Rama University Uttar Pradesh, Kanpur

Faculty of Engineering & Technology

Ref: RU/FET/ PG /BT/BOS/2020 **Dated:** 02/05/2020

Department of Biotechnology

Minutes of Meeting

Boards of Studies

A meeting of Boards of Studies of M.Tech. Biotechnology, FET was held on 02/05/2020 (Monday) at 3:30 PM. in conference room of FET. The following members were present:

1. Dr. Ajay Kumar - Chairperson
2. Dr. Vivek Srivastava - Member
3. Dr. Anand Kumar - Member
4. Prof. (Dr.) Nand Lal - External Member
5. Prof.(Dr.)Vinay Dwivedi - External Member

Agenda:

1. **Action Taken Report (ATR) on Minutes of Previous Meeting.**

   The BOS committee reviewed and confirmed the minutes of the BOS meeting held on 18/05/2019

2. To consider and approve new Evaluation Scheme and Syllabus.

S. No.	Item No.	Existing	Recommendation /Action Taken
1	To consider and approve the CBCS based Evaluation Scheme and Syllabus for M.Tech. (Biotechnology) students to be admitted in the session 2020-21	The BOS reviewed existing Evaluation Scheme and Syllabus for M.Tech. (Biotechnology) for deciding CBCS based curriculum	The BOS considered suggestions for the Evaluation Scheme and Syllabus for said courses and thereafter discussion, recommended the same

The meeting concluded with a vote of thanks to the chair.

Date of the Next Meeting: to be decided and conveyed later

(Chairperson)

Signature: .....

Name : Prof (Dr.) Ajay Kumar

Date :

Internal Members

Signature:	1.....	2.....
Name:	Dr. Vivek Srivastava	Dr. Anand Kumar
Date:		

External Members

Signature:	1.....	2.....
Name:	Prof. (Dr.) Nand Lal	Prof.(Dr.)Vinay Dwivedi
Date:		

Encl.: Recommended Curricula attached for consideration and approval.

CC:

1. Dean
2. Registrar Office

M. Tech Biotechnology

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To develop a programme oriented knowledge in scientific, mathematical, and engineering fundamentals required to solve engineering problems and also to pursue higher studies.

PEO 2: To emphasize upon students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context.

PEO 3: To develop students with engineering attitude so as to comprehend, analyze, design, and create novel products and solutions for the real-life problems, through broad and in-depth learning.

PEO 5: Graduates will be able to implement the engineering principles to biological systems for the development of industrial applications as well as Entrepreneurship skills to start biotech industries.

PEO 6: To make the students able to adopt lifelong learning, act with integrity and have inter-personal skills needed to engage in, lead and nurture diverse teams with commitment to their ethical and social responsibilities.

PEO 9: Graduates will consider the social implications of their work as it affects the health, safety and environment of human population.

PROGRAM OUTCOMES (POS)

PO 1: Develop the understanding of Biotechnology Theory and Research including Human Physiology, Genetics, Cancer Biology, Proteomics and Genomics.

PO 2: Build Knowledge of current industrial practice including Biotechnology Innovations and Molecular Biological Techniques.

PO 3: Gain experience in Experimental or Case Study design, Scientific Data Analysis, Writing and Communication, Ethical Practices and Effective Collaboration.

PO 4: Communicate effectively with scientific community and with society at large.

PO 5: An ability to independently carry out research/investigations and development work to solve practical problems.

PO 6: Comprehend and write and present substantial report documentation.
PO 7: Effectively disseminate technical information using written progress report, strategic report, scientific communication and operations.

PO 8: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO 1: Apply the basics of science, mathematics and engineering knowledge to identify, formulate, design and investigate complex problems of biotechnology.

PSO 2: Formulate a hypothesis and conduct research using appropriate tools and techniques with in the area of biotechnology to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

PSO 3: Recognize the need for the preparation and ability to carry out an independence research in broadest context of biotechnological relevance.

PSO 4: Aware of the impact of professional engineering solutions in societal, environmental context, professional ethics and be able to communicate effectively.

PSO 5: Demonstrate competence in basic science and engineering courses to pursue higher education.

PSO 6: Demonstrate an ability to acquire technical skills and work ethics to meet the industry needs and to become an entrepreneur.

PSO 7: Understand the current state of Biotechnology in their area of specialization.

ORDINANCE

FOR

THE DEGREE

OF

MASTER OF TECHNOLOGY

(M.Tech.)

RAMA UNIVERSITY UTTAR PRADESH

KANPUR, INDIA

Approved in Academic Council Meeting held on----------

APPLICABILITY:

This ordinance shall apply to all programmes leading to Master's Degrees in Technology.

1. DEFINITIONS:

1. Academic Programme/ Programmes shall mean a programme of courses and/or any other component leading to a Master's degree in Technology.

2. An Academic Year is a period of nearly 12 months devoted to completion of requirements specified in the Scheme of Teaching and the related examinations.

3. Board of Studies (BoS) shall mean the Board of Studies of the Institute concerned.

4. Course means a component of the academic programme, carrying a distinctive code number and specific credits assigned to it.

5. University shall mean **Rama University**

6. External Examiner shall mean an examiner who is not in the employment of the University.

7. Semester System – A programme wherein each academic year is apportioned into two parts known as semesters.

8. Student shall mean a person admitted and registered for a programme in the Institutes of the University.

2. ADMISSION

• The University will permit admission and award of M.Tech. degrees in only such courses which are duly approved by the Academic Council of the University

• Admission to M.Tech. First Semester will be made as per the rules prescribed by the Academic Council of the University.

• Admission on migration from any other university to the university is not permitted. However, a student of constituent Institution/College enrolled in any other university may be allowed to migrate to the University provided that he/she has failed. He/she will continue his/her study in the same Institution/College where he/she was previously studying.

3. ELIGIBILITY FOR ADMISSION

B.Tech. or an equivalent degree in the relevant branch of Engineering with a minimum of 50% marks from a recognized University.

OR

MCA or M.Sc. degree in a related branch with 55% or higher aggregate marks from a recognized University

4. CURRICULUM

M.Tech. courses shall be of any one of the following types:

(a) M.Tech. (Residential/Full-Time/Regular): It shall be a regular four-semester course in which students will be required to spend the entire study duration in the University campus or the Industry/ Institution/ R&D Organization where they shall be doing their dissertation/ project work.

(b) M.Tech. (Week-End): It shall be a regular four-semester course specially run by the University for working teachers, persons employed in Industry or Research and Development Organizations, who have a 5-day working week. The programme consists of three semesters of coursework in the University campus and one semester of dissertation/ project work in the University or in the Industry/ Institution/ R&D Organization. Number of contact hours in each subject will be the same as that of Residential M.Tech. Course. A candidate shall normally be required to submit a no objection certificate from his/her employer for this course.

(c) M.Tech. (Part Time): It shall be a six-semester part-time course meant for serving engineers/ teachers of the neighboring areas who can attend the classes during morning or evening hours only. A candidate shall normally be required to submit a no objection certificate from his/her employer for this course.

5. PROGRAMMES CONTENT & DURATION

(a) A Master's Degree programme shall comprise of a number of courses and/or other components as specified in the Teaching & Examination Scheme of the concerned programme duly approved by the Academic Council.

(b) The minimum period required for completion of a programme shall be the programme duration as specified in the Teaching & Examination Scheme for the concerned programme.

(c) The maximum permissible period for completing a programme for which the prescribed programme duration is n semesters, shall be (n+2) semesters. All the programme

requirements shall have to be completed in (n+2) semesters. Under very special circumstances the duration of the total period may further be extended by a maximum of two (2) semesters with the approval of the Vice Chancellor. This excludes the period of expulsion or suspension by the University / medical leave.

