ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

M.Tech.

INDUSTRIAL BIOTECHNOLOGY

(FULL TIME & PART TIME)

HAND BOOK
2016-17

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

Our vision is to be a leading Chemical Engineering Department in the Nation, to create and develop technocrats, entrepreneurs and business leaders

MISSION

The department fosters chemical engineering as a profession that interfaces engineering and all aspects of basic sciences to disseminate knowledge in order to prepare the students to be successful leaders and practitioners and to meet the present and future needs of the society by highest degree of standards and ethics.

PROGRAME EDUCATIONAL OBJECTIVE (PEO):

1. To provide students with solid fundamentals and strong foundation in statistical, scientific and engineering subjects required to create and innovate in the field of biotechnology.
2. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.
3. To familiarize with the tools and techniques used in recombinant technology for strain improvements for various industrial applications
4. To prepare students to excel and succeed in Biotechnology research or industry through the latest state-of-art post graduate education.
5. This course enables the student to develop good communication and leadership skills, respect for authority, loyalty, necessity of bioethics, social responsibility, awareness of the environment and the life-long learning needed for a successful scientific and professional career.

PROGRAME OUTCOME (PO):

1. Acquire in depth knowledge of Biological science and Bioengineering for gaining ability to develop and evaluate new ideas

2. Demonstrate Scientific and technological skills to design and perform research through modern techniques for the development of high throughput process and products.

3. Analyze Biotechnological problems and formulate intellectual and innovative vistas for research and development

4. Provide potential solutions for solving technological problems in various domains of Biotechnology considering the societal, public health, cultural environmental factors.

5. Examine the outcomes of Biotechnological issues critically and gain knowledge for composing suitable corrective measures.

6. Create and apply modern engineering tools for the prediction and modeling of complex bioengineering activities

7. Posses self management and team work skills towards collaborative, multidisciplinary scientific endeavors in order to achieve common goals and acquire communication skills relevant to professional positions

8. Develop entrepreneurial and managerial skills for the implementation of multidisciplinary projects

9. Demonstrate adherence to accepted standards of professional bioethics and social responsibilities and posses the attitude necessary for lifelong learning

10. Acquire knowledge in advanced fermentation techniques catering to fulfill the need of the society and Develop skills in genetic engineering, enzyme engineering and bioprocess engineering to meet out the needs of biotechnology industries.

Mapping PO with PEO										
PEOs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
PEO1	√	√	√		√	√				
PEO2	√		√		√		√			
PEO3		√	√	√					√	
PEO4		√		√			√	√		√
PEO5					√	√		√	√	√

ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY

M.E. / M. Tech (Two-Year Full Time & Three-year Part Time) DEGREE PROGRAMME

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS

1. **Condition for Admission**
   Candidates for admission to the first year of the four-semester **M.E / M.Tech Degree programme in Engineering** shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part time programme is restricted to those working or residing within a radius of **90 km** from Annamalainagar. The application should be sent through their employers.
2. **Branches of Study in M.E / M.Tech**
   The Branch and Eligibility criteria of programmes are given in **Annexure 1**
3. **Courses of study**
   The courses of study and the respective syllabi for each of the M.E / M. Tech programmes offered by the different Departments of study are given separately.
4. **Scheme of Examinations**
   The scheme of Examinations is given separately.
5. **Choice Based Credit System (CBCS)**
   The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.
6. **Assignment of Credits for Courses**
   Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.
7. **Duration of the programme**
   A student of **M.E / M.Tech** programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.
8. **Registration for courses**
   A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.

9. Electives

The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/ allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First assessment (Test-I)	:	15 marks
Second assessment (Test-II)	:	15 marks
Maintenance of record book	:	10 marks
End Semester Examination	:	60 marks

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester, monitor their progress in SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee

For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet **three** times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study

A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of **four years for Full time / six years for Part time.**

14. Substitute Assessments

A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. Attendance Requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. Passing and declaration of Examination Results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

90 to 100 marks	Grade 'S'
80 to 89 marks	Grade 'A'
70 to 79 marks	Grade 'B'
60 to 69 marks	Grade 'C'
55 to 59 marks	Grade 'D'
50 to 54 marks	Grade 'E'
Less than 50 marks	Grade 'RA'
Withdrawn from the Examination	Grade 'W'

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.\

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree

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

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking Of Candidates

The candidates who are eligible to get the M.E /M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. Transitory Regulations

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

ANNEXURE 1

S.No.	Department		Programme (Full Time & Part time)	Eligible B.E./B.Tech Programme *
1	**Civil Engineering**	i.	Environmental Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Industrial Engg, Chemical Engg, BioChemical Engg, Biotechnology, Industrial Biotechnology, Chemical and Environmental Engg.
		ii.	Environmental Engineering & Management	
		iii.	Water Resources Engineering & Management	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Agricutural anf irrigation Engg, Geo informatics, Energy and Environmental Engg.
2	**Civil & Structural Engineering**	i.	Structural Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg.
		ii.	Construction Engg. and Management	
		iii.	Geotechnical Engineering	
		iv.	Disaster Management & Engg.	
3	**Mechanical Engineering**	i.	Thermal Power	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical Engg (Manufacturing).
		ii.	Energy Engineering & Management	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical (Manufacturing) Engg, Chemical Engg
4	**Manufacturing Engineering**	i.	Manufacturing Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Mechatronics Engg, Industrial Engg.
		ii.	Welding Engineering	
		iii.	Nano Materials and Surface Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Chemical Engg
5	**Electrical Engineering**	i.	Embedded Systems	B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Information technology, Electronics and communication Engg, Computer Science and Engg
		ii.	Smart Energy Systems	B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg,
		iii.	Power System	
		i.	Process Control & Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Control and

				Instrumentation Engg, Instrumentation Engg
6	**Electronics & Instrumentation Engineering**	ii.	Rehabilitative Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics.
		iii.	Micro Electronics and MEMS	B.E. / B.Tech – B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics, Telecommunication Engg
7	**Chemical Engineering**	i.	Chemical Engineering	B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology
		ii.	Food Processing Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Biochemical Engg, Agricultural Engg.
		iii.	Industrial Bio Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology
		iv.	Industrial Safety Engineering	B.E. / B.Tech – Any Branch of Engineering
8	**Computer Science & Engineering**	i.	Computer Science & Engineering	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
9	**Information Technology**	i	Information Technology	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
10	**Electronics & Communication Engineering**	i.	Communication Systems	B.E. / B.Tech - Electronics and Communication Engg, Electronics Engg.

*** AMIE in the relevant discipline is considered equivalent to B.E**

ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY

B.E. (Four Year) DEGREE PROGRAMME
Choice Based Credit System (CBCS)
SYLLABUS

New Curriculum with Effect from 2017 - 18

FIRST SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	HS-I	00HS101	Technical English	4	-	-	75	25	100	3
2	BS-I	00BS102	Engineering Mathematics I	4	-	-	75	25	100	3
3	BS-II	00BS103	Applied Physics I	4	-	-	75	25	100	3
4	BS-III	00BS104	Applied Chemistry I	4	-	-	75	25	100	3
5	**ES-I Lab**	00SP105	**Computer Programming Laboratory**	**-**	**1**	**3**	**60**	**40**	**100**	**3**
6	**ES-II Lab**	00SP106	**Engineering Graphics**	**-**	**2**	**3**	**60**	**40**	**100**	**4**
			Total	**16**	**3**	**6**	**420**	**180**	**600**	**19**

SECOND SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	BS-IV	00BS201	Engineering Mathematics II	4	-	-	75	25	100	3
2	BS-V	00BS202	Applied Physics II	4	-	-	75	25	100	3
3	BS-VI	00BS203	Applied Chemistry II	4	-	-	75	25	100	3
4	ES-I	00ES204	Basic Engineering*	4		-	75	25	100	3
5	HS-II	00HP205	Communication Skills and Language Laboratory	-	2	3	60	40	100	4
6	**BS-I Lab**	00BP206	**Applied Physics Laboratory**	**-**	**-**	**3**	**60**	**40**	**100**	**2**
7	**BS-II Lab**	00BP207	**Applied Chemistry Laboratory**	**-**	**-**	**3**	**60**	**40**	**100**	**2**
8	**ES-III Lab**	00SP208	**Engineering Workshop**	**-**	**-**	**3**	**60**	**40**	**100**	**2**
			Total	**16**	**2**	**12**	**540**	**260**	**800**	**22**

*** Basic Civil Engg. Subject** for Mech., Manuf., EEE, EIE, ECE, CSE & IT
Basic Electrical Engg. Subject for Civil, Civil and Structural, Mech., Manuf.,& Chem. Engg.
Basic Mechanical Engg. Subject for Civil, Civil and Structural, EEE, EIE, ECE, CSE, IT & Chem. Engg.
L-Lecture; **T**-Tutorial; **P**-Practical.
Exam-End Semester Examination; **CA**-Continuous Assessment

COURSES OF STUDY AND SCHEME OF EXAMINATIONS

Full-Time

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
S e m e s t e r – I										
1	PC-I	IBTC 101	Biochemistry and Enzymology	4		-	25	75	100	3
2	PC-II	IBTC 102	Cell and Molecular Biology	4		-	25	75	100	3
3	PC-III	IBTC 103	Instrumentation methods	4		-	25	75	100	3
4	PC-IV	IBTC 104	Bioinformatics	4		-	25	75	100	3
5	PE-I	IBTE 105	Professional Elective – I	4		-	25	75	100	3
6	PE-II	IBTE 106	Professional Elective – II	4		-	25	75	100	3
7	PC Lab-I	IBTP 107	Microbiology and Biochemistry laboratory	-	3	-	40	60	100	2
			Total	**24**	**3**	**-**	**190**	**510**	**700**	**20**

