran, "Bioprocess Enginneering Principles", Academic Press.
6. J. Nielson and J. Villadsen, "Bioreaction Engineering Principles", Plenum Press.
7. J.M. Coulson, and J.F. Richardson, "Chemical Engineering", Butterworth Heinemann.
8. H.C. Vogel, C.L. Todaro, C.C. Todaro, "Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment", Noyes Data Corporation/ Noyes Publications.
9. W.L. Badger, and J.T. Banchero, "Introduction to Chemical Engineering", Tata McGraw Hill.
10. T. Scheper, "New Products and New Areas of Bioprocess Engineering (Advances in Biochemical Engineering/Biotechnology, 68)", Springer Verlag.
11. A.T. Jackson, "Process Engineering in Biotechnology", Prentice Hall.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC18	**Enzymology**	**3L - 0T - 2P**	BTC05

COURSE OUTCOMES (COs):

1. Students will be capable in identification of various biocatalysts and show differences between their structural and catalytical properties
2. Students will be able to recognize the type of enzyme specificity and be able to explain the basic mechanisms of enzyme action and factors affecting the reaction rates and enzyme stability
3. Students will be able to understand and describe various types of enzyme activation and inhibition along with its kinetics
4. Students will learn about the identification of enzymes characterized by different structure, kinetics and regulatory properties and the evaluation/selection of the proper methods of enzyme extraction, isolation and purification
5. Students will be able to compare enzyme immobilization methods and assess the usefulness

of immobilized enzymes for application in analysis, medical diagnostics, food processing, chemical and pharmaceutical industries.

COURSE CONTENT:

Enzymes: Introduction and scope, Nomenclature, Mechanism of Catalysis, Industrial applications.

Enzyme Kinetics: Single substrate steady state kinetics, King-Altman's method, Inhibitors and activators, Multi-substrate systems, Effect of pH and temperature, Allosteric enzymes.

Immobilization of Enzymes: Advantages, Carriers, adsorption, covalent coupling, cross-linking and entrapment methods, Micro-environmental effects

Enzyme Reactors: reactors for batch/continuous enzymatic processing, Choice of reactor type: idealized enzyme reactor systems, Mass Transfer in Enzyme Reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

Bio-process Design: Physical parameters, reactor operational stability, Immobilized cells.

Challenges and future trends: Enzyme catalysis in organic media, Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from Extreme Thermophilic and Hyperthermophilic Archaea and Bacteria.

PRACTICAL:

1. Assays for Enzymes
2. Substrate specificity and efficiency of enzymatic catalysis
3. Kinetics of enzyme catalyzed reactions.
4. Preparation of immobilized enzymes.
5. Microenvironmental effects in immobilized enzymes.
6. Mass transfer and biochemical reactions in continuous flow enzyme reactors.

SUGGESTED READINGS:

1. R.C.B. Currell, V.D. Mieras, "Biotechnological Innovations in Chemical Synthesis", Butterworth Heinemann.
2. I.H. Segel, "Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady- State Enzyme Systems", Wiley-Interscience.
3. M.F. Chaplin and C. Bucke, "Enzyme Technology", Cambridge University Press.
4. R.A. Copeland, "Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis", John Wiley and Sons Inc.
5. H. Uhlig, "Industrial Enzymes and their Applications", John Wiley and Sons Inc.
6. M. Roberts, N.J. Turner and A.J. Willetts, "Introduction to Biocatalysis using Enzymes and Micro-Organisms", S. Publisher: Cambridge University Press.
7. C. Branden and J. Tooze, "Introduction to Protein Structure", Garland.
8. T.E. Creighto, "Proteins – Structure and Molecular properties" W.H. Freeman and Company.
9. A. Fersht, "Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding", W.H. Freeman and Company.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC19	**Bioprocess Technology**	**3L - 0T - 2P**	BTC06, BTC17

COURSE OUTCOMES (COs):

1. To understand the basic concepts of bioprocess technology and its interrelation with other fundamental branch of engineering including chemical, mechanical, electrical, civil and computer engineering
2. To learn the techniques for aseptic transfer, inoculum development and upstream processing of fermentation process
3. To become familiar with the processes kinetics and various other ancillaries of a bioprocess
4. To learn about the various fermentation processes for production of value added products using low value substrates as raw materials and microorganism/enzymes as biocatalyst
5. To understand the application of the various bioprocess techniques/principles in the real industrial scale fermentation.

COURSE CONTENT:

Bioreactor kinetics and engineering: Ideal continuous stirred tank fermenter: material balance, concept of wash out, cell recycle, multiple fermenters in series. Feb batch fermentation: Principle and applications. Kinetic analysis, comparison with batch fermentations, applications and its limitations

Bioreactor operations, measurement and control: Inoculum development and aseptic transfers, design of media, measurement and control of process variables (pH, dissolved oxygen, viscosity, temperature, NADH), agitative power, foam control, On-line analysis and computer control of fermentation process.

Process Technology: Process technology for the production of biomass as product (Baker's yeast, mushrooms, SCP), primary metabolites, eg. ethanol, acetone-butanol, citric acid, amino acids, polysaccharides and plastics, Microbial production of industrial enzymes – glucose isomerase, penicillin acylase, cellulase, amylase, lipase, protease etc.

Production of secondary metabolites – penicillin, cephalosporins, streptomycin, etc., Metabolites from plant and animal cell culture, Biofertilizers and biopesticides

Bioprocess Economics Advances: Commercial aspects of Biotechnological processes. New challenges and future prospects in industrial bioprocess.

PRACTICAL:

1. Experiments with Batch, Fed-batch and continuous fermentation
2. Experiments on study of effect of pH, temperature and dissolved oxygen on batch fermentation
3. Comparative studies of ethanol production using different substrates
4. Solid sate fermentation for production of industrial enzyme
5. Preparation and use of immobilized cell for enzyme production

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

6. Production of Secondary metabolites
7. Biomass (Mushroom) production

SUGGESTED READINGS:

1. W.F. Veith, "Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression", John Wiley and Sons Inc.
2. S. Aiba, A.E. Humphrey and N.F. Millis, "Biochemical Engineering", University of Tokyo Press.
3. J.E. Baily and D.F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill.
4. B. Atkinson, "Biochemical reactors", Pion Limited.
5. M.L.Shuler and F.Kargi, "Bioprocess Engineering Basic Concepts", Prentice Hall.
6. B.K. Lydersen, K.L. Nelson, B.K. Lyderson and N. D'Elia, "Bioprocess Engineering", John Wiley and Sons Inc.
7. P. Doran, "Bioprocess Enginneering Principles", Academic Press.
8. J. Nielson and J. Villadsen, "Bioreaction Engineering Principles", Plenum Press.
9. W. Crueger and A. Crueger, "Biotechnology - A Textbook of Industrial Microbiology", Sinauer Associates.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC20	**Plant and Animal Technology**	**3L - 0T - 2P**	BTC07

COURSE OUTCOMES (COs):

1. Students will learn the basic and practical concepts of plant tissue culture technique
2. Students will understand the application and advantages of tissue culture technique over classical breeding for crop improvement
3. Students will understand the tools and techniques of genetic manipulation of plants for strain improvement
4. Students will be introduced to the application of transgenic technology for production of plants with resistance to various biotic and abiotic stress along with production of vaccines and neutraceuticals for human welfare.
5. Students will understand the financial, social, ethical and IPR issues related to plant biotechnology
6. Students will learn tools and techniques used for culturing mammalian cells, tissues and organs. They will also be able to understand the basic differences between types of cell lines and the different technologies used for culturing them
7. Students will learn the techniques for characterization of cell lines including authentication and stability of cell lines as well as long term maintenance and storage of cell lines
8. Students will learn the importance of stem cells for studying developmental biology and will understand its potential as regenerative medicine.
9. Students will understand the application of transgenic technology for production of

improved animals and cell lines for production of important metabolities to be used in healthcare and medicine

10. Students will understand the financial, social, ethical and IPR issues related to Animal biotechnology

COURSE CONTENT:

Plant Biotechnology – Historical perspectives, tissue culture lab. Organization, sterilization techniques, nutrient media, culture techniques- callus cultures, cell cultures and protoplast cultures, plant regeneration pathways – role of phytohormones, organogenesis and somatic embryogenesis, applications of plant tissue and cell culturemicropropogation, pathogen free plants, secondary metabolites, production of haploids, somaclonal variation, preservation of germplasm, Genetic engineering in plantstransformation vectors, Gene transfer techniques – vector mediated and vectorless gene transfer, transgenic plants – trans gene integration and expression, trans gene silencing, protein targeting, chloroplast transformation, targeted gene transfer, transgenic crops with

new traits – herbicide tolerance, insect and disease resistance, nutrient quality, post harvest quality traits, metabolic engineering – therapeutic proteins and compounds, oral vaccines, antibodies and secondary products, bioethics of plant genetic engineering

Animal Biotechnology - Historical perspectives, sterilization methods, organ culture – culture techniques, plasma clot, raft methods, agar gel, grid method, organ engineering, cell culture substrates, cultural media, natural and artificial media, initiation and maintenance of cell cultures, immobilized cultures, cell culture products, stem cell research, cryopreservation techniques, in vitro fertilization and embryo transfer, somatic cell hybridization, hybridoma technology, organismal cloning, embryo split and nuclear transplantation, Animal genetic engineering – vectors, gene transfer methods – microinjection, virus mediated and other methods of gene transfer, targeted gene transfer, molecular characterization of transforments, transgenic animals with new traits, transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutic etc. Bioethical issues related to animal biotechnology, molecular markers.

PRACTICAL:

1. Sterilization techniques and preparation media. Membrane filtration.
2. Surface sterilization
3. Callus propogation, organogenesis, transfer of plants to soil.
4. Protoplast isolation and culture.
5. Anther culture, production of haploids
6. Cell counting and cell viability
7. Macrophage monolayer from PEC and measurement of phagocytic activity
8. Trypsinization of monolayer and subculturing
9. Cryopreservation and thawing
10. Measurement of doubling time
11. Role of serum in cell culture
12. Cell fusion with PEG

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SUGGESTED READINGS:

1. M.K. Razdan, "An Introduction to Plant Tissue Culture", Oxford and IBH Publishing.
2. J.R.W. Masters, "Animal cell culture – A Practical Approach", Oxford.
3. M. Clynes, "Animal Cell Culture Techniques", Springer Verlag.
4. M. Butler and M. Dawson, "Cell culture LabFAx", Bios Scientific Publications Ltd.
5. R.Basega, "Cell Growth and Division – A Practical Approach", IRL Press.
6. R.I. Freshney, "Culture of Animal Cells", Wiley-Leiss.
7. J.H. Dodds and L.W. Roberts, "Experiments in Plant Tissue Culture", Cambridge University Press.
8. R. Walden, "Genetic Transformation in Plants", Prentice Hall.
9. J.P. Mather and D. Barnes, "Methods in Cell Biology - Animal cell culture methods", Academic Press.
10. K.M.O. Caldentey, W.H. Barz and H.L. Willis, "Plant Biotechnology and Transgenic Plants", Marcel Dekker.
11. J. Hammond, P. McGarvy and V. Yusibov, "Plant Biotechnology", Springer Verlag.
12. K. Lindsey and M.G.K. Jones, "Plant Biotechnology in Agriculture (Biotechnology Series)", Prentice Hall.
13. T-J Fu, G. Singh and W.R. Curtis, "Plant Cell and Tissue culture for the Production of Food Ingredients", Kluwer Academic/ Plenum Press.
14. O.L. Gamborg and G.C. Phillips, "Plant Cell Tissue and Organ Culture", Narosa Publications.
15. S.S. Bhojwani and M.K. Razdan, "Plant Tissue Culture: Theory and Practice", Elsevier Health Sciences.
16. M.J. Chrispeels, D.E. Sadava and M.J. Chrispeels, "Plants, Genes and Crop Biotechnology", Jones and Bartlett Publications.
17. R.J. Henry, "Practical Application of Plant Molecular Biology", Chapman and Hall.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC21	**Downstream Processing**	**3L - 0T - 2P**	BTC06, BTC10 BTC17

COURSE OUTCOMES (COs):

1. Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
2. Learned cell disruption techniques to release intracellular products from the cell.
3. Learned various techniques like extraction, precipitation, membrane separation for concentrating biological products.
4. Learned the basic principles and techniques of chromatography to purify the biological products.
5. Learned various drying techniques for the formulation the products for different end uses.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

COURSE CONTENT:

Introduction: Overview of Bioseparation technology, Importance of Downstream Processing in Biotechnology, Problems associated with purification of bioproducts, Stages in recovery of intracellular and extracellular bioproducts, Choice of recovery process, Cost cutting strategies

Primary separation and Recovery Process: Cell Disruption, Physical, chemical and Enzymatic cell disruption, Removal of microbial cells and other solid matter, Separation techniques – Flocculation, Sedimentation, Centrifugation and Filtration.

Product Extraction and Isolation: Adsorption, Solid- Liquid and Liquid -liquid extraction, Distillation, Enrichment: microfiltration and ultrafiltration, Precipitation: Ammonium Sulphate, organic solvents and High molecular weight polymers

Product Purification: Electrophoresis: Horizontal, Vertical and Isoelectric focussing, Chromatography - Principle, Instrumentation, methodology and application of ion-exchange, affinity, Gel exclusion, GLC and HPLC

Product Polishing: Crystallization, Drying. Case studies for Bioseparation of: Citric acid, Glutamic acid, Penicillin G, Enzymes and Antibodies

PRACTICAL:

Bioseparation and purification of different products from fermentation broth:

1. Alcohol (Ethanol, Butanol)
2. Acid (Acetic acid, citric acid)
3. Enzymes (Intracellular, Extracellular)
4. Antibiotics (Penicillin)
5. Harvesting of SCP and Baker's yeast
6. Crystallization and drying of Protein and enzyme samples

SUGGESTED READINGS:

1. J.E. Bailey and D.F. Ollis, "Biochemical Engineering Fundamentals", McGraw-Hill.
2. P.A. Belter, E.L. Cussler and W.S. Hu, "Bioseparations", John Wiley and Sons Inc.
3. P.A. Belter et al., "Bioseparations: Downstream Processing for Biotechnology", John Wiley and Sons Inc.
4. T. Scheper et al., "Biotreatment, Downstream Processing and Modelling (Advances in Biochemical Engineering/Biotechnology, Vol 56)", Springer Verlag.
5. C.A. Costa and J.S. Cabral, "Chromatographic and Membrane Processes in Biotechnology", Kluwer Academic Publishers.
6. J.P. Hamel, J.B. Hunter and S.K. Sikdar, "Downstream Processing", American Chemical Society.
7. M.R. Ladisch, R.C.Willson, C.C. Painton and S.E. Builder, "Protein Purification", American Chemical Society.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC22	**Training**	**0L - 0T - 2P**	BTC05, BTC06, BTC07
Training gives an exposure to students on the working on practical applications of Biotechnology and on work ethics. Students will undergo Training at Industry/Research organizations/ reputed institutions during the summer vacation after VI Semester. This will be evaluated as a VII Semester subject during end-semester examination.			

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC23	**Project - I**	**0L - 0T - 4P**	BTC05, BTC06, BTC07, BTC11, BTC12, BTC14
Project work is based on the students' ability to understand, design and implement the fundamental concepts of the basic sciences, mathematics, engineering subjects and human values.			

Course No.	Title of the Course	Course Structure	Pre-requisite
BTC24	**Project - II**	**0L - 0T - 4P**	BTC05, BTC06, BTC07, BTC11, BTC12, BTC14
Project work is based on the students' ability to understand, design and implement the fundamental concepts of the basic sciences, mathematics, engineering subjects and human values and will be a continuation of Project-I.			

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SYLLABUS OF FOUNDATION ELECTIVES

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE001	Sports-I	0L-0T-4P	None

COURSE OUTCOMES (CO):

To evolve a higher education system that is suitability blended with provision for knowledge values and skill practice where every student learns in without sacrificing his/her creativity.

COURSE CONTENT:

(Any Two out Of 4 Components)

A. INTRODUCTION TO PHYSICAL EDUCATION IN THE CONTEMPORARY CONTEXT (Any Two)

1. Learn and demonstrate the technique of Suryanamaskar.
2. Develop Physical Fitness through Calisthenics / Aerobics / Circuit-Training / Weight-Training and demonstrate the chosen activity.
3. Select any one game available in the college and learn different techniques involved in its play

B. CORE PHYSICAL EDUCATION-: FITNESS, WELLNESS AND NUTRITION (Any Two)

1. Measurement of Fitness Components – Leg-raise for Minimal Strength (Muscular Strength), Sit-ups Muscular Endurance), Harvard Step Test, Run and Walk Test (Cardiovascular Endurance), Sit and Reach Test (Flexibility)
2. Measuring height, weight, waist circumference and hip circumference, Calculation of BMI (Body Mass Index) and Waist-Hip Ratio
3. Engage in at least one wellness programme and write a report on it.

C. CORE PHYSICAL EDUCATION-: POSTURE, ATHLETIC CARE AND FIRST AID (Any Two)

1. Demonstrate Stretching and Strengthening Exercises for Kyphosis, Scoliosis, Lordosis, Knock Knees, Bow Legs, Flat Foot, Back Pain and Neck Pain
2. Illustration and Demonstration of Active and Passive Exercises
3. Asanas with Therapeutic Value (Any five asanas): Karnapeedasana, Padmasana, Dhanurasana, Sarvangasana, Paschimottanasana, Chakrasana, Halasana, Matsyasana, Ardhmatsyendrasana, Usthrasana, Mayurasana, Shirshasana, Vajrasana.
4. Practice P.R.I.C.E. in First Aid.

D. SPORTS ADMINISTRATION & MANAGEMENT (Any Two)

1. Demonstration of Supervision activities in Sports Management.
2. Demonstration of skills of Management.
3. Demonstration of fixtures of various kinds in sports competitions.
4. Demonstration of technical and non-technical purchase procedure.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SUGGESTED READINGS:

1. Graham, G., ``Teaching Children Physical Education : Becoming a Master Teacher. Human Kinetics,'' Champaign, Illinois, USA.
2. Corbin, C. B., G. J. Welk, W. R Corbin, K. A. Welk, ``Concepts of Physical Fitness: Active Lifestyle for Wellness,'' McGraw Hill, New York, USA.
3. Anspaugh, D.J., G. Ezell and K.N. Goodman, `` Teaching Today Health,'' Mosby Publishers
4. Beotra, Alka, ``Drug Education Handbook on Drug Abuse in Sports,'' Applied Nutrition Sciences, Mumbai.
5. Ammon,R., Southall , R.M. and Blair, D.A., ``Sports Facility Management, ''West Virginia, USA: Fitness Information Technology Publishers.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE002	Sports-II	0L-0T-4P	FE001

COURSE OUTCOMES (CO):

To evolve a higher education system that is suitability blended with provision for knowledge values and skill practice where every student learns in without sacrificing his/her creativity.

COURSE CONTENT:

(Any Two out Of 4 Components)

A. Sports for all (Any Two)

1. To participate in any intramural Tournaments (one team game and one Individual Game) of choice.
2. To participate/ attend at least 15 hours in Fitness training at Field or at Gymnasium.
3. Participate in at least one track and one field event on Annual Sports day.
4. To participate in Inter College Tournament

B. MEDIA AND CAREERS IN PHYSICAL EDUCATION (Any Two)

1. Organize an event / intramural / tournament in your college.
2. Prepare a News Report of an observed Sports competition.
3. Create a presentation on any topic from Physical Education using an audio-visual aid.
4. Demonstrate Warming-up / Conditioning / Cooling-down exercises.

C. MANAGEMENT OF AEROBICS & GROUP TRAINING (Any Two)

1. Measurement of Fitness Components – Leg-raise for Minimal Strength (Muscular Strength), Sit-ups (Muscular Endurance), Harvard Step Test or Run and Walk Test (Cardiovascular Endurance), Sit and Reach Test (Flexibility)

2. Measurement of Pulse Rate / Heart Rate at Radial Artery and Carotid Artery, Calculation of Target Heart Rate

3. Developing a 5-10 minute routine of aerobics with appropriate music for each component of health related physical fitness

D. SPORTS INDUSTRY & MARKETING (Any Two)

1. Identify an issue or a trend in the sports industry: o Players in professional or college

sports o Ownership
2. Marketing Plan: Environmental Factors and Product Plan Draft, Paper bibliography/works cited.
3. Sponsorship proposal
4. Developing a budget plan for an event
5. Athlete branding

SUGGESTED READINGS:

1. Covey, S. , `` 7 Habits of Highly Effective People, '' Covey Publications, USA
2. Magill, R.A., `` Motor Learning and Control: Concepts and Applications,'' McGraw Hill Publication.
3. Masteralexis, L.P., C. Barr and M. Humms, ``Principles and Practices of Sport Management,'' Jones and Bartlett Publisher
4. Bishop, J.G., ``Fitness through Aerobics,'' Benjamin Cummings USA.
5. Brown K.M., `` Physical Activity and Health: An Interactive Approach,'' Jones and Bartlett Publisher
6. Cornwell. T.B, `` Sponsorship in marketing: Effective communications through sports, arts and events, '' Routledge Publishers
7. DeGarris, L., ``Sports Marketing: A Practical Approach,'' Routledge Publishers, USA

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE003	**National Service Scheme (NSS)**	**0L-0T-4P**	**None**

COURSE OUTCOMES (CO):

1. Develop among them a sense of social and civic responsibility,
2. Utilize their knowledge in finding practical solution to individual and community problems,
3. Identify the needs and problems of the community and involve them in problem solving process,
4. Utilize their knowledge in finding practical solution to individual and community problems,
5. Develop capacity to meet emergencies and natural disasters

COURSE CONTENT:

Unit-I Introduction to NSS: Orientation and structure of NSS, History of Social Reforms in Modern India: Brahmo Samaj, Arya Samaj, Satya Shodhak Samaj: Principles and Functions

Unit-II Regular activities: Distribution of working hours- association between issues and programs- community project- urban rural activities, association- modes of activity evaluation

Unit-III concept of society- development of Indian society: Features- Division of labors and cast system in India, Features of Indian constitution, Provisions related to social integrity and development

Unit – IV N.S.S. Regular Activities

A) College campus activities

B) N.S.S.activities in Urban and Rural areas

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

C) Role of Non-Government Organisation (NGO) in social Reforms
i) Red Cross
ii) Rotary

SUGGESTED READINGS:

1. National Service Scheme Manual, Govt. of India
2. Training Programme on National Programme scheme, TISS.
3. Orientation Courses for N.S.S. programme officers, TISS.
4. Ram Ahuja, ``Social Problems in India,'' Rawat Publication.
5. History of Social Reforms in Maharashtra, Ed. J. Y. Bhosale, S. U. Kolhapur.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE004	**National Cadet Corps (NCC)**	**0L-0T-4P**	**None**

COURSE OUTCOMES (CO):

1. Develop among them a sense of social and civic responsibility,
2. Utilize their knowledge in finding practical solution to individual and community problems,
3. Identify the needs and problems of the community and involve them in problem solving process,
4. Utilize their knowledge in finding practical solution to individual and community problems,
5. Develop capacity to meet emergencies and natural disasters,

COURSE CONTENT:

UNIT I: Introduction to NCC, National Integration & Awareness: Religions, Culture, Traditions and Customs of India, National Integration: Importance and Necessity, Freedom Struggle.