(d) (i) A student may be allowed to "audit" a course(s) not included in the Teaching & Examination Scheme, or one of the elective course(s) in the Teaching & Examination Scheme, which the student is not opting for as a credit course.

(ii) The University may ask a student to audit one or more courses as pre-requisite courses so as to make up any deficiency at the entry level.

(iii) Such audited course(s) shall be shown in the final mark-sheet under a distinct head of "Audited Course(s)" provided the attendance requirement of the course is duly certified to have been met by the concerned teacher(s).
However, a student shall neither be entitled to any credits for such course(s), nor these shall be considered for the purpose of declaration of results.

(e) Except for the first semester, registration for the next semester will be done during the first week of the next semester.

(f) From the second semester onwards, all students have to enroll on a specified day at the beginning of a semester. A student is eligible for enrolment if he has paid all the dues for the semester.

6.(a) MINIMUM REQUIREMENT TO CONTINUE IN THE PROGRAM

(i) The M. Tech. Program has a total of 80 credits and students are required to complete all courses. On completion of all courses, the students shall earn 80 credits and would be eligible for award of the M.Tech. Degree.

(ii) A student should have a minimum CGPA of 5.0 calculated for the courses successfully completed at the end of each semester. If CGPA continues to be less than 5.0, then his/her name will be struck off.

6.(b) SEMESTER DURATION

(i) An academic year shall be of two semesters, each of about 20 weeks duration. There shall be a break of 3 to 5 weeks after autumn semester and 6 to 10 weeks after the spring semester.

The Academic Calendar shall be notified by the University each year before the start of the Academic Session.

(ii) The academic break-up of the semesters shall be as follows:

Theory and Practical Classes (including Mid-Sem. tests) 16 – 18 Weeks

Semester-end Examination, including Practical / - 02 - 04 Weeks
Laboratory Examination

7. Examination:

7.1 The performance of a student in a semester shall be evaluated through continuous evaluation and end semester examination. The continuous evaluation shall be based on Mid Term Examination, assignments/tutorials, quizzes/viva-voce and attendance. The marks for continuous evaluation (Sessional marks) shall be awarded at the end of the semester. The end semester examination shall be comprised of written papers, practicals and viva-voce, inspection of certified course work in classes and laboratories, project work, design reports or by means of any combination of these methods.

7.2 The distribution of marks for Sessional, end semester theory papers, practicals and other examinations, seminar, project, industrial training shall be as prescribed.

7.3 The marks obtained in a subject shall consist of marks allotted in end semester theory paper, practical examination and sessional work.

7.4 The minimum pass marks in each theory subject (including sessional marks) shall be 50% with a minimum of 40% marks in each theory paper in the end semester examination. If there is no provision of sessional marks in any subject, the minimum pass marks in that subject shall be 50% in the end semester examination.

7.5 The minimum pass marks in a project/practical subject (including Sessional marks if any) shall be 50%.

7.6 A candidate, in order to pass, must secure 50% marks in the aggregate in a particular academic year inclusive of both semesters of the academic year subjected to conditions as bye laws.

7 (a) Carryover System:

A candidate satisfying university clause shall be required to exercise his/her choice upto a maximum of four theory papers in year which he/she desires to appear in the examination to fulfill the requirements of clause . He/she shall inform the college about his/her choice within 15 days after the start of new session.

The highest marks secured in any subject in various attempts (end semester and carryover examinations) shall be considered.

7.(b) Ex-studentship:

A candidate opting for ex-studentship shall be required to appear in all the theory & practical subjects in the end semester examinations of both semesters of the same academic year. However, the marks pertaining to Sessional, Industrial Training, and Seminar shall remain the same as those secured earlier.

A candidate opting for ex-studentship shall be required to apply to the FET by paying only examination fee within 15 days from the start of new session.

7(c) Re-admission:

- A Candidate may be allowed for re-admission provided he/she satisfies one of the following conditions:
- A candidate is declared fail.
- A candidate did not appear in a semester examination / or he/she was not granted permission to appear in the examination.
- A candidate has been detained by the department and subsequently has been permitted to take re-admission.
- A candidate as an ex-student passed the examination of the academic year or qualified for carryover system.
- A candidate promoted with carry over subjects and he/she opted for re- admission.

8. ATTENDANCE

All students are normally expected to have attendance of 100% in each subject (Lectures, Tutorials and Practical's). The attendance can be condoned upto 25% for genuine reasons. The Director of the concerned Institute/ Programme Coordinator may give further relaxation up to 10% on account of illness and other pre-approved occasions. Vice Chancellor may further condone attendance shortage up to 5% on genuine grounds. However, under no circumstances, a student with an attendance of less than 60% in a subject shall be allowed to appear in the semester-end examination of that subject. Provided that the late admitted students in the first semester of any course maintain at least 80% attendance (including medical and other reasons) from the date of their admission.

Director/Dean of the Institute / Programme Coordinator shall announce the names of all such students who are not eligible to appear in the subject(s) of semester-end examination, at least one week before the start of the semester-end examination and simultaneously intimate the same to the Controller of Examinations.

In case any student appears in the Examinations by default, who in fact has been detained by the Institute, his/ her result shall be treated as null and void.

9. Assessment Criteria (M.Tech.)

All courses of M.Tech. shall be evaluated for 150 marks, of which 50 marks shall be for Internal Assessment and 100 for Comprehensive sem End Examination. Internal Assessment for 50 marks shall be as per the criteria given below:

Criteria	**Marks**
Class Test I	15
Class Test II	15
Assignments, class participation and discussion	10
Attendance	10
Total Internal Assessment	**50**

Marks for Practical Assessment shall be awarded as per the criteria given below:

Criteria	**Marks**
Attendance	5
File Record	5
Practical Perform/Execution	5
Viva-Voce	5
Total Practical Assessment	**20**

All students should have a minimum of 75% attendance in all subjects, in order to appear in term end examination / viva voce. The 75% criterion includes all leaves of absence – whether approved or not approved.

Students failing to obtain 75% attendance shall be required to repeat the course in the subsequent year, along with the next batch, to make up for the shortage of attendance.

Under extraordinary circumstances, a student with attendance below 75% shall be allowed to appear in the term end exams / viva voce. This will be at the discretion of the Vice Chancellor of the University. Circumstances when such leniency shall be shown include:

a. Death of a blood relative – father, mother, grandfather, grandmother, brother or sister.
b. Extreme cases of health adversity requiring hospitalization of the student.

In such cases, the student shall be required to give a written application to the Vice Chancellor of the University, along with appropriate proof. In case of death of blood relative, an application from the parent(s) shall be considered.

All faculty members shall maintain appropriate records and make them available to the University's Examination Centre at the end of the semester.

Credits

The M. Tech. Program has a total of 80 credits and students are required to complete all courses. On completion of all courses, the students shall earn 80 credits and would be eligible for award of the M.Tech. Degree.

Final Year Dissertation-I Work (M. Tech 3rd Semester)

During the 3rd semester, each student shall undertake a pre thesis work to be pursued by him/ her under the supervision of a guide/ supervisor. The guide/ supervisor shall be appointed by the Dean, Faculty of Engineering & Technology. Minimum four copies of Project Report along with one soft copy on a CD shall be submitted at least two weeks prior to the commencement of the Term End Examination of the 3rd Semester. The Dissertation-I Work shall carry 500 marks and shall be evaluated by a Board of Internal and External Examiners, appointed by the Dean. The Dissertation-I Work shall be evaluated in the following manner:

Criteria	Internal	External	Total
Pre-Thesis Report	100	150	250
Viva Voce	100	150	250
Total	200	300	**500**

Note: to move into fourth semester, the candidate will have to opt minimum E Grade in Dissertation-I.