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
S e m e s t e r – II										
1	PC-V	IBTC 201	Genetic Engineering	4	-	-	25	75	100	3
2	PC-VI	IBTC 202	Bioprocess Engineering	4	-	-	25	75	100	3
3	PC-VII	IBTC 203	Separation Techniques	4	-	-	25	75	100	3
4	PC-VIII	IBTC 204	Bioprocess Modelling & Simulation	4	-	-	25	75	100	3
5	PE-III	IBTE 205	Professional Elective – III	4	-	-	25	75	100	3
6	PE-IV	IBTE 206	Professional Elective – IV	4	-	-	25	75	100	3
7	PC Lab-II	IBTP 207	Bioprocess and Genetic Engineering Laboratory	-	3	-	40	60	100	2
			Total	**24**	**3**	**-**	**190**	**510**	**700**	**20**

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
S e m e s t e r – III										
1	OE-I	IBTE 301	Open Elective – I	4	-	-	25	75	100	3
2	OE-II	IBTE 302	Open Elective – II	4	-	-	25	75	100	3
3	Thesis	IBTT 303	Thesis Phase-I	-	-	4	40	60	100	6
			Total	**8**	**-**	**4**	**90**	**210**	**300**	**12**

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
S e m e s t e r – IV										
1	Thesis	IBTT 401	Thesis Phase-II	-	-	8	60	40	100	13

			Total	**-**	**-**	**8**	**40**	**60**	**100**	**13**

L-Lecture ;**P-**Practical; **T-**Thesis; **CA-**Continuous Assessment; **FE-**Final Examination

LIST OFPROFESSIONAL ELECTIVES

S.No	**Subject**
1	Genomics and Proteomics
2	Food Technology
3	Statistics for Biotechnologists
4	Animal and Plant Tissue Culture
5	Biology of the Immune system
6	Advanced Microbiology
7	Research and Research Methodology in Biotechnology
8	Bioreactor Engineering
9	Advanced Process Control
10	Nanobiotechnology

LIST OFOPEN ELECTIVES

S.No	**Open Elective**
1	Stem Cells in Health Care
2	Pharmaceutical Technology
3	Environmental Biotechnology
4	Advances in Agricultural Biotechnology
5	Entrepreneurship and Intellectual Property Rights and Biosafety

Part Time

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.Tech. Full Time
S e m e s t e r – I											
1	PC-I	PIBTC 101	Biochemistry and Enzymology	4	-	-	25	75	100	3	IBTC 101
2	PC-II	PIBTC 102	Cell and Molecular Biology	4	-	-	25	75	100	3	IBTC 102
3	PC-III	PIBTC 103	Instrumentation methods	4	-	-	25	75	100	3	IBTC 103
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.Tech. Full Time
S e m e s t e r – II											
1	PC-IV	PIBTC 201	Genetic Engineering	4	-	-	25	75	100	3	IBTC 201
2	PC-V	PIBTC 202	Bioprocess Engineering	4	-	-	25	75	100	3	IBTC 202
3	PC-VI	PIBTC 203	Separation Techniques	4	-	-	25	75	100	3	IBTC 203
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.Tech. Full Time
S e m e s t e r – III											
1	PC-VII	PIBTC 301	Bioinformatics	4	-	-	25	75	100	3	IBTC 104
2	PE-I	PIBTE 302	Professional Elective – I	4	-	-	25	75	100	3	IBTE 105
3	PE-II	PIBTE 303	Professional Elective – II	4	-	-	25	75	100	3	IBTE 106
4	PC Lab-I	PIBTP 304	Microbiology and Biochemistry laboratory	-	3	-	40	60	100	2	IBTP 107
			Total	**12**	**3**	**-**	**115**	**285**	**400**	**11**	

S.No	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.Tech. Full Time
S e m e s t e r – IV											

1	PC-VIII	PIBTC 401	Bioprocess Modelling & Simulation	4	-	-	25	75	100	3	IBTC 204
2	PE-III	PIBTE 402	Professional Elective – III	4	-	-	25	75	100	3	IBTE 205
3	PE-IV	PIBTE 403	Professional Elective – IV	4	-	-	25	75	100	3	IBTE 206
4	PC Lab-II	PIBTP 404	Bioprocess and Genetic Engineering Laboratory	-	3	-	40	60	100	2	IBTP 207
			Total	**12**	**3**	**-**	**115**	**285**	**400**	**11**	

Sl. No.	**Category**	**Course Code**	**Course**	**L**	**P**	**T**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.Tech. Full Time**
S e m e s t e r – V											
1	OE-I	PIBTE 501	Open Elective – I	4	-	-	25	75	100	3	IBTE 301
2	OE-II	PIBTE 502	Open Elective – II	4	-	-	25	75	100	3	IBTE 302
3	Thesis	PIBTT 503	Thesis Phase-I	-	-	4	40	60	100	6	IBTT 303
			Total	**8**	**-**	**4**	**90**	**210**	**300**	**12**	

Sl. No.	**Category**	**Course Code**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.Tech. Full Time**
S e m e s t e r – VI											
1	Thesis	PIBTT 601	Thesis Phase-II	-	-	8	40	60	100	13	PIBTT 401
			Total	**-**	**-**	**8**	**40**	**60**	**100**	**13**	

L-Lecture ;**P-**Practical; **T-**Thesis; **CA-**Continuous Assessment; **FE-**Final Examination

LIST OFPROFESSIONAL ELECTIVES

S.No	**Subject**
1	Separation Techniques
2	Food Technology
3	Statistics for Biotechnologists
4	Bioprocess Modeling and Simulation
5	Biology of the Immune system
6	Advanced Microbiology
7	Research and Research Methodology in Biotechnology
8	Bioreactor Engineering
9	Advanced Process Control
10	Nanobiotechnology

LIST OFOPEN ELECTIVES

S.No	Open Elective
1	Stem Cells in Health Care
2	Pharmaceutical Technology
3	Environmental Biotechnology
4	Advances in Agricultural Biotechnology
5	Entrepreneurship and Intellectual Property Rights and Biosafety

IBTC 101	BIOCHEMISTRY AND ENZYMOLOGY	L	T	P
		4	0	0

COURSE OBJECTIVES:

The objective of the course is to enable the students to develop understanding in the basics of Biochemistry and Enzymology.

- To provide basic knowledge on biomolecules and the cell metabolism
- To provide knowledge on enzymes: classification, structure & functions, active site and mechanism
- To provide knowledge on enzyme catalysis and kinetics; enzyme applications

Introduction to biomolecules

Structure and properties of Mono, Di, Oligo and polysaccharides, complex carbohydrates, Structure and properties of Fatty acids, Glycerolipids, phospholipids, sphingolipids, glycolipids, steroids, Structure and properties of amino acids, peptides, proteins and conjugated proteins. Primary, secondary and tertiary and quaternary structures of proteins Structure of purines, pyrimidines, nucleosides, nucleotides, polynucleotides, Structure and functions of DNA and RNA, types of RNA. nucleoprotein complexes.

Intermediary metabolism

Biosynthesis and degradation of fatty acids and cholesterol, Biosynthesis and degradation of amino acids – General aspects, Removal of amino groups.Urea cycle, Biosynthesis and degradation of purines, pyrimidines and nucleic acids. Glycolysis, gluconeogenesis, Pentose phosphate shunt,TCA cycle, interconnection of pathways, metabolic regulation, Bioenergetics: energy rich compounds, Respiratory chain,TP cycle.

Enzyme kinetics

Classification, Nomenclature Isoenzymes – Coenzymes.Specificity of enzymes: Types of specificity, The Koshland “induced fit” hypothesis. Enzyme kinetics: Factors affecting the rate of chemical reaction, Kinetics of uncatalyzed chemical reaction, Kinetics of enzyme – catalyzed reaction,MichaelisMenton Equation. Methods for investigating the kinetics of enzyme catalyzed reactions, inhibition of enzyme activity – Kinetics of reversible inhibition-competitive, uncompetitive and non competitve.

Enzyme active site and catalysis

Definition of active site – Investigation of active site structure and chemical nature of enzyme catalysis: The identification of binding site and catalytic site, three dimensional structure of active site.General mechanisms of catalysis: strain, proximity, orientation effects. Transition state, stabilization and catalysis.Mechanism of reaction catalyzed by enzyme without cofactor, Metal activated enzyme and metalloenzyme, Coenzymes in enzyme catalyzed reactions.

Applications of enzymes

Applications of enzymes in industry: lipases, Penicillin acylase, Amino acylase& amino acid production, Cyclodextrin&Cyclodextringlycosyltransferase, Enzymes in animal nutrition, Oxidoreductases, Enzymes in molecular biology. Immobilization of enzymes: Concept, methods of immobilization, Kinetics of immobilized enzyme, effect of solute partition and diffusion on kinetics of immobilized enzyme. Bioreactors using immobilized enzyme. Enzyme engineering: prediction of enzyme structure, design and construction of novel enzymes.

REFERENCES:

1. Lehninger A.L., Nelson D.L., Cox M.M., "Principles of Biochemistry ", CBS Publications, 1993.
2. Voet D., Voet G., "Biochemistry ", Second Edition, John Wiley and Sons, 1994.
3. Stryer L., "Biochemistry ", Fourth Edition, 1994.
4. Enzymes by Palmer (2001): Horwood Publishing series.
5. Fundamentals of enzymology by Price and Stevens (2002): Oxford University Press.
6. Enzyme technology by Helmut uhling (1998): John Wiley
7. Introduction to Protein Structure by Branden and Tooze (1998): Garland Publishing group.

COURSE OUTCOME:

After learning the course the students will be able to understand:

1. Acquire knowledge on enzyme and enzyme reactions that will be the key step in to proceed towards various concepts in biotechnology.
2. Understand the theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
3. Know the process of immobilization in food, pharmaceutical and chemical industries and will provide simple and easy method of implementation.
4. Get ideas on Processing, Production and Purification of enzymes and metabolites at an industrial scale will be helpful to work technologically.
5. Acquire knowledge on applications of enzymes in food, pharma industries and effluent treatments.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√								
CO2										
CO3					√					
CO4					√	√		√		
CO5										√

IBTC 102	**CELL AND MOLECULAR BIOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVE:

- To enable the students to understand the knowledge about the cellular organelles and its functions, transport systems, mutation & repair mechanism, transcription & translation and cell signalling mechanism.