UNIT II: Adventure Training: – Obstacle course, Slithering, Trekking, Cycling, Rock Climbing, Para Sailing, gliding, Scuba Diving- methods and use.

UNIT III: Environment Awareness and Conservation: Natural Resources – Conservation and Management. Water Conservation and Rainwater Harvesting

UNIT IV: Personality Development and Leadership: Introduction to Personality Development, Factors Influencing /Shaping Personality: Physical, Social, Physiological, Philosophical and Psychological, Self Awareness Know yourself/ Insight, Change Your Mind Set, Communication Skills: Group Discussion / Lecturettes (Public Speaking), Leadership Traits, Types of Leadership

SUGGESTED READINGS:

1. Bhogle Anita & Bhogle Harsha, ``The Winning way, Learning from sports for managers,'' Westland Publications
2. Sharma Robin, `` The leader had no title, '' Simon and Schuster Ltd.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE005	**Corporate social responsibilities**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

1. The course will help students to understand corporate and emerging social responsibility for the corporate in reference to India and global situation
2. The course will support students to prepare themselves to work with corporate understanding collective aspiration of the society, individual and corporate social responsibility.

COURSE CONTENT:

UNIT I: Corporate social responsibility in Indian context and International: CSR – Definition, concepts, Approaches of CSR, overview of corporate social responsibility and corporate social accountability, SR Tools, National and International CSR activities, corporate philanthropy, drivers of CSR, difference between corporate governance, corporate philanthropy and CSR

UNIT II: Business ethics and corporate social responsibility: Concept of business ethics – meaning, Importance and factors influencing business ethics. Corporate Governance – meaning, significance, principles and dimensions. Ethical decision – making in different culture, consumer protection, environment protection, gender issues in multiculturalism, ethics and corruption, ethics and safety. Business benefits of CSR

UNIT III: Legislative measures of CSR: Corporate, labor, stake holders, Environmental and pollution. Social Accounting, Social Auditing, SA: 8000 and Corporate Social Reporting.

SUGGESTED READINGS:

1. Harsh Srivastava,`` The business of social responsibility,'' books for change
2. CV. Baxi and Ajit Prasad,`` Corporate social responsibility – concepts and cases," Excel Books
3. Dr. M. Mahmoudi,`` Global strategic management," Deep & Deep Publications Pvt. Ltd.
4. S K. Bhatia,`` International Human resource management – Global perspective," Deep & Deep Publications Pvt. Ltd.
5. J.P. Sharma, ``Governace, Ethics and Social responsibility of business, '' Ane books Ltd.
6. Kotler Philip and Lee Nancy, `` Corporate social responsibility, doing the most good for your company,'' John Wiley
7. Simpson, Justine and Taylor, John R, `` Corporate Governace Ethics and and CSR,'' Kogan Page Publishers

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE006	**Environmental Sciences**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

1. Recognize major concepts in environmental sciences and demonstrate in-depth

understanding of the environment.
2. Develop analytical skills, critical thinking, and demonstrate problem-solving skills using scientific techniques.
3. Demonstrate the knowledge and training for entering graduate or professional schools, or the job market.

COURSE CONTENT:

UNIT I: Environmental Studies: Ecosystems, Bio-diversity and its Conservation

(i) The Multidisciplinary Nature of Environmental Studies Definition, scope and importance of Environmental Studies. Biotic and a biotic component of environment, need for environmental awareness.

(ii) Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structures and function of different ecosystem

(iii) Bio-diversity and its Conservation: Introduction to biodiversity —definition: genetic, species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity : Habitat loss, Poaching of wildlife, man wildlife conflicts, rare endangered and threatened species(RET) endemic species of India, method of biodiversity conservation: In-situ and ex-situ conservation.

UNIT II: Natural Resources: problems and prospects

(i) Renewable and Non-renewable Natural Resources

Concept and definition of Natural Resources and need for their management

• Forest resources: Use and over-exploitation, deforestation, case studies, timber extraction, mining, dams and their effects on forests and tribal people.

• Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Water conservation, rain water harvesting, watershed management.

• Mineral resources: Uses are exploitation, environmental effects of extracting and using mineral resources, case studies.

• Food resources: World food problems, changes causes by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

• Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Urban problems related to energy, case studies.

• Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

UNIT III: Environmental Pollution Control: Environmental Pollution, Definition, types, causes, effects and control measures of (a) Air pollution, (b) Water pollution, (c) Soil pollution, (d) Marine pollution, (e) Noise pollution, (f) Thermal pollution. Nuclear hazards. Solid waste and its management: causes, effects and control measures of urban and industrial waste.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

UNIT IV: Disaster Management, Social Issues, Human Population and the Environment. Social Issues, Human Population and the Environment, Sustainable development, Climate change, global warming, acid rain, ozone layer depletion, Environmental ethics: Issues and possible solutions, Consumerism and waste products, , Wasteland reclamation. Population growth, problems of urbanisation.

SUGGESTED READINGS:

1. E. Barucha,`` Textbook of Environmental Studies for Undergraduate Courses," Universities Press (India)
Pvt. Ltd.
2 . S. Chawla,`` A Textbook of Environmental Studies," McGraw Hill Education Private Limited.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE007	**Environmental Development and Society**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

1. To sensitize the students regarding the relationship between human society and ecosystem.
2. To help students understand the various approaches to the study of environment and ecosystem.
3. To create awareness among the students regarding environmental degradation and the importance of development and sustainable Development.

COURSE CONTENT:

UNIT I. Basic Issues and Approaches

a. Importance of the study of ecology and society
b. The relation between Environment and Development
c. Conceptual clarifications: social ecology, sustainable development, sustainability.
d. Approaches: Realism, Appropriate Technology, Ecofeminism

UNIT II. People and Natural Resources: Unequal Access and Shrinking Commons

a. Water: depleting water resources & pollution, unequal distribution of water –(utilization of water for commercial crops, industrial use, power generation), the big dams debate.
b. Forest: Colonial policy, diverting resources for mining and other commercial and industrial use, monoculture and loss of biodiversity, rights of forest dwelling communities.
c. Land: modern technology, green revolution, biotechnology and impact on land, shrinking commons and its effects on rural poor.

UNIT III. Environmental issues and Problems.

a. Environmental Pollution: Air, Water, Noise, Land and Radioactive Pollution
b. Problems of urban environment (pollution, health, industrial accidents (e.g. Bhopal), occupational hazards)
c. Climate change/Global warming.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

UNIT IV. Role of Environmental Movements and the State.

a. Environmental Movements in India – Chipko, Narmada Bachao Andolan, Chilka Lake Orissa, are some examples.

SUGGESTED READINGS:

1. Chandna R.C,`` Environmental Awareness," Kalyani Publishers.
2. Agarwal S.K,`` Environmental Issues and Themes," APH Publishing corporation.
3. Barry John,`` Environment and social theory," Routledge.
4. Gadigil, Madhav and Ramachandra Guha,`` Ecology and Equity: The use and Abuse of Nature in contemporary India," OUP.
5. Gole Prakash,`` Nature conservation and sustainable development in India," Rawat publications .

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE008	**Spoken Skills in English**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

1. This course will focus on oral & presentation skills of students with practice sessions in the language lab.
2. This course will develop confidence building in oral skills of learners.
3. It will seek to encourage the day to day conversations/dialogues and communicative needs of learners with ample practice in the lab.
4. The theory class will boost practice in ample language exercises to encourage oral skills.
5. This will also involve practice sessions in interview skills, group discussions & pair work.
6. Basics of communication

COURSE CONTENT:

- Practice on listening and reading comprehension
- Language lab practice for group discussion and interviews
- Definition and discussion on communication & the barriers in communication with practical training to use language as a tool for sharing, discussing, handling and convincing others.

SUGGESTED READINGS:

Everyday English I & II Cambridge University Press/Foundation books

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE009	**Financial Literacy**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

1. To provide in-depth knowledge of the banking and Principles of Investment, financial planning.
2. Help students in understanding stocks, sell strategy, mutual fund options, investing in

education, planning for the future, purchasing your first home, taxes and tax planning, life insurance options, health insurance, property insurance, estate planning, and keeping money in perspective.

COURSE CONTENT:

UNIT I: Banking- Definition, Role of Bank in growth of saving and Investment, Types of banks , Services offered by banks, Deposits and Loans, Types of A/c, Opening a bank A/c, How to Transact with banks, KYC norms, (A/c opening form, Address Proof), How to read bank statement, Banking products and services, Calculating Interests – Saving, FD, Simple and Compound Interest, Power of compounding Loans, Types of loans, taking a home loan, Definition of EMI, Calculation of EMI, Post office-Account and transactions, Basic of foreign Exchange, Importance and Use of Foreign Exchange, Regulator Role of RBI, mutual funds.

UNIT II: Investment: Principles of Investment – Safety, Liquidity and Return, Investment plans, Hybrid plans-Ulip, SIP and VIP of mutual funds, index funds

UNIT III: Financial Planning- Meaning, Household financial health checkup, Important life stages, Medical and other Emergencies, , Insurance, Meaning, Need and Wants, Loss protection, Life, non-life and health, Benefits of Insurance, Term plans, Social obligations Budgeting, Buying a house, Plan a vacation, Retirement planning, Price of procrastination, Market and financial instruments, Primary market, Secondary market, Financial Statement analysis,

UNIT IV: Scams, Fraud Schemes-Insider trading, Money laundering, Consumer protection and redressal mechanism, Rights of Consumers, Applicable to financial services, Filing a complaint, Complain to entity concerned, Regulators, Arbitration, Consumer courts, Govt. Websites-(PG Portals), Investor Associations, Taxes, Meaning, Need of Taxes, Types of taxes, How taxes impact income, Income, wealth and gift tax, Service tax, STT, Stamp Duty, Tax planning v/s tax evasion, Tax rates, Tax free bonds, Tax saving investment

SUGGESTED READINGS:

1. Braunstein, Sandra, and Carolyn Welch,`` Financial literacy: An overview of practice, research, and
policy," Fed. Res. Bull.
2. Cole, Shawn A., and Gauri Kartini Shastry,`` Smart money: The effect of education, cognitive ability, and financial literacy on financial market participation,” Harvard Business School, 2009.
3. Study material of NSE.
4. Gitman, joehnk and Billingsley, ``Personal financial planning,'' Cengage Learning
5. Madura Jeff,`` Personal finance student edition,'' Prentice Hall PTR.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE010	**Introduction to Indian Society**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

To acquaint the students with the emergence and understanding of Indian Society, theoretical

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

underpinnings of the complexity of society and also with the whole discourse contextualizing Sociology in India.

COURSE CONTENT:

1. **Unit –I Conceptualizing Indian Society:**

Hindu society and Diverse society (Regional, Linguistic, Religious diversities), Peoples of India- Groups and Communities , Unity in diversity, Ethnicity and ethnic identities.

2. **Unit –II Theoretical perspectives I:**

Indological/ Textual (G.S. Ghurye, L. Dumont Structural – Functional M.N. Srinivas, S.C. Dube). Marxian (D.P. Mukherjee, A.R. Desai)

3. **Unit –III Theoretical perspectives II:**

Civilizational view (N.K. Bose, Surajit Sinha). Subaltern perspective (B.R. Ambedkar, David Hardiman).

SUGGESTED READINGS:

1. Robert W. Stern, `` Introduction: Change, the societies of India and Indian society'' Cambridge University Press
2. Dhanagare. D.N,`` Themes and perspectives in Indian sociology," Rawat Publication.
3. Dube. S.C.`` The Indian Villages," R and K Publication
4. Dumont. Louis Homo Hyerrchicus,`` The Caste System and its implications," Vikas publications.
5. Hardiman, David,`` The coming of the Devi :Adivasi Assertion in western India," Oxford University Press.
6. Marrott. Mckim,`` India through Hindu categories ," Sage publication.
7. Momin. A. R,`` The legacy of G.S. Ghurye. A cemennial festschrift," Popular prakashan.
8. Mukherjee. D.P,`` Diversities," Peoples publication house.
9. Singh. Y,`` Indian Sociology social conditioning and emerging concerns," Vistaar publication.
10. Singh. Y,`` Modernisation of Indian tradition," Thomson press.
11. Singh. K.S.`` The Peoples of India. An introduction," Seagull books.
12. Srinivas. M.N,`` India's Villages," Asia publishing house.
13. Singh Y,`` Identity & Theory in Indian Sociology," Rawat Publication.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE011	**Soft Skills and Personality Development**	**1L-0T-2P**	**None**

COURSE OUTCOMES (CO):

Enable students to develop a basic English workplace vocabulary, comprehend sentences spoken or written in English and enables them to confidently converse in simple English.

COURSE CONTENT:

Unit 1: Conceptual Understanding of Communication, Cognition and Re-Cognition, Types of

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

communication: Oral, Verbal, Non-verbal, Kinesics, Interpersonal, Group and Mass Communication, Communion, Barriers to communication, Values and Belief system.

Unit 2 : Spoken Communication, Art of debating, Elocution, Stage Anchoring, Group Discussion, Interviews, Quiz, Use of Jargon, Slangs and Vocabulary for effective Communication, Voice Modulation and Intonation, Clarity, Brevity, Articulation of thought and speech, Assertiveness, Affirmation.

Unit 3 : Written Communication, KISS rule, Resume writing, Letter writing, Taking notes, Recording minutes and preparing proceedings of meetings, Role of empathy and compassion.

Unit 4 : Self-assessment, Self awareness, Self-esteem, Self-confidence, Perception and observation skills, Benefits of Meditation and Self-Hypnosis, Goal setting and career planning.

Practical: Debate, Declamation, Presentation exercises and written communication exercises.

SUGGESTED READINGS:

1. Barker. A,`` Improve Your Communication Skills," Kogan Page India Pvt Ltd.
2. Adrian Doff and Christopher Jones,`` Language in Use (Upper-Intermediate)," Cambridge University.
3. John Seely,`` The Oxford Guide to Writing and Speaking," Oxford University Press.
4. Shiv Khera,`` You Can Win," Macmillan Books.
5. Stephen Covey,`` 7 Habits of Highly Effective People," Simon and Schuster
6. John Collin,`` Perfect Presentation ," Video Arts Marshal.
7. Jenny Rogers,`` Effective Interviews," Video arts Marshal.
8. Robert Heller,`` Effective Leadership: Essential Manager Series," DK Publishing.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE012	**Business Communication and Presentation Skills**	**1L-0T-2P**	**None**

COURSE OUTCOMES (CO):

To develop management communication skills in the students that will help the students to face future endeavors and will also help in their interviews.

COURSE CONTENT:

Unit-I:

Identity Management Communication:– Face to Face Impression Management & Mediated Communication (Self Introduction & Self-Promoting– Over Stating And Under Stating – Strategies to Overcome Communicative Inhibitions – Creating Positive Self-image through words - Appearance- Verbal and Non Verbal Manners) – Giving Polite Yet Assertive Responses – Responsive strategies to handle criticism - Accepting Failure and Declaring Success.

Unit-II

Business Presentations:– Oral and Power Point Presentations, Preparing Successful Presentations, Assessing Audience, Making Effective Use of Visual Aids, Delivering Presentation,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Using Prompts, Handling With Questions and Interruptions, Mock Presentations.
Unit-III
Oratory Skills: – Group Discussion, Extempore, Mock Parliament and Mock Press.
Unit-IV
Interview Management: – Resume Preparation, Types of Interviews, Preparing For Interviews, Facing Interviews, Handling Tough & Tricky Questions, Reviewing Performance, Participating In Mock Interviews

SUGGESTED READINGS:

1. Lori Harvill Moore,`` Business Communication," Bookboon

2. John Thill, Courtland L. Bovee ,`` Excellence in Business Communication," Pearson Prentice Hall

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE013	Theatre	0L-0T-4P	None

COURSE OUTCOMES (CO):

Our goal is to nurture artist-scholars who are well read in dramatic literature, who understand the social and historical contexts of that literature, who appreciate contemporary performance and dance, who think critically, who master discipline-specific skills, and who make compelling artistic choices on stage.

COURSE CONTENT:

Unit 1 : Concept of Acting in Indian Classical theatre. Western styles of theatre acting.
Unit 2 : Basics of the following: Acting in Grotowski's Poor Theatre, Modern concept of Actor training with reference to Meyerhold, Bertold Brecht and ConstantinStanislavesky, Artaudian acting, Theatre of Cruelty, Theatre of Absurd.
Unit 3 : Acting for Camera –Knowledge of camera frames and movement within the confines of a frame, blocking, difference between theatre and Camera acting, Concentration.
Unit 4 : Acting consistently for different takes, acting scenes out of order, Auditions, acting exercises. Art of Dubbing.

SUGGESTED READINGS:

1. Boleslavsky, Richard,`` Acting: the First Six Lessons," New York Theatre Arts.
2. Hagen, Uta,`` Respect for Acting," Macmillan Press.
3. Hodge, Alison,`` Twentieth Century Actor Training," London and New York.
4. Routledge ,Stanislavski, Konstantin,`` An Actor's Work: A Student's Diary," Trans. and ed. Jean
5. Jeremiah Comey ,`` The Art of Film Acting," Focal Press .
6. Philips B Zarrilli,`` Acting (Re) Considered," Routeledge .
7. Cathy Hassey,`` Acting for Film," Allworth Press

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE014	Dance	0L-0T-4P	None

COURSE OUTCOMES (CO):

This course will provide the student with the fundamentals necessary for advanced dance skills. Further, this course will develop student appreciation of dance as an art form and lifetime activity. Designed to familiarize students with technique, the student will also study vocabulary, different forms of dance, issues in dance and the history pertaining to the world of dance. The student will develop kinesthetic awareness, movement memory, creative abilities and aesthetic appreciation of various dance forms. The enhancement and the development and maintenance of physical fitness, self-confidence, self-discipline and independence with the body by providing informal showings during class are the goals expected to be achieved. Each student should leave this class having been encouraged, esteemed, and take with them a new appreciation of dance.

COURSE CONTENT:

- Basic workout
- Introduction to Hip Hop and B-Boying with a simple choreography
- Exercise like: Rolling, jumping, moving shoulders. Footwork, Floor steps, Beat knowledge.
- Freestyle combination along with House dance style.
- Expressions class: Body expressions, Face expressions.
- Introduction of Contemporary Dance. Basic exercise of Contemporary Dance. Exercise for flexibility, Floor steps, Spinning and Balancing.
- Introduction to Jazz. Basic exercise and proper routine practice.

SUGGESTED READINGS:

1. Jonathan Burrows, ``A Choreographer's Handbook,'' Routledge
2. Jacqueline M. Smith-Autard, ``Dance Composition: A Practical Guide to Creative Success in Dance Making,'' Routledge

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE015	Yoga	0L-0T-4P	None

COURSE OUTCOMES (CO):

Students will learn about the importance of yoga in their lives. They will be exposed various types of yoga, their health benefits.

COURSE CONTENT:

UNIT-I

Origin of Yoga & its brief development, Meaning of Yoga & its importance, Yoga as a Science of Art (Yoga Philosophy),Meaning of meditation and its types and principles.

UNIT- II

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Classification of Yoga/Types of Yoga, Hatha Yoga , Raja Yoga, Laya Yoga, Bhakti Yoga, Gyan Yoga, Karma Yoga, Asthang Yoga.

UNIT –III

Principles of Yogic Practices, Meaning of Asana, its types and principles, Meaning of Pranayama, its types and principles, Meaning of Kriya its types and principles.

UNIT -IV

Yogic therapies and modern concept of Yoga, Naturopathy, Hydrotherapy, Electrotherapy, Messotherapy,Acupressure, acupuncture, Meaning and importance of prayer, Psychology of mantras, Different mudras during prayers.

SUGGESTED READINGS:

1. William Broad,`` The Science of Yoga: The Risks and the Rewards," Simon and Schuster
2. Swami Vishnu Devananda,`` The Complete Illustrated Book of Yoga," Harmony

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE016	Digital Film Making	0L-0T-4P	None

COURSE OUTCOMES (CO):

Students will learn about various technicalities involved in digital film making. They will also expose to history of cinema, preproduction etc.

COURSE CONTENT:

Unit 1 – History of Cinema, Research & Script

Early Cinema, Development of Classical Indian & Hollywood Cinema, History of Global Film including European Film (1930-present), Origin of Classical narrative cinema-Soundless film, Exploration of film and analysis of the three-part beginning, middle and end of story, **Research**(Finding and Collecting materials and facts related to your story. Where and How to find the materials related to your story. Things to consider before sketching down your story), **Script (Scriptwriting Process and its various phases), Film Grammar for Scriptwriting.**

Unit 2 – Pre-Production

Digital Video Cinematography: Introduction to Digital Video Cinematography
Cinematography, Interactivity and emotions through Cinematography,
Building blocks, Compositions, Lenses and Cameras, Types of lenses: Zoom Lens, Prime Lens, Types of Cameras: HD Cameras, Basics of Film Camera, Difference between, Film Camera and Digital Camera, DSLR and HDSLR Cameras, Lighting, Psychology of light, Visual Environment, Directional Effect of Light, Lighting design process, Three-point lighting, High-Key lighting, Low Key lighting, Construction of a Shot, Color, Contrast, Deep Focus, Shallow Focus, Depth of Filed, Exposure, Racking focus, Frame Rate, Telephoto shot, Zoom shot.

Unit 3- Digital Video Editing

Effective Editing, Principles of Video Editing, Non-Linear Editing (NLE) Concept, The Three-Point Edit, Non-Linear Editing (NLE) Techniques, Working in the Timeline, Transitions, Key framing, Applying Filters, Ingesting.