Final Year Dissertation-II Work (M.Tech. 4th Semester)

During the fourth semester, each student shall undertake a Thesis work to be pursued by him/ her under the supervision of a guide/ supervisor. The guide/ supervisor shall be appointed by the Dean, Faculty of Engineering & Technology. Minimum four copies of Project Report along with one soft copy on CD shall be submitted at least two weeks prior to the commencement of the Term End Examination of the 4th Semester. The Dissertation-I Work

shall carry 800 marks and shall be evaluated by a Board of Internal and External Examiners, appointed by the Dean/ VC. The Board shall be consisting of two Internal Faculty Members. The Dissertation-II work shall be evaluated in the following manner:

Criteria	Internal	External	Total
Thesis Report	100	200	300
Viva Voce	200	300	500
Total	300	500	**800**

Note: for getting degree, the candidate will have to opt minimum E grade in Dissertation-II.

Guide Lines for Dissertation Work:

Student will follow any one of given below to complete M.Tech. Dissertation Work:

1. Candidate should present/ publish at least two papers in International Conferences.
2. Candidate should publish at least one paper in International Journals.
3. Candidate should publish at least one paper in National Journals & at least one paper present/ publish in International/ National Conferences.

Note: Dissertation Work Report should be documented in University Format & Norms.

Calculation of Grade Point and Grade Point Average

Relative grading shall be adopted at the Faculty of Engineering & Technology, Rama University. The list of alphabet grades, the grade points associated with them are given below:

Grade	Grade Point
A^+	**10**
A	**9**
B	**8**
C	**7**
D	**6**
E	**5**
F	**4**

In order to arrive at these alphabet grades, the total marks in a particular course for all the students pursuing the course are tabulated in the descending order (equivalently a histogram). The performance of the course is analyzed in terms of the highest, lowest and the average

marks and the dividing lines between the clusters of students.

Gaps and dips between the clusters and the nature of the clusters guide in drawing the dividing lines between the grades. In a normal class of large size, the C grade usually covers the average performance. This is, however not a hard and fast rule and exceptions may arise in case of small classes, skewed histogram etc. Borderline cases may be considered individually on the basis of regularity and the attendance, class room discussions, progressive good performance throughout the semester, etc.

How to Calculate of Semester Grade Point Average:

- Computation of the Semester Grade Point Average (SGPA) and Cumulative Performance Index (CPI):

  The SGPA is an indicator of the overall academic performance of a student in all the courses he/she has registered during a given semester. It is computed as follows: If the grades awarded to a student are G_1, G_2 etc in courses with corresponding credits C_1, C_2 etc, the SGPA is given by:

$$SGPA = \frac{C_1 \times G_1 + C_2 \times G_2 + \cdots + C_n \times G_n}{C_1 + C_2 + \cdots + C_n}$$

- The CPI indicates the overall academic performance of a student in all the courses registered upto and including the latest completed semester/summer term. It is computed in the same manner as the SGPA, considering all the courses (say, n) and is given by:

$$CPI = \frac{\sum_{i=1}^{n} C_i \times G_i}{\sum_{i=1}^{n} C_i}$$

- Percentage conversion of CPI :

$$Percentage\ of\ Marks = CPI \times 10$$

- Students should get a minimum grade E in each subject with 5CPI to clear the semester.
- CPI conversion

≥8 CPI	**Ist Division with Honours**
≥6 CPI	**Ist Division**
≥5 CPI	**IInd Division**
<5 CPI	**Fail**

- In case a student gets a F grade in more than one subject, he / she has to repeat one or more of the subjects by registering for "Guided Study" in the semester the courses are offered. Registration for Guided Study shall be made on the payment of Rs. 500 per subject as well as registering for the examination with a payment of Rs. 1000 per subject.

- If the students get F grade in four subjects in an academic session then he/ she will repeat the year.
- M. Tech. Course should be completed within Four Years. If a student does not complete the M. Tech. program in stipulated time, he / she will have to appear freshly in the program.

9 (b). Results:

- The result of a candidate shall be declared on the basis of performance of both semesters of the same academic year. However, a final year student, who is not permitted in any one of the final year semester examinations due to shortage of attendance, will be permitted in that particular semester of the next academic session to study as a regular student and appear at that semester examination.
- Result of the final year shall be declared on the basis of working out Grand Total by adding marks of all the years of study in the following ways:

Award of Division: The division shall be awarded on the basis of final year result.

10. CANCELLATION OF ADMISSION

The admission of a student at any stage of study shall be cancelled if:

(i) He / She are not found qualified as per the eligibility criteria prescribed by the University.

OR

(ii) He / She are involved in ragging.

OR

(iii) He / She are found involved in creating indiscipline in the Institute/Institute or in the University.

11. BOARD OF STUDIES

The constitution of the Board of Studies of each Institute shall be:

(a) The Director/ Dean of the Institute (Chairperson)
(b) Two Professors
(c) Two Associate Professors
(d) Two Assistant Professors
(e) Two External Expert Members

12. ACADEMIC PROGRAMME COMMITTEE

(a) There shall be an Academic Programme Committee in the Institute/ Department/ Constituent Institutions of the University.

(b) All the teachers of a Institute of Study shall constitute the Academic Programme Committee of which the Director of the Institute shall act as its Chairperson. This Committee shall coordinate the implementation of the courses for optimum utilization of resources and shall also take care of the coordination of the Institute's programmes with the other programmes run by the different Institutes of the University.

(c) The Academic Programme Committees shall also perform other tasks as assigned to it by the Board of Studies of the concerned Institute of the University.

(d) The Academic Programme Committee shall meet as and when required but at least once every semester. The Chairperson of the Committee will convene the meetings.

First Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
1.	MTBT-101	Microbial Process Engineering	3	1	0	30	20	100	150	4	4
2.	MTBT-102	Molecular Biology and Genetic Engineering	3	1	0	30	20	100	150	4	4
3.	MTBT-103	Enzyme Engineering and Technology	3	1	0	30	20	100	150	4	4
4.	MTBT-104-105	Core Elective I	3	1	0	30	20	100	150	4	4
5	MTBT-106-109	Open Elective I	3	1	0	30	20	100	150	4	4
PRACTICALS											
6.	MTBT-110	Microbial Process Engineering Lab	0	0	4	-	20	30	50	2	4
7	MTBT-111	Molecular Biology Lab	0	0	4	-	20	30	50	2	4
8	MTBT-112	Seminar I	0	0	4	-	20	30	50	2	4
		TOTAL	**15**	**5**	**12**	**150**	**160**	**560**	**900**	**26**	**32**

Second Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
1.	MTBT-201	Bioreactor Engineering	3	1	0	30	20	100	150	4	4
2.	MTBT-202	Immunology and Immunotechnology	3	1	0	30	20	100	150	4	4
3.	MTBT-203	Plant Biotechnology	3	1	0	30	20	100	150	4	4
4.	MTBT-204-205	Core Elective II	3	1	0	30	20	100	150	4	4
5	MTBT-206-209	Open Elective II	3	1	0	30	20	100	150	4	4
PRACTICALS											
6.	MTBT-210	Bioprocess Engineering Lab	0	0	4	-	20	30	50	2	4
7.	MTBT-211	Plant Biotechnology Lab	0	0	4	-	20	30	50	2	4
8	MTBT-212	Seminar II	0	0	4	-	20	30	50	2	4
		TOTAL	**15**	**5**	**12**	**150**	**160**	**560**	**900**	**26**	**32**

Third Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
1	MTBT-301	Project Work Review I	0		8		50	100	150	4	8
2	MTBT-302	Dissertation I	0	0	16	-	200	300	500	12	16
		TOTAL	**6**	**2**	**24**	**60**	**250**	**400**	**650**	**16**	**24**