Introduction

The cell: A macromolecular assembly, Cellular compartmentization, Organellar architecture. The Nucleus: Chromosomal DNA and its packaging, the global structure of Chromosomes, Chromosome replication, Organization and evolution of the nuclear genome, Cytoskelton. Organization of the bacterial chromosome, organization of eukaryotic chromosome,

Cell junctions and transport system:
Cell junctions, Cell adhesion, and Extracellular matrix: Cell junctions, Cell – cell adhesion.The plant cell wall. Membrane structure, Transport of molecules and membrane excitability: The lipid bilayer, Membrane proteins, Principles and types of membrane transport, Ion channels and electrical properties of membranes. The transport of molecules into and out of the nucleus, The transport of proteins into mitochondria, and chloroplasts, Perxisomes, The endoplasmic reticulum, Transport from ER through the Golgi apparatus.

DNA replication,Mutation, repair and recombination:
Chromosome duplication and segregation, Mechanisms of DNA polymerase, types of DNApolymerases, replicon model, eukaryotic replication, role of telomerase.Replication errors and their repair, Mutagens, repair of DNA damage – photoreactivation, base excision repair, homologous recombination, holliday model, recBCD pathway, homologous recombination in eukaryotes, site specific recombination, transposition-transposase – replicative transposition, non-replicative transposition.

Transcription, splicing and translation:
Types of RNA polymerases, sigma factor, transcription mechanism, rho dependent and independent termination , eukaryotic transcription, RNA processing, RNA polymerase I and III promoter, mechanism of splicing, RNAediting, mRNAtransport, inhibitors of transcription. Genetic code, wobble hypothesis, mechanism of translation, eukaryotic translation factors, peptide bond formation, termination.Prokaryotic gene regulation- Lac operon, trpoperon.Brief account on eukaryotic gene regulation.
Homeodomain proteins, Zn containing DNA-binding domains, leucine zipper motifs, helix – loop helix proteins, nucleosome modifiers.

Cell signaling and cell cycle:
Cell signaling: general principles of cell signaling, signaling via G- protein linked cell surface receptors, signaling via enzyme linked cell surface receptors,Tyrosinekinase receptors,Second messengers,Cell cycle and division: The general strategy of the cell cycle, The mechanism of cell division, The early embryonic cell cycle, in yeasts and multicellular Animals. Cancer: Cancer as a micro evolutionary process, Tumor cells, Proto – oncogenes and viral oncogenes, Tumor suppressor genes.

REFERENCES:

1. Molecular Biology of the Gene, 5th Edition, Watson et al., Pearson Education.
2. Molecular biology by David freifelder
3. Molecular biology- Baltimore
4. Molecular biology- H. Lodish, A.Berk, C.A Kaiser and M.Kniger, Molecular biology,6^{th} edition, 2007.
5. BB.Alberts, A.Jhonson, J.Lewis and M.Raff, Molecular biology of cell,Garland science, 5^{th} edition.
6. The Cell by Cooper.ASM Press
7. Cell and Molecular Biology by Karp. John Wiley & sons

COURSE OUTCOME:
After learning the course the students will be able to
1. Know the system of cellular organelles and its functions
2. Understand the transport system followed in cellular organelles
3. Understand the mutation and repairing mechanism, cell cycle and cell signalling system

4. Get ideas on Processing, Production and Purification of enzymes and metabolites at an industrial scale will be helpful to work technologically.
5. Know the process of immobilization in food, pharmaceutical and chemical industries and will provide simple and easy method of implementation.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√				√	√				
CO2	√		√		√					
CO3								√	√	
CO4		√		√						√
CO5					√	√				√

IBTC 103	INSTRUMENTATION METHODS	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To enable the students to understand the knowledge about the analytical techniques used in various molecular biology applications: microscopy, spectroscopy, chromatography, electrophoretic, radioisotope technique, protein separation and biomedical instrumentation.

Microscopy:
Light microscopy, phase contrast microscopy, fluorescence microscopy, dark field microscopy, electron microscopy (SEM & TEM) Laser confocal microscopy and digital image analysis

Spectroscopy:
Traditional Spectrophotometer, Diode Array Spectrophotometer Absorption Spectrophotometer, Fluorescence Spectrometer, Spectrofluorimetry, IR, Raman, UV, visible spectroscopy and mass spectroscopy.

Chromatography and Electrophoresis:
Adsorption chromatography, partition chromatography, gas chromatography, ion exchange chromatography, gel filtration chromatography, affinity chromatography, HPLC, FPLC, Gel Electrophoresis, (Agarose& SDS- PAGE), Isoelectric focusing, 2D Gel electrophoresis, Pulse-field Gel electrophoresis, Southern, Northern, and Western Blotting.

Radioistope techniques: Autoradiography, Radioimmuno assay (RIA), ELISA RIA, Radioreceptor assay (RRA), Liquid Scintillation counter, nature of radioactivity, detection, measurements, counters, safety aspects

Isolation, Separation and Detection of Proteins:
Protein isolation – General principles- Cell lysis and centrifugation, osmotic lysis and protein extraction, Protein assay: Spectrophotometry (BioRad) assay.

Protein separation and Detection- Gel electrophoresis, Coomassie blue staining, gel drying, ELISA and western blotting Immunocytochemistry and immunoflourescence.

Biomedical Instrumentation:
Electrocardiography (EKG),Electromyography (EMG) ,Electro-occulography (EOG), Electroencephalography (EEG) ,Other physiological measurements ,Phonocardiogram Respiratory Measurements, Sphygmomanometry, Temperature ,Photoplethysmography Data Acquisition & Telemetry .

REFERENCES:

1. Principles of Bioinstrumentation" (ISBN 0-471-60514-x) by Richard A. Normann, Wiley Publications (May 10, 1988)
2. "At the Bench- A Laboratory Navigator", by K. Barker, Cold Spring Harbor Laboratory Press, 2005. J. G. Webster (ed.), Bioinstrumentation, Hoboken, NJ: John Wiley & Sons, 2004.
3. Carr, Joseph J. and John M. Brown., Introduction to Biomedical Equipment Technology,
4. Fourth Edition, ©2001, Prentice Hall, Upper Saddle River, New Jersey, ISBN 0-13-010492-2.
5. Webster, John G., Medical Instrumentation, Third Edition, ©1998, John Wiley and Sons, New York, ISBN 0-471-15368-0.

COURSE OUTCOME:
After learning the course the students will be able to

1. Handle and use different microscopy to study the microbial structures
2. Apply the spectrophotometric and chromatographic principles in biomolecule assays
3. Use radioisotope techniques for immune assays
4. Isolate and quantify proteins and familiar with biomedical instrumentations
5. R&D and industrial quality control is monitored by these instrumental techniques and enhance the society value.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√	√		√	√				
CO2	√		√		√					
CO3		√	√	√						
CO4		√		√						√
CO5					√	√				√

IBTC 104	**BIOINFORMATICS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To educate the students in application of software tools for the identification of microbial species
- To provide knowledge on sequence analysis in microbial identification
- To provide knowledge in application of software tools for structure related analysis and data array of biomolecules

Sequence-alignment related problems:
Sequence databases; Similarity matrices; Pairwise alignment; BLAST; Statistical significance of alignment; Sequence assembly; Multiple sequence alignment; Clustal; Phylogenetics: distance based approaches, maximum parsimony.

Pattern analysis in sequences
Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Structure-related problems
Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Structure classification (SCOP, CATH); Visualization software (Pymol, Rasmol etc.); Experimental determination of structures (X-ray crystallography, NMR); Structure databases; Secondary structure prediction; RNA structure prediction; Mfold; Protein structure prediction by comparative modelling approaches(homology modelling, threading); Ab initio structure prediction: force fields, backbone conformer generation by Monte Carlo approaches, side-chain packing; Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions.

System-wide analyses
Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics: 13C NMR based metabolic flux analysis.

REFERENCES:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2ndEdition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edn, Wiley-Liss, 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
5. C.Branden and J. Tooze, Introduction to Protein Structure, 2nd Edition, Garland Publishing, 1999.

COURSE OUTCOME:
After learning the course the students will be able to
1. Develop bioinformatics tools with programming skills.
2. Apply computational based solutions for biological perspectives.
3. Acquire knowledge on sequencing techniques
4. Gain knowledge in computer based tools in Bioinformatics
5. Develop skills on structural analysis of proteins and data analysis of gene

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√	√		√	√			√	
CO2		√	√		√	√				

CO3	√	√	√			√				
CO4		√	√			√				
CO5	√	√				√		√		

IBTP 107	**MICROBIOLOGY AND BIOCHEMISTRY LABORATORY**	**L**	**T**	**P**
		0	**0**	**3**

COURSE OBJECTIVES:

- Transfer living microbes using aseptic technique
- Demonstrate proficiency and use ofstreak plate isolation technique; bacterial staining techniques; wet mounts; and proper culture handling
- Visually recognize and explain the macroscopic and microscopic characteristics of fungi, protozoa, and bacteria
- Understand and explain environmental factors that influence microbes
- Properly obtain, culture, identify, and explain microorganisms in environmental cultures

Microbiology

1. Maintenance and identification of microorganisms.
2. Biochemical Characterization
3. Methods of quantification of microorganisms from soil, air and water.
4. Fermentation: growth curve, shake flask bioreactor, importance including off - gas analysis.

Biochemistry

1. Centrifugation: Ultra/Density gradients and continuous gradients.
2. Adsorption chromatography
3. Ion Exchange chromatography
4. Electrophoresis in Agarose and SDS gels
5. Membrane separation of proteins
6. Extraction of lipids from liver (normal and fatty) and thin layer chromatography
7. Estimation of carbohydrates-glucose and starch
8. Estimation of proteins and nucleic acid
9. Estimation of vitamins.