Unit-4Advanced Editing Techniques

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

NLE Compositing, Color Correction & Color Grading, Working on Audio, Titling

SUGGESTED READINGS:

1. Mark Brindle and Chris Jones, `` **The** Digital Filmmaking Handbook," Quercus

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE017	**Workshop (Electrical and Mechanical)**	**0L-0T-4P**	**None**

COURSE OUTCOMES (CO):

1. Student will be able to make various joints in the given object with the available work material.
2. The students will be able to understand various wiring connections

COURSE CONTENT:

Mechanical Workshop Experiments

1. BLACKSMITH
2. CARPENTRY
3. FITTING
4. FOUNDRY
5. WELDING

Electrical workshop Experiments

1. STUDY & PERFORMANCE OF DIFFERENT TYPES OF WIRE JOINTS
2. STUDY AND PERFORMANCE OF STAIRCASE WIRING
3. STUDY AND PERFORMANCE OF SERIES AND PARALLEL CONNECTION OF FLOURESCENT TUBE LIGHT
4. STUDY AND PERFORMANCE OF GODOWN WIRING
5. SERIES AND PARALLEL CONNECTION OF BULBS AND POWER SOCKETS BY SINGLE SWITCH AND MULTI SWITCHES.

SUGGESTED READINGS:

1. Hajra Choudhury, Hazra Choudhary and Nirjhar Roy, ``Elements of Workshop Technology, vol. I, '' Media promoters and Publishers Pvt. Ltd.
2. W A J Chapman, Workshop Technology,`` Part -1, 1st South Asian Edition,'' Viva Book Pvt Ltd.
3. P.N. Rao, ``Manufacturing Technology, Vol.1,'' Tata McGraw Hill
4. Kaushish J.P., `` Manufacturing Processes, '' Prentice Hall

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE018	**Music**	**0L-0T-4P**	**None**

COURSE OUTCOMES (CO):

The student will be familiarized with the basic terms used in Indian classical music. Also it familiarizes with the life history of some dignitaries in the field of music. This course also throws some light on the ancient music and its origins in India.

COURSE CONTENT:

Unit 1 : Study of the following terms:- Mela (Thãt), ÃshrayRãga, Rãga, Lakshana, Shruti, Alankar, Gamak, Vadi-SamvãdiAnuvãdi-Vivãdi, VakraSwara, Varjit-Swara.

Unit 2 : Biographies & contributions of the following:- Jaidev, MansinghTomar, Abdul Karim Khan, Tyagaraja, Pt. Bhatkhande, Pt. Ravi Shankar

Unit 3 : Study of following Rãgas&TãlaRãga- Yaman, Jaunpuri, Khamaj. Tãla- Ektãl, Jhaptãl

Unit 4 :Genaral discussion and definition of the following:-

a. Khyãl, MaseetKhani – Razakhani gat, Dhrupad, Tarana, Meend, Soot, Murki, Kan, Khatka, Krintan, Harmony, Melody.

b. Writing of Bhatkhande Swarlipi Paddhati.

c. Writing of Tãlasand Compositions in Notation.

d. Detailed study of Rãgas (Rãga- Bihag, Malkauns, Vrindavani Sarang) and comparative study of Rãgas.

e. Essay, Shastriya Sangeet (Classical Music) & SugamSangeet(Light Music)

Unit 5 : Vedic Music – Samvedic Sangeet, Swara, Vadya, Bhakti, Vikãr .

General study of Natyashastra, SangeetRatnakar.

SUGGESTED READINGS:

1. Vasant and Laxmi Narayan Garg,`` Sangeet Visharad,” Sangeet Karyalay
2. Sarat Chandra Pranjpayee and Chowbhamda ,`` BhartiyaSangeetkaItihas,” Surbharti Prakashan
3. Bharat Muni,`` NatyaShastra,”
4. Sharangdeva ,`` SangeetRatnakar,”
5. Sharad Chandra Pranjpayee ,`` Sangeet Bodh,”
6. Thakur Jaidev Singh ,`` Indian Music,” Sangeet research academy
7. V. N. Bhatkhande,`` Mallika Part II & III,” KramikPustak.
8. V. N. Patwardhan,`` RaagVigyan,”
9. RaginiTrivedi,`` Ragvibodha Mishrabani, Vol. I & II,’’

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE019	**Sociology of Development**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

The course introduces the students to the issues pertaining to development in the contemporary context. It familiarizes and discusses the theories and models of development

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

and their alternatives and critiques. It also introduces the concept of social exclusion that has emerged in the development discourse in the era of globalization.

COURSE CONTENT:

1. Concepts Progress, Growth, Modernization and Development
2. Development Theory Adam Smith, Karl Marx, Talcott Parsons.
3. Development of Underdevelopment, Dependency and World Capitalist System- A.G.Frank, Paul Baran, Samir Amin, Immanuel Wallerstein
4. Critique and Alternative to Development
5. Gender and Development, Culture and Development, Environment and Development, Human Development Index, Gender Development Index
   Gandhi and Schumacher on Alternative development model Appropriate Technology, Sustainable Development
6. Understanding India's Development Debate on the Development Model in India: Nehru, Gandhi, Ambedkar,
7. New Economic Policy
8. Disparities in Development: Class, Caste, Gender, Tribe, Region and Religion
9. Social Exclusion in the era of Globalization
10. Social Exclusion: Minorities and the other Marginalized Development of the Marginalized: Perspectives and Challenges

SUGGESTED READINGS:

1. Debal K. Singha Roy,`` Social Development and the Empowerment of Marginalized Groups," Sage Publications
2. Desai, A.R.,`` Essays on Modernisation of Underdeveloped Societies Vol I and II," Thacker and Company Ltd.
3. Dereze Jean and SenAmartya,`` India Development and Participation," Oxford University Press.
4. Preston, P. W.,`` Development Theory An Introduction," Blackwell Publishers, Oxford.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE020	**Universal Human Values 1: Self and Family**	**2L-0T-0P**	**None**

COURSE OUTCOMES (CO):

1. Sensitization of student towards issues in all dimensions of life

There are a whole range of issues which one faces in life towards which the young students are generally unfamiliar and therefore insensitive. Almost all the concerns - environmental, societal, familial or personal, are result of human action. Sensitization towards them therefore is an important step.

2. Inculcation of Self Reflection.

Human action is governed by various internal factors primarily the beliefs one holds, and

therefore 'looking-in' becomes essential, to see what beliefs one is holding, whether they are really true or not, if they are not true, then what could be the process to get the "right" belief and then further validate it.

Most of the young people are somehow trained to look only —outside‖. The motivation and the skill to look inside are missing. Inculcation of self reflection in students will result in them becoming more responsible, honest and trustworthy. Lack of such dualities in individuals is major concern of organizations, institutions and society in general.

3. Understanding (Clarity) of Human Relationships and Family.

It will try to show that relationships and material prosperity are the basic desire for a human being. Two global problems which we face today are war (including terrorism) and imbalance in nature (global warming). If we look at reasons for war, the fundamental cause is: Human Being is in opposition to other Human Being. Therefore one is willing (or gets compelled) to exploit others. This is due to lack of
understanding of relationships.

4.Exposure to Issues in Society and nature (larger manmade systems and Nature).

- To show that the fundamental reasons for imbalance in nature are: pollution and resource depletion. Both these aspects are result of consumerist model of development.
- To show how harmony can be ensured at following levels of our living: Individual, human –human relationships, larger society, Various social systems like education system, economic system, political system and others, and rest of the nature.

5. Development of Commitment and Courage to Act.

If the understanding is right, then the actions become right. Commitment and courage to act are considered consequences of right understanding in an individual. In the course, an attempt will be made to build right understanding in the individual, and then further plan of actions will also be discussed in order to implement the understanding in various life situations in the right manner.

At the end of the course, students are expected to become more aware of their self and their relationships and would have better reflective and discerning ability. They would also become more sensitive to their surroundings including both people and nature, with commitment towards what they believe in (human values).

It is hoped that they would be able to apply what they have learnt to their own self in different ordinary day-to-day settings in real life with higher commitment and courage.

COURSE CONTENT:

1. Motivation and Objectives of Human Values Course.

Introduction to the objectives of the course. Content and process of the course including mode of conduct. Daily life as lab for the course. Activities in the course.

2. Purpose of Education How human being has a need for Knowledge, what should be the content of knowledge, how the content should be discussed in education. Complimentarily of skills and values, how the current education system falls short.

3. Peers Pressure, Social Pressure In various dimensions of life, how do these things work. What is the way out? In the context of education, peer pressure etc. movie —TaareZameen Par‖ can

be used.

4. Concept of Competition and Excellence How competition leads to degradation of self and relationships. How excellence is the basic need of a human being. What is excellence? Movie —Fearless‖ can be used to discuss the concept.

5. Time Management:

How does one deal with myriads of activities in college? Focus of the mind.

6. Concept of Preconditioning. How preconditioning affects our thinking, behavior, work, relationships, society and nature. How do we develop pre-conditioning?

What are the various sources of preconditioning? How do we evaluate our Preconditioning? How do we come out of it?

7. Concept of Natural Acceptance in Human Being. What is natural acceptance? How can the concept of natural acceptance be used to evaluate our preconditioning. Universal nature of natural acceptance. Are anger, jealousy, hatred natural? How do we feel when we experience them? Which feelings are natural for a human being and which are not?

8. Understanding Relationships.

a) Are relationships important? What is the role of relationships in our life? If relationships are important then why they are important? If they are important then why it is the case that we are not discussing them?

What are the notions/conditions and factors which stop us to explore more into relationships. Relationships in family and extended family. Dealing with anger. Show film —Right Here, Right Now‖.

b) Basic expectations in relationships. Seven types of relations.

c) Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

d) Nine universal values in human relationships. Trust as the founding value.

e) Concept of acceptance. Unconditional acceptance in relationships.

f) Our preconditioning affecting our relationships. Our relationships with subordinate staff, with people of opposite gender, caste, class, race. Movie —Dharm‖(set in Varanasi) can be used to show the conflict between reconditioning and relationships. How relationships have the power to force a person to change his preconditioning.

9. Concept of prosperity

Material goods and knowledge of one's physical needs is essential for feeling of prosperity. What role others have played in making material goods available to me: Identifying from one's own life.

10. Idea of Society. What is a society? What constitutes a society? What systems are needed for a society to work? What is the purpose of society and various systems which are working in it? How understanding of Human Nature is important in order to understand the purpose of Society and various social systems? And what happens when this understanding is lacking?

11. Idea of decentralization of politics, economics, education, justice etc. Its comparison with centralized systems. The idea of Swaraj. Various social initiatives by NGOs, social organizations and other people. (If time permits)

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

12. Balance in nature
a) Balance which already exists in nature.
b) How human beings are disturbing the balance. Resource depletion and pollution.
Our own role in wastage of electricity, water and in use of plastics. Waste management. (Show episode on city waste from SatyamevaJayate 2.)
c) Issues like global warming, animal extinction. Show —Story of Stuff‖ documentary film. —Home‖ film can also be used.

SUGGESTED READINGS:

1. Annie Leonard, `` The Story of Stuff,'' Free Press
2. Mohandas Karamchand Gandhi,`` The Story of My Experiments with Truth," Beacon Press
3. J Krishnamurthy,`` On Education," Official repository
4. Hermann Hesse ,`` Siddhartha," Bantam Books
5. ThichNhatHanh,`` Old Path White Clouds," Parallex Press
6. On Education - The Mother Aurobindo Ashram Publication
7. Anne Frank,`` Diaries of Anne Frank ,"
8. G S Banhatti`` Life and Philosophy of Swami Vivekananda," Atlantic
9. Swami Vivekanand`` Swami Vivekananda on Himself," Advaita Ashram
10. E. F Schumacher,`` Small is Beautiful: Economics as if people mattered,"Harper Pereinnial.
11. Cecile Andrews ,`` Slow is Beautiful," New society publishers
12. A.Nagaraj,`` JeevanVidya: EkParichaya," Jeevan Vidya Prakashan.
13. A.N. Tripathi,`` Human Values," New Age Intl. Publishers.
14. Dharampal,`` Rediscovering India," Other India Press
15. Mohandas K. Gandhi,`` Hind Swaraj or Indian Home Rule," Navjeevan publication house
16. Maulana Abdul Kalam Azad,`` India Wins Freedom," Stosius Inc
17. Ramakrishna kijeevani ,`` Romain Rolland
18 Romain Rolland , "Vivekananda" Advait ashram.
19. Romain Rolland , "Gandhi" Srishti Publishers & Distributors.
20. ParamhansaYogananda,`` Autobiography of a Yogi," ," Rider publication.
21. Sahasrabudhe, "Gandhi and Question of Science,"Other India Press.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE021	**Universal Human Values 2: Self, Society and Nature**	**2L-0T-0P**	**FE020**

COURSE OUTCOMES (CO):

1. Sensitization of student towards issues in society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human
relationships and resolved individuals.

3. Strengthening of self reflection.
4. Development of commitment and courage to act.

At the end of the course, students are expected to become more aware of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they believe in (humane values. humane r learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction relationships and humane society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

COURSE CONTENT:

In Universal Human Values 2 course, the focus is more on understanding society and nature on the basis of self and human relationships. and motivation for the course.-conditioning, and natural acceptance.

-existence of self and body. Identifying needs and satisfying needs of self and body. Self observations. Handling peer pressure family. Hostel and institute as extended family. Real life examples.

-student relationship. Shraddha. Guidance. Goal of education.

– material order, plant order, animal order and human order.

Salient features of each. Human being as cause of imbalance in nature. (Film “Home” can be used.)

– water, food, mineral resources.

Pollution. Role of technology. Mutual enrichment not just recycling.

on of needs of the self and

needs of the body. Right utilization of resources. Understanding the purpose they try to fulfil. Recapitulation on society. Five major dimensions of human society. Fulfilment of the individual as major goal. Justice in society. Equality in human relationships as naturally acceptable. Establishment of society with abhaya (absence of fear). being through holistic education in just order.

SUGGESTED READINGS:

Text Book

1. R R Gaur, R Sangal, G P Bagaria, “Human Values and Professional Ethics “Excel Books, New Delhi,
2010

Reference Books

2 . A Nagaraj , “Jeevan Vidya: EkParichaya, “ Jeevan VidyaPrakashan, Amarkantak.
3 . A.N. Tripathi , “Human Values,” New Age Intl. Publishers, New Delhi, .
4. Annie Leonard, “The Story of Stuff” Simon and Schuster.
5. Mohandas Karamchand Gandhi, “ The Story of My Experiments with Truth “ Becon Press.
6. J Krishnamurthy, “ On Education “ Official repository.
7. Hermann Hesse, “Siddhartha “ Bantan press.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

8. ThichNhatHanh, " Old Path White Clouds " parallax press.
9. On Education - The Mother Aurobindo Ashram Publication.
10 . Diaries of Anne Frank – Anne Frank
11. G.S Banhatti, "Life and Philosophy of Swami Vivekananda," Atlantic publisher.
12. Swami Vivekananda , "Swami Vivekananda on Himself," Advait publication.
13. E. F Schumacher , "Small is Beautiful: Economics as if people mattered,"Harper Pereinnial.
14. Cecile Andrews , "Slow is Beautiful" New society publishers.
15. J C Kumarappa, "Economy of Permanence" Serve seva sangh prakashan.
16. Pandit Sunderlal , "Bharat Mein Angreji Raj"
17. Mahatma and the Rose plant
18 . M.Gandhi, "The Poet and the Charkha" Mani Bhavan
19. Dharampal, "Rediscovering India" other India press.
20 .Mohandas K. Gandhi , "Hind Swaraj or Indian Home Rule," Navjeevan publication house.
21. Arvind Kejriwal , "Swaraj" Harper publication.
22 . Maulana Abdul Kalam Azad, "India Wins Freedom."Stosius Inc.
23. Romain Rolland , "Ramakrishna kijeevani,"Advait Ashram.
24. Romain Rolland , "Vivekananda" Advait ashram.
25. Romain Rolland , "Gandhi" Srishti Publishers & Distributors.
26 . ParamhansaYogananda, " Autobiography of a Yogi," Rider publication.
27. Sahasrabudhe, "Gandhi and Question of Science,"Other India Press.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SYLLABUS OF DISCIPLINE CENTRIC ELECTIVES

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD01	**Biology of Infectious Disesases**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To study about the diseases caused by pathogens and, their mode of transmission
2. To understand the dynamics of disease progression and immune modulation during infection
3. To distinguish antiparasitic host immune responses that control disease from those that causes disease
4. To understand the mechanism of immune mediated pathology
5. To study the effect of microbiome on the immune response
6. To study the mechanism of tumor generation and progression
7. To study the diagnosis and current treatment regimens of cancer
8. To understand the immunobiology of mycobacterium and HIV infections and associated diseases

COURSE CONTENT:

Infectious Agents & Pathogenesis: Bacteria, viral, fungal and parasitic (including helminthic and protozoan) infections (with examples from each Group), biology of prions, mechanism of pathogenesis (tuberculosis, HIV-AIDS, malaria)

Hallmark of immune response to parasite: Distinct phases during course of infection, course of adaptive immune responses to infection, Mechanism underlying Th1/Th2 response selection, Effector mechanism of host response towards extracellular and intracellular parasite,

Mechanism of Immune evasion and latency: Evasion of Immune Recognition, Evasion by Immune Supression, Immune suppression and Latency

Immunopathologic mechanism and their regulation (pathology of chronic Th1/Th2 responses), Gut and Mucosal Immune responses

Tumor immunology – Tumor antigens, Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy,

Immunodeficiency - Primary immunodeficiencies, Acquired or secondary immunodeficiencies, Sexually Transmitted Diseases (STIs)

PRACTICAL:

1. Permanent slides of pathogens. Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
2. WIDAL test
3. Identification of clinical isolates

4. Anti-microbial susceptibility assay
5. Differential gene expression by Quantitative RT-PCR
6. Identification of biomarkers using flow cytometer
7. PCR based diagnosis
8. Preparation of various parasite antigen for functional assays
9. Chemokine and cytokine ELISA

SUGGESTED READINGS:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne, "Immunology, 6th Edition", Freeman.
2. Janeway et al., "Immunobiology, 4th Edition", Current Biology Publications.
3. Paul, "Fundamental of Immunology, 4th edition", Lippencott Raven.
4. Anthony A. et. al., "Mims' Pathogenesis of Infectious Disease"
5. Greenberg, R.S., Daniels, S.R., Flanders, W.D., Eley, J.W. and Boring, J.R., "Medical Epidemiology", Lange Medical Books/McGraw Hill, New York

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD02	**Microbiome and Metagenome**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. The students will learn about the basic concepts of metagenomics
2. The students will gain knowledge about the various platforms used for metagenomics
3. The students will learn about the significance of human microbiome, healthcare and environmental issues
4. The students will learn about the tools required for annotation and assembly of metagenomes.

COURSE CONTENT:

Introduction of metagenomics, concept of great plate anomaly, Time scale of metagenomics, Problems associated with cultivation of microorganisms, Host derived unculturability, Significance of metagenomics.

Metagenomic DNA extraction and associated problems, Construction of metagenomic libraries (plasmid, fosmid and BAC), Approaches of metagenomics (Functional driven screening and Sequence driven metagenomics).

Principle of sequencing techniques (Sanger method, Maxum Gilbert method, pyrosequencing). High-throughput methods on metagenomics (Roche 454, Illumina, Solexa, Soild, HiSeq and Miseq, iontorrent, PacBio). Platforms and platform specific issues, DNA extraction methodologies, Preparation of samples Quality Control-reports (QC) & quality controls, Mapping of sequencing reads.

Introduction of Next generation sequencing, understanding NGS Analysis and their applications, NGS analysis: sequencing technologies, platforms and platform specific issues, DNA extraction methodologies, Preparation of samples Quality Control-reports (QC) & quality controls,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Mapping of sequencing reads.
Signature sequences of bacteria, archaea and fungus. Structures of variable and hypervariable regions of 16S rDNA. Introduction of Microbiome and Human microbiome project, Food project, significance of human microbiome, Microbiome,.
Understanding basic terminology of NCBI, Available Databases, NCBI Blast search (Blastn, Blastp, Blastx, tBlastn, tBlastp), Comparative Genomics, BlastP, PSI-Blast, and Translated Blast. MEGA, DiAlign, MAFFT. Multiple sequences alignments, designing of PCR primers. Phylogenetic analysis: Operation of MEGA 6.0, phylogenetic analyses with both Neighbor-joining and Maximum likelihood methods.
Metagenomic analysis resources 16S RNA database (Greengenes, SILVA, RDP), Functional annotation database (RAST, Pfam, TIGRfam, KEGG, COG, SEED, CAGE, EBI), Search strategy (BLAST, PyNAST, USERACH, UCLUST, HMMER) LCA (Lowest Common Ancestor) algorithm, PhymmBL, Ribosomal Database Project (RDP) classifier. Microbial diversity analysis (MLST, MOTHUR, EstimateS, QIIME).
Taxonomic annotation, functional annotation & function determination, Prediction of unknown gene, comparative metagenomics, Sequencing of amplicon, shotgun meta-transcriptomics, calling taxa, Assembly of metagenome and their evaluation, Visualization and preparation of results, tools and algorithms, 16S rDNA profiling, Databases, Mapability, k-mer profiling, cross assembly.
Personal Human Microbiome/metagenomic project

PRACTICAL:

1. Perform basic taxonomic and functional assignment using a sequence similarity method
2. Perform basic taxonomic assignment using a marker-gene method: MetaPhlan
3. Methods and algorithms for analyzing metagenomic datasets.
4. Study of Human Microbiome in Space and Time using three different datasets.
5. Learn Data handling, in particular from next generation sequencing.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD03	**Nanobiotechnology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. Students will understand about the interaction of biomolecules with surfaces of different chemical and physical species and its applications.
2. Students will be able to produce and make use of various types of nano-structured materials in the field of biological sciences
3. Students will be able to suggest methods for the design of enzyme reactors and other bioconjugates on surfaces and second carriers, and explain the carrier's influence on the activity of the biomolecule.
4. Students will explore different case studies regarding applications of nanobiotechnology within the field of bioelectronics and account for the basic principles they are based on.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

5. Students will be able to apply basic principles of microfluidics to solve biotechnical and bioanalytical problems and would be able to make a risk assessment of a nanobiotechnological project

COURSE CONTENT:

Introduction: Fundamental principles of nanobiotechnology and bionanotechnology, topdown and bottom up approach for building nanomaterials

Cellular nanostructures

Nanoparticle characterization: UV-visible spectroscopy, SEM, TEM, AFM, XRD, STM

Nanotechnology and drug delivery: Advantages of nanostructured delivery systems, targeted and non targeted drug delivery, nanotechnology-based tumor and blood brain barrier targeting strategies, polymeric nanoparticles, liposomes and lipid nanoparticles dendrimers, nanofibres, nanotubes, nanogels, solid lipid nanoparticles, nanocapsules, controlled drug delivery systems

Nanostructures for diagnostics and therapy: Quantum dots, nanoshells, gold nanoparticles, silver nanoparticles, paramagnetic nanoparticles, nanobiosensors, use of nanoparticles for MRI, X Ray, ultrasonography, gamma ray imaging, nanoparticles as molecular labels, photothermal therapy, photodynamic therapy, hyperthermia

Multifunctional nanoparticle systems

Microorganisms for synthesis of nanomaterials

Nanotoxicology: Sources of nanoparticles in the environment, entry routes into the human body, effect of size and surface charge, nanoparticles and cellular uptake, in vitro assyas for toxicity

PRACTICAL:

1. Demonstration of nanoparticle characterization techniques: UV-visible spectroscopy, transmission electron microscopy, scanning electron microscopy, powder X-ray diffraction, etc
2. Preparation of colloidal silver nanoparticles with trisodium citrate and their characterization by UV-Vis spectroscopy.
3. Preparation of metal oxide nanoparticles by microemulsion technique.
4. Synthesis of polymeric nanocomposites
5. Synthesis of different sizes of metallic nanoparticles and their characterization by UV-Vis spectroscopy.
6. Antibacterial activity of silver nanoparticles
7. Characterization of aggregation of nanoparticles
8. Drug delivery through nanoparticles
9. Experiments on various applications of nanoparticles

SUGGESTED READINGS:

1. C. M. Niemeyer, C. A. Mirkin, “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley
2. David S Goodsell, “Bionanotechnology”, John Wiley & Sons

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

3. T. Pradeep, "Nano: The Essentials", McGraw – Hill education
4. Avouris, P., Klitzing, K. Von, Sakaki H. & Wiesendanger. R, "Nano Science & Technology Series", Springer

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD04	**Cell & Tissue Engineering**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

COURSE OUTCOMES (COs):

1. The students will learn the basic concepts and develop skills for culturing various types of cells and tissues.
2. The students will get a holistic view of the different type of cell-cell communication which occurs between various cell types and tissues.
3. The students will learn the modern techniques of establishing 3D cultures and how they can utilize to generate therapeutics.
4. The students will develop an understanding of the transport of biological fluids/metabolites required for tissue engineering
5. The students will able to appreciate the large scale production of therapeutics using bioreactor for commercial applications benefiting the society.