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
PRACTICALS											
1.	MTBT-401	Project Work Review II	0		8		50	100	150	4	8
2.	MTBT-402	Dissertation II	0	0	16	-	200	300	500	12	16
		TOTAL	**0**	**0**	**24**	**00**	**250**	**400**	**650**	**16**	**24**

Program Core

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J	CA	MTE	ETE				
THEORY													
1.	MTBT-101	Microbial Process Engineering	3	1	0	0	30	20	100	150	4	4	
2.	MTBT-102	Molecular Biology and Genetic Engineering	3	1	0	0	30	20	100	150	4	4	
3.	MTBT-103	Enzyme Engineering and Technology	3	1	0	0	30	20	100	150	4	4	
4.	MTBT-201	Bioreactor Engineering	3	1	0	0	30	20	100	150	4	4	
5.	MTBT-202	Immunology and Immunotechnology	3	1	0	0	30	20	100	150	4	4	
6.	MTBT-203	Plant Biotechnology	3	1	0	0	30	20	100	150	4	4	
PRACTICALS													
8.	MTBT-110	Microbial Process Engineering Lab	0	0	4	0	-	20	30	50	2	4	
9.	MTBT-111	Molecular Biology Lab	0	0	4	0	-	20	30	50	2	4	
10.	MTBT-210	Bioprocess Engineering Lab	0	0	4	0	-	20	30	50	2	4	
11.	MTBT-211	Plant Biotechnology Lab	0	0	4	0	-	20	30	50	2	4	
Total			21	7	16	0	210	220	820	1250	32	40	

Core Elective I

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective I													
THEORY													
1.	MTBT-104	Basic Engineering Mathematics and Statistics	3	1	0	0	30	20	100	150	4	4	
2.	MTBT-105	Biochemistry and Metabolic Regulation	3	1	0	0	30	20	100	150	4	4	

Core Elective II

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective II													
THEORY													
1.	MTBT-204	Downstream processing	3	1	0	0	30	20	100	150	4	4	
2.	MTBT-205	Biochemical Reaction Engineering	3	1	0	0	30	20	100	150	4	4	

Open Elective I

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective III													
THEORY													
1.	MTBT-106	Process Engineering Principles	3	1	0	0	30	20	100	150	4	4	
2.	MTBT-107	Industrial biotechnology	3	1	0	0	30	20	100	150	4	4	
3.	MTBT-108	Environmental Biotechnology	3	1	0	0	30	20	100	150	4	4	
4.	MTBT-109	Animal Biotechnology	3	1	0	0	30	20	100	150	4	4	

Open Elective II

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective III													
THEORY													
1.	MTBT-206	Tissue Engineering and Stem Cell Technology	3	1	0	0	30	20	100	150	4	4	
2.	MTBT-207	Research methodology and communication skills	3	1	0	0	30	20	100	150	4	4	
3.	MTBT-208	Bioethics, Bio safety and Regulatory affairs	3	1	0	0	30	20	100	150	4	4	
4.	MTBT-209	Bioinformatics and Systems Biology	3	1	0	0	30	20	100	150	4	4	

Projects

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
PRACTICALS													
1.	MTBT-301	Dissertation-1	0	0	16	0	-	200	300	500	12	16	
2.	MTBT- 401	Dissertation-II	0	0	24	0	-	200	300	500	12	16	
TOTAL			**0**	**0**	**40**	**0**	-	**400**	**900**	**1300**	**24**	**40**	

(Chairperson)

Signature: .....

Name : Prof (Dr.) Ajay Kumar

Date :

Internal Members

Signature:	1.....	2.....
Name:	Dr. Vivek Srivastava	Dr. Anand Kumar
Date:		

External Members

Signature:	1.....	2.....
Name:	Prof. (Dr.) Nand Lal	Prof.(Dr.)Vinay Dwivedi
Date:		

Encl.: Recommended Curricula attached for consideration and approval.

CC:

1. Dean
2. Registrar Office

Rama University Uttar Pradesh, Kanpur
Faculty of Engineering and Technology
Department of Biotechnology

COURSE STRUCTURE

M. Tech.

BIOTECHNOLOGY

Under

Choice Based Credit System (CBCS)

2020-21

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-101 MICROBIAL PROCESS ENGINEERING

Objective:

This course will give the knowledge of different types of bioreactor and its functional pathways. The enzymatic reactions and immobilization kinetics. The subject deals with microbial reaction kinetics and inhibition kinetics. This allows students to quantitatively estimate the biomass growth and product formation rate and help in designing bioreactor and the process in general.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**MATERIAL BALANCES:** Introduction to engineering Calculations, Thermodynamics preliminaries, Law of conservation of mass, Procedure for Material Balance calculations, Material Balance worked examples, Material Balances with Recycle, Bypass and Purge streams, Stoichiometry of cell growth and product formation.	8
II	**ENERGY BALANCES:** Basic Energy concepts, General Energy Balance Equations, Enthalpy change in Non reactive processes, procedure for Energy Balance calculations without reaction. Energy Balance worked Examples without reaction, Enthalpy change due to reaction, Heat of reaction for process with biomass production,	8
III	**MEDIA OPTIMIZATION AND STERILIZATION** **Media Optimization:** Optimization techniques with special emphasis on statistical techniques, Placket-Burman design, ANOVA, central composite design, response surface methodology. **Sterlization:** Media sterilization, Kinetics of thermal death of cells, design of batch and continuous thermal sterilization, sterilization of air and filter design, Radiation and Chemical sterilization.	8

IV	**UNSTRUCTED MODEL FOR MICROBIAL GROWTH:** The development of different microbial growth kinetics like Monod. The limitation of Monod model and development of other constitutive models of growth. Multi-substrate models, inhibition models for substrate, Product and toxic substances. Development of logistic equation. Maintenance and endogenous metabolism kinetics.	8
V	**STRUCTURED MODELS OF MICROBIAL GROWTH:** Kinetics based on molecular mechanism, Compartmental models, Models of product formation, single cell model, Plasmid Expression and Replication, Model of plasmid stability, parameter estimation, Model validation and bioprocess optimization.	8

Reference Books/ Text Book / Cases:

1. Biochemical Engineering Principles and functions by Syed Tmveer Ahmed Inamdar, PHI Learning Private limited.
2. Wiseman, A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication (1999)
3. Moser, A; Bioprocess technology, kinetics and reactors; Springer Verlag, (1988)
4. Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling and control; Springer – verlog, berlin (2000)
5. Introduction to Biochemical Engineering by D G Rao. Tata, McGraw Hill, New Delhi.
6. Bailey JE, Ollis DF; Biochemical Engineering fundamentals (1986)

Outcome:

CO1. At the end of this unit students understand thermodynamic principles, Material balance and stoichiometry.

CO2. At the end of this unit students will get the knowledge about energy balances calculations, heat reactions.

CO3. At the end of this unit students will expertise in Sterilization process, kinetics and media optimization techniques.

CO4. At the end of this unit students learn microbial growth for unstructured models and its kinetics.