REFERENCES:

1. J.Jayaraman, Lab manual in biochemistry, Wiley Eastern LTd (1981)
2. Bergey's Journal of determinative biotechnology Edn (1986)
3. Collins and Lyne, Microbiological Methods, Butterworths, Singapore (1986),5thEd.
4. Plummer, An Introduction to Practical chemistry, Tata-McGraw Hill, New Delhi (1987), 3rd Ed.

COURSE OUTCOMES:

1. Students will be able to successfully perform protocols of a number of biochemical and microbiological procedures
2. Develop laboratory skills and be conversant with techniques and equipment
3. Solve problems related Enzyme involved reactions and kinetics

4. Design processes for the recovery and subsequent purification of target biological products.
5. Learn about the analytical techniques in estimation of bio molecules

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√	√		√					
CO2		√	√					√		
CO3		√	√	√				√		
CO4				√						√
CO5			√	√		√				√

SECOND SEMESTER

IBTC 201	GENETIC ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To enable the students to understand the basic concepts of genetic engineering by introducing the following the tools used in recombinant DNA technology: cloning and expression of genes, DNA library, DNA sequencing, PCR technique and gene transfer and gene therapy

Cloning and expression of genes

Overview of Restriction and Modification system.Restriction endonucleases, Cloning vehicles: Plasmids – Host range,Copy number control, Compatibility. λ phage, lytic and lysogenic lifecycle,Insertional and Replacement vectors, *in vitro*packaging. Single strand DNA vector – M13 Phage.Cosmids, Phasmids, PAC, BAC andYAC. Expression vector – Characteristics, RNA probe synthesis, High level expression ofproteins, Protein solubilization, purification and export.

Construction of DNA libraries

DNA library – Types and importance.cDNA library: Conventional cloning strategies – Oligo dT priming, self priming and its limitations. Full length cDNA cloning – CAPture method and Oligo capping. Strategies for gDNA library construction – Chromosome walking. Differences between gDNA and cDNA library. Screening strategies – Hybridization, PCR,

Immunoscreening, South-western and North-Western. Functional cloning – Functional complementation and gain of function.Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR.Overview on microarray and its applications.

DNA sequencing and analysis of gene expression

DNA sequencing – Importance, Chemical & Enzymatic methods, Pyrosequencing,Automated sequence, Genome sequencing methods – top down approach, bottom upapproach.

PCR and mutagenesis

PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, LATE-PCR, Colony PCR, *in situ* PCR, Long PCR. Real-time PCR – SYBR Green assay, Taqman Probes, Molecular beacons.Mutagenesis and chimeric protein engineering by PCR, RACE, Kuntels' method of mutagenesis.

Gene transfer & gene therapy

Introduction of foreign genes into animal cells – Importance, DNA Microinjection, Retroviral vectors, Trasnsfection of Embryonic stem cells, recombination. Transgenic plants Importance, Ti Plasmid, Co integrate and Binary vectors. Overview of Gene therapy.

REFERENCES:

1. Primrose S.B., Twyman R.H., and Old R.W. Principles of Gene Manipulation, 6th ed.,Blackwell Science, 2001
2. Winnacker E.L. From Genes to clones: Introduction to Gene Technology, Panima,2003
3. Glick B.R. and Pasternak J.J. Molecular Biotechnology: Principles and applications ofrecombinant DNA, 3rd ed., ASM Press, 2003
4. Lemonie, N.R. and Cooper, D.N. Gene therapy, BIOS Scientific, 1996

COURSE OUTCOME:

After learning the course the students will be able to

1. Acquire knowledge on gene and Genetic modification that will be the key step in to proceed towards various concepts in Genetic engineering.
2. Understand the theoretical and practical aspects of kinetics will provide the importance and utility of Genetic engineering towards research.
3. Know the process Genetic engineering in food, pharmaceutical and chemical industries and will provide simple and easy method of implementation.
4. Get ideas on Processing, Production and Purification of genetics and metabolites at an industrial scale will be helpful to work technologically.
5. Acquire knowledge on applications of Genetic engineering in food, pharma industries and effluent treatments.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√			√	√			√	
CO2		√			√	√				
CO3	√		√			√				√
CO4		√	√			√				√
CO5	√					√		√		

IBTC 202	BIOPROCESS ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To enable the students to understand the concepts of fermentation technology applied to industrial processes for making products: fermenters, reaction kinetics, media formulation, utilization of microbial cultures, design aspects of bioreactors

Overview

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes.

Reaction kinetics:

Types of reaction, order of reaction, Michealis-Menten constant, effect of temperature on reaction rate, activated complexes, catalysed reactions, thermal death of micro organisms, enzyme inhibition. Fermentation Kinetics: Continuous fermentation, advantages and limitations, theory of single and two stage continuous fermentation systems application.

Media formulation

Media formulation and preparations-complex and synthetic media, Selection of components, buffers, pH adjustment.Media and air- Batch and Continuous In-situ sterilization in fermenter.

Microbial culture

Isolation, selection and improvement of cultures – screening methods, culture preservation, strain improvement. Aseptic culture transfer and incubation, inoculum age/size, studies on growth kinetics in batch, continuous and fed batch cultures. Details of Industrial manufacture of important biotechnological products

Bioreactors

Ideal bioreactors, various configurations, Mechanical construction, various parts and accessories - Introduction to Mass and Heat transfer: Agitation and aeration, Modes of reactor operations.

Industrial fermentations

Details of the process parameters and materials for the industrial manufacture of Antibiotics, solvents, amino acids, organic acids and Biopharmaceuticals.

REFERENCES:

1. Stanbury, Whitaker & Hall – Principles of Fermentation Technology (1997)
2. Shuler and Kargi - Bioprocess Engineering, Prentice Hall of India Pvt.Ltd.(2002)
3. Bailey J.E. and Ollis, D.F. Biochemical Engineering Fundamentals, McGraw Hill, (1986).
4. Pauline M Doran - Bioprocess Engineering Principles –, Academic Press, 1995.
5. James M.Lee - Biochemical Engineering by, Prentice Hall 1992
6. A.H.Scragg -Bioreactors in Biotechnology – A practical approach; 1991

COURSE OUTCOMES:

After learning the course the students will be able to

1. Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
2. Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.
3. Gain knowledge on modeling of biological systems
4. Apply the knowledge of mass transfer in biological systems
5. Acquire knowledge about effective factor of immobilized biological systems

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√	√	√					√	
CO2	√	√	√							
CO3	√	√	√	√		√		√		
CO4			√			√	√			√
CO5			√					√		

IBTC 203	SEPARATION TECHNIQUES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To make the student to understand the basics of bioseparation techniques
- To make them to understand the engineering principles of solid -liquid separation and cell distribution
- To make them to understand the fundamentals of chromatography and its application in biomolecules separation
- To make the students to learn about the final polishing operations in bio-products separation with case studies

Introduction to bioseparation

Characterization of biomolecules and fermentation broth. Guidelines to recombinant protein purification.

Solid-liquid separation and cell disruption

Solid liquid separation- microfiltration and centrifugation – theory and design for scaleup operation. Cell disruption – Homogeniser ,dynomill – principle, factors affecting disruption, batch and continuous operation. Cell disruption by chemical methods.

Concentration and purification

Liquid- liquid extraction – theory and practice with emphasis on aqueous two phase extraction.Solid liquid extraction.Precipitation techniques using salt and solvent. Separation by ultrafiltration, Dialysis, Electrophoresis

Chromatography

Theory, practice and selection of media for – Gel filtration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, reverse phase chromatography, Affinity chromatography – Metal affinity chromatography, dye affinity chromatography, immunosorbent affinity chromatography & Expanded bed chromatography. Scale up criteria for chromatography, calculation of no of theoretical plates and design

Final polishing and case studies

Freeze drying, spray drying and crystallization. Purification of cephalosporin, aspartic acid, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase, Insulin.

REFERENCES:

1. Belter,P.A. Bioseparations: Downstream Processing For Biotechnology, John-Wiley, 1988
2. Janson J.C, &Ryden L. Protein Purification: Principles, High Resolution Methods and Applications, VCH Pub. 1989.
3. Scopes R.K. – Protein Purification – Principles and Practice, Narosa , 1994.

COURSE OUTCOME:

After learning the course the students will be able to

1. Acquire knowledge about bio products and purifications strategies.
2. Apply advanced downstream processing methods for product recovery.
3. Know about the components of downstream equipment and shall be used in the effective design of separation system for successful operations.
4. Enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.
5. Gain knowledge about finishing operation and formulation of bioproducts

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√	√		√				√	
CO2	√	√	√					√		
CO3				√		√		√		√
CO4			√	√		√	√			√
CO5		√	√					√		√

IBTC 204	**BIOPROCESS MODELING AND SIMULATION**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To introduce the fundamental aspects of modelling of various biological systems
- To address the various modelling paradigms, based on the level of detail, the extent of data available as well as the question the model must address.
- To outline the applications of such modelling techniques

Modeling of biological systems

Modeling Principles, model development from first principles. Modeling approaches for Biological systems – structured and unstructured systems; Compartment models; Deterministic and stochastic approaches for modeling structured systems.

Modelling of diffusion systems (biofilm and immobilized enzyme systems
External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models,the effectiveness factor concept, case studies; oxygen diffusion effects in a biofilm, biofilm nitrification

Modeling bioreactor
Bioreactor modelling: Ideal and non-ideal bioreactors; Stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, Tower Reactor Model; Flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models

Linear system analysis
Study of linear systems, linearization of non-linear systems; Simulation of linear models using MATLAB; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production.