COURSE CONTENT:

Introduction to Tissue Engineering: Basic definition, general aspects of cells in culture, current scope of development and use in therapeutics and *in vitro* testing.

Structure and Organisation of Tissue: Epithelial, Connective, Vascularity, Lymph. Basic Developmental Biology

Matrices for Tissue Engineering: Matrices properties, surface modifications to affect cell and tissue behavior

Cell-Matrix and Cell-Cell Interactions, Hormone and Growth Factor Signaling (RTK's, G-proteins, TGFb, FGF) Growth Factor Delivery, Applications of growth factors – VEGF/Angiogenesis

Cell Migration: Control of Cell Migration for Tissue Engineering

Transport properties of Tissue: Intro to Mass transfer in tissue engineering, Diffusion of simple metabolites, Diffusion and reaction of proteins, bioreactor design strategies, application of physical forces, transport limits on 3D cultures.

Scaffolds and Tissue Engineering – Basic Properties, Basic Transplantation Immunology,

Design and Biology of engineered tissues: Skin, Osteochondral tissue, Cardiovascular tissue, Liver tissue and Bone.

PRACTICAL:

1. Culture of different cell types
2. Growth of cells on different matrices
3. Establishment of 3D culture

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

4. Growth Characteristics of 3D culture
5. Lipofectamine based cell transfection
6. Viability Assays
7. 3D culture in Bioreactor

SUGGESTED READINGS:

1. L Hench and J. Jones, "Biomaterials, Artificial Organs and Tissue Engineering"
2. Robert Lanza, Robert Langer and Joseph Vacanti, "Principles of Tissue Engineering (Third Edition)"

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD05	**Molecular & Cellular Diagnostics**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. The students will understand the importance of diagnostic techniques for detection of various pathologies.
2. The students will develop the concepts of principles used for diagnostics based on different biomolecules such as DNA, enzymes and metabolites.
3. The students will also understand the role and importance of latest PCR based technologies for solving forensic cases.
4. The students will develop the skill set for interpretation of results and the importance of documentation.

COURSE CONTENT:

Cell based diagnostics: Antibody markers, CD Markers, Flow Cytometry based diagnostics, HLA typing, ELISpot, Bioassays, case studies

DNA based diagnostics: PCR, RFLP, SSCP, Microarrays, FISH, *In-situ* hybridization, Case studies related to bacterial, viral and parasitic infections

Enzyme based diagnostics: Principle of diagnostic enzymology, liver, cardiac and skeletal enzymes, Digestive enzymes, Miscellaneous enzymes

Metabolite based diagnostics: Liver function test, Cardiac Function Test, Renal Function Test, Thyroid Function test, Reproductive endocrine function test

Immunodiagnostics: Introduction, Diagnostics based on Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections.

Product Development: Assay Development, Evaluation, and Validation, Reagent Formulations and Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.

PRACTICAL:

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

1. Characterization of white blood cells by flow cytometer
2. Identification of CD markers by flow cytometer
3. Cell cycle analysis by flow cytometer
4. Determination of Apoptotic markers by flow cytometer
5. HLA Typing
6. FISH for chromosomal aberration
7. SNP assays
8. RFLP Assays
9. Protein analysis by western blot in different disease conditions
10. Alanine aminotransferase (ALT) and Aspartate aminotransferase Tests
11. Serum Urea, Uric acid and creatinine
12. Detection of polyclonal antibodies produced in response to specific antigens

SUGGESTED READINGS:

1. Campbell, M.A and Heyer L.J., "Discovering Genomics, Proteomics and Bioinformatics", CSHL Press, Pearson/Benzamin Cummings San Francisco, USA.
2. Andrew Read and Dian Donnai, "New Clinical Genetics", Scion Publishing Ltd, Oxfordshire.
3. James W Goding, "Monoclonal antibodies: Principles and Practice, 3rd Edition", Academic Press.
4. George Patrinos and Wilhelm Ansorage, "Molecular Diagnostics, 1st Edition", Academic Press.
5. Lela Buchingham and Maribeth L Flawsm, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition" F A Davis Company, Philadelphia, USA.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD06	**Anatomy & Physiology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. Students will be able to identify the anatomical structures and their importance in the body.
2. The students will develop a basic understanding of the phenomenon of homeostasis.
3. Students will be learn about the basic concepts of working of integumentary system
4. The students will learn about the working of various organ systems and associated diseases.
5. To learn human physiology and its clinical significance

COURSE CONTENT:

Body organization: General Anatomy of the body, Introduction to various kinds of body planes, cavities and their membranes, Tissues level of organization (Types, origin, function & repair), introduction to organ systems

Integumentary system: Anatomy and histology of human skin. Function of skin temperature regulation by skin.

Muscular system: Functional anatomy of muscular system, types of muscles, neuromuscular transmission, general and molecular mechanism of skeletal muscle excitation and contraction,

energetics of muscle contraction and characteristics of whole muscle contraction. An overview of concepts of muscle fatigue, oxygen debt, shivering/tremor, muscle degeneration, tetany, muscular dystrophy.

Skeletal System: Cartilage: structure, function and types. Bones: structure, function, location and types. Joints: structure, function and types. An overview of disorders of skeletal system: arthritis, gout, fractures, osteoporosis.

Blood: Composition and Function of blood and its components: WBC, RBC, platelets. Hematopoiesis, Hemoglobin structure and function. Hemostasis and blood coagulation mechanism, blood groups and blood banking. An overview of lymphoid tissue and Lymph. Basic concepts about Anemia, abnormal hemoglobin, Polycythemia, Thalassemia, Leukemia.

Nerve System: Structure and function of Brain, Central NS, Peripheral NS and Autonomous NS

Hormones: types, source and physiological role

PRACTICAL:

1. Estimation of hemoglobin (Sahli's method).
2. Determination of bleeding time and clotting time of blood.
3. Determination of total erythrocyte count.
4. Determination of total leukocyte count.
5. Preparation of blood smears and identifying various WBC
6. To perform differential leukocyte count of blood.
7. Determination of specific gravity of blood.
8. Determination of osmotic fragility of RBC.
9. To study various types of fractures from X ray films
10. To study different human organs and their sections through permanent histological slides T. S. of brain, spinal cord, skeletal fibres, cardiac muscles, skeletal muscles, cartilage joints and different tissues.

SUGGESTED READINGS:

1. J. E. Hall, "Guyton and Hall Textbook of Medical Physiology, 11th edition", W B Saunders and Company.
2. Stuart I. Fox, "Human Physiology, 9th edition", Tata McGraw Hill.
3. Dr. Gayatri Prakash, "Lab Manual on Blood Analysis and Medical Diagnostics, 1st edition", S. Chand.
4. A. K. Jain, "Manual of Practical Physiology, 4th edition", Arya Publication
5. Gerard J. Tortora and Bryan H. Derrickson, "Principles of Anatomy and Physiology, 13th edition", Wiley and Sons.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD07	Fuel Cell Technology	3L - 0T - 2P	None

COURSE OUTCOMES (COs):

1. To identify the electrolytes, temperature range and operation of different fuel cells.
2. To analyze the efficiency and open circuit voltages of a fuel cell
3. To identify activation, ohmic, crossover and concentration losses in fuel cells and apply the Nernst/Butler Vollmer equation
4. To apply fuel cell equations to compute the mass flow rates of reactants, heat generated and water produced in a hydrogen fuel cell
5. To analyze physical compressor problems as applied to fuel cell systems
6. To demonstrate the systematic approach in reforming various types of fuels to obtain hydrogen and reformates and its industrial applications
7. To develop an in-depth understanding of safety and regulatory issues regarding transportation, storage and onboard transportation of Fuel cells

COURSE CONTENT:

Introduction to Fuel Cells Brief history of fuel cells, Operating principles, Differences between electrochemical and chemical energy conversion, Types of fuel cells (with an emphasis on PEMFC and DMFC technology), Applications, Current state of the art, Limitations and principle research areas (addressing limitations)

Fuel Cell Thermodynamics Brief review of first and second laws of thermodynamics, Application of the first and second law to fuel cells, Significance of the Gibbs free energy, Concept of chemical potential and EMF, Derivation of the Nernst equation, Fuel cell efficiencies, comparison with Carnot efficiencies, Thermodynamic advantage of electrochemical energy conversion

Essential Concepts of Electrochemistry and Electrode Brief review of electrochemical concepts, Electrochemical cells, oxidation and reduction processes, Half cell potentials and the electrochemical series, Faraday's law, faradaic and nonfaradaic processes, Important factors involved in faradaic processes, Current and reaction rate, Polarization and overpotential

Fuel Cell Electrolytes – The Ionomeric Membrane Different fuel cell technologies – electrolytes and catalyst used, The ionomeric membrane in a PEFC, Properties (requirements) of ionomeric membranes, Mechanisms of proton transport in ionomeric membranes, Water content and transport in ionomeric membranes, Relationship between proton conductivity and membrane water content, Hydrogen oxidation (anode) electro-catalysis in a PEFC, Effect of impurities on anode electro-catalysis in a PEFC

Fuel cell Biotechnology Working Principle of Enzymatic and Microbias Fuel Cells, and its Various Materials, Bioremediation Using Fuel Cell Technology, Exo-electrogens : Mechanism of electron transfer, Electrically active microorganism, Fuel cell for hydrogen production.

PRACTICAL:

1. Open-Circuit Voltage Calculation from Gibb's Free Energy
2. Assembling of Fuel cell

Passed in the meeting of Standing Committee on Academic Matters, University of Delhi, held on June 03, 2016

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

3. Drawing Polarization Curve with Concentration Effects for a given Fuel cell
4. Drawing Polarization Curve with Temperature & Humidity Effects for a given Fuel cell
5. Electrolysis of water using fuel cell
6. Performance study of a PEM fuel cell (current density vs. voltage curve)
7. Measurement of Gas (Hydrogen) Generation – Collecting gas in the tank and measuring the rate of generation.
8. Fuel Cell Empirical Model determination
9. Experimental Study of Microbial Fuel Cells for Electricity Generating: Performance Characterization procedure
10. Experimental Study of Microbial Fuel Cells for Electricity Generating: Capacity Improvement procedure
11. Optimizing Microbial Fuel Cell Output by Varying Relative Surface Area
12. The Effect of Variable Microorganisms and pH on the Efficiency of a Microbial Fuel Cell

SUGGESTED READINGS:

1. O,Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, "Fuel Cell Fundamentals", Wiley, N.Y.
2. Bard, A. J., L. R., Faulkner, "Electrochemical Methods", Wiley, N.Y.
3. Basu, S., "Fuel Cell Science and Technology", Springer, N.Y.
4. Liu, H., "Principles of fuel cells", Taylor & Francis, N.Y.
5. Logan B, "Microbial fuel cell", Willey, N.Y.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD08	**Computational Biology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. Learning fundamental concepts in computational biology and its applications.
2. To learn application of networks, algorithms, and models in biology.
3. To learn manipulation of DNA and proteins to generate information from sequences and whole genomes
4. To learn modeling of biological processes by application of computer programming
5. To learn techniques and concepts for investigating interactions among biomolecules
6. To develop skills in applications of computational biology.

COURSE CONTENT:

Introduction and overview - Mathematics, statistics and computer science. Cloning and clone libraries – libraries by complete and partial digestion, Physical genome maps – mapping by fingerprinting and mapping by anchoring, clone overlap and sequence assembly, Shotgun sequencing, sequencing by hybridization.

Simple problems in Computational Biology: Double digest problem, Algorithms for DDP, Exact string matching – classical comparison based methods, seminumerical string matching, suffix

trees – construction and application

Pairwise sequence comparisons: Databases and rapid sequence analysis – Tree representation of a sequence, hashing a sequence, repeats in a sequence, sequence comparison by hashing, sequence comparison by at most *l* mismatches, sequence comparison by statistical content, Dynamic programming alignment – The number of alignments, shortest and longest paths in a network, global distance and similarity alignments, scoring matrices and gap penalties, filtering, position specific scoring matrices

Database search techniques: parametric sequence comparison, statistical significance of alignments, Probability and statistics for sequence alignment, extreme value distributions, database searching algorithms and artifacts, sequence alignment with scores.

Multiple sequence alignment – uses of multiple sequence alignment, programs and methods for multiple sequence alignment, pattern searching programs, family and superfamily representation, structural inference, dynamic programming in r-dimensions, weighted average sequences, profile analysis, alignment by hidden Markov models, consensus word analysis, more complex scoring.

Phylogenetic prediction- Trees-splits and metrices on tress, tree interpretation, Distance - additive, ultrameric and nonadditive distances, tree building methods, phylogenetic analysis, parsimony , tree evaluation, maximum likelihood trees – continuous time markov chains, estimating the rate of change, likelihood and trees, analysis software.

PRACTICAL:

1. Writing a sequence assembly program
2. Implementation of a selected sequence alignment algorithm
3. Introduction to NCBI: sequence databases, sequence retrieval, sequence file formats
4. Introduction to NCBI: Literature and other resources
5. Introduction to NCBI: Structure and other resources
6. Pairwise comparisons: - effect of different substitution matrices, change in gap penalties
7. Database search: Evaluate the statistical significance of the match with a web program. Effect of presence of low complexity regions in the sequence and filtering.
8. Multiple sequence alignment: Tools and resources
9. Phylogenetic analysis: Tools and resources

SUGGESTED READINGS:

1 D. Gusfield, “Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology”, Cambridge University Press.

2. Biocomputing Hypertext Coursebook at http://www.techfak.unibielefeld.de/bcd/Curric/welcome.html/

3. A.D. Baxevanis and B.F.F. Ouellette, “Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins”, Wiley-Interscience.

4. D.W.Mount, “Bioinformatics: Sequence and Genome Analysis”, Cold Spring Harbor Laboratory Press.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

5. R.F. Doolittle, J.N. Abelson and M.I. Simon, "Computer Methods for Macromolecular Sequence Analysis", Academic Press.
6. C. W. Sensen, "Essentials of Genomics and Bioinformatics", John Wiley and Sons.
7. "European Biotechnology Information Project (Ebip): Business Information Sources in Biotechnology Publisher", British Library Publications.
8. A.Crafts-Lighty, "Information Sources in Biotechnology", Grove's Dictionaries.
9. T. Attwood and D. Parry-Smith, "Introduction to Bioinformatics" Prentice Hall.
10. M. Waterman, "Introduction to Computational Biology: Maps, sequences and Genomes", Chapman and Hall.
11. G. Von Heijne and G. Von Heijne, "Sequence Analysis in Molecular Biology: Treasure Trove or Trivial Pursuit", Academic Press

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD09	**Environmental Biotechnology**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To understand the evolution of earth and origin of life with respect to perturbations in its composition leading to global environmental problems.
2. Students will learn about existing and emerging technologies that are important in the area of environment biotechnology.
3. To learn existing and emerging technologies that are important in the area of environmental biotechnology
4. Students will learn the importance of microbial world for environmental systems and processes.
5. To undertake a range of practical approaches relevant to environmental biotechnology and analyze case studies representative of key areas of environmental biotechnology
6. To critically analyze relevant journal articles and investigate industrial applications of the concepts of biotechnology for effluent treatment.
7. Students should learn as to how they can manipulate, enhance or retard biological processes for bioremediation of natural sources and xenobiotic degradation.

COURSE CONTENT:

Environment: Basic concepts and issues, Origin of earth, Origin of Life
Environmental pollution: Pollutants, Types of Pollutants, Air, Water and Soil pollution
Global environmental problems: Ozone depletion, UV – B, Greenhouse Effect and Acid Rain
Waste Water Treatment: Water as a scarce natural resource, Measurement of water pollution, sources of water pollution, waste water treatment – physical, chemical and biological treatment processes.
Microbiology of waste water treatments: Aerobic process, Activated sludge, Ananerobic processes, Anaerobic digestion, Anaerobic filters
Treatment schemes for Industrial Effluents: waste waters of dairy, distillery, tannery, sugar,

antibiotic industries.

Microbiology of degradation of xenobiotics in environment – ecological considerations, decay behavior and degradative plasmids: Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

Bioreactors, Bioremediation and Biopesticides

PRACTICAL:

1. Dissolved Oxygen in waste water
2. Biochemical oxygen demand in waste water
3. Chemical Oxygen demand in waste water
4. Hardness of water
5. Total, dissolved and suspended solid in waste water
6. Alkalinity of waste water
7. Acidity of waste water
8. Hexavalent chromium in waste water
9. Nitrate in waste water
10. Sulphate in waste water
11. Estimation of optimum dosage of ferric chloride for removal of suspended matter

SUGGESTED READINGS:

1. M. Moo-Young, "Comprehensive Biotechnology", Pergamon Press.
2. A.K. De, "Environmental Chemistry", Wiley Eastern Ltd.
3. D. Allsopp and K.J. Seal, "Introduction to Biodeterioration", ELBS/Edward Arnold.
4. Metcalf, Eddy and G. Tchobanoglous, "Waste Water Engineering – Treatment, Disposal and Reuse", Tata McGraw Hill.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD10	**Bioremediation & Waste Management**	**3L - 0T - 2P**	**None**

COURSE OUTCOMES (COs):

1. To acquire knowledge about various water contaminants and their remediation techniques
2. To understand the basic principles of separation processes
3. To learn the waste management practices and guidelines for safe disposal
4. To get familiar with industrial effluent treatment plant

COURSE CONTENT:

Introduction to bioremediation technologies, Hazardous site remediation process, Microorganisms in Bioremediation process, Phytoremediation, Basic techniques involved in Bioremediation

Biofertilizers and Biopesticides: Pesticides vs Biopesticides, Biofertilizers in agroecosystem, types of biopesticides, Integrated crop management

Composting: Composting process, Materials for composting, Composting system, Methods of

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

composting, Vermicomposting

Biopolymers and Bioplastics: Degradable, Biodegradable and compostable plastics, types of biopolymers, Plastics of plant origin, Properties and practical applications of PHA, Sustainable development of biopolymers and bioplastics

Waste monitoring and management, Treatment and Disposal of Hazardous and Non-hazardous solid waste, Management of non degradable solid waste, Medical solid waste management, Electronic waste and Hazardous waste management

PRACTICAL:

1. Activated sludge process for wastewater treatment
2. Electrostatic precipitation of particles
3. Cyclone design for particulate matter
4. Ponds and lagoon design of for wastewater
5. Bioaugumentation of organic and inorganic pollutants
6. Solid waste management in landfill sites

SUGGESTED READINGS:

1. D. K. Maheshwari, R. C. Dubey, “Bioremediation of Pollutants”
2. C. K. Choudhary, “Waste management and bioremediation”
3. A.K. Rathoure and V.K. Dhatwalia, “Toxicity & Waste Management Using Bioremediation”

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD31	Neurobiology	3L - 1T - 0P	None

COURSE OUTCOMES (COs):

1. To learn the basic structure and function of Neurons and glial cells
2. To study the various forms of nervous systems and their functioning
3. To understand the concept of signal transduction by nerves
4. To design the modern biological tool to monitor the signal transduction
5. To study various diseases related to nervous system and its treatments.
6. To study the modern genetic and molecular tools for diagnosis

COURSE CONTENT:

Introduction to neurons, Neuron structure, classification & types, Cytology of neurons, Structure and function of dendrites, Structural and functional aspects of axons, Ultrastructure, Myelination and synapses.

Glial cells: Types, Structure and function.

Nervous System (NS): Type of NS: Central (CNS), Peripheral (PNS), Autonomous (ANS)

Constitutions of CNS: Grey and white matter, Spinal cord: Gross anatomy, internal structure, tracts of the ascending and descending fibers, spinal reflexes, Cranial nerves: Functional aspects, Classification of cranial and spinal nerve component

Brain: Brainstem: Medulla oblongata, pons, fourth ventricle, midbrain, Cerebrum: Cerebral cortex, Basal ganglia, Amygdala and Hippocampus Diencephalon: Thalamus and Hypothalamus

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Cerebellum.

Constitutions of PNS: Cervical Spinal Nerves, Brachial Plexus,Lumbosaccaral Plexus

Constitution of ANS: sympathetic nervous system and parasympathetic nervous system, sensory neurons, innervations and motor neurons

Neurophysiology: Neurons as conductors of electricity, Neural Signals, Electrical properties of neurons, synaptic vesicles, Principles of synaptic transmission: Electrical and chemical synapses, **Calcium hypothesis**: Control of transmitter release, Synthesis and trafficking of neuronal proteins, Synaptic transmission at nerve-muscle synapses, Synaptic transmission at central synapses, Ligand gated channels, Second messengers and synaptic transmission.