CO5: At the end of this unit students will learn about structured models of microbial growth.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	H	L	L	L	M	L
CO2	H	M	L	H	L	L	M	L
CO3	H	L	H	L	L	H	M	M
CO4	L	M	H	L	L	L	L	H
CO5	L	M	H	L	L	L	L	H

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur
Faculty of Engineering and Technology
Department of Biotechnology

MTBT-102 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Objective:

The main objective of the course is to create awareness of the basic concepts of molecular biology and regulation of gene expression. It also gives an insight of principles and procedures involved in genetic engineering and gene manipulations, expression of cloned gene and applications of r-DNA technology.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**MOLECULAR BIOLOGY FUNDAMENTALS:** DNA replication and Regulation, Repair mechanisms, Gene expression, Regulation of gene expression in prokaryotes (Lac. Ara and His operons), Transcription and Translation. RNA: Different classes of RNA and their functions. RNA synthesis and other post transcriptional modifications.	8
II	**REGULATION OF GENE EXPRESSION AND TRANSPOSONS:** Transcriptional controls in Eukaryotes (Complexity of genome organization, Regulatory elements, Motifs of protein secondary structure); Protein synthesis and post-translational modifications.	8
III	**INTRODUCTION TO GENETIC ENGINEERING: Molecular Tools in Genetic Engineering** - Restriction enzymes and DNA Modifying enzymes. Restriction mapping of DNA fragments and Map construction, Nucleic acid Amplification (PCR analysis) and its applications.	8
IV	**GENE CLONING AND EXPRESSION:** Gene Cloning vectors, Gene Cloning strategies, Transformation and selection of recombinants; Construction of DNA libraries (Genomic library and cDNA library) preparations and their screening;	8
V	**TRANSGENICS, ANTISENSE AND RIBOZYMES AND PROTEIN ENGINEERING: TRANSGENIC TECHNOLOGY**: Gene tagging (T-DNA	8

	tagging and Transposon tagging). Transgenic and Gene Knockouts and Gene knock down Technologies - Targeted gene replacement, Chromosome engineering, Gene Therapy, Strategies of gene delivery, gene correction, gene editing.	

Reference Books/ Text Book / Cases:

1. "Molecular Biology of the gene" by Waston et al 4th edition.
2. "Genes VII" by Benjamin Lewis
3. Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press, 2005.
4. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
5. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
6. Principles of Gene manipulation, Introduction to Genetic Engineering : R W Old, S B Primrose

Outcome:

CO1: The goal of the instructor in this course is to introduce the students to the concept of molecular biology viz. regulation of gene expression, posttranscriptional, post translational modifications.

CO2: Acquire sufficient knowledge of molecular tools and techniques in genetic engineering.

CO3: Impart students an understanding of various gene cloning vectors and gene cloning strategies.

CO4: Acquire advanced level knowledge of techniques involved in gene expression and protein engineering.

CO5: Students will learn about the basic concepts of transgenesis.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	L	L	L	L	M	L
CO2	H	L	M	H	L	L	M	L
CO3	H	M	L	M	L	H	L	M
CO4	H	L	H	L	L	H	M	L

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-103 ENZYME ENGINEERING AND TECHNOLOGY

Objective:

This course will give the knowledge of different types of enzymatic reaction and its functional pathways. The kinetics of reaction in free and immobilization form. The inhibition kinetics by the substrates or toxic substances. This is an essential subject that allows students to quantitatively estimate the enzymatic conversion rate, estimation of model constants and helps in designing bioreactor based on enzymatic catalyst

Credits: 04 **L-T-P: 3-1-0**

Module No.	Contents	Teaching Hours
I	**INTRODUCTION TO ENZYMES:** Introduction, Nomenclature and Classification of enzymes. Applications in Industrial, Medical, Analytical, Chemical, Pharmaceutical and Food Sectors. Enzyme isolation and purification.	8
II	**ENZYME KINETICS:** Kinetics of single-substrate reactions, Michaelis - Menten equations, Brigg's Haldane equation & estimation of constants using graphical techniques, Turnover number (k_{cat}), Kinetics for reversible reactions.	8
III	**PRE-STEADY–STATE AND MULTI-SUBSTRATE ENZYME KINETICS:** **Pre-Steady–State Kinetics**: Determination of rate constants: Rapid mixing, Stopped flow and Relaxation techniques, Determination of the number of active sites of enzyme. **KINETICS OF MULTI-SUBSTRATE REACTIONS:** Mechanism for two substrates reactions, compulsory order, random order reactions and Ping-Pong mechanism.	8
IV	**FACTORS AFFECTING ENZYME ACTIVITY & ACTIVE SITE STUDIES:** Factors affecting enzyme activity: Temperature and pH effects, thermal deactivation of enzymes. pH dependence: Ionization of Acids and Bases. **Active site studies:** The identification of binding sites and catalytic sites, Trapping	8

	the enzyme substrate complex.	
v	**ENZYME IMMOBILIZATION & KINETICS OF IMMOBILIZATION:** Enzyme immobilization & kinetics of immobilization: Immobilization of Biocatalysts an Introduction, Electrostatic effect, Effect of charged and uncharged support, Effect of external and internal mass transfer, Effect of Intra-particle diffusion with uncharged supports.	8

Reference Books/ Text Book / Cases:

1. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker 1987.
2. Enzymes ,Biochemistry , Biotechnology Clinical Chemistry : Trevor Palmer.2001

Outcome:

CO1: This unit helps to understand the commercial enzymes applications, enzymes catalyzed reactions.

CO2: At the end of this unit students understand the specificity, kinetics of industrially important enzymes.

CO3: At the end of this unit students understand substrate enzyme intereactions, steady state and multi substrate enzyme kinetics.

CO4: At the end of this unit students learn enzyme activity effects by different factors and active site analysis.At the end of this unit students learn immobilization kinetics.

CO5: At the end of the this course students will learn about enzyme immobilization.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	L	M	L	L	M	H
CO2	H	L	M	H	L	L	H	L
CO3	H	M	H	L	L	H	L	L
CO4	H	H	H	L	L	H	H	H

H = Highly Related; M = Medium; L = Low

MTBT- 104 BASIC ENGINEERING MATHEMATICS AND STATISTICS

Objective:

The course intends to provide the knowledge of differential and integral calculus, matrices, statistics and concept of random variables

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**DIFFERENTIAL CALCULUS**: Functions, limits, continuity and differentiation. Differentiation of sum, product and quotient of function. Differentiation of implicit, trigonometric, inverse trigonometric functions; Partial differentiation; Euler's theorem on homogenous function; Maxima and minima (Basics).	8
II	**INTEGRAL CALCULUS**: Basics, Methods of substitution integration by parts. Integration of national, irrational, trigonometric functions, Definite integrals (Basics); Trapezoidal rule. Simpsons 1/3 rule; Ordinary differential equations of First order. Formation and method of variable separable, simple applications.	8
III	**MATRICES**: Basics, addition, subtraction, multiplication and Determinants (Basic concept) of Matrices. Adjoint, inverse of a matrix, Rank of matrix (Basics); solution of linear system of equations: elementary operations, Gauss-Jordan method – Matrix inversion method.	8
IV	**INTRODUCTION TO STATISTICS**: population-sample –primary data and secondary data - graphical and diagrammatic representation of data. Measure of central tendency:- Mean, median and mode. Measure of dispersion:-range-standard deviation-raw and skewness and kurtosis(definition only)-Concept of probability – classical and relative frequency definition of probability-addition and multiplication laws of probability (without proofs) and examples.	8

v	**CONCEPT OF RANDOM VARIABLES**: Probability mass function-probability density function-probability distribution function (definitions only) - Binomial, Poisson and Normal distribution (definitions and statements of properties and examples). Principles of least square-fitting of straight line –Pearson's coefficient of correlation and concept of linear regression.	8

Reference Books/ Text Book / Cases:

1. Statistical methods S.P.Gupta. S Chand Publications
2. Business Statistics by S.P Gupta & M.P.Gupta
3. Engineering Mathematics - N.P. Bali and others.
4. Engineering mathematics - B.V. Ramana

Outcome:

CO1: At the end of the course students will have a good knowledge of the Functions, limits, continuity and differentiation

CO2: At the end of the course students will have a good knowledge of integral calculus