Hybrid and other modeling techniques
Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

REFERENCES:

1. B. Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, 1998, PHI
2. Said S.E.H. Elnashaie, ParagGarhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, 2003, Marcel Dekker.
3. Process Dynamics, Modelling, Analysis and Simulation, B.W. Bequettre, PHI (1998).
4. Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples, I.J. Dunn, Wiley-VCH (2003). ISBN 3527307591**.**

COURSE OUTCOME:
After learning the course the student will be able to
1. Gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
2. Know about fermentation strategies in biochemical product production
3. Acquire knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
4. Learn the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.
5. Understand about the purification and polishing methods of biological products

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		√	√	√	√				√	
CO2	√	√	√					√	√	
CO3			√			√		√	√	√
CO4	√	√	√	√			√			√
CO5		√				√		√	√	√

IBTP 207	BIOPROCESS AND GENETIC ENGINEERING LABORATORY	L	T	P
		0	0	3

COURSE OBJECTIVES:

- To develop practical skills in microbial fermentation techniques
- To evaluate enzyme kinetics
- To carry out enzyme immobilized reaction
- To develop practical skills in solid substrate fermentation
- To familiarize molecular biology techniques for develop recombinant strains

List of Experiments:

Bioprocess laboratory:

1. Growth kinetics of bacteria, Actinomycetes and Fungi
2. Fermentation studies – batch, controlled run, fed-batch and continuous cultivation.
3. RTD and Performance Studies of Bio Reactors
4. Solid- state fermentation techniques
5. Immobilization – studies with conventional enzymes and plant based active principles.
6. Kinetics –study for conversion of glucose to ethanol
7. Polyethylene glycol studies for product recovery.
8. Sedimentation and Filtration - Principles and practical applications.
9. Centrifugation, Spray drying, Freeze drying and Vacuum Drying– Principles and practical applications.
10. Analytical techniques for estimation of ethanol, glutamate, acetate and other metabolites.

Genetic engineering laboratory:

1. Genome isolation
2. DNA isolation and determination
3. RNA isolation
4. Agarose gel electrophoresis
5. SDS-PAGE
6. PCR amplification
7. Cloning, recombinant techniques

REFERENCES:

1. Collins and Lyne, Microbiological Methods, Butterworths, Singapore (1986),5thEd.
2. Plummer, An Introduction to Practical chemistry, Tata-McGraw Hill, New Delhi (1987), 3rd Ed.

COURSE OUTCOME:

1. Know on immunological /clinical tests.
2. Understand the main principles, methods for preparation and cloning of DNA in various organisms.
3. Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
4. Know clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
5. Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.

Mapping with Programme outcomes										
COs/PO s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1			√	√	√					
CO2	√	√	√	√				√		
CO3								√		√
CO4					√					√
CO5					√			√	√	√

Third Semester

IBTT 303	THESIS PHASE – I	L	T	P
		-	4	-

COURSE OBJECTIVES:

- To introduce the students for searching research problems
- To make the students to prepare various methodologies for experimentation to pursue their researches in the selected fields

COURSE OUTCOMES:

After learning the course, the students should be able to

1. Able to develop better knowledge about bioprocess engineering, fermentation techniques and genetic engineering from literatures.
2. Benefitted by the implementation of computational tools to solve the problems arising in bioprocesses.
3. Acquiring knowledge to represent bioprocesses with suitable kinetic models.
4. Gaining knowledge to transform technology to commercial products by scaling up
5. Developing technical reporting and project preparation for entrepreneurship

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		√	√	√					√	√
CO2	√	√	√	√		√	√	√	√	√
CO3		√	√	√	√	√	√	√	√	√
CO4		√	√	√		√	√		√	√
CO5		√	√	√		√	√	√		

Fourth Semester

IBTT 401	THESIS PHASE - II	L	T	P
		-	8	-

COURSE OBJECTIVES:

- To make the students to take any challenges and to find the solutions through the research skills
- To make the students to learn and develop the research skills in the area of biotechnological applications in various fields
- To make the students to empathize in experimentations and to prepare thesis report in specified field of research undertaken

The thesis work on a specialized topic in industrial biotechnology, already selected in the Third Semester will be continued in the fourth semester. A report must be submitted at the end of the Fourth semester and there will be a Viva Voce examination on the thesis.

COURSE OUTCOMES:

After completing the course, the students should be able to

1. Able to develop better knowledge about bioprocess engineering, fermentation techniques and genetic engineering from literatures.
2. Benefitted by the implementation of computational tools to solve the problems arising in bioprocesses.
3. Acquiring knowledge to represent bioprocesses with suitable kinetic models.
4. Gaining knowledge to transform technology to commercial products by scaling up
5. Developing technical reporting and project preparation for entrepreneurship

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		√	√	√					√	√
CO2	√	√	√	√		√	√	√	√	√
CO3		√	√	√	√	√	√	√	√	√
CO4		√	√	√		√	√		√	√
CO5		√	√	√		√	√	√		

PROFESSIONAL ELECTIVES

IBTE XXX	GENOMICS AND PROTEOMICS	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To enable the students to know about the sequence of gene and protein of different microbial species, genome of microbes, mapping techniques, functional genomics, protein sequencing and analysis and protein profiling

Overview of genomes

Genomes of Bacteria, archae and eukaryota

Genome mapping and sequencing techniques

Cytogenetic, genetic and physical, mapping techniques.Molecular markers for mapping.Genome sequencing; placing small fragments on map; STS assembly; gap closure; pooling strategies.Top down and bottom up approach; linking and jumping of clones.

Functional genomics

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

Proteomics techniques

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

Protein profiling

Post translational modification; protein-protein interactions; Yeast 2 Hybrid system; glycoprotein analysis; phosphoprotein analysis; Protein arrays and Protein chips.

REFERENCES:

1. Cantor, C.R. and Smith, C.L. Genomics. The Science and Technology Behind the human genome project, John Wiley & Sons, 1999.
2. Pennington, S.R. and Dunn, M.J. Proteomics: From protein sequence to function, Vina Books, 2002.
3. Liebler,D.C. Introduction to Proteomics: Tools for the New Biology, Humana Press, 2002.
4. Hunt, S.P. and Livesey, F.J. Functional Genomics, Oxford University press, 2000
5. Primrose, S.B. Principles of genome analysis: A guide to mapping and sequencing DNA from different organisms, 2nd ed., Blackwell Science, 1998.

COURSE OUTCOMES:

After learning the course the students will be able to

1. Apply the knowledge of genome and physical mapping of microbes for various fields of applications
2. Use the tools to identify the functional regions of genome for recombinant applications
3. Apply the techniques of protein separation and protein profiling in specific enzymatic applications
4. Acquire the concept of biosynthesis and degradation of proteins.
5. Know the role of functional proteins in various field of study.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√			√	√			√	
CO2		√			√	√				
CO3	√		√			√				√
CO4		√	√			√				√
CO5	√					√		√		

IBTE XXX	**FOOD TECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

To make the students

- To study the importance and significance of microorganisms related to food.
- to aware the knowledge about various food preservation techniques used in different food products

Importance and significance of microorganisms in food science. Micro-organisms importance in food – Factors affecting the growth of micro organisms in food – Intrinsic and Extrinsic parameters that affect microbial growth.

Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods – Cereal and cereal products, vegetables and fruits, meat poultry and sea foods, milk and milk products, packed and canned foods.

Food borne diseases: Bacterial food borne diseases Food Borne Viral Pathogens, Food Borne Animal Parasites Protozoa. Principles of fresh food storage: Nature of harvested crop, plant, animal; product storage; effect of cold storage and quality – storage of food grains.

Processing and preservation by heat: Blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying. Retort processing of Ready to eat (RTE) products. Drying – water activity, microbial spoilage due to moisture. Dehydration of fruits, vegetables, milk, animal products Newer methods of thermal processing – batch and continuous.

Processing and preservation by low Temperature and irradiation – refrigeration, freezing and dehydrofreezing. Food irradiation, history and mechanism, the electro-magnetic spectrum, forms of radiant energy. Principles of using electromagnetic radiation in food processing. ionizing radiations and non ionizing radiations, advantages and disadvantages. Controlling undesirable changes in food during irradiation.

Processing and preservation by drying, concentration and evaporation : Various methods employed in production of dehydrated commercial products , selection of methods based on characteristics of foods to be produced, advantages and disadvantages of different methods, sun-drying , tray drying, tunnel drying , spray drying , drum drying , freeze drying and fluidized bed drying. Physical and chemical changes during drying control of chemical

changes, desirable and undesirable changes. Packaging and storage of dehydrated products. Ultra-filtration, reverse osmosis, Freeze drying and freeze concentration.

REFERENCES:

1. Frazier, W.C. 2007. "*Food Microbiology*", Mc Graw Hill Inc. 4th Edition.
2. James, M.J. 2000. "*Modern Food Microbiology*", 2nd Edition. CBS Publisher
3. Adams, M.R. and M.G. Moss 2009. "*Food Microbiology*", 1st Edition, New Age International (P) Ltd.
4. Doyle, P., Bonehat, L.R. and Mantville, T.J. 2010. "*Food Microbiology, Fundamentals and Frontiers*", ASM Press, Washington DC.
5. Desrosier, N.W. and James, N. 2007. "*Technology of food preservation*". AVI. Publishers
6. Fellows, P.J. 2009. "*Food Processing Technology: Principle and Practice*". 3rd Ed. CRC Publishers
7. Jelen, P. 2005. "*Introduction to Food Processing*". Prentice Hall.

COURSE OUTCOME:

1. Students will understand the role of microorganisms on food materials.
2. Acquire knowledge about the microorganisms associated with spoilage of various food products
3. Apply the knowledge of suitable preservation techniques in storage of specific food materials
4. To know about various food processing operations
5. Apply the knowledge on food process industries and becoming entrepreneur

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√			√				√	
CO2	√	√			√		√			
CO3	√		√							√
CO4		√	√							√
CO5							√	√		√

IBTE XXX	**STATISTICS FOR BIOTECHNOLOGISTS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

To make the students to understand

- the data characteristics and form of distribution of data structure
- the exact method of data analysis for the problem under investigation
- and to draw valid inferences and to plan for future investigations

Introduction

Random variable-sample spaces-Events-Axiomatic approach to probability- conditional probability-additional theorem, Multiplication theorem- Baye's theorem problems-continuous and discrete random variables, Distribution function-Expectation with properties-Moments, mean, Variance problems-for continuous and discrete distributions.