Neuropathy: Diseases involving myelin, Multiple sclerosis and other demyelinated disorders, Neurotransmiters and disorders of basal ganglia, Molecular targets of abused drugs, Ischaemia and hypoxia, Epileptic seizures, Genetics and diagnosis of Huntington disease and other triplet repeat disorders, Alzheimer's disease: Molecular, genetic, immunological aspects and diagnostics Parkinson's disease, Motor Neuron Diseases, Prion's Disease, Anxiety disorders, Mood disorders, Attention disorders, Schizophrenia

SUGGESTED READINGS:

1. Frank Amthor, "Neurobiology for Dummies", John Wiley and Sons, Inc.
2. Eric R. Kandel, "Principles of Neural Science", TMH.
3. Peggy Mason, "Medical Neurobiology", Oxford University Press
4. Gordon M. Shepherd, "Neurobiology 3rd Edition", Oxford University Press.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD32	**Chemical Reaction Engineering**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To learn the fundamental principles of chemical reaction kinetics in problems involving mass and energy balances with/without reaction
2. To understand and design different types of reactors for bioprocess
3. To learn and assess the advantages and disadvantages of each reactor type.
4. To understand the detailed reaction mechanism for the interpretation of kinetic data

COURSE CONTENT:

Chemical Reactions: Rate of chemical reactions, variables affecting the reaction rate, order of reaction, reaction rate constant, elementary and non-elementary reaction mechanism, Arrhenius equation, Collision theory and theory of absolute reaction rates, predictability of reaction rate.

Kinetics of homogeneous chemical reactions, rate equations for simple and complex reactions, irreversible reactions, parallel reactions, consecutive reactions, auto catalytic reactions and homogeneous catalytic reactions.

Interpretation of reactor data in constant volume and variable volume batch reactions, integral and differential method of following kinetic data.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Classification of chemical reactions, Interpretation of reactor data in flow reactions. Reactor designs for homogeneous, batch, semi-batch, plug flow and continuous stirred tank.

Electrochemical reactors. Isothermal as well as non-isothermal operation, space velocity and residence time in flow reactors. Size comparison of single reactors like batch, plug flow and CSIR for first and second order single reactions. Multiple reactor systems, Plug flow reactions in series and for parallel equal sized CSTR's in series.

Catalysts: Preparation, activity and the factors which influence it. The effect of physical properties such as surface area and pore size etc. on catalyst activity, methods of determination of their physical properties, catalyst poisoning, Biocatalysis. Heterogeneous catalytic reactions, principles, absorption isotherms, kinetics of solid catalysed fluid reactions, rate-controlling steps. Use of computers in designing, modeling, optimization and simulation of chemical process.

SUGGESTED READINGS:

1. D.M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering"
2. E.I. Shaheen, "Basic Principles of Chemical Engineering"
3. G.Stephanopoulos, "Chemical Process Control - An introduction to Theory and Practice"
4. O. Levenspiel, "Chemical Reaction Engineering"
5. J.F. Richardson and D.G. Peacock, "Coulson's and Richardson's Chemical Engineering"
6. R.M. Felder and R.W. Rousseau, "Elementary Principles of Chemical Processes"
7. C.D Holland and R.G.Anthony, "Fundamentals of Chemical Reaction Engineering"
8. W.L. Luyben, "Process Modelling, Simulation and Control for Chemical Engineers"

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD33	**Bioelectronics**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To learn the basic concepts and motivations behind bioelectronics.
2. To understand the concept of bioelectricity and various bioelectric potentials emanating in nerve, muscle and heart.
3. To attain working understanding of the design and use of electrodes for measuring and interpreting biopotentials.
4. To learn basic concepts of biosensor, its characteristics and instrumentation as well as three generations of biosensors.
5. To learn various types of biosensors classified on basis of bioreceptor used and transducer used.
6. To understand the role of nanotechnology in development of biosensors with examples.
7. To understand applications of biosensors in various fields including commercial technologies.
8. To learn the basic concept of biochip and its applications.
9. To understand the concept of neural interfacing and electrode designs for interfacing with nervous system to restore sensory functions

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

10. To understand technical challenges in implanting devices and how they are overcome with some examples of implantable devices
11. To have an idea of field of stretchable bioelectronics

COURSE CONTENT:

Introduction to Bioelectronics

Bioelectricity: introduction, bioelectric current, neuron as structural and functional unit, action events of nerve, structure of muscle, action events of muscle, structure of heart, electroconduction system of heart, detection of bioelectric events: bioelectrodes and the electrode-skin interface, double layer, electrode impedance, electrode electrochemistry, electrode polarization, stimulating bioelectrodes, electrode-skin interface, skin preparation, types of bioelectrodes, electrical interference problems in biopotential measurement, Biopotential interpretation: ECG, EMG, EEG, ENG, other biopotentials

Biosensors: basic principle, components of biosensors, biosensor parameters, generations of biosensors, classification of biosensors on the basis of biological recognition systems and transducers, electrochemical biosensors, optical biosensors, piezoelectric biosensors, calorimetric biosensors, nanotechnology based biosensors, biosensor applications and commercial examples.

Introduction to Biochips and their application in modern sciences

Neural Interfaces: Interfacing robotics with peripheral and central nervous systems, deep brain stimulation, electrical modulation of nerve regeneration and inflammation, pain modulation, future directions for neural interfacing

Implantable bioelectronics: biocompatibility of implantable sensors, progression of wound healing, impact of wound healing on implanted sensors, controlling the tissue response to sensor implantation, examples of implantable devices

Stretchable bioelectronics

SUGGESTED READINGS:

1. Ronald R. Pethig, "Introductory Bioelectronics: For Engineers and Physical Scientists", Stewart Smith
2. S. Bone and B. Zabba, "Bioelectronics", John Wiley and Sons Inc.
3. E.A. Hall, "Biosensors" John Wiley and Sons Inc.
4. V. C. Yang and T.T. Ngo, "Biosensors and their Applications", Plenum Publishing Corporation.
5. B.R. Eggins, "Chemical Sensors and Biosensors", John Wiley and Sons Inc.
6. F.G. Barth, et al., "Sensors and Sensing in Biology and Engineering", Springer Verlag.
7. Evgeny Katz, "Implantable Bioelectronics", Wiley-VCH Verlag GmbH & Co. KGaA

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD34	**Pharmaceutical Chemistry**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. Students will achieve a good understanding of the basic concepts pertaining to

pharmaceutical chemistry along with the mode of action, metabolism and toxicity of a range of pharmaceutical agents

2. Students will understand the chemistry of different class of natural products and pharmaceutical molecules and will become able to apply their knowledge to develop solutions to problems.
3. Students will achieve understanding of basic experimental techniques, safety issues and environmental regulations, and will be able to apply this information in the laboratory.
4. Students will be able to learn independently, to explore the scientific literature using a variety of resources, communicate that information effectively and to develop modern tools and techniques for the betterment of society
5. Students will become aware of the environmental, health, economic and ethical implications of scientific discoveries and technical innovations in general, and of the impact of pharmaceutical chemistry on society and on the environment in particular

COURSE CONTENT:

Physicochemical Properties in Relation to Biological Action - Effects of route of administration, Sites of loss, Solubilities and partition coefficients (Ferguson, Hansch), Drug-receptor interactions, Steric features of drugs, The drug receptor, Structure-Activity Relationships, Representative physicochemical properties as related to biological action

Drug Metabolism – Oxidative, Reductive, Hydrolytic, Conjugative

Drug toxicity, tolerance, dependence, addiction

Survey of Various Drug Classes - Anaesthetics (general, local), Analgesics, Neurotransmitters (adrenergic, cholinergic effects, psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants, Antibiotics (especially b-lactam), Steroids

Natural products as medicinal compounds - Nucleic acids- Synthesis of purines and pyrimidines, isolation and structure determination of nucleosides and nucleotides, Pigments- Carotenoids, Anthocyanins, Flavones, flavonols, pyrrole pigments, porphyrins, haemoglobin and chlorophyll - Structure, General properties, classification, Alkaloids and Terpenoids **–** Introduction, classification, properties and structure, Amino acids **-** Classification of amino acids, synthesis of amino acids, isolation and separation of amino acids from proteins, general physical and chemical properties of amino acids, polypeptides, general principles of polypeptide synthesis, structure of polypeptides, amino end degradation, carboxyl end degradation, Carbohydrates and lipids **-** Nomenclature, classification, structure and general reactions, Steroids and hormones **-** Diel's hydrocarbon, sterols, progesterone and androsterone. plant hormones (auxins, heteroauxins, gibberellins, kinins, ethylene, traumatin)

SUGGESTED READINGS:

1. D.A. Williams, T.L. Lemke and William O. Foye, "Foye's Principles of Medicinal Chemistry", Lippincott Williams and Wilkins.
2. G. Thomas, "Medicinal Chemistry: An Introduction", John Wiley and Sons
3. C. R. Ganellin and S. M. Roberts, "Medicinal Chemistry: The Role of Organic Chemistry in Drug Research", Academic Press.
4. H.C. Ansel, L.V. Allen, N.G. Popovich, "Pharmaceutical Dosage Forms and Drug Delivery

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Systems" Lippincott Williams and Wilkins Publishers.
5. T.L. Lemke, "Review of Organic Functional Groups: Introduction to Medicinal Organic Chemistry", Lea and Febiger.
6. J.N. Delgado, O. Gisvold and W.A. Remers, "Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry" Lippincott Williams and Wilkins.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD35	**Drug Design, Development & Delivery Systems**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. Understanding of the fundamentals related to drug design
2. To learn designing drugs through rational approach to save the manpower and resources.
3. To learn the bottlenecks and conceptualize effective strategies in drug development process
4. Learning various systems of Drug delivery and NDDS techniques for targeted drug delivery

COURSE CONTENT:

Rational Approach in Drug Design: Analogues & prodrugs, concept of lead, factors governing drug design, rational approach to drug design, rigidity & flexibility vs drug design, Structure based drug design, homology modeling & docking

Stereochemistry & Drug Design: Isosterism & bioisosterism, enantiomers, diastereoisomers, stereochemistry & biological activity.

QSAR: Classical QSAR, 3D-QSAR, drug design to discovery & development, problems in drug discovery & development.

Basic Concepts of Drug Delivery: Basic terminologies in drug delivery and drug targeting, bioavailability, pharmacokinetic processes.

Drug Administration: Various routes of administration of drugs, Advantages and disadvantages of different drug delivery systems, Novel Drug Delivery Systems (NDDS) and their applications.

SUGGESTED READINGS:

1. Donald J. Abraham and David P. Rotella, "Burger's Medicinal Chemistry, Drug Discovery and Development, 7th Edition, 8 Volume Set", John Wiley and Sons, Inc., Publication.
2. Francis A. Carey, "Organic Chemistry", Mc-Graw Hill.
3. Ashutosh Kar, "Medicinal Chemistry", New Age International Publishers.
4. R. Mannhold, P. Krogsgaard-Larsen, H. Timerman, "Methods and Principles in Medicinal Chemistry", VCH Publishers, New York, USA
5. A.M. Hillery, A.W. Lloyd and J. Swabrick, "Drug Delivery and Targeting", Harwood Academic Publishers

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

6. W.M. Saltzman, "Drug Delivery: Engineering Principles for Drug Therapy (Topics in Chemical Engineering)", Oxford University Press
7. A. J. Domb, J. Kost and D.M. Wiseman, "Handbook of Biodegradable Polymers (Drug Targeting and Delivery)", Dunitz Martin Ltd
8. H.C. Ansel, L.V. Allen and N.G. Popovich, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Lippincott Williams and Wilkins Publishers

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD36	**Metagenomics & Metabolomics**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. Students will understand the development of the field of metagenomics and the methods to determine microbial diversity
2. Students will learn to check purity of metagenoimc DNA with methods to clone, propogate, construct and maintain metagenomic libraries
3. Students will understand the minimum standards required for submission of metagenomic data to comply with the Genomic Standards Consortium (GSC) and to use a range of bioinformatic tools to analyze and apply the same for biotechnological applications
4. Students will understand the development and rising importance of tools and techniques of metabolomics and its limitation
5. Students will be able to apply their knowledge and skills of metabolomic analysis for human welfare

COURSE CONTENT:

Metagenomics

Metagenomics: Introduction, History & definition of Metagenomics, Understanding microbial communities, Human microbiome and its significance

Squencing Strategy in metagenomics: Shortgun metagenomics and High throughput sequencing (next generation sequencing)

Bioinformatics for Metagenomics: Sequence pre-filtering, Sequence Assembly, Gene Prediction, Species Diversity, Data integration & Data Analysis

Application of Metagenomics in various fields (in Medicine, Biofuel, Environmental Remediation, Agriculture & Ecology)

Metabolomics

Introduction: History, background and definitions of metabolomics, metabolome, metabolite and metabolomics, significance of metabolomics

Metabolite isolation purification and detection, Metabolite Profiling based on NMR, Mass Spectrometry, metabolite library and finger printings

Metabolic pathway database (KEGG pathway database), Statistical Methods in metabolomics.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Application of metabolomics: Toxicology, Neutrigenomics, Functional genomics, Environmental metabolomics

SUGGESTED READINGS:

1. Campbell, A. M. and L. J. Heyer, "Discovering genomics, proteomics, and bioinformatics", San Francisco, CSHL Press: Pearson/Benjamin Cummings.
2. John C. Lindon , Jeremy K. Nicholson , Elaine Holmes, "The Handbook of Metabonomics and Metabolomics 1st Edition"
3. Diana Marco, "Metagenomics: Theory, Methods and Applications"

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD37	**Biosafety & Hazard Management**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To understand the basic concepts of workplace Hazardous Material Information System (WHMIS)
2. To become familiar with the biohazards, hazardous chemicals and radioactive materials
3. To learn the personal precautions, protective equipment and emergency procedures to ensure biosafety guidelines
4. To get familiar with MSDS (Material safety data sheet)
5. To understand the methods and importance of safe disposal of hazardous waste

COURSE CONTENT:

Introduction to Biosafety: General principles, hazardous material and types, Route of exposure, Storage of hazardous chemicals, risk assessment, Biosafety laboratories level 1-4, Laboratory animal facilities, WHO biosafety collaborating centres

Laboratory equipments and biosafety: Biological safety cabinets, equipment related hazards, equipment design to reduce biological hazards, Laboratory fire and electrical hazards

Good laboratory practice: Safe laboratory techniques, Biosafety and rDNA technology, Transport of infectious substances and hazardous chemicals, contingency plans and emergency procedures, disinfection and sterilization, Safety organization and training, Immunization of staff

Biohazard Waste Management: Identification of Biohazardous Waste, Liquid and Solid Biohazardous Waste Management, Autoclaving Biohazardous Waste, Final Packaging and Disposal of Biohazardous Waste, Biohazardous Waste Risk Minimization and Awareness

SUGGESTED READINGS:

1. Wilson, DL, Chosewood, LC, Editiors, "CDC/NIH Biosafety in Microbiological and Biomedical Laboratories, 5th Edition", U.S. Govt. Printing Office, Washington, D.C.
2. Fleming, D.O., and Hunt, D.L., "Biological Safety Principles and Practices, 4th Edition", ASM Press, Washington, D.C.
3. "WHO Lab Biosafety Manual and Health Canada's Laboratory Biosafety Guidelines (both available online under Biosafety Resources off the ABSA web page www.absa.org)"

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

4. "CDC/NIH Primary Containment for Biohazards: Selection, installation and Use of Biological Safety Cabinets, 2000"
5. "Biosafety, Biosecurity and the Evaluation of Biohazards: Course Facilitators' Manual", Yale Center for Public Health Preparedness, 2009

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD38	**Bioenergy Fundamentals**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To understand the biomass feedstock and their biochemical composition
2. To learn about the various available bioenergy option and biofuel routes
3. To become familiar with the energy requirements and energy system for rural sectors
4. To learn the biotechnological application in bioenergy generation
5. To lean the guidelines for bioenergy use and audits

COURSE CONTENT:

Bioenergy feedstocks: Biomass types, characterization and chemistry, Terrestrial *vs* aquatic biomass, bioenergy feedstock cultivation and harvesting, bioenergy products and by-products,

Socio-economic impact of bioenergy: national and international scenario of bioenergy production and utilization, sustainability and policy, food vs. fuel, environmental policy and regulatory issues at the biofuels / sustainability interface

Rural bioenergy systems

Major technologies for biofuel production

Biotechnology for bioenergy: recent advancements and challenges

SUGGESTED READINGS:

1. Kishore V V N," Renewable Energy Engineering and Technology, Principles and Practice", The Energy and Resources Institute (TERI), 2009
2. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable Energy Sources", Narosa Publishing House, N.D, 2007
3. Mital K. M, "Biogas Systems: Principles and Applications", New Age International publishers (P) Ltd., 1996.
4. Nijaguna, B.T., "Biogas Technology", New Age International publishers (P) Ltd., 2002.
5. D. Yogi Goswami, Frank Kreith, Jan. F .Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003
6. Rezaiyan. J and N. P. Cheremisinoff, "Gasification Technologies, A Primer for Engineers and Scientists", Taylor and Francis, 2005

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD39	Epigenetics	3L - 1T - 0P	None

COURSE OUTCOMES (COs):

1. To develop the concepts of epigenetics and to appreciate the differences between Mendelian and epigenetic inheritance
2. To understand how DNA methylation, chromatin modifications and remodeling regulate gene expression
3. The students will understand the role of non-coding RNAs in epigenetic regulation
4. The students will learn about the impact of epigenetics on various diseases.
5. The students will learn how to exploit the epigenetic marks for drug discovery.

COURSE CONTENT:

Introduction to Epigenetics, Basic concepts, overview and brief history of the field

Epigenetic modifications and gene expression: DNA methylation in epigenetic modification and gene function, Histone modifications, Non-coding RNAs in Epigenetics

Epigenetic modifications in chromatin remodeling and transcription, Model Systems for study of epigenetic regulation, Genomic imprinting in mammals, Study of multiple layers of epigenetic regulation, genome-wide analysis of epigenetic marks

Epigenetics and the environment: Nature vs. Nurture, Mother's Love, Sins of the fathers and ghosts in your genes, Something eXtra: X inactivation

Epigenetic programming in cell renewal and pluripotency, Epigenetics in diseases, Epigenetics in nervous system, **Epigenetics in drug discovery**

SUGGESTED READINGS:

1. Nessa Carey, "The Epigenetics Revolution: How Modern Biology is Rewriting our Understanding of Genetics, Disease and Inheritance"
2. Sun Woo Kang, "Epigenetics, Environment, and Genes"
3. Nelson Cabej, "Epigenetic Principles of Evolution"

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD40	Biomechanics	3L - 1T - 0P	None

COURSE OUTCOMES (COs):

1. The students will understand the basic concepts involved in mechanics of moving systems.
2. The students will be able to appreciate the human anatomy and the resulting gross movement of the human body.
3. The students will learn about the dynamics of various body parts using various computational tools and theories enabling them to appreciate the working of biological system
4. The students will be able to appreciate the various fluid model theories with the working of biological fluids in the human body.

COURSE CONTENT:

Introduction: Historical Perspective, Cellular Biomechanics, Cell Cytoskeleton, Matrix Models, Mechanotransduction, Cell Signaling in Tissues, Tissue-Level Mechanics,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Introduction to Biosolids: Bone Biology and Composition, Mechanical Properties of Bone, Bone Adaptation and Remodeling,

Introduction to Biodynamics: Kinematics, Statics, Joint Mechanics, Dynamics, Joint Reaction Mechanics, Advanced Bone Mechanics, Fracture, Crack Propagation Theory & Application, Fatigue Theory, Structure Design

Introduction to fluids: Archimedes & Buoyancy Principle, Bernoulli's Equation and Applications, Poroelasticity, Navier Stokes & Fluid Pressure

SUGGESTED READINGS:

1. Duane Knudson, **"**Fundamentals of Biomechanics"
2. Jhari Sahoo, Ram Kishore Saxena, H. C. Dash, "Biomechanics"

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD41	**Systems Biology**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To understand the basic concepts of system biology and its application
2. To explore how interactions between genes influence the decision-making of cells.
3. Examine how interactions between individuals shape how the population behaves in response to environmental pressures.
4. To be able to retrieve biological data from different databases and to extract information from it
5. To be able to model metabolism and use it for process optimization

COURSE CONTENT:

Overview of system biology, Different areas associated with system biology, Computational models, Modelling biological processes and constraint-based modeling.

Data Mining and Information extraction, Approaches to database integration and software interoperability, Coupling of software, websites, and databases

Online databases and repositories for sharing data and models, Models of molecular interactions, Representation of biological models

Basic graph theory and network biology, Network-based Analysis Weighted correlation network analysis,

Metabolic Flux Analysis, Metabolic Control Analysis and Kinetic Modeling, Case Studies in system biology

SUGGESTED READINGS:

1. Stephen Krawetz, "Bioinformatics for Systems Biology", Humana Press.
2. Voit, Eberhard, "A First Course in Systems Biology", Garland Science
3. Zvelebil, Marketa, and Jeremy O. Baum, "Understanding Bioinformatics", Garland Science
4. Alon, Uri, "An Introduction to Systems Biology: Design Principles of Biological Circuits", Chapman & Hall.
5. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, and R. Losick, "Molecular

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Biology of the Gene", Cold Spring Harbor Laboratory Press.
6. J. M., J. L. Tymoczko, and L. Stryer, "Biochemistry", W.H. Freeman.
7. Branden, C., and J. Tooze, "Introduction to Protein Structure", Garland Pub.
8. Alon, U, "Network Motifs: Theory and Experimental Approaches", Nature Publishing Group 8 (2007): 450-461.

Course No.	Title of the Course	Course Structure	Pre-requisite
BTD42	**Bioprocess Plant Design**	**3L - 1T - 0P**	**None**

COURSE OUTCOMES (COs):

1. To understand the basic calculations of bioprocess equipments
2. To learn the design criteria of bioreactor and ancillary equipments
3. To apply online/offline control of bioreactor operations
4. To apply the safety manuals during biochemical operations

COURSE CONTENT:

Introduction, General design information of a bioreactor for microbial or animal cell culture, Aseptic Operation and containment

Materials of construction for bioprocess plants, Body construction, Mechanical design of process equipment, Design of fermenters for aseptic operation, proper aeration and agitation

Bioreactor configurations: Stirred Tank, bubble column, Airlift reactor, Packed bed, Fluidised bed, trickling filter etc.