CO3: At the end of the course students will have a good knowledge of matrices

CO4: At the end of the course students will have a good understanding of the various concepts of statistics

CO5: At the end of the course students will have a good understanding of the various concept of random variables.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	M	L	M	L	L	M	H
CO2	H	L	M	H	L	L	H	M
CO3	L	M	H	M	L	H	M	L
CO4	H	L	H	L	L	H	H	H
CO5	L	M	L	H	H	L	M	L

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-105 BIOCHEMISTRY AND METABOLIC REGULATION

Objective:

The course provides insights about Basic knowledge of Bio molecules, their metabolism and cell signalling

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**FUNDAMENTALS OF BIOCHEMISTRY AND BIOENERGETICS: Fundamentals:** Water, pH, pK, buffers, covalent bond, non-covalent interactions.	8
II	**BIOMOLECULES:** Classification, physical and chemical properties of carbohydrates, lipids, amino acids and proteins; protein structural hierarchy, Ramachandran plot; nucleotides and nucleic acids.	8
III	**METABOLISM: Catabolism of biomolecules:** Carbohydrate metabolism - (GLYCOLYSIS, TCA cycle, Pentose phosphate pathway, **Anabolism of biomolecules:** Gluconeogenesis, Biosynthesis of lipids, Biosynthesis of amino acids – Glutamate, Tyrosine, Proline.	8
IV	**MEMBRANE TRANSPORT AND SIGNAL TRANSDUCTION: Plasma Membrane:** Structure of plasma membranes. Transportation of molecules across plasma membrane. **Signal Transduction:** Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.	8
v	**STRATEGIES FOR METABOLIC CONTROL: Metabolic control:** Need for control, control of enzyme activities, allosteric control and control by phosphorylation. Hormonal control of metabolism.	8

Reference Books/ Text Book / Cases:

1. Lehninger, A. L. (1982). Principles of biochemistry (4th ed.). New York, NY: Worth.
2. Voet, D., & Voet, J. G. (2004). Biochemistry (4th ed.). Hoboken, NJ: J. Wiley & Sons. Biochemistry and Molecular Biology, Third Edition by William H. Elliott and Daphne C. Elliott, Oxford University press.
3. Stryer, L. (1988). Biochemistry. New York: Freeman.

Outcome:

At the end of the course the student understands

CO1: Fundamentals of Biochemistry and Bioenergetics
CO2: Fundamentals of Bio molecules
CO3: Metabolism of Bio molecules
CO4: Membrane Transport And Signal Transduction
CO5: Strategies for Metabolic Control

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	L	M	H	L	M	H
CO2	H	L	M	H	L	H	H	M
CO3	M	H	H	M	H	H	M	L
CO4	H	L	H	L	L	H	H	H
CO5	L	H	M	L	H	L	L	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-106 PROCESS ENGINEERING PRINCIPLES

Objective:

This course enables students to understand the concept of fluids, flow properties, heat, heat flow mechanism, mass, mass flow mechanism and their equipment design.

Credits:04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**PROCESS CALCULATIONS:** Overview of Chemical Engineering, Concepts of Unit operations & Unit processes with examples, Units & Dimensions, Stoichiometric principles, Law of conservation of mass.	8
II	**UNIT OPERATION:** Introduction, Characterization of solid particles, Screen analysis, Size reduction – law of crushing, various types of size reduction equipment.	8
III	**HEAT TRANSFER:** Modes of heat transfer with examples, Conduction – Fourier's law, one dimensional conduction through plane wall, composite wall, cylinder and spherical system.	8
IV	**RADIATION:** Introduction, Black body, Laws of black body radiation; Kirchoff's law, Stefan-Boltzmann law, Wein's displacement law.	8
V	**MASS TRANSFER:** Introduction, Molecular diffusion, Fick's law of diffusion, diffusivities of gases and liquids, Theories of mass transfer, Concept of mass transfer coefficients, extraction, Distillation and Drying.	8

Reference Books/ Text Book / Cases:

1. Unit operations of Chemical Engineering, by W.L. McCabe, J.C. Simth and Harriott, McGraw Hill publishers.
2. Bioprocess Engineering principles By Pauline M Doran, Academic Press.
3. Unit Operations-1, K. A. Gavhane, Nirali Prakashan Publication.

4. Introduction to Biochemical Engineering, Second edition, By D.G. Rao, Tata McGraw Hill Publications.

Outcome:

CO1: At the end of this unit student can able to understand the process calculations & thermodynamics.

CO2: At the end of this unit student can able to understand unit operation & fluid mechanics.

CO3: At the end of this unit student can able to understand about heat transfer by conduction and convection.

CO4: At the end of this unit student can able to understand about heat transfer by radiation and equipments used for heat transfer.

CO5: At the end of this unit student can able to understand about mass transfer operations.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	L	M	H	L	M	H
CO2	H	L	M	H	L	H	H	M
CO3	M	H	H	M	H	H	M	L
CO4	H	L	H	L	L	H	H	H
CO5	L	H	M	H	L	L	H	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-107 INDUSTRIAL BIOTECHNOLOGY

Objective:

The major objective of this course is to familiarize students to microbes & microbial processes, including fermentation and optimization covering all areas of industrial biotechnology.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**INTRODUCTION AND METHODS IN MICROBIOLOGY:** History, Scope & milestones of microbiology, Ultra-structural organization of prokaryotic and eukaryotic cells.	8
II	**MICROBIAL GROWTH AND FORMULATION OF MICROBIOLOGICAL MEDIA: Microbial growth:** Microbial growth curve - mathematical expression of growth, classification of microbes based on physical factors (pH, temperature, O_2 requirement).	8
III	**FERMENTATIONS: Overview of Industrial fermentation processes and products:** Antibiotics - Penicillin, Streptomycin; Organic acids – Citric acid , Lactic acid; Industrial enzymes – Amylases, Proteases, Cellulases; Alcoholic beverages – Ethanol, Beer, Wine.	8
IV	**PRODUCTION OF r-DNA BASED PRODUCTS:** Special procedures for production of r-DNA based products – Monoclonal antibodies (mAb's) and Bio-therapeutics Eg.: Insulin , vaccines. Applications of Bioconversions in r-DNA products.	8
V	**FOOD & ALLIED PRODUCTS:** Food industry: Bakers' yeast and bread making, rennet and other proteolytic enzymes in cheese making, production of different cheeses; other products from diary industry. Single cell protein, Bio fertilizers, Bio Fuels, Biopesticides: Methane generation, biological production of hydrogen.	8

Reference Books/ Text Book / Cases:

1. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984).
2. Industrial Microbilogy by A.H. Patel, Macmillan India Ltd.
3. Industrial Biotechnology by S.N. Jogdand, First edition, Himalaya Publishing House, (2006).

Outcome:

CO1: At the end of this unit student can able to understand about introduction to prokaryotic and eukaryotic cells. And also about different microbiological staining techniques.

CO2: At the end of this unit student can able to understand microbial growth and formulation of microbiological media.

CO3: At the end of this unit student can able to understand overview of Industrial fermentation processes and products.

CO4: At the end of this unit student can able to understand r-DNA based products production process.

CO5: At the end of this unit student can able to understand food & allied products production process.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	M	L	M	L	L	M	H
CO2	M	L	L	H	H	L	M	M
CO3	L	M	M	L	L	H	M	L
CO4	H	L	H	L	L	H	L	H
CO5	L	M	H	M	M	L	H	H

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-108 ENVIRONMENTAL BIOTECHNOLOGY

Objective:

The main objective of this course is to impart students an understanding of pollution of environment by air, water and soil responsible for degradation of natural resources and degradation of biodiversity. It also familiarizes them with various remediation techniques, non polluting technologies viz bioenergy and biomining.