Distribution
Bivariate distribution-conditional and marginal distribution-Discrete distribution-Binomial, Poisson, geometric distribution-Continuous distribution, Normal, exponential and negative exponential, gamma distributions-simple problems-properties.

Correlation
Correlation coefficient, properties-problems-Rank correlation-Regression equation problems-curve fitting by the method of least squares-fitting curves of the form ax+b,ax2+bx+c,abx and axb- Bivariate correlation application to biological problems.

Sampling
Concept of sampling-Methods of sampling-sampling distributions and Standard Error-Small samples and large samples-Test of hypothesis-Type I, Type II Errors-Critical region-Large sample tests for proportion, mean-Exact test based on normal , t, f and chi-square distribution-problems-Test of goodness of fit.

Basic principles of experimentation-Analysis of variance-one-way, Two-way classifications-Randomised block design, Latin square design-problems.

REFERENCES:

1. "Elements of Mathematical statistics" by V.C.Kapoor and Gupta.
2. Vittal, P.R.& V.Malini."Statistical and Numerical Methods".Margham Publications
3. Veerarajan,T. "Probability, Statistics and Random Processes".3rd ed., Tata Mc Graw-Hill,2008.
4. Johnson, R. A."Miller& Freund's Probability and Statistics for Engineers". 6th ed. PHI,2003.
5. Spiegel, Murray R., J.Schiller and R.AluSrinivasan."Schaum's Outlines Probability and Statistics".2nd ed. Tata McGraw-Hill 2000.
6. Comprehensive Statistical Methods by P. N. Arora, SmeetArora, S. Arora – S. Chand & Co.
7. Kandasamy, P. K. Thilagavathi& K. Gunavathi."Probability Statistics and Queuing Theory". S. Chand & Co., 2004

COURSE OUTCOME:
After learning the course the student will be able to
1. Understand and apply the knowledge of statiscal techniques in the analysis of biological data.
2. Apply the fundamental ideas of statistical tools for data analysis, interpretation and inference
3. Experimental data collection and analysis from the conduct of biological experiments.
4. Use the sampling techniques and regression analysis in bio problems for development of correlations of the system
5. Optimization of bioprocess system to increase the productivity

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√							√	
CO2	√	√					√			
CO3	√	√	√							
CO4	√	√	√							
CO5	√	√	√				√	√		

IBTE XXX	ANIMAL AND PLANT TISSUE CULTURE	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To make the students to understand and apply the knowledge of cell and animal culture techniques in the production of vaccines and drugs and for crop improvements

Introduction:

Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Sterilization.

Tissue culture:

Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines;

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Plant tissue culture:

Fundamentals of plant tissue culture, plant regeneration: organogenesis. Somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Cell/callus line selection for resistance to herbicide, stress and diseases. Isolation, culture and plant regeneration, protoplast fusion, identification and characterization of somatic hybrids., Field techniques for propagation of regenerated plants.

Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; Induction and growth parameters; Chromosomal variability in callus culture. Plant regeneration from embryo, meristem and callus culture.Androgenesis: Anther and pollen culture; Isolation and culture of protoplasts.

REFERENCES:

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO
3. Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
4. I. Gordon, Laboratory production of cattle embryos, 2nd edition,CAB International, 2003.

5. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5thEdn, CRC Press, 1997.

COURSE OUTCOMES:

After learning the course the students will be able to

1. Understand the animal cell culture, animal diseases and its diagnosis.
2. Gain the knowledge for therapy of animal infections.
3. Know the concepts of micromanipulation technology and transgenic animal technology.
4. Acquire knowledge about the gene manipulation.
5. Use the knowledge gained in this section to apply in the field of clinical research.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√							√	
CO2	√	√					√			
CO3	√	√	√							
CO4	√	√	√							
CO5	√	√	√				√	√		

IBTE XXX	**BIOLOGY OF THE IMMUNE SYSTEM**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To introduce the fundamental aspects of immune system
- To address the various cell immune system
- To outline the Tumor Immunology, AIDS and other immunodeficiences

Introduction:

Central and peripheral lymphoid organs.Immune system, innate and acquired immunity, Clonal nature of immune response.Organisation and structure of lymphoid organs.Nature and Biology of antigens and super antigens.

Antibody:

Antibody structure and function, antigen and antibody interactions, Major histocompatibility complex, HLA.Generation of antibody diversity and complement system.

Cells of immune system:

Haematopoiesis and differentiation, lymphocyte trafficking, B-lymphocyte, T-lymphocytes, macrophages, Dentritic cells, natural killer and lymphokine activated killer cells. Eosinophils, neutrophils and mast cells.Activation of B and T- lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity

Immune response and regulation:

Antigen processing and presentation, generation of humoral and cell mediated immune responses, cytokines and their role in immune regulation, T- cell regulation, MHC-regulation, Immunological tolerance, Hypersensitivity, Autoimmunity, Immunosenesence.

Transplantation, Immunity to infectious agents (intracellular parasites, helimenths& viruses,) Tumor Immunology, AIDS and other immunodeficiences. Immuno techniques- Genereation of monoclonal and polyclonal antibodies, Hybridoma Technology and Monoclonal Antibodies.

.

REFERENCES:

1. Roitt. I. M ,Essensials of Immunology.
2. Kuby J, Immunology (V or VI edition).
3. Advanced Immunology (1991) Male D., Champion B. Cooke A. and Owen M.
4. Principle and practice of Immunoassay (IInded.) Christopher P. Price and David J.
5. Kuby Immunology Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne 6 Ed. 2007.

COURSE OUTCOME:

After learning the course the students will be able to:

1. Apply the basics of immune system in immunology assays
2. Carryout immunological techniques in industry
3. Apply the concept of hybridoma technology and monoclonal antibodies
4. Gain knowledge about the tissue culture and transgenic immune system
5. To acquire knowledge about immune system facilities in biological system

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1					√				√	
CO2					√		√			
CO3			√							√
CO4			√							√
CO5							√	√		√

IBTE XXX	**ADVANCED MICROBIOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To introduce new approaches to bacterial taxonomy
- To address the various fermentation methods
- To outline the biodeterioration control and soil

New approaches to Bacterial taxonomy, determination and significance of DNA Base composition, nucleic acid hycridization, RNA fingerprinting, bacterial phylogeny.

Metabolic diversity of aerobic heterotrophs – mechanisms in uptake of substrates Entner-Doudoroff pathway, sugar degradation via Pentose Phosphate cycle, methyl glyoxal bypass, diversity in energy metabolism.

Bacterial Fermentation – Alcohol fermentation, lactate fermentation, buatyrate&butanol – acetone fermentation, Anaerobic food chains; Chemolithotrophic and phototropic metabolism.

Degradation of natural substances – Cellulose degradation, microbial conversion in the rumen, xylan degradation, degradation of starch, fructans, mannan, pectin, agar, chitin, lignin; formation of humus, utilization of hydrocarbons – methane, ethane, propane, butane, aromatic hydrocarbons, xenobiotics.

Biodeterioration control and soil, waste and water management – Indicator microorganisms, fouling biofilms, treatment of solid waste, landfills, composting, treatment of liquid waste, biological oxygen demand.

REFERENCES:

1. General Microbiology, Fifth edition, (2006), Stanier RY, Ingraham JL, Wheels ML and RP Painter, Macmillan Press.
2. Bacterial Metabolism, 2nd Edition (1986) Gerhard Gottschalk, Springer Verlag.
3. Atlas RM and R Bartha, Microbial Ecology – Fundamentals and Applications, 4th Edition, (2005).
4. General Microbiology, 7thEdn (1992), Hans G.Schlegel, Cambridge University Press.

COURSE OUTCOMES:

After learning the course the students should be able to

1. Apply the knowledge of microbiology for RNA finger printing
2. Understand knowledge about fermentation methods
3. Apply the concept of BOD ,treatment of solid waste
4. Understand the theoretical and practical aspects of kinetics will provide the importance and utility of microbial kinetics towards research.
5. Get ideas on Processing, Production and Purification of microbial technology

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√	√							√	
CO2	√	√					√			
CO3	√	√	√							
CO4	√	√	√							
CO5	√	√	√				√	√		

IBTE XXX	**RESEARCH AND RESEARCH METHODOLOGY IN BIOTECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To develop understanding of the basic framework of research process.
- To understanding of various research designs and techniques
- To develop an understanding of the ethical dimensions of conducting applied research.

Research and its methodologies (With examples)

Objectives of research, research process – observation, analysis, inference, hypothesis, axiom, theory, experimentation, types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research, the concept of laboratory to market (bench to public) and Industrial R&D.

Research in biotechnology – an overview
Biological systems and their characteristic:.Type and outcome of research, Exploratory and product-oriented research in various fields of biotechnology (health, agri, food, industrial etc) – types of expertise and facilities required. Interdisciplinary nature of biotech research, sources of literature for biotech research.

Experimental research: basic concepts in design and methodology
Precision, accuracy, sensitivity and specificity; variables, biochemical measurements, types of measurements, enzymes and enzymatic analysis, antibodies and immunoassays, instrumental methods, bioinformatics and computation, experimental planning – general guidelines.

Results and analysis
Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective) and cross verification, correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc.

Scientific and technical publication
Different types of scientific and technical publications in the area of biotechnology, and their specifications, Ways to protect intellectual property – Patents, technical writing skills, definition and importance of impact factor and citation index - assignment in technical writing.

REFERENCES:

1. Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005 John Wiley & Sons Publishers, Inc
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers,Inc
3. Guide to Publishing a Scientific paper, Ann M. Korner, 2004, Bioscript Press.