Selection and specification of equipment for handling fluids and solids, Selection, specification, design of heat and mass transfer equipment used in bioprocess industries

Design of facilities for cleaning of process equipment used in biochemical industries, Utilities for biotechnology production plants, Process economics, Bioprocess validation, Safety considerations, Case studies

SUGGESTED READINGS:

1. E.E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Butterworth-Heinemann.
2. R.K. Sinnott, J.M. Coulson and J.F. Richardsons, "Chemical Engineering", Butterworth-Heinemann.
3. R.H. Perry and D.W. Green, "Chemical Engineers Handbook", McGraw-Hill.
4. F.E. Meyers and M.P. Stephens, "Manufacturing Facilities Design and Material Handling", Publisher: Prentice Hall.
5. M. Peters and K. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw-Hill.
6. E. Bausbacher and R. Hunt, "Process Plant Layout and Piping Design", Prentice Hall PTR.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

SYLLABUS OF OPEN ELECTIVES

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO001	**Technical Communication**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. The course will improve writing and documentation skills of students with emphasis on the importance of effective communication with focus on choice of words, formation of proper sentence structures and writing styles.
2. This will enhance the students capability to prepare technical documents and correspondence.
3. The course will equip the student with good communications skills for placements, preparing SOPs and CVs.
4. The course will sensitize the students towards research ethics, copyright and plagiarism.

COURSE CONTENT:

- Definition of communication, meaning, importance & process of communication, objectives, types, C's of communication, barriers to communication
- human & non -human communication, distinctive features of human languages
- Business correspondence-definition, meaning and importance of business communication, business letters- purchase, enquiry, quotation, order, followup, acceptance-refusal
- Emphasis on (i) paragraph writing, its kinds, coherence & cohesion
  (ii)writing a paragraph/thesis: selection of topic and its development
  (iii) writing reports, manuals, notices, memos, agendas, minutes
  (iv)Interviews, speeches, presentations,
- research ethics, methodologies, copyright, plagiarism

SUGGESTED READINGS:

1. Martin Hewing, ``Advanced English Grammar,'' Cambridge University Press
2. Meenakshi Raman and Sangeeta Sharma, ``Technical Communication,'' Oxford University Press

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO002	**Disaster Management**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. Demonstrate a critical understanding of key concepts in disaster risk reduction and

humanitarian response.

2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

COURSE CONTENT:

Unit -I: Introduction

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit -II: Disaster Prone Areas In India

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Unit -III: Disaster Preparedness And Management

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit -IV: Risk Assessment

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Unit -V: Disaster Mitigation

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

SUGGESTED READINGS:

1. R. Nishith, Singh AK,`` Disaster Management in India: Perspectives, issues and strategies,'' New Royal book Company

2. Sahni, Pardeep, ``Disaster Mitigation Experiences And Reflections,'' Prentice Hall Of India

3. Goel S. L., ``Disaster Adminastration And Management Text And Case Studies,'' Deep & Deep Publication

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO003	Basics of Financial Management	3L-1T-0P	None

COURSE OUTCOMES (CO):

The course's objective is to provide a theoretical framework for considering corporate finance problems and issues and to apply these concepts in practice. In this course, you will enhance your knowledge and understanding of financial management. You will learn how managers should organize their financial transactions effectively and with integrity and how to give everybody the ability and confidence to tackle common financial problems in practice. It will also provide adequate preparation for future finance classes.

COURSE CONTENT:

Unit I

Nature, scope and objectives of financial management, Time value of money, Risk and return (including Capital Asset Pricing Model).

Unit II

Long term investment decisions: The Capital Budgeting Process, Cash Flow Estimation, Payback Period Method, Accounting Rate of Return, Net Present Value (NPV), Net Terminal Value, Internal Rate of Return (IRR), Profitability Index.

Unit III

Financing Decisions: Sources of long-term financing, Estimation of components of cost of capital, Methods for calculating Cost of Equity, Cost of Retained Earnings, Cost of Debt and Cost of Preference Capital, Weighted Average Cost of Capital (WACC). Capital Structure- Theories of Capital Structure (Net Income, Net Operating Income, MM Hypothesis, Traditional Approach). Operating and Financial leverage. Determinants of capital structure

Unit IV

Dividend Decisions: Theories for Relevance and irrelevance of dividend decision for corporate valuation-Walter's Model, Gordon's Model, MM Approach, Cash and stock dividends. Dividend policies in practice.

Unit V

Working Capital Decisions: Concepts of Working Capital, Operating & Cash Cycles, sources of short term finance, working capital estimation, cash management, receivables management, inventory management.

SUGGESTED READINGS:

1. Khan, M.Y. and P.K. Jain,`` Financial Management: Text and Problems,'' Tata McGraw Hill
2. Srivastava, Rajiv, and Anil Mishra,`` Financial Management,'' Oxford University Press
3. Chandra, P., ``Financial Management-Theory and Practice,'' Tata McGraw Hill.
4. Horne, Van; James C., John Wachowicz, ``Fundamentals of Financial Management,'' Pearson Education.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO004	**Basics of Human Resource Management**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

This course is designed to provide students with an understanding of human resource management (HRM) functions within organizations, including an appreciation of the roles of both HRM specialists and line managers in designing and implementing effective HRM policies and practices.

COURSE CONTENT:

Unit - I

Evolution and growth of human resource management (with special reference to scientific management and Human relations approaches).Role of HR in strategic management.Nature.objectives, scope, and functions of HR management.

Unit - II

Challenges of HR (the changing profile of the workforce - knowledge workers, employment opportunities in BPOs, IT and service industries, Flexi options), Workforce diversity (causes, paradox, resolution of diversity by management).

Unit III

HRD; Human resource management as a profession.Concepts of line-staff in the structure of human resource department and the role of human resource manager.

Unit - IV

Manpower planning -objectives, elements, advantages, process. Job design - (simplification, rotation, enlargement, enrichment and approaches}.Job analysis.Job evaluation.

Unit - V

Recruitment (factors affecting, sources, policy, evaluation). Selection(procedure, tests, interviews). Placement and Induction.

SUGGESTED READINGS:

1. Aswathappa K., ``Human Resource and Personnel Management,'' Tata McGraw-Hill
2. Chhabra T.N., ``Human Resource Management,'' Dhanpat Rai and Co.
3. Saiyadain S. Mirza, `` Human Resource Management,'' Tata Mc-Graw Hill
4.Chadha, N.K, ``Human Resource Management-issues, case studies, experiential exercises,'' Sri Sai Printographers

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO005	**Project Management**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

In this comprehensive course, student will learn the fundamentals of project management: how to initiate, plan, and execute a project that meets objectives and satisfies stakeholders. This course provides a step-by-step guide to planning and executing a project and to develop a

manageable project schedule.

COURSE CONTENT:

Unit-I

Objectives of Project Planning, monitoring and control of investment projects. Relevance of social cost benefit analysis, identification of investment opportunities. Pre-feasibility studies.

Unit-II

Project Preparation: Technical feasibility, estimation of costs, demand analysis and commercial viability, risk analysis, collaboration arrangements; financial planning; Estimation of fund requirements, sources of funds.Loan syndication for the projects.Tax considerations in project preparation and the legal aspects.

Unit-III

Project appraisal: Business criterion of growth, liquidity and profitability, social cost benefit analysis in public and private sectors, investment criterion and choice of techniques. Estimation of shadow prices and social discount rate.

Unit-IV

Project review/control-Evaluation of project. PERT/CPM.resource handling/leveling.

Unit-V

Cost and Time Management issues in Project planning and management , success criteria and success factors, risk management.

SUGGESTED READINGS:

1. Ravi Ravindran, `` Operations Research and Management Science Handbook,'' CRC Press
2. Harold Kerzner, ``Applied Project Management: Best Practices on Implementation,'' John Wiley & Sons
3. Goodpasture, J. C., ``Quantitative Methods in Project Management,'' J Ross Publishing
4. Meredith, J. R. and Mantel Jr., S. J., ``Project Management: A Managerial Approach,'' John Wiley
5. Clifford Gray, ``Project Management,'' Richard D. Irwin

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO006	**Basics of Corporate Law**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

The objective of this Course is to provide in-depth knowledge of the Corporate laws and process related to integrate these aspects of management studies in decision making within an organization; analyze and interpret management information; make decisions based on the information available; communicate information effectively; understand and apply the theoretical aspects of accounting methods used for collecting, recording and reporting financial information; explain and appraise the taxation laws which govern corporations and individuals.

COURSE CONTENT:

Unit I: Introduction : Administration of Company Law, characteristics of a company; common

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

seal; lifting of corporate veil; types of companies including private and public company, government company, foreign company, one person company, small company, associate company, dormant company, producer company; association not for profit; illegal association; formation of company, promoters and their legal position, pre incorporation contract and provisional contracts; on-line registration of a company.

Unit II: Documents: Memorandum of association and its alteration, articles of association and its alteration, doctrine of constructive notice and indoor management, prospectus, shelf prospectus and red herring prospectus, misstatement in a prospectus; GDR; book building; issue, allotment and forfeiture of shares, calls on shares; public offer and private placement; issue of sweat capital; employee stock options; issue of bonus shares; transmission of shares, buyback and provisions regarding buyback; share certificate; D-Mat system; membership of a company.

Unit III: Management and Meetings: Classification of directors, additional, alternate and adhoc director; women directors, independent director, small shareholders' director; director identity number (DIN); appointment, who can appoint a director, disqualifications, removal of directors; legal position, powers and duties; key managerial personnel, managing director, manager; meetings of shareholders and board; types of meeting, convening and conduct of meetings, requisites of a valid meeting; postal ballot, meeting through video conferencing, e-voting; committees of board of directors – audit committee, nomination and remuneration committee, stakeholders relationship committee, corporate social responsibility committee; prohibition of insider trading.

SUGGESTED READINGS:

1. Hicks, Andrew & Goo S.H., ``Cases and Material on Company Law,'' Oxford University Press
2. Gowar, LCB, ``Principles of Modern Company Law,'' Stevens & Sons, London.
3. Majumdar, A.K., and G.K. Kapoor, ``Company Law and Practice,'' Taxmann
4. Hanningan, Brenda, ``Company Law,'' Oxford University Press
5. Sharma, J.P., ``An Easy Approach to Corporate Laws,'' Ane Books Pvt. Ltd
9. Ramaiya, ``A Guide to Companies Act,'' Lexis Nexis Buttersworth wadhwa
6. Kannal, S., and V.S. Sowrirajan, ``Company Law Procedure,'' Taxman's Allied Services (P) Ltd.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO007	**Biological Computing**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. To understand computing in context of biological systems
2. To understand computing languages needed to solve biological problems
3. To acquire computational skills for analysis of biological processes through grid computing
4. To gain knowledge of different biological databases and their usage
5. To gain innovative insight into DNA computing

COURSE CONTENT:

Introduction, Orientation and UNIX,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Python: Introduction to Variables and Control flow, Python II - Parsing In and Output, Python III - Scripting and Functions, Python IV- Number Crunching and Plotting, **Grid computing**, Biogrid, R basics and Visualization, Unix for fast text processing, SQL, Database **Biological databases**, R for speed, R for fun, Local BLAST, Unit Testing and Code Correctness **DNA computing**,
SUGGESTED READINGS: 1. H. Bolouri, R. Paton, `` Computations in cells & tissues,'' Springer **2.** Haubold**,** Bernhard**,** Wiehe, Thomas, `` Introduction to Computational Biology: An Evolutionary Approach,'' Springer

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO008	**Basics of Social Sciences**	**3L-1T-0P**	**None**
COURSE OUTCOMES (CO): **Social science** is a major category of academic disciplines, concerned with society and the relationships among individuals within a society. It in turn has many branches, each of which is considered a "social science".			
COURSE CONTENT: **Unit I:** Economics, political science, human geography, demography and sociology. **Unit II:** Humanities, anthropology, archaeology, jurisprudence, psychology, history, and linguistic. **Unit III:** Political science, economics, sociology, international politics and scientific methodology.			
SUGGESTED READINGS: 1. A.C. Kapoor, "Principles of Political Science,'' S. Chand Publications 2. A.K. Sharma, "Issues in Social Demography,'' Mittal Publications 3. Kathy S. Stolley, "The Basics of Sociology,'' Greenwood Press. 4. Paul M. Muchinsky ,"Psychology Applied to Work,'' Thomson Learning Inc			

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO009	**Entrepreneurship**	**3L-1T-0P**	**None**
COURSE OUTCOMES (CO): This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of who the entrepreneurs are and what competences are needed to become an entrepreneur.			
COURSE CONTENT: **Unit I-Introduction:** Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship;			

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

Unit II- Creating Entrepreneurial Venture:

Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Challenges in managing innovation; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership- components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection- Patents Trademarks and Copyrights – importance for startups, Legal Acts Governing Business in India.

Unit III-Functional plans:

Marketing plan– for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, pro forma cash budget, funds Flow and Cash flow statements; Pro forma balance sheet; Break Even Analysis; Ratio Analysis.

Unit IV- Entrepreneurial Finance:

Debt or equity financing, Sources of Finance- Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.

Unit V- Enterprise Management:

Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers & acquisitions.

SUGGESTED READINGS:

1. Kumar, Arya,`` Entrepreneurship: Creating and Leading an Entrepreneurial Organization'', Pearson
2. Hishrich., Peters, ``Entrepreneurship: Starting, Developing and Managing a New Enterprise,'' Irwin
3. Taneja, ``Entrepreneurship,'' Galgotia Publishers.
4. Barringer, Brace R., and R. Duane, ``Entrepreneurship,'' Pearson Prentice Hall
5. Hisrich, Robert D., Michael Peters and Dean Shephered, ``Entrepreneurship,'' Tata McGraw Hill
6. Lall, Madhurima, and Shikha Sahai, ``Entrepreneurship,'' Excel Books
7. Charantimath, Poornima, ``Entrepreneurship Development and Small Business Enterprises,'' Pearson Education

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO010	Social work	3L-1T-0P	None

COURSE OUTCOMES (CO):

In this course students will learn about various methods of social work, about community organization, social welfare administration, Problems pertaining to Marriage, Family and caste

COURSE CONTENT:

Unit 1.Social work

Philosophy and Methods. Social work: Meaning, Objectives, Scope, Assumptions & Values; History of Social work in U.K. U.S.A.and India, philosophy of Social Work. Democratic (Equality, Justice Liberty & Fraternity) and Humanitarian (Human Rights) Matrix.Social works as a profession.

Unit 2. Methods of Social work

Meaning, Scope Principles, Processes (Psychosocial study, Assessments, treatment-goal formulation and techniques), Evaluation, Follow-up and Rehabilitation. Social Groups work: Meaning,Objective, Principles, Skills, Processes (Study, Diagnosis, treatment and evaluation), Programme, Planningand Development, Role of Social group worker, Leadership Development.

Unit 3 Community organization

Meaning, Objective, Principles, Approaches, Roles of Community Organization Worker.

Unit 4 Social Welfare Administration

Meaning Scope, Auspices-Private and Public, Principles, Basic Administrative Processes and Practice decision making communication, planning.organisation, budgeting and finacial control, reporting. Social work Research: Meaning objectives, types, scope, scientific method, Selection and formulation of the problem Research Design Sampling, Sources and Methods of Data Collection, Processing of Data, analysing and interpretation, Report writing. Social Action: Meaning,Scope, approaches (Sarvodays, Antyodaya etc.) and Strategies.

Unit 5 Work in India Problem pertaining to Marriage, Family and caste

Dowry- child Marriage, Divorce, Families with working couples, Disorganised Families, Families with Emigrant Heads of the Households, Gender Inequality, Authoritarian Family structure, Major Changes in Caste systems and problem of casteism. Problems Pertaining of Weaker Sections. Problems of Children, Women Aged. Handicapped and Backward Classes (SCs, STs, and other Backward Classes). **Problems of Deviance:** Truancy Vagrancy and Juvenile Delinquency, Crime, White Colla Crime, Organized Crime,Collective Violence, Terrorism, Prostitution and Sex Related Crimes. Social Vices: Alcohilism. Drug Addiction, Beggary, Corruption and communalism. **Problems of Social Structure :** Poverty, Unemployment, Bonded Labour, Child Labour. **Fields of Soclal work India :** Child Development, Development of Youth, Women's Empowerment, Welfare of aged, Welfare of Physically. Mentally and Social Handicapped, Welfare of backward Classes (Scs, STs and Other Backward Classes) Rural Development Urban Community Development, Medical And Psychiatric Social work, Industrial Social work, Social Security offender Reforms.

SUGGESTED READINGS:

1. Rajni Bedi, ``Social Work: An Introductory Text Book,'' Regal Publication

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

2. Sanjay Bhattacharya, ``Social Work: An Integrated Approach,'' Deep and Deep Publication
3. Nitesh Dhawan, ``Social work perspective Philosophy and Methods,'' Bharat Book Center
4. P. R. Gautam, ``Social Work: Methods Practices And Perspectives,'' Centrum Press

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO011	**Intellectual Property and Patenting**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

The objective of this Course is to provide in-depth knowledge of the laws and process related to Trademarks, Copyrights and other forms of IPs with focus on Patents, the Indian and International Patent filing procedure, drafting patent application and conducting prior art searches. Students will be exposed to the technical, management and legal aspects of IP and Patents.

COURSE CONTENT:

UNIT I: Introduction: Historical and philosophical background of patents and other intellectual property, Patent System: the Constitution, Congress, Patent Office (PTO), and courts; Analyzing and understanding judicial opinions

UNIT II: Comparative overview of patents, copyrights, trade secrets, and trademarks: Legal fundamentals of patent protection for useful inventions**,** Design and plant patents, Legal fundamentals of copyright protection, Similarity and access, Expression vs. ideas and information, merger, Fair use of copyrighted works (e.g., for classroom use), Contributory copyright infringement, Critical differences between patent and copyright protection, Copyright infringement distinguished from plagiarism, Legal fundamentals of trade-secret protection, Legal fundamentals of trademark protection

UNIT III: Requirements and limitations of patentability: New and useful: (A) The legal requirement of novelty (B) First to invent vs. first inventor to file, The legal requirement of non-obviousness.

UNIT IV: The process of applying for a patent ("patent prosecution"): Anatomy of a patent application, Adequate disclosure, The art of drafting patent claims, Patent searching: (A) Purposes and techniques, Actions for patent infringement, Interpretation of claims, Doctrine of equivalents, Product testing as a possibly infringing use, Doctrine of exhaustion

SUGGESTED READINGS:

1. Robert H. Rines, ``Create or Perish: The Case for Inventions and Patents,'' Acropolis.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO012	**Supply Chain Management-Planning and Logistics**	**3L-1T-0P**	**None**

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

COURSE OUTCOMES (CO):

Supply chain management consist of all parties (including manufacturer, marketer, suppliers, transporters, warehouses, retailers and even customers) directly or indirectly involved in fulfillment of a customer. The main objective is to acquaint the students with the concepts and tools of supply chain management and logistics as relevant for a business firm.

COURSE CONTENT:

Unit I

Introduction: Concept of supply chain management (SCM) and trade logistics; Scope of logistics; Logistic activities – an Overview; Contribution of logistics at macro and micro levels; SCM and trade logistics; Business view of SCM; Concept, span and process of integrated SCM; Demand management – methods of forecasting; Supply chain metrics (KPIs), performance measurement and continuous improvement; Product development Process and SCM; Strategic role of purchasing in the supply chain and total customer satisfaction; Types of purchases; Purchasing cycle.

Unit II

Managing Relationship: Role of Relationship marketing in SCM; Managing relationships with suppliers and customers; Captive buyers and suppliers; Strategic partnerships; Supplier-retailer collaboration and alliances.

Unit III

Focus Areas of Logistics and Supply Chain management: Transportation-Importance of effective transportation system; Service choices and their characteristics; inter-modal services; Transport cost characteristics and rate fixation; In-company management vs. out-sourcing; World sea borne trade; International shipping- characteristics and structure; Liner and tramp operations; Liner freighting; Chartering-Types, principles and practices; Development in sea transportation-Unitization, containerisation, inter and multimodal transport; CFC and ICD. Air transport: Set up for air transport and freight rates; Carriage of Goods by sea -Role and types of cargo intermediaries. Warehousing and inventory management: Reasons for warehousing; Warehousing evaluation and requirements; Warehousing location strategies; Inventory management principles and approaches; Inventory categories -EOQ, LT, ICC; Material management systems and techniques – JIT purchasing, manufacturing and in-bound logistics; Packing and marking; Control and communication.

Unit IV

IT Enabling Logistics and Supply Chain: Technology in logistics – EDI, bar Coding, RFID etc., data warehousing, electronic payment transfers; Business management systems; TRADITIONAL ERP, SPECIAL ERP, MR, DRP, PDM, EIP, CPFR, WMS, TMS; Re-engineering the supply chain- Future directions.

Unit V

Trends and Challenges in logistics and supply chain management: Third party logistic outsourcing –challenges and future directions.

SUGGESTED READINGS:

1. M. Christopher, ``Logistics and Supply Chain Management,'' Prentice Hall.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

2. Handfield and Nicholas, Jr, `` Introduction to Supply Chain Management,'' Prentice Hall.
3. Jhon J Coyle, C. Jhon and Langley, Brian J Gibs, ``Logistics approach to Supply Chain Management,'' Cengage Learning.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO013	**Organization Development**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

Organisation Development is a growing field of Human Resource Management. It has its foundations in a number of behavioural and social sciences .