Credits: 04

L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**INTRODUCTION TO AIR POLLUTION:** Introduction to Environmental pollution, Air, water and soil pollution-common effects and control measures and monitoring of pollutants.	8
II	**WASTE WATER TREATMENT:** WATER: Water Pollution and treatment technologies (clean technology). Waste water types, major contaminants in waste water. Physical, chemical and biological methods of waste water treatment.	8
III	**WASTE MANAGEMENT:** Management of Contaminated land, lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting	8
IV	**BIOREMEDIATION:** Bioremediation Technologies: Definition, constraints and priorities of bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons and lignocellulosic Compounds.	8
v	**BIOENERGY & BIOMINING:** BIO ENERGY: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass.	8

Reference Books/ Text Book / Cases:

1. Wastewater Engineering - Treatment, Disposal, and Resuse, Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.

2. Industrial Pollution Control Engineering- AVN Swamy., Galgotia Publication, (2006).

Outcome:

CO1: At the end of the unit students to learn the various types of environmental pollutions like air, water and soil pollution, their common effects and control technologies.

CO2: At the end of the unit students to learn definition, types of waste water, composition of waste water and types of waste water treatments (aerobic, Facultative and aenrobic).

CO3: At the end of the unit students will understand the Techniques used to improve the soil (phytoremedation and vermicomposting).

CO4: At the end of the unit student will understand the bioremediation, types and factors influences the bioremediation, application of bioremediation in degradation of pollutants.

CO5: The energy obtained from industrial waste and biomass followed by role of microorganisms in mining industry and production of electricity from microorganism.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	M	H	M	H	L	M	H
CO2	H	L	M	H	L	H	H	M
CO3	L	H	H	M	H	H	M	L
CO4	H	M	H	L	L	H	M	H
CO5	L	L	H	M	M	L	H	L

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur
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Department of Biotechnology

MTBT-109 ANIMAL BIOTECHNOLOGY

Objective:

This course aims to impart in students an understanding of the cell culture and methods that convert them to long term established cultures. They will be exposed to all factors which could impact cell culture and equipment requirements for propagation. Awareness is generated about recent advances in the area of stem cell technology, organ culture, tissue engineering etc.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**BASICS OF ANIMAL CELL AND ITS CULTURING:** Structure and organization of an animal cell, Types of animal cell culture – cell culture, organ/tissue culture, organotypic culture and histotypic culture, Equipments and materials needed for animal cell culture technology.	8
II	**BASICS OF ANIMAL CELL AND ITS CULTURING:** Structure and organization of an animal cell, Types of animal cell culture – cell culture, organ/tissue culture, organotypic culture and histotypic culture, Equipments and materials needed for animal cell culture technology.	8
III	**BASIC TECHNIQUES OF MAMMALIAN CELL CULTURE *in vitro*:** Primary and established cell lines, Biology and characterization of the cultured cells, measuring parameters of growth. Maintenance of cell culture, Cell separation, Cell transformation, Cell synchronization, Measurement of viability and cytotoxicity, Apoptosis – characteristic features and molecular mechanisms, Measurement of cell death.	8
IV	**ENGINEERING ANIMAL CELLS:** Somatic cell genetics, Cell culture based vaccines, Genetic engineering of mammalian cells in culture, Scaling up of animal cell culture, Stem cell cultures – embryonic and adult stem cells and their applications.	8

v	**APPLICATIONS OF ANIMAL CELL CULTURE:** Three dimensional culture and tissue engineering, Applications of animal cell culture technology (heterologous, Primary culture/CEF culturing, Protein Expression).	8

Reference Books/ Text Book / Cases:

1. Culture of Animal Cells, (3rd Edition), Fl. !an Froshney. Wiley-Liss.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,
3. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd..Oxford.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

Outcome:

1. At the end of this unit student can understand I basics of animal cell and its culturing
2. At the end of this unit student can understand preparation of animal cell culture medium and its components and their significance
3. At the end of this unit student can understand basic techniques of mammalian cell culture
4. At the end of this unit student can understand Engineering animal cells
5. At the end of this unit student can understand applications of animal cell culture

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	L	L	H	M	H	L	M	H
CO2	H	M	M	H	L	H	H	M
CO3	L	H	H	L	H	H	L	M
CO4	H	L	M	L	L	H	L	H
CO5	M	L	H	M	M	L	H	M

H = Highly Related; M = Medium; L = Low

MTBT-110 MICROBIAL PROCESS ENGINEERING LAB

Objectives:

This course is formulated to provide exposure to the students with media optimization techniques and basic concepts of fluid mechanics, Heat transfer techniques.

Credits: 02 **LT-P: 0-0-4**

Sr. No.	Experiments
1	Isolation of pure culture from a mixed sample (a desired product)
2	Production of microbial products.
3	Medium Design – a) PLACKETT – BUKMAN design for media. b) Response surface methodology for media design
4	Reynold's apparatus
5	Bernoulli's Theorem (Verification)
Heat Transfer	
6	Thermal Conductivity of insulating material a. Concentric sphere b. Lagged pipe
8	Heat Transfer coefficient from a vertical tube and free convection
9	Thermal Conductivity Of Metal Rod
10	Dropwise & Filmwise Condensation Apparatus

11	Emissivity Measurement Apparatus
12	Single Effect Evaporator
13	Shell & Tube Heat Exchanger

OUTCOMES:

CO1: At the end of the course the students understand medium design for isolated pure culture for the desired product production

CO2: At the end of the course the students understand basic concepts of fluid mechanics and heat transfer techniques.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	M	H	L	M	H
CO2	M	M	M	H	L	H	H	M

H = Highly Related; M = Medium; L = Low

MTBT-111 MOLECULAR BIOLOGY LAB

COURSE OBJECTIVE: At the end of the course the students understand how to clone a gene of interest

Credits: 02 **LT-P: 0-0-4**

Sr. No.	Experiments
1	Isolation of Chromosomal DNA from E.coli
2	Isolation and analysis of Plasmid DNA
3	Restriction digestion
4	Ligation
5	Preparation of competent cells
6	Transformation & checking for transformants

COURSE OUTCOME:

CO1: At the end of the course the student can perform-Insertion of gene of interest in a vector and validate it

CO2: At the end of the course the student will understand the procedure of Genetic engineering.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	L	H	L	H	L	M	M
CO2	H	M	M	H	L	H	H	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-201 BIOREACTOR ENGINEERING

Objective:

In bioprocessing of raw materials bioreactor remains at the heart of the operation. In this subject students will learn different types of bioreactor and their different modes of operation. The students will come to know the essential parts of bioreactor their importance, control and monitoring of physical, chemical and biological parameters. The design and scaling up of bioprocesses is an essential component of this subject.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**BIOREACTORS:** Different types of bioreactor, different modes of operation. Main components of the bioreactor and their function. Bioreactor design: batch reactor, cell death in batch reactor, chemostat, endogenous metabolism, maintenance, product and substrate inhibition on chemostat, multiple steady state, enzyme catalysis in CSTR, cascade reactor,PFR,Fed batch reactor, Chemostat with cell recycle and feed forward control.	8
II	**MASS TRANSPORT IN BIOREACTORS:** Gas-liquid mass transfer in cellular systems, Basic mass transfer concepts, solubility of gases (O_2, CO_2) in biological media, mass balances for two-phase bioreactor. Bubble column, bubble generation at an orifice,	8
III	**MASS TRANSFER CORRELATIONS IN BIOREACTORS:** Mass transfer in agitated tanks, correlations with K_{La} in Newtonian and non Newtonian liquid, power number. Experimental determination of K_{La}, static method, dynamic method, chemical method and electrochemical method. Power requirement for mixing in aerated and non aerated tanks,	8
IV	**MOMENTUM TRANSPORT IN STIRRED TANK BIOREACTORS:** Agitator Design & Operation-Radial flow impellers, Axial flow impellers, Agitator design for low Viscous and High Viscous fluids. Laminar and turbulent flow in stirred tank	8

	bioreactors, Kolmogorov eddy size, preventing vortex formation, off centre impellers, baffles. Oxygen delivery systems: Sparger design, Effect of impeller speed.	
v	**NON IDEAL REACTORS AND SCALE UP:** Introduction, Non ideal parameters, Residence Time Distribution, E(t) or F(t) and the bioreactor design, Models for Non ideal flow, Application of RTD based models to Non ideal bioreactors.	8

Reference Books/ Text Book / Cases:

1. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987
2. Bioreactors Analysis and Design: Tapobrata Panda, Tata McGraw Hill Year of publication 2011

Outcome:

CO1: In this unit students understand the basic principles of bioreaction kinetics and basic calculations of principal types of homogeneous biochemical reactors: batch, continuous fed batch and continuous stirred tanks.