COURSE OUTCOMES:
After learning the course the students should be able to
1. Develop testable hypotheses, differentiate research design and/or statistics, evaluate aptness of research conclusions, and generalize them appropriately
2. Design and conduct quantitative or qualitative research studies in laboratory or field settings.
3. Use research data to formulate or evaluate new research questions, using reason and persuasion in a logical argument
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. . Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			√	√	√				√	
CO2	√	√	√	√						
CO3		√	√				√			√
CO4		√	√		√		√			√
CO5		√	√		√			√	√	

IBTE XXX	BIOREACTOR ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To acquire basic understanding of transport process in bioreactor
- To understanding design procedures for commonly used process parameter
- To develop an understanding of the design and analysis of biological reactors

Transport process in bioreactor

Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, mass transfer for freely rising or falling bodies, forced convection mass transfer, Overall kla estimation and power requirements for sparged and agitated vessels, mass transfer across free surfaces, other factors affecting kla, non Newtonian fluids, Heat transfer correlations, thermal death kinetics of microorganisms, batch and continuous heat, sterilisation of liquid media, filter sterilisation of liquid media, Air. Design of sterilisation equipment batch and continuous.

Monitoring of bioprocesses

On-line data analysis for measurement of important physico-chemical and biochemical parameters; Methods of on-line and off-line biomass estimation; microbial calorimetry; Flow injection analysis for measurement of substrates, product and other metabolites; State and parameter estimation techniques for biochemical processes. Case studies on applications of FIA and Microbial calorimetry.

Modern biotechnological processes

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; Bioreactor strategies for maxmising product formation; Case studies on high cell density cultivation and plasmid stabilization methods. Bioprocess design considerations for plant and animal cell cultures. Analysis of multiple interacting microbial populations – competition:survival of the fittest, predation and parasitism: LotkaVolterra model.

Design and analysis of biological reactors

Ideal bioreactors-batch, fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, enzyme catalyzed reactions. Reactor dynamics and stability.Reactors with non ideal

mixing. Other types of reactors- fluidized bed reactors, packed bed reactors, bubble column reactors, trickle bed reactors.

Scaleup of reactors
Scaleup by geometry similitude, oxygen transfer, power correlations, mixing time.

REFERENCES:

1. Moser, Anton, Bioprocess Technology: Kinetics and Reactors, Springer Verlag, 1988.
2. Bailey J.E. &Ollis, D.F. Biochemical Engineering Fundamentals, 2nd ed., McGraw Hill, 1986
3. Lee, James M. Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Blanch,H.W. Clark, D.S. Biochemical Engineering, Marcel Decker, 1999.

COURSE OUTCOMES:
After learning the course the students should be able to
1. Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
2. Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.
3. Gain knowledge on modeling of biological systems
4. Apply the knowledge of mass transfer in biological systems
5. Acquire knowledge about effective factor of immobilized biological systems

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			√	√	√				√	
CO2	√	√	√	√						
CO3		√	√				√			√
CO4		√	√		√		√			√
CO5		√	√		√			√	√	

IBTE XXX	**ADVANCED PROCESS CONTROL**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:
- To acquire basics of feedback control system
- To understanding the analysis and control of advanced control systems
- To develop an automatic controllers

Analysis and design of feed back control system
Dynamic behaviour, stability analysis, design of feed back controllers, design of feed back control systems using frequency response techniques, PID controller for multicapacity processes.

Optimum controller setting
Optimum settings from the plant response, continuous cycling method, damped oscillation method, reaction curved method.

Analysis and control of advanced control systems
Feedback control of systems with large dead time, control systems with multiple loops, feed forward and ratio control, adaptive and inferential control systems.
Automatic controllers
Electronic, controllers, operational amplifier, electronic controller input and output, PID and on-off control models, microprocessors, general architecture, algorithms, applications in chemical process control.

Process control using digital computers:
Characteristics and performance of control computers, signals-types, signal transmission, analog feedback control systems. The direct digital control concept, advantages of DDC, computer process interface for data acquisition and control, computer control loops.

REFERENCES:

1. George Stephanopolous – Chemical Process Control, An introduction to Theory and
2. Practice, prentice Hall of India Pvt.Ltd., New Delhi 1990.
3. Emanule S. Savas _ Computer control of industrial processes, McGraw Hill, London, 1965.
4. Peter Harriot – Process Control, Tata McGraw Hill Publishing Co, New Delhi 1977.

COURSE OUTCOMES:
After learning the course the students should be able to
1. Understand the Knowledge about the fundamental models of bioprocesses.
2. Select appropriate bioreactor configurations and operation modes based upon the nature of bio products.
3. Apply modelling and simulation of bioprocesses to enhance the quality of products and systems.
4. Identify problems and seek practical solutions for large scale implementation of Biotechnology.
5. Acquire knowledge of various tools for controlling of bioprocesses

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√		√	√	√				√	
CO2	√	√	√						√	
CO3		√	√	√		√		√	√	√
CO4		√	√		√	√		√	√	√
CO5			√		√			√	√	

IBTE XXX	**NANOBIOTECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:
- To provide fundamental concepts of nanotechnology
- To understanding the advanced knowledge on the application of nanotechnology to biological sciences
- To update knowledge about nanodrug delivery and nanomedicine.

Nanoscale and nanobiotechnology
Introduction to Nanoscience and Nanotechnology; Milestones in Nanotechnology; Overview of Nanobiotechnology and Nanoscale processes; Physicochemical properties of materials in Nanoscales.

Abrication and characterization of nanomaterials
Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.

Properties and measurement of nanomaterials
Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.

Nanobiology and bioconjugation of nanomaterials
Properties of DNA and motor proteins; Lessons from nature on making nanodevices; Reactive groups on biomolecules (DNA & Proteins); Surface modification and conjugation to nanomaterials. Fabrication and application of DNA nanowires; Nanofluidics to solve biological problems.

Nano drug delivery and nanomedicine
Properties of nanocarriers; drug delivery systems used in nanomedicine; Enhanced Permeability and Retention effect; Blood-brain barrier; Active and passive targeting of diseased cells; Health and environmental impacts of nanotechnology.

REFERENCES:

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley-VCH; 1 edition , 2004.
2. NanoBioTechnology: BioInspired Devices and Materials of the Future by OdedShoseyov and Ilan Levy, Humana Press; 1 edition 2007.
3. NanoBiotechnology Protocols (Methods in Molecular Biology) by Sandra J Rosenthal and David W. Wright , Humana Press; 1 edition, 2005.
4. Bio-Nanotechnology_ Concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012
5. Microscopy Techniques for Material Science. A. R. Clarke and C. N. Eberhardt (Editors) CRC Press. 1st Edition, 2002.

COURSE OUTCOMES:
After learning the course the students should be able to
1. Familiarize about the science of nanomaterials
2. Demonstrate the preparation and characterization of nanomaterials
3. Understand the production of nanomaterials using biological molecules
4. Knowledge of nanomaterials in genetic engineering
5. Applications of nanomaterials in drug development.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√		√		√					
CO2	√	√	√	√						
CO3	√		√	√		√	√	√		√
CO4	√	√	√			√		√		√
CO5		√	√	√			√	√		

OPEN ELECTIVES

IBTE XXX	STEM CELLS IN HEALTH CARE	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To strengthen the knowledge of students on stem cell basics and their applications for the benefit of mankind.
- To impart knowledge about stem cell and stem cell signaling
- To understand cell based gene therapy and benefits to human.

Stem cells

Introduction: Tissue organization - Stem cells - Sources -Unique properties of stem cells-classification- Embryonic stem cells-adult stem cells - similarities and differences between adult and embryonic stem cells – Functional characterization.

Embryonic stem cells

Stem cells and their developmental potential. In vitro fertilization-culturing of embryos-blastocyst-inner cell mass-isolation and growing ES cells in labIdentification and characterization of human ES cells-Cloning and controlled differentiation of human embryonic stem cells. Applications of Embryonic stem cells – Gene knock in – Gene knock out - Ethical issues.

Adult stem cells

Somatic stem cells-test for identification of adult stem cells- adult stem cell differentiation-trans differentiation-plasticity-different types of adult stem cells-liver stem cells-skeletal muscle stem cells-bone marrow derived stem cells – Stem cell specific transcription factors - Induced pluripotent cells.

Cancer stem cell signaling

Introduction: Tumor stem cells - Breast Cancer Stem Cells: Identification – Signalingpathways:Notch signaling – Wnt signaling in stem cells and cancer cells.

Stem cells in tissue engineering

Introduction: Biomaterials – Cell and biomaterial interactions - Haematopoietic Stem Cells -. Mesenchymal stem cells - Bone tissue engineering – Cartilage tissue engineering – Cardiovascular tissue engineering – Neural tissue engineering. Therapeutic applications - BT-Parkinson's disease – Diabetes: Pancreatic cells regeneration. Stem cell based gene therapy and benefits to human.

REFERENCES:

1. AriffBongso, EngHin Lee “Stem Cells: From Bench to Bedside” World Scientific Publishing Company. 2005.
2. C S Potten “Stem Cells” Elsevier,1996.
3. Daniel R. Marshak “Stem cell biology” Cold Spring Harbor Laboratory Press.
4. Robert Lanza “Essentials of Stem Cell Biology” Elevier, 2009.
5. Peter Quesenberry “Stem cell biology and Gene Therapy” WileyLiss,1988.

COURSE OUTCOMES:
After learning the course the students should be able to

1. Understand the applications of Embryonic stem cells
2. Understand the adult stem cells and the stem cells in tissue engineering
3. Understand the stem cell culture, animal diseases and its diagnosis.
4. Gain the knowledge for therapy of animal infections.
5. Know the concepts of micromanipulation technology and transgenic health cara.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1					√				√	
CO2					√		√			
CO3			√							√
CO4			√							√
CO5							√	√		√

IBTE XXX	**PHARMACEUTICAL TECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To understand the role of patents in the drug industry
- To understand the pharmacokinetics and pharmacodynamic principles
- To understand the concept of advanced drug delivery systems

Introduction
History of pharmaceutical industry, Drugs discovery and Development phases; Drugs and Cosmetics ACT and regulatory aspects; Definition: Generics and its advantages; Biogenerics and Biosimilars; The role of patents in the drug industry; Protein-based biopharmaceuticals; International Non-proprietary Names (INN) nomenclature system biosimilars regulation.