COURSE CONTENT:

1. Organizational Systems and Human Behaviour - Developing a basic knowledge of how organizattons and groups function as systems; introducing and discussing various theoretical approaches and issues.
2. Interpersonal and Consulting Skills - Increasing effectiveness as a change agent by providing a variety of opportunities in order to increase self-awareness, practice alternative ways of approaching personal and interpersonal problem-solving and develop basic consulting and interviewing skills.
3. Introduction to Organization Development - Introducing some basic theories, models and methods in the field of organization development, especially those relating to the role of consultant and strategies for change.
4. Intervention and Change in Organizations - Consolidating and further developing consulting skills and strategies
5. Action Research Project - Carrying out a change activity in an organization, while also researching the effects and/or the process. This provides participants with an opportunity to consolidate and demonstrate skills and knowledge gained in other units of the course

SUGGESTED READINGS:

1. Wendell L. French, Cecil H. Bell Jr., Veena Bohra, "Organization development," Pearson Prentice Hall.
2. Donald L. Anderson, "Organization Development: The process of leading organizational change,'' Sage Publications, Inc.
3. W. Warner Burke, Debra A. Noumair, "Organization Development: A process of learning and changing,'' Pearson Education Ltd.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO014	**Industrial Organization and Managerial Economics**	**3L-1T-0P**	**None**

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

COURSE OUTCOMES (CO): This course help students in understanding the basics of management and Industrial organization			
COURSE CONTENT: **Unit I:** Principles of management, General idea, various functions, scope of engineering. Organisation structure, Types, merits and demerits. **Unit II:** Plant location and layout, Factors effecting location, types of layout. Production planning and control, Sequence of planning and control of production. Scheduling , routing, despatching., Methods Study, Methods analysis, time study methods of rating. **Unit III:** General idea of personnel management, Industrial psychology, job evaluation and monitoring. Business decision making and forward planning. Demand and demand forcasting of production analysis- prices and pricing decision-profit and capital, management. Analysis of inter-industry relation, macro-economics and business.			
SUGGESTED READINGS: 1. Lawrence L. Bethel ,"Industrial organization and management" McGraw-Hill 2. Ralph Currier Davis,"Industrial organization and management" Harper & Row 3. James L. Riggs, Lawrence L. Bethel,"Industrial organization and management" McGraw-Hill 4. Richard Hines Lansburgh, William Robert Spriegel, "Industrial management" John Wiley 5. Harold T. Amrine, John A Ritchey, Colin L. Moodie, Joseph F. Kmec, "Manufacturing Organization and Management" Pearson Education India			

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO015	**Global Strategies and Technology**	**3L-1T-0P**	**None**
COURSE OUTCOMES (CO): **Course Objectives** This subject focuses on the specifics of strategy and organization of the multinational company, and provides a framework for formulating successful and adaptive strategies in an increasingly complex world economy.			
COURSE CONTENT: Globalization of industries, the continuing role of country factors in competition, organization of multinational enterprises, and building global networks Analysis of competitive situations from the general management point of view, including fit between key environmental forces and the firm's resources, and changes in these over time. Formulating and implementing strategy based on that analysis. Developing and leveraging a firm's core competencies to gain long-term sustainable advantage.			
SUGGESTED READINGS: 1. Kazuyuki Motohashi ,"Global Business Strategy" Springer			

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

2. M. Pinedo, I. Walter, "Global Asset Management: Strategies, Risks, Processes, and Technologies" SimCorp, strategylab
3. Frank McDonald and Richard Thorpe, " Organizational Strategy and Technological Adaptation to Global Change" Macmillan Business
4. Prashant Palvia, Shailendra C. Jain Palvia, Albert L. Harris ," Managing Global Information Technology : Strategies and Challenges
5. **McDonald**, Frank, **Thorpe**, Richard, "Organizational Strategy and Technological Adaptation to Global Change" Macmillan Business

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO016	**Engineering System analysis and Design**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

The students will learn about system definitions and role of system analyst. They will learn about system modeling and design. They will be exposed to System Implementation and Maintenance issues.

COURSE CONTENT:

Unit 1

System definition and concepts: Characteristics and types of system, Manual and automated systems

Real-life Business sub-systems: Production, Marketing, Personal, Material, finance Systems models types of models: Systems environment and boundaries, Real time and distributed systems, Basic principles of successful systems

Unit 2

Systems analyst: Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst, agent of change.

Various phases of systems development life cycle: Analysis, Design, Development, Implementation, Maintenance

Unit3

Systems Design and modeling:Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ERD diagrams. Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems

Unit 4

User Interfaces – Relational Analysis – Database design – program design– structure chart – HIPO – SSADM – Alternate Life cycles – Prototypes.

Unit 5

System Implementation and Maintenance:Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Testing and validation, Systems qualify Control and assurance, Maintenance activities and issues.

SUGGESTED READINGS:

1) Haryszkiewycz, ``Introduction to Systems Analysis and Design,'' Prentice Hall India
2) James A Senn , ``Analysis and Design of Information Systems,'' McGraw Hill

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO017	**Biology For Engineers**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. General understanding of organization in biological systems
2. Conceptual knowledge of functioning in biological systems
3. Clarity about relevance of Biology to engineering graduates
4. Understanding human body as a study-model for engineering students
5. Understanding electrical, chemical and magnetic forces, and communication networks in human body

COURSE CONTENT:

Unit I: Principles of Biology: Form and Function, Modularity and Incremental Changes, Genetic Basis, Competition and Selection, Biological Hierarchies, Biological complexity vs simplicity

Unit II: Biological Responses: Need for Water, Oxygen, Food, Nutrients, Heat Sources and Sinks, Adaptation to their Environments, Waste tolerance, Response to Chemical and Mechanical Stresses, Optimization to Save Energy and Nutrient Resources, **Allometric Relationships from Evolutionary Pressure**

Biology for Engineering Solutions: Systems Approach, Relationships between Engineering and Biology, The Completed Design

Biological Systems and Dynamics: Basic principles, Qualitative and quantitative description of Human Body, Modeling of Human Body: Compartments, Fluid streams, Production sources, The Hemodynamic System, Cheyne-Stokes Respiration,

Neural system: Action Potentials and Ion Channels, Ficks Law, Ohms Law and the Einstein Relation, Cellular Equilibrium: Nernst and Goldman, Equivalent Circuits, Dendrites; **Mathematical Neurodynamics:** Hodgkin, Huxley and the Squid Giant Axon FitzHugh-Nagumo Model, Fixed Points and Stability of a One-Dimensional Differential Equation, Nullclines and Phase Plane, Pitchfork and Hopf Bifurcations in Two Dimensions Excitability

Bioelectric and biomagnetic phenomena and their measurements

SUGGESTED READINGS:

1. T. Johnson,`` Biology for Engineers,'' CRC Press
2. Michael Small, `` Dynamics of Biological system,'' CRC Press
3. Johnny T. Ottesen, MS Olufsen, JK Larsen, ``Applied Mathematical Models and Human Physiology,'' Society for Industrial and Applied Mathematics

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO018	**Energy, Environment and Society**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

The objective is to aware students about various renewable resources, Basics of energy, environmental Impact of Energy sources. Students will also learn about the role of appropriate Technology in Transformation of Society

COURSE CONTENT:

Unit 1 Technology and Development

Introduction to Technology, Appropriate Technology, Role of Appropriate Technology in Transformation of Society, Importance of Technology Transfer, Impact of technology on Society.

Unit 2 Energy Basics

Importance of Energy in achieving Maslow's hierarchy of Needs, Human Development Index and Energy Consumption, Current Energy Trends, Demand and Supply of Energy in World and Nepal, Introduction to Global warming, Clean Development Mechanism, and Sustainability Issues, Conventional and Non-Conventional/Renewable Energy Sources,. Conventional Energy Sources: Fossil fuel, Nuclear Energy

Unit 3 Renewable Energy Sources

Solar radiation, Solar thermal energy, Solar Cell (Photovoltaic Technology), Hydropower Water sources and power , Water turbines and hydroelectric plants, Hydro Power Plant Classification (pico, micro, small, medium, large), Wind Energy , Availability of Wind Energy sources, Wind turbines, wind parks and power control, Geothermal Energy, Sources of Geothermal Energy, Uses of Geothermal Energy, .Bio-mass and Bio-energy, Synthetic fuels from the biomass ,Thermo-chemical, physio-chemical and bio-chemical conversion, Bio-fuel cells , Hydrogen Energy and Fuel Cell , Basics of electrochemistry, Polymer membrane electrolyte (PEM) fuel cells, Solid oxide fuel cells (SOFCs) , Hydrogen production and storage.

Unit 4 Environmental Impact of Energy sources : Emission hazard, Battery hazard, Nuclear hazard

Unit 5 Energy Storage

Forms of energy storage, Hybrid vehicles, Smart grid systems, Batteries, Super-capacitors

SUGGESTED READINGS:

1) A. B. Saxena, ``A Textbook of Energy, Environment, Ecology and Society,'' New Age Publication

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO019	**Public Policy and Governance**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Students will be introduced to Public Policy and Administrative governance. They will also learn about Administrative Governance.

COURSE CONTENT:

Unit 1 Introduction to Public Policy and Administrative Governance: Introduction to public policy, econometrics for policy research, policy analysis, economics for public decision making.

Unit 2 Public Bureaucracy in Theory and Practice: Benefit cost analysis, public budgeting, revenue and expenditures, managing and leading public service organisations.

Unit 3 Administrative Governance: The Challenge of Policy Implementation, public and non-profit programme evaluation.

Unit 4 Non-state Actors in Policy-making and Administrative Governance: governance in twenty-first century, Social Diversity and the Question of "Difference" in Policy-making and administrative Governance

SUGGESTED READINGS:

1. John Shields and B. Mitchell Evans., `` *Shrinking the State: Globalization and Public administration reform,''* Halifax: Fernwood

2. Beryl Radin, Beyond Machiavelli, `` Policy Analysis Reaches Midlife,'' Georgetown University Press

3. Frank R. Baumgartner, Jeffrey M. Berry, Marie Hojnacki, and David C. Kimball, ``Lobbying and Policy Change: Who Wins, Who Loses, and Why,'' University of Chicago Press.

4. Timothy Conlan, Paul Posner, and David Beam, ``Pathways of Power: The dynamics of National Policymaking,'' Georgetown University press.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO020	**Mathematics IV, Numerical Methods**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

1. Write program and solve algebraic & transcendental equations and system of equations.
2. Analyze data through interpolation and able to write programs for Numerical Integration.
3. Write programs to solve Ordinary Differential Equations and Partial Differential Equations.

COURSE CONTENT:

Solution of Algebraic and Transcendental Equations: Bisection method, Regula Falsi method, Secant methods, Newton's method, Rate of convergence, Fixed-point iteration method.

System of Linear Algebraic Equations: Gauss elimination method, Gauss-Jordan method, Crout's method, Jacobi's method, Gauss-Seidel method, Relaxation method.

Interpolation: Finite difference operators, Interpolating polynomials using finite difference (Newton forward, Newton backward, Stirling and Bessels). Lagrange polynomials, divided difference

Numerical Differentiation and Integration: Derivatives from differences tables, Higher order derivatives, Newton-Cotes integration formula, Trapezoidal rule, Simpson's rules and error estimation, Romberg's Integration.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Numerical Solution of Ordinary Differential Equations: Taylor series method, Euler and Modified Euler method, Runge-Kutta methods, Milne's method.

Numerical Solution of Partial Differential Equations: Finite difference approximations of partial derivatives, Solution of Laplace equation and Poisson's method (Standard 5-point formula only), One-dimensional heat equation (Schmidt method, Crank-Nicolson method) and Wave equation.

Practical:

Based on the above methods using C / C++

SUGGESTED READINGS:

1 Curtis F. Gerald and Patrick G. Wheatley, ``Applied Numerical Analysis,'' Pearson, Education Ltd.
2 E. Balagurusamy, ``Numerical Method,'' Tata McGraw Hill
3 M. K. Jain, S. R. K. Iyenger and R. K. Jain, ``Numerical Methods for Scientific and Engg. Computations,'' Wiley Eastern Ltd.
4. S. S. Sastry, ``Introductory Methods of Numerical Analysis,'' Prentice hall India

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO021	**Mathematics V, Mathematical Statistics**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. Collect and analyze the data using statistical techniques.
2. Describe sampling distributions of sample means and sample proportions
3. Estimate unknown parameters of the population from a sample.
4. Construct confidence intervals for mean difference of means and proportions; and perform hypothesis tests for means.

COURSE CONTENT:

Random Variable, Moments, Rectangular distribution, Exponential distribution, Beta distribution of first and second kind, Gamma distribution, Marginal and Conditional probabilities, Tchebycheff's and Markov's inequalities, Important theoretical Distributions: Binomial, Poisson, Normal and Multinomial distributions and their properties, Fitting of Normal Distribution by Method of ordinates and Method of areas, Dirichlet distribution, Moment Generating Functions and Cumulants, Weak Law of Large Numbers, Central Limit Theorem.

Method of least square: Fitting a straight line, Parabola and Exponential Curves.

Bivariate distribution: Correlation and Regression, Probable Error, Rank Correlation.

Simple sampling of Attributes: Large samples, Mean and S.D. in simple sampling of attributes, Test of significance for large samples, Standard error, Null Hypothesis, Confidence Limits, Chi-Square Distribution, Degree of Freedom, m. g. f. of Chi square distribution, Level of Significance, Test of Goodness of Fit, Test of Independence, Coefficient of Contingency, Yate's Correction for

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Continuity.

Sampling of Variables: Small samples, t-Distribution, Test of significance of the mean of random sample from Normal population, F-Distribution, ANOVA: Analysis of variance, meaning and definition, Variance within and between classes, One criterion of Classification and problems based on it.

SUGGESTED READINGS:

1. Walpole, ``Probability and Statistics for Engineers and Scientists,'' Prentice Hall
2. S. M. Ross, `` Introduction to Probability and Statistics for Engineers and Scientists,'' Academic Press.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO022	**Mathematics VI, Abstract and Linear Algebra**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. Know the concepts of Group theory and its applications
2. Know the concept of Rings
3. Know the concepts of Vector Spaces and Linear Transformations

COURSE CONTENT:

GROUPS: Binary operation, Group, Finite and Infinite Groups, Order of a Group, Additive and Multiplicative groups of integers (mod m). Composition table, Subgroup, Permutation group, Cyclic permutation, even and odd permutations, Cayley's Theorem, Isomorphism, Automorphism, homomorphism, Lagrange's Theorem, Quotient Group, Cyclic Group, Normal Subgroup, Centre of a group, Normalizer, Homomorphism, Isomorphism.

RINGS: Rings, Integral domain, Field, Theorems on Rings, Integral domain and Fields, Subrings, Left and Right Ideals, Quotient Ring, Homomorphism, Isomorphism, Kernel of a homomorphism.

VECTOR SPACES: Vector space and its examples, Subspaces, Linear combinations, Linear spaces, Linear dependence and Linear Independence, Cauchy–Schwarz's inequality, Minkowski inequality, Basis, Dimension and simple examples. Linear Transformation, Isomorphism, Nullity and Rank, Linear functional, Linear operators, Dual Space, Dual Basis, Annihilator, Transpose of a Linear map.

SUGGESTED READINGS:

1. I. N. Herstein, ``Topics in Algebra, '' Wiley Publishing
2. J. B. Fraleigh, ``A First Course in Algebra,'' Narosa Publication

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO023	**Mathematics VII, Optimization Techniques**	**3L-1T-0P**	**None**

COURSE OUTCOMES (CO):

1. Know the concepts of Linear Programming
2. Know the concept of Non-linear Programming
3. Know the concepts of Dynamite Programming

COURSE CONTENT:

Linear programming, Duality Theory, dual Simplex method, Revised Simplex method, Sensitive analysis.
Integer Programming, Cutting plane algorithm.
Branch and bound technique, travelling salesman problem.
Nonlinear Programming, Kuhn-Tucker conditions, quadratic programming, Wolfe's algorithm.
Dynamite programming, Deterministic and stochastic examples. Advanced queuing Models, Finite source queues, Balking and Reneging, Priority queue disciplines.

SUGGESTED READINGS:

1. Hamdy Taha, ``Operations Research, An Introduction,'' Pearson Education
2. J R Fletcher, ``Practical Methods of Optimization,'' Wiley Publishing

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO024	**Mathematics-VIII, Introduction to Mathematical Software and Programming Languages**	**2L-0T-4P**	**None**

COURSE OUTCOMES (CO):

1. Know using different Mathematical Software to solve Engineering Problems.
2. Know preparing Texts/ Reports / Dissertation and presentations using Latex

COURSE CONTENT:

Use of MATHEMATICA, MATLAB, MATHCAD, MAPLE, STASTITICA, LATEX, and other application software packages to study models of simultaneous equations, eigenvalues and eigenvectors, system of linear and non-linear differential equations, stability analysis, numerical integration, regression analysis, etc.

SUGGESTED READINGS:

1. Online Manuals of the related Software.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO025	**Mathematics IX, Mathematical Finance**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

Mathematical Methods for Finance covers topics from calculus and linear algebra that are fundamental for the study of mathematical finance. Students successfully completing this course will be mathematically well prepared to study quantitative finance at the graduate level.

COURSE CONTENT:

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index. Forwards and futures, marking to market, value of a forward/futures contract, replicating portfolios, futures on assets with known income or dividend yield, currency futures, hedging (short, long, cross, rolling), optimal hedge ratio, hedging with stock index futures, interest rate futures, swaps. Lognormal distribution, Log-normal model / Geometric Brownian Motion for stock prices, Binomial Tree model for stock prices, parameter estimation, comparison of the models. Options, Types of options: put / call, European / American, pay off of an option, factors affecting option prices, put call parity.

SUGGESTED READINGS:

1. David G. Luenberger , ``Investment Science, '' Oxford University Press
2. John C. Hull, ``Options, Futures and Other Derivatives,'' Prentice Hall India
3. Sheldon Ross, `` An Elementary Introduction to Mathematical Finance,'' Cambridge University Press

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO026	**Quantum Electronics**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course imparts understanding of various mechanisms in semiconductor, laser, maser and optical fibre communication using quantum mechanics as fundamental tool. It prepares

students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies. This course is very useful in designing electronic and optical communication devices for using in optical communications, medicine, environment, industries and related fields.

COURSE CONTENT:

1. Semiconductor Laser

Homojunction laser: Population inversion at a junction; Emission spectra; The basic semiconductor laser; Heterojunction: Formation of ideal heterojunctions between (a) a p-type wide band-gap semiconductor and an n-type narrower band-gap semiconductor, (b) an n-type wide band-gap semiconductor and a p-type narrower band-gap semiconductor, (c) wide and lightly doped narrower band gap n-type semiconductors; Anderson's model of ideal heterojunction. Heterojunction laser: Single and double heterojunction laser; Analysis of carrier confinement in a single heterojunction laser.

2. Electrons in quantum structures

Energy level and wave functions for quantum well, quantum wire and quantum dot; Density of states for quantum well, quantum wire and quantum dot; Modulation | doped quantum well; Multiple quantum well; Coupling between quantum wells. Super lattice: The concept of a super lattice; Kronig-Penney model of a super lattice | zone folding, Tight binding approximation for a super lattice.

3. Quantum Semiconductor Laser

Light amplification in quantum well; Modulation bandwidth; Strained quantum well laser; Quantum wire laser; Blue quantum well laser.

4. Electro-optic effect in quantum structures

Franz-Keldysh effect in Semiconductor; Electro-optic effect in quantum wells; Electro-optic effect in super lattice.

5. Parallel and Perpendicular Transport in Quantum Structures

High field electron transport|Hot electrons in quantum structures; Double barrier resonant-tunneling structures; Super lattices and ballistic injection devices.

6. Quantum Transistor

Resonant-tunneling unipolar and bipolar transistor; Velocity modulation and quantum interference transistor.

7. Guided wave optics

(a) Waveguide modes, Modes characteristics for a planar waveguide, Step index planar waveguide, Maxwell equations in inhomogeneous media: TE modes and TM modes, Radiation modes, Guided modes, Leaky modes, Quasi modes.

(b) Propagation in optical fibre, Numerical aperture, Pulse dispersion in fibres, Scalar wave equation and modes of the fibre, Modal analysis for a step index fibre.

8. Masers

Ammonia beam maser, Energy levels, Methods for population inversion, Maser operation.

9. Coherent interactions of a radiation field and an atomic system

(a) Induced resonant transitions, Inclusions of decay phenomena, Rotating wave approximation,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Exact Rabi Solution in the strong field, Rabi flopping, Dressed state picture.
(b) Density matrix, Rate equation for density matrix, Optical Bloch equations, Vector model of density matrix, The Bloch sphere.
10. Semiclassical laser theory
Electromagnetic field equations, Expansion in normal modes of a cavity, Lambs self-consistency equations, Density matrix equations, Polarization of the medium, Single mode operation, Non-linear effect in polarization, Hole burning, Steady state power, Frequency pulling and pushing.

SUGGESTED READINGS:

1. Mitin, Kochelap and Stroscio, `` Quantum Heterostructures: Microelectronics and Optoelectronics,'' Cambridge University Press
2. Martinez-Duart, Martin-Palma, Agullo-Rueda, ``Nanotechnology for Microelectronics and Optoelectronics,'' Elsevier Science
3. A. Yariv, ``Quantum Electronics,'' John Wiley
4. A.K. Ghatak and K. Thyagarajan, ``Optical Electronics,'' Cambridge University Press
5. O. Svelto, ``Principles of Lasers,'' Springer
6. P. Bhattacharyya, ``Semiconductor Optoelectronics Devices,'' Prentice Hall
7. R. W. Boyd, ``Nonlinear Optics,'' Academic Press
8. B. G. Streetman and S. Banerjee, ``Solid State Electronic Devices,'' Prentice Hall India
9. T. Suhara, ``Semiconductor laser fundamentals,'' CRC Press
10. S. M. Sze, ``Physics of Semiconductor Devices,'' Wiley Publishing
11. J. Orton, ``The Story of Semiconductors,'' Oxford University Press
12. Rogers, Pennathur, Adams, ``Nanotechnology: Understanding Small Systems,'' CRC Press

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO027	**Laser Systems and Applications**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

The concept and understanding of laser action are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics. It also gives value addition in the students' understanding of the basic principles involved. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D in the related field.

COURSE CONTENT:

Introduction: Review of elementary quantum physics, Schrodinger equation, concept of coherence, absorption, spontaneous emission and stimulated emission processes, relation between Einstein's A and B coefficients, population inversion, pumping, gain, optical cavities.

Lasers & Laser Systems: Main components of Laser, principle of Laser action, introduction to general lasers and their types. Three & four level Lasers, CW & Pulsed Lasers, atomic, ionic, molecular, excimer, liquid and solid state Lasers and systems, short pulse generation and Measurement.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Applications: Laser applications in medicine and surgery, materials processing, optical communication, metrology and LIDAR and holography(recording and reconstruction).

SUGGESTED READINGS:

1. K.R. Nambiar, "Laser Principles, Types and Application," New Age International.
2. S. A. Ahmad, "Laser concepts and Applications," New Age International.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO028	**Optoelectronics and Photonics**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course imparts understanding of various mechanisms in semiconductor laser, photonics and optical fibre communication. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies. This course is very useful in designing opto-electronic and optical communication devices for using in optical communications, medicine, environment, industries and related fields.