Dosage form: science, pharmacokinetics and pharmacodynamics
Definition of Dosage forms, Classification of dosage forms (solid unit dosages – Tablets, capsules; liquids – solutions, lotions, suspension etc; semi-solid – ointments, creams, gel, suppositories, etc; Parenterals, Aerosols etc), Introduction to pharmacokinetics and pharmacodynamic principles (factors affecting the ADME process); bioavailability, bioequivalence.

Drug delivery and characterisation of biogeneric recombinants
Advanced drug delivery systems – controlled release, transdermals, liposomes and drug targeting. Approaches to the characterization of biosimilars; Problems in characterizing biologics (Types of biologic, Peptides, Non-glycosylated proteins, Glycosylated proteins, Monoclonal antibodies); Equivalence issues; Post-translational modifications; Effect of microheterogeneity.

Pharmacology principles, classification of drugs and mechanism
Understanding principles of pharmacology, pharmacodynamics Study of a few classes of therapeutics like laxatives, antacids and drugs used in peptic ulcers, drugs used in coughs and

colds, analgesics, contraceptives, antibiotics (folate inhibitors, protein synthesis inhibitors, DNA inhibitors), hormonal agonists and antagonists**.**

Case studies on biopharmaceutical product development

Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte- macrophage CSF, Factor VIIa, Factor IX, Factor VIII, Tissue plasminogen activator, Monoclonal antibodies and engineered Mabs

REFERENCES:

1. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000.
2. Katzung B.G. Basic and Clinical Pharmacology, Prentice Hall of Intl. 1995.
3. T.V.Ramabhadran. Pharmaceutical Design And Development : A Molecular Biology Approach, Ellis Horwood Publishers, New York, 2005
4. Goodman & Gilman's The Pharmacological Basis of Therapeutics,11th edition, McGrawHill Medical Publishing Division New York, 2006.
5. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues, CRC Press, 2006.
6. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1st Edition, Wiley Liss, 2003.
7. Brahmankar D M, Jaiswal S B, Biopharmaceutics and Pharmacokinetics A Treatise, Vallabh Publisher, (2008).

COURSE OUTCOMES:

After learning the course the students should be able to

1. Understand the students about the drug discovery and development phases
2. Understand on the drug delivery and characterisation of biogeneric recombinants
3. Update knowledge about various biopharmaceutical product development
4. Use the knowledge for the development of therapeutic products and Learn the separation techniques of herbal agromedicines and its analysis.
5. Gain the knowledge about the microbial based secondary metabolites and Use of the gained knowledge for improvement in quality of products.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	√				√				√	
CO2	√	√			√		√			
CO3	√	√	√							
CO4	√	√	√							
CO5	√						√	√		

IBTE XXX	**ENVIRONMENTAL BIOTECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To understand the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments.

- To understand the advancements in biotechnological field such as molecular biology and genetic engineering strategies
- To make them understand the paves the way for the alternate sources of energy to avoid environmental issues.

Microbial flora of soil, Ecological adaptations, Interactions among soil microorganisms, biogeochemical role of soil microorganisms. Biodegradation, Microbiology of degradation and its mechanism, Bioaugmentation, Biosorption, Bioleaching, Bioremediation- Types of Bioremediation, Bioreactors for Bioremediation, Metabolic pathways for Biodegradation for specific organic pollutants.

Pollution- Sources of pollutants for Air, Water (ground water, marine), Noise, Land and its characteristics- Pollution control and management- Environmental monitoring & sampling, Physical, chemical and biological methods and analysis- Air pollution- control and treatment strategies. Modes of Biological treatment methods for wastewater- aerobic digestion, anaerobic digestion, Anoxic digestion, the activated sludge process, Design and modeling of activated sludge processes, Aerobic digestion, Design of a trickling biological filter, Design of anaerobic digester.

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

Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience in Environmental management.

Phytoremediation for heavy metal pollution, Biosensors development to monitor pollution. Alternate Source of Energy, Biomass as a source of energy, Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomineralization, Bioethanol and Biohydrogen, Bioelectricity through microbial fuel cell, energy management and safety.

REFERENCES:

1. Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989.
2. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.
3. Environmental Biotechnology, Forster, C. F and Waste, D.A. J. (1987) Ellis Horwood Halsted Press.
4. Environmental Biotechnology by Alan Scragg (1999); Longman.
5. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, LutgardeRaskin, “In-situ Bioremediation” (II Edn) Nayes Publication, U.S.A, 1991.
6. New Processes of Waste water treatment and recovery. G.Mattock E.D. (1978) Ellis Horwood.
7. Environmental Biotechnology, Jogdand, S.N. (1995) Himalaya Publishing House, New Delhi.
8. Martin, A.M., Biological Degradation of Wastes, Appl. Science, New York, 1991.
9. Sayler, Gray S. Robert Fox and James W. Blackburn,” Environmental Biotechnology for Waste Treatment, Plenum Press, New York, 1991.

COURSE OUTCOMES:

After learning the course the students should be able to

1. Gain knowledge about the fundamentals of environmental Pollution and its problems.
2. Find the scientific solutions for the environmental protection.
3. Acquire knowledge about the applications of microbes in waste water treatment systems.
4. Design microbial based air pollution treatment facilities.
5. Understand the various methods for biological conversion of waste materials into useful products

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1				√	√				√	
CO2		√	√	√	√			√		
CO3	√		√	√						√
CO4		√	√	√	√		√	√		√
CO5	√			√	√					√

IBTE XXX	**ADVANCES IN AGRICULTURE BIOTECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To strengthen the knowledge of students on basic techniques and tools in plant tissue culture
- To impart knowledge about biotechnology for crop improvement
- To understand the concept of map based cloning

Basic techniques and tools in Plant Tissue Culture.Establishment of plant tissue culture lab: equipment, culture vessels, surface sterilization of various explants, pretreatment of explant, subculture and repeated transfer of explants and cultures.Composition of various tissue culture media and their preparation. Establishment of callus, suspension cultures, organogenesis and embryogenesis, Meristem tip culture, Hardening of plants, Techniques of anther, embryo and ovule culture.Protoplast isolation, culture and fusion.Artificial seed (synthetic seed) Cell line selection using selection pressure, Production of secondary metabolites, Cryopreservation.

Biotechnology for Crop Improvement.Conventional methods for crop improvement (Pedegree breeding, Heterosis breeding, Mutation breeding). Tissue culture in crop improvement, Micropropagation for virus-free plants, Somaclonal variation, Somatic hybridization, Haploids in plant breeding,

Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency.Genetic engineering for biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds). Genetic engineering for abiotic stress (drought, flooding, salt and temperature)

Genetic engineering for quality improvement of Protein, lipids, carbohydrates, vitamins & mineral nutrients, Plants as bioreactor, Molecular breeding, constructing molecular maps, Molecular tagging of genes/traits. Marker-assisted selection of qualitative and quantitative traits.Physical maps of chromosomes.The concept of gene synteny. The concept of map-based cloning and their use in transgenics

Plant Metabolic Engineering. The concept of secondary metabolites, Historical and current views, Importance of secondary metabolites in medicine and agriculture, Introduction to various pathways, Flavanoid pathway, Terpenoid pathway, Polyketoid pathway.

REFERENCES:

1. Dodds JH and Roberts LW, Experiments in Plant Tissue Culture, Cambridge University Press (1990).
2. George EF, Plant Propagation by Tissue Culture: The Technology, Exegenetics Limited, UK (1993)
3. Day JG and Stacey GN, Cryopreservation and Freeze Drying Protocol, Humana Press (2007).
4. Bhojwani SS and Razdan M K, Plant Tissue Culture: Theory and Practice, Elsevier (1996).
5. Slater A, Scott N and Fowler M, Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press (2008).
6. Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).

COURSE OUTCOMES:

After learning the course the students should be able to

1. Gain knowledge about the basic techniques and tools in plant tissue cultureand its problems.
2. Find the scientific solutions for the agriculture biotechnology.
3. Acquire knowledge about the applications of microbes in agriculture biotechnology systems.
4. Design microbial based agriculture biotechnology.
5. Understand the various methods for biological conversion of waste materials into useful products in agriculture

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1					√				√	
CO2		√	√	√	√			√		
CO3	√		√							√
CO4		√	√	√			√	√		
CO5	√			√	√					√

IBTE XXX	**ENTREPRENEURSHIP AND INTELLECTUAL PROPERTY RIGHTS AND BIOSAFETY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To understand the functions and kinds of entrepreneurs

- To understand the IPs of relevance to biotechnology
- To understand the concept of prior art

Entrepreneurship
Definition.Functions and kinds of entrepreneurs.Intrapreneur, Entrepreneurship and economic development, Entrepreneurial competencies and traits, developing competencies.Project identification, selection and financing.Project report- content and significance, Planning Commission's guidelines for formulating project reports-methods of project appraisals**.**

Introduction to intellectual
Types of Intellectual property (IP): Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology Agreements and Treaties.History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

Basics of patents and concept of prior art
Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENT Scope(WIPO), IPO, etc.)

Patenting procedures
National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringementmeaning, scope, litigation, case studies

Biosafety
Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

REFERENCES:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007
3. S.S.Kanka Entrepreneurship Development, S.Chand&Co, New Delhi 1997 BY7104 A.

COURSE OUTCOMES:
After learning the course the students should be able to
1. Understand research problem formulation.
2. Analyze research related information and follow research ethics
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Mapping with Programme outcomes										
COs/PO s	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			√	√	√			√	√	
CO2		√	√	√				√		
CO3	√	√	√			√				
CO4		√	√		√	√		√		
CO5		√	√		√					