COURSE CONTENT:

Semiconductor lasers for optical fiber communications, Fabry-Perot cavity, heterostructure semiconductor lasers, single frequency semiconductor lasers, semiconductor lasers for coherent systems. Distributed feedback in Ga-As-P lasers. Device structure and fabrication, photodetectors for fiber optics, reverse bias photo-detectors, dark current, quantum efficiency, signal to notice ratio, types of detectors. Receivers for digital fiber optic communication systems: basic components, detectors for digital fiber optic receivers, PIN diode, Avalanche photodiode, Fronts ends for digital fiber optic receivers, equalizer for optical communication, receivers, PIN-FET receivers for longer wavelength communication systems. Coherent optical fiber transmission systems, coherent detection principles, comparison of direct and coherent performance, homodyne and heterodyne systems. Non linear process in optical fibers, phase matching in waveguide, phase matched harmonic generation in waveguides. Second harmonic generation (SHG) in integrated optics, Cerenkov configuration SHG. Optical fiber sensor and devices, intensity modulation through light interruption, distributed sensing with fiber optics. Basic principles of interferometric optical fiber sensor, signal processing in mono mode fiber optic sensor, photonic band gap materials.

SUGGESTED READINGS:

1. G. Keiser, ``Optical fiber communication,'' McGraw-Hill.
2. J. Senior, `` Optical fiber Communication,'' Prentice- Hall International
3. S.O. Kasap, `` Optoelectronics and Photonics: Principles and Practices,'' Pearson Education

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO029	**Electromagnetic Theory and Waveguides**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course imparts understanding of various mechanisms in the propagation of electromagnetic waves through space and wave guides. The understanding of various electromagnetic laws are helpful in designing and developing new devices used in optical communications, industries and related field. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.

COURSE CONTENT:

Electrostatics; Boundary value problems Dielectrics, Steady currents, Magnetostatics; Time varying fields, Maxwell's equations, Lorentz force equation and motion of charges, Plane electromagnetic waves. Waveguides and resonant cavities, fields at the surface of and within a conductor, cylindrical cavities and waveguides, modes in a rectangular waveguide, energy flow and attenuation in waveguides, perturbation of boundary conditions, resonant cavities, power losses in a cavity, Earth and ionosphere as resonant cavity, dielectric waveguide.

SUGGESTED READINGS:

1. Griffiths D. J., ``Introduction to Electrodynamics,'' Prentice- Hall Pvt.Ltd.
2. J. D. Kraus, ``Electromagnetics,'' Tata McGraw Hill.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO030	**Polymer Science & Technology**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

1. To know about polymer science and technology.
2. To have an understanding of nanotechnology in polymers.

COURSE CONTENT:

Polymer Chemistry, Polymer Physics, Polymer Technology, Polymer Characterization, Polymer Engineering and Rheology, Polymer Processing, Polymer Testing and properties, Polymer Composites, Polymer Blends and Alloys, Rubber Technology, Polymer Processing, Polymers in Packaging, Nanotechnology in Polymers, Engineering Plastics and Specialty Polymers, New innovations in Polymers.

Practical related to above theory.

SUGGESTED READINGS:

1) P. J. Flory, ``Introduction to polymer Chemistry, '' Asian Books
2) Miles & Briston, ``Polymer Technology,'' J. G. Chemical Publishing Company
3) R. T. Fenner , ``Principle of Polymer Processing, '' Maxwell McMillan International Edn
4) Stephen L. Rosen, ``Fundamental principles of polymer materials practices for engineers,

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Plastics Materials,'' Barnes & Noble
5) Joel Frados, Van Nostrand, ``Plastics Engineering Handbook,'' Reinhold, New York
6) Morton & Jones, ``Polymer Processing,'' Chapman & Hall.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO031	**Semiconductor Physics and Devices**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course is very helpful in understanding the various phenomena/mechanisms which are very useful in designing electronic devices, energy storage devices and other transistor based devices used in all sphere of life. It prepares students to take advanced courses in the related fields and finally equips them to take up R&D and higher studies.

COURSE CONTENT:

Semiconductor Physics; Semiconductor, Bonds in Semiconductors, Energy band, Effect of temperatures on Semiconductor, Hole currents, Intrinsic & extrinsic semiconductor, Majority and minority carriers, p-n junction, Volt- ampere characteristics of p-n junction. Semiconductor Diode: Semiconductor diode, Crystal diode rectifiers, Half wave rectifiers, Efficiency of half wave rectifier, Full wave rectifier, Centre tap full wave rectifier, Ripple factor, Filter Circuits, Voltage stabilization, Zener diode, Zener diode as Voltage stabilizer. Transistors: Transistors, Transistors connections, Common base connection, Common emitter connection, common collector connection, Comparison of transistor connections, Transistor as an amplifier in CE arrangement, Transistor load line analysis, Operating point, Cut off and saturation points, Applications of Common base amplifier, Bipolar junction Transistors, Hybrid Parameters, Field effect Transistor: JFET/MESFET, MOSFET, Unipolar Devices.

SUGGESTED READINGS:

1. Joseph Lindmayer and Charles Y. Wrigly, ``Fundamentals of Semiconductor Devices,'' Litton Educational Publishing Inc.
2. S. M. Sze, ``Physics of Semiconductor Devices,'' John Wily & Sons.
3. A. K. Sharma, ``Semiconductor Electronics,'' New Age International (P) Limited Publisher.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO032	**Elements of Fiber Optics**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course imparts understanding of various mechanisms in optical fibre communication. Concepts of Optical Fiber waveguides are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

COURSE CONTENT:

Over view of optical fiber communications, the evolution of fiber optics systems, elements of an optical fiber transmission links. Electromagnetic analysis of optical waveguides, classification of modes for a planner waveguide, TE and TM modes in a symmetric step index planner waveguide, power associated with a mode, excitation of guided modes, Maxwell equations in inhomogeneous media: TE and TM modes in planner waveguide. Leaky modes, leakage of power from the core, bending loss in optical waveguides. Optical fiber waveguides, optical fiber types, numerical aperture, pulse dispersion in step index fibers, scalar wave equations and modes of a fiber, Modal analysis for a step index fiber and graded-index fiber. Linearly polarized modes, power flow, multi mode fibers with optimum profiles, single mode fiber, propagation modes in single mode fibers, fiber materials, fiber fabrication. Vapor-deposition methods, Fiber optic cables, optical fiber connections, joints and couplers, signal degradation in optical fiber, absorption loss, radiation loss, attenuation, signal distortion in optical waveguides, pulse broadening, mode coupling.

SUGGESTED READINGS:

1. G. Keiser and J. Seniar, ``Optical fiber communication'' McGraw Hill
2. A. K. Ghatak, ``Introduction to Optical fiber,'' Cambridge University Press

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO033	Material Physics	3L-0T-2P	None

1. COURSE OUTCOMES (CO):
2. Given a type of material, be able to qualitatively describe the bonding scheme and its general physical properties, as well as possible applications.
3. Given a type of bond, be able to describe its physical origin, as well as strength. Be able to qualitatively derive a material's Young's modulus from a potential energy curve.
4. Given the structure of a metal, be able to describe resultant elastic properties in terms of its 1D and 2D defects.
5. Given a simple set of diffraction data, be able to index the peaks and infer the structure.
6. Be able to describe a polymer's elastic behavior above and below the glass transition.
7. Be able to do simple diffusion problems.

COURSE CONTENT:

1. Overview of materials

Crystalline and amorphous materials, glasses, semiconductors, compound semiconductors, solar energy materials, luminescent and optolectronic materials, polymer, liquid crystals, ceramics, classification according to bonding | Pauling and Philips theories.

2. Synthesis and preparation of materials

Single crystal growth, zone refining, doping techniques of elemental and compound semiconductors, fabrication and control of thin films, PVD and CVD processes, principles of polymer processing, preparation of ceramics powders | mechanical and chemical methods.

3. Characterization of materials

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Defects and microstructures; Diffraction techniques: X-ray diffraction | structure determination from XRD data; Neutron diffraction; Thermal methods: DTA, TGA, DSC; Microscopy: TEM, SEM; Optical spectroscopy: UV and IR; Nuclear techniques: NMR, ESR, Mossbauer and Positron annihilation. Heat treatments, quenching and annealing; Radiation damage.

4. Phase transition in materials

Thermodynamics and phase diagrams, statistical theories of phase transitions, critical phenomena, calculation of critical exponents for van der Waals gas and ferromagnets; Diffusion in solids, variation of diffusion constant with temperature.

5. Mechanical properties

Deformation and fracture, Deformation at low and high temperature, Intrinsically hard materials.

6. Spinodal decomposition

Spinodal curve, Free energy of composition fluctuations, Kinetics of Spinodal decomposition.

7. Electrical properties of alloys, ceramics, and conducting polymer

Resistivity variation of metals at low and high temperature, Kondo effect; Effect of pressure on resistivity, resistivity variation in ceramics and conducting polymer; Ferroelectricity, Landau-Ginzburg theory of ferroelectricity; Piezoelectricity.

8. Magnetic properties of different materials

Antiferromagnetism, ferrimagnetism, magnons, thermal properties of magnons, magnetic storage, applications as capacitors, transducers, sensors, memories, displays; Quantum Hall effect.

9. Glasses

Definitions, properties of glass transition, tunnelling states, calculation of specifc heat from tunneling states and from a model two level system having random energy gap, theories for glass transition.

10. Non-crystalline semiconductors

Classifcations, electrical properties, temperature variation of dc conductivity, ac conductivity, magnetoresistance, Colossal magnetoresistance (CMR).

11. Exotic solids

Structure and symmetries of liquids, liquid crystals, amorphous solids; Aperiodic solids and quasicrystals; Fibonacci sequence; Penrose lattices and their extensions in 3 dimensions; Special carbon solids, fullerenes and tubules, formation and characterization of fullerenes and tubules, single wall and multiwall carbon tubules; Electronic properties of tubules; Carbon nanotubule based electronic devices, Defnition and properties of nanostructured materials. methods of synthesis of nano-structured materials; Special experimental techniques for characterization of materials; Quantum size effect and its applications.

SUGGESTED READINGS:

1. C. Kittel, ``Introduction to Solid State Physics'' Wiley
2. R. Zallen, ``The Physics of Amorphous Solids'' Wiley Classic
3. N. F. Mott and E.A. Davies, ``Electronic Processes in Non-crystalline Materials'' Oxford Classic
4. C. N. R. Rao and B. Raveau, ``Colossal Magnetoresistance, Charge Density and Related

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Properties of Manganese oxides,'' World Scientific
5. J. M. Yeomans, ``Statistical Mechanics of Phase Transitions'' Claredon Press
6. R. E. Prange and S. M. Girvin (editors), ``The Quantum Hall Effect'' Springer
7. H. P. Klug and L. E. Alexander, `` X-ray Diffraction Procedures'' Wiley

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO034	**Advanced Electromagnetic Theory and Special Relativity**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course imparts understanding of various mechanisms in the propagation of electromagnetic waves through space and wave guides. The understanding of various electromagnetic laws are helpful in designing and developing new devices used in optical communications, industries and related field. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.

COURSE CONTENT:

Maxwell's equations, wave equations in scalar and vector potential, solutions of scalar and vector wave equations by Fourier analysis. Relativistic motion in electromagnetism, postulates of special theory of relativity, Lorenz transformation, relativistic mechanics, contraction of length, dilation of time, magnetism as relativistic effect, four vector, co-variance of Maxwell's equations, Lienard-Wiechert potentials and the field of a uniformly moving electron, radiation from an accelerated charge, cyclotron synchrotron, Brensstrahlung and Cerenkov radiations. Scattering and absorption of electromagnetic waves, antenna, radiated power and angular distribution of radiation, electric dipole radiation.

SUGGESTED READINGS:

1. R. Resnik, ``Introduction to Special Relativity,'' Wiley Eastern Ltd.
2. J. D. Jackson , ``Classical Electrodynamics'' John Wiley & Sons

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO035	**Fiber and Integrated Optics**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course imparts understanding of various mechanisms in optical fibre communication. Concepts of Optical Fiber waveguides are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

COURSE CONTENT:

Modes in an asymmetric planer waveguides. Ray analysis of planer waveguide, W. K. B. analysis of inhomogeneous planer waveguide, strip waveguides, periodic waveguide-coupled mode analysis, and rectangular core waveguides metal clad waveguides. Anisotropic polarizer, leaky modes in a planer structure. Polarization maintaining fibers and their applications different types of polarization maintaining fibers, high birefringent fibers, single polarization single mode fibers. Integrated optic devices: electro-optic effect, phase modulator, polarization modulators and wavelength filters. The Mach Zhender Interferometric modulator, logic operations, optical directional coupler, leaky mode, metal clad polarizer.

SUGGESTED READINGS:

1. A. W. Snyder and J. D. Love, ``Optical Wave guide Theory'' Chapmann and Hall.
2. A. K. Ghatak, `` Introduction to optical fiber'', Cambridge University Press.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO036	**Condensed Matter Physics**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

This course aims to establish fundamental concepts in condensed matter physics, and applies the physics you have learned previously (in particular quantum mechanics, classical mechanics, electromagnetism and statistical mechanics) to these real-world materials. The structure and properties of solids including thermal and electrical properties are described.

COURSE CONTENT:

1. Symmetry in crystals

Concepts of point group; Point groups and Bravais lattices; Crystal symmetry | space groups; Symmetry and degeneracy | crystal _eld splitting; Kramer's degeneracy; Quasicrystals: general idea, approximate translational and rotational symmetry of two-dimensional Penrose tiling, Frank-Casper phase in metallic glass.

2. Lattice dynamics

Classical theory of lattice vibrations in 3-dimensions under harmonic approximation; Dispersion relation: accoustical and optical, transverse and longitudinal modes; Lattice vibrations in a monatomic simple cubic lattice; Frequency distribution function; Normal coordinates and phonons; Occupation number representation of the lattice Hamiltonian; Thermodynamics of phonons; The long wavelength limits of the acoustical and optical branches; Neutron diffraction by lattice vibrations; Debye-Waller factor; Atomic displacement and melting point; Phonon-phonon interaction, interaction Hamiltonian in occupation number representation; Thermal conductivity in insulators.

3. Density Functional Theory

Basics of DFT, Comparison with conventional wave function approach, Hohenberg-Kohn Theorem; Kohn-Sham Equation; Thomas-Fermi approximation and beyond; Practical DFT in a many body calculation and its reliability.

4. Electronic properties: I
The Boltzmann transport equation and relaxation time; Electrical conductivity of metals | impurity scattering, ideal resistance at high and low temperatures, U-processes; Thermo-electric effects;
Thermal conductivity; The Wiedemann-Franz law.
5. Electronic properties: II
Electronic properties in a magnetic field; Classical theory of magneto-resistance; Hall effect and magneto-resistance in two-band model; K-space analysis of electron motion in a uniform magnetic field; Idea of closed, open and extended orbits, cyclotron resonance; Azbel-Kaner resonance; Energy levels and density of states in a magnetic field; Landau diamagnetism; de Haas-van Alphen effect; Quantum Hall effect.
6. Optical properties of solids
The dielectric function: the dielectric function for a harmonic oscillator, dielectric losses of electrons, Kramers-Kronig relations; Interaction of phonons and electrons with photons; Interband transition | direct and indirect transition; Absorption in insulators; Polaritons; One-phonon absorption; Optical properties of metals, skin effect and anomalous skin effect.

SUGGESTED READINGS:

1. M. Tinkham, ``Group Theory and Quantum Mechanics,'' Dover Publications
2. M. Sachs, ``Solid State Theory'' McGraw Hill
3. A. O. E. Animalu, ``Intermediate Quantum Theory of Crystalline Solids'' Prentice Hall
4. N. W. Ashcroft and N. D. Mermin, ``Solid State Physics'' Brooks
5. J. M. Ziman, ``Principles of the Theory of Solids'' Cambridge University Press
6. C. Kittel, ``Introduction to Solid State Physics,'' Wiley

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO037	Microwave	3L-0T-2P	None

COURSE OUTCOMES (CO):

1. Helping the students to gain insight into the subject, to develop suitable hardware/software that addresses the industrial/social problems effectively.
2. Knowledge about Microwave Solid State Devices.
3. Ability to identify and study the performance of Wave Guides and Resonators
4. Study the performance of various components used in microwave engineering.
5. Designing of Microwave filters
6. Knowledge about Microwave Measurements.
7. To motivate the students towards professionalism effective communication skills and team work.

COURSE CONTENT:

1. Transmission line and waveguide
Interpretation of wave equations; Rectangular wave guide | TE and TM modes, power

transmission, excitation of modes; Circular waveguide | TE, TM and TEM modes, power transmission, excitation of modes. Microstrip lines | characteristic impedance, loss and Q of microstrip lines, coplanar strip lines and shielded strip lines.

2. Component

Scattering parameter and scattering matrix, properties of S-parameter; Quality factor and Q-value of a cavity resonator, Q-value of a coupled cavity; Wave guide tees, magic tee, hybrid ring, couplers; Ferrites and Faraday's rotation, gyrator, circulator, isolator and terminator; λ/4 section filter, tuner and sliding short.

3. Measurement

Smith chart, single stub and double stub matching; Microwave bridge, measurement of frequency, attenuation and phase; Measurement of dielectric parameters of amorphous solids | dielectric constant, ac conductivity, resistivity, insertion loss, return loss, shielding coefficient. Measurement of microstrip line parameters.

4. Source

Conventional sources & their limitations.

(a) Vacuum tube sources | Klystron, reex klystron, travelling wave tubes and switching tubes; Magnetrons, FWCFA and Gyrotrons.

(b) Microwave transistors and FETs, Gunn, IMPATT, TRAPATT and parametric devices.

(c) Laser | Laser processes, Pockels-Cell; Laser modulators, infrared radiation and sources.

5. Antenna

Transmitting and receiving antennas, antenna gain, resistance and bandwidth; Antenna dipoles, straight, folded and broadband dipoles; Beam width and polarisation; Antenna coupling.

6. Microwave integrated circuit

Materials and fabrication technique; MOSFET fabrication, memory construction, thin film formation, planar resistor, planar inductor and planar capacitor formation; Hybrid integrated circuit formation.

SUGGESTED READINGS:

1. Samyel Y. Liao, ``Microwave Devices and Circuits'' Prentice hall publication,
2. Herbert J. Reich, ``Microwave Principles,'' Van Nostrand
3. K. C. Gupta, ``Microwaves,'' New Age publisher.
4. M. L. Sisodia and G. S. Raghubanshi, ``Microwave Circuits and Passive Device'' New Age publisher.
5. N. Mercuvitz, ``Waveguide Handbook'' IET
6. S. M. Sze, ``Physics of Semiconductor Devices'' John Wiley publisher.
7. R. E. Collins, ``Foundations of Microwave Engineering'' Wiley publication.
8. J. D. Ryder, ``Network Lines and Fields'' Prentice Hall publication.
9. Royal Signals, ``Handbook of Line Communication'' The War Office
10. W. Frazer, ``Telecommunications'' Macdonald
11. J. D. Kraus, ``Antenna'' Tata Mc Graw Hill publication.

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO038	**Fundamentals of Instrumentation and experimental techniques in Physics**	**3L-0T-2P**	**None**

COURSE OUTCOMES (CO):

The knowledge of various measurement instruments and techniques are very helpful in the scientific laboratories, organizations and industries for faithful measurements, characterizations and interpretation of data with high accuracy. It also gives value addition in the students' understanding of the basic principles involved. It prepares students to take advanced courses in the related fields and finally equips students to take up higher studies and R&D in the related field

COURSE CONTENT:

Physical Measurement: Sources of uncertainty and experimental error, Systematic and random error, Analysis of repeated measurements, Distribution functions, Propagation of error, Analysis of data. Optical measurements and the electromagnetic spectrum, Temperature transducers and linear position sensors.

Signal to noise considerations: Fluctuations and noise measurement systems, Noise in frequency domain, Signal to Noise and experimental design, Frequency and bandwidth considerations, Signal to noise enhancement, Digital and auto correlation methods.

Vacuum techniques: Characteristics and applications of vacuum, Vacuum systems-pumps and gauges, pumping speed, Thin film techniques, Film thickness monitors and measurements.

Optical Instruments: Spectroscopic Instrumentation, visible and infrared spectroscopy, Spectrometer design- lenses and refractive optics, Dispersive elements. Lasers and fibre optics.

X-ray Measurement: X-ray Fluorescence- line spectra, fine structure, Absorption and emission processes, X-ray production, X-ray diffraction and crystallography- powder diffraction spectra, information available from spectra.

Analytical Instrumentation: Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Environmental Scanning Electron Microscope (ESEM), Surface Analytical Methods-Auger Electron spectroscopy, X-ray photo electron spectroscopy (XPS) and secondary ion mass spectrometer (SIMS). X-ray fluorescence, Tunneling scanning microscope.

Occupational Health and Safety : Occupational health and safety, Chemical substances- Storage and Disposal, Work hazardous materials information system(WHMIS). Safety from electromagnetic radiation, General Electrical and testing standards- CSA approval, General laboratory and workshop practice.

SUGGESTED READINGS:

1. Michael Sayer and Abhai Mansingh, ``Measurement, Instrumentation and Experiment Design in Physics and Engineering'' Prentice-Hall India

SCHEME OF COURSES - B.E. BIOTECHNOLOGY

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO039	Lasers and Photonics	3L-0T-2P	None

COURSE OUTCOMES (CO):

The understanding of Laser, Photonics and Optical Fiber are helpful in designing and developing new devices used in optical communications, solar energy devices, medicine, environment, industries and related physics. It also gives value addition in the students' understanding of the basic principles involved. It prepares students to take advanced courses in the related fields and finally equips students to take up higher studies and R&D in the related field

COURSE CONTENT:

Properties of Lasers, Absorption**,** Spontaneous emission and stimulated emission processes, relation between Einstein's A and B coefficients, population inversion, pumping, gain, Working principle of laser, Optical cavities. Ruby Laser, Helium Neon Laser, Semiconductor Laser. Three & four level Lasers, CW & Pulsed Lasers, atomic, ionic, molecular, excimer, liquid and solid state Lasers and systems, short pulse generation and Measurement. Laser applications in medicine and surgery, materials processing, optical communication, metrology and LIDAR and holography(recording and reconstruction)

Photonics : Basics of Solid state lighting- LED- Photodetectors, photovoltaic cell, Junction & avalanche photodiodes, photo transistors, thermal detectors, Solar cells- I-V characteristics, Optic fibre- principle of propagation, numerical aperture, optical communication system. Industrial, medical and technological applications of optical fibre. Fibre optic sensors- basics of Intensity modulated and phase modulated sensors.

SUGGESTED READINGS:

1. K.R. Nambiar, "Laser Principles, Types and Application" New Age International
2. G.Keiser, ``Optical fiber communication,'' McGraw-Hill.