CO2: This unit helps to understand the mass transfer operations in bioreactors, principles of mass/energy conservation and calculations of mass transfer constants. Understand the kinetics of both free and immobilised biocatalysts impact on bioreactor selection and operation.

CO3: This unit helps to understand the Mass Transfer Correlations in Bioreactors.

CO4: This unit helps to understand the concepts of Momentum Transport in stirred tank Bioreactors and case studies of different bioreactors.

CO5: This unit helps to understand the scale up and scale down studies of bioreactors.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	L	H	M	H	L	M	H
CO2	H	M	M	L	L	H	L	M
CO3	L	H	H	L	H	H	H	M
CO4	M	L	M	L	M	H	M	H
CO5	M	L	H	M	M	L	H	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur
Faculty of Engineering and Technology
Department of Biotechnology

MTBT-202 IMMUNOLOGY AND IMMUNOTECHNOLOGY

Objective:

This course intends to provide the knowledge of innate and acquired immunity, cells and organs of immune system, humoral immunity, cell mediated immunity and the role of autoimmunity in diseases & immunotherapy.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**INTRODUCTION:** Immune system and organs of the immune system: Phylogeny of Immune System - Innate and acquired immunity - Clonal nature of immune response, antigens, immunogens, super antigens. Lymphoid organs: Lymphoid follicle, Thymus, Lymph node, Spleen, MALT, GALT, SALT.	8
II	**HUMORAL IMMUNITY AND APPLICATIONS:** B cell types, B cell receptors and activation, Immunoglobulin diversity, Antibody structure and function, Antigen- antibody interactions (including ADCC), antibodies in diagnosis, Hybridoma technology, B cell memory.	8
III	**T CELLS AND CELL MEDIATED IMMUNITY:** MHC restriction, Antigen presentation, T cell subsets and functions of each, T cell activation and regulation, Cell mediated immune functions- cytotoxicity, interferon; T cell memory - Central and peripheral.	8
IV	**AUTOIMMUNITY AND TRANSPLANTATION IMMUNOLOGY:** Autoimmune disorders: Rheumatoid arthritis, Insulin dependent Diabetes Mellitus Transplantation: Transplantation	8
V	**IMMUNOTHERAPY, VACCINES AND ADJUVANTS:** Immune response to infectious diseases (humoral, cell-mediated, examples), Vaccines – Types , technologies, Adjuvants – Function, mechanism of action, new generation adjuvants, Immunotherapy – antibodies (polyclonal, monoclonal), cytokines, cell therapy, diseases (HIV, HCV).	8

Reference Books/ Text Book / Cases:

1. 1. Kuby Immunology (Kindt, Kuby Immunology) - Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, publisher: W. H. Freeman, 2006
2. Immunology- David Male, Jonathan Brostoff, David Roth, Ivan Roitt, publisher: Mosby, 2006

Outcome:

1. By the end of the course, student will have the in-depth knowledge of innate immunity, nature of antigens and cells and organs of immune system
2. At the end of this course the student will be well equipped with the knowledge of humoral immunity, antigen – antibody interactions and hybridoma technology
3. By the end of this course students will have a thorough understanding of MHC and cell mediated immunity
4. By the end of this course students will have a thorough knowledge of autoimmune disorders and the role of immune system in transplantation
5. At the end of this course the student will have a thorough understanding of the role immune system in infectious diseases and immunotherapy

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	H	M	H	L	M	H
CO2	H	M	M	L	L	H	H	M
CO3	L	M	H	L	H	H	H	M
CO4	M	H	M	H	M	H	H	H
CO5	M	H	H	M	H	L	H	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-203 PLANT BIOTECHNOLOGY

Objective:

The objective of this course is to familiarize students with the concepts of plant tissue culture its various areas and their applications. It also gives them an exposure to genetic transformation methods and application of transgenic crops for yield enhancement and as bioreactors.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**PLANT TISSUE CULTURE & TOTIPOTENCY:** Totipotency, Biotechnological applications of plant tissue culture, Establishment of aseptic cultures, Initiation of callus and suspension cultures, Nutritional components of tissue culture media.	8
II	**TISSUE CULTURE TECHNIQUES-I:** Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis. Anther and Pollen culture, Production of haploids and their application, Storage of plant genetic resources (Cryopreservation), Somaclonal variation, Commercial production of plants – Automation. Selection of callus, cell lines – Utilization of artificial, neural networks.	8
III	**TISSUE CULTURE TECHNIQUES-II:** Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization, Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites,	8
IV	**TRANSGENIC TECHNOLOGY-I:** Genetic Transformation methods for production of transgenic plants (Direct, Indirect), In planta genetic transformation, Direct Gene Transfer (DGT) methods, Agrobacterium mediated genetic transformation (Indirect), Chloroplast transformation and production of transplastomics.	8
v	**TRANSGENIC TECHNOLOGY-II:** Production of genetically modified plants/crops for agronomic traits, transgenic plants for biotic and abiotic stress tolerance, Industrial enzymes, Molecular farming for therapeutic protein	8

	(Plantibodies, Plantigens, Edible Vaccines).	

Reference Books/ Text Book / Cases:

1. "Plant Cell, Tissue, and Organ culture" by J Reinert and Y P S Bajaj.
2. Plant Tissue Culture Theory and Applications Bhojwani SS and Razdan , Elsevier Publication.

Outcome:

1. The goal of the instructor in this course is to introduce the students to the concept of totipotency in plants and its applications in science, agriculture and industry.
2. Acquire sufficient knowledge of role of cell cultures in development of pure breeding lines, germplasm conservation and production of variants.
3. Impart students an understanding of somatic hybridization for production of hybrid plants and advantages of plant cell cultures for production of pharmaceutically important secondary metabolites.
4. Acquire advanced level knowledge of Transformation techniques for transgenic plant production with their advantages and limitations
5. Understand the role of plants as expression systems for production of therapeutic proteins viz. edible vaccines, plantibodies and lysosomal enzymes. The course shall expose students to the challenges encountered in the area of plant biotechnology.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	L	H	M	H	L	M	H
CO2	H	M	L	L	L	H	H	M
CO3	H	M	H	L	L	H	L	M
CO4	M	L	M	L	M	H	H	H
CO5	H	H	H	M	H	L	H	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-204 DOWNSTREAM PROCESSING

Objective:

This course aims to introduce the students to different steps of downstream Processing including cell disruption, separations, extractions, fractionations, & Concentrations.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**SCOPE OF DOWNSTREAM PROCESSING:** Importance of Down Stream Processing (DSP) in Biotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics.	8
II	**SOLID- LIQUID SEPARATION:** Principles of precipitation, precipitation equipment, applications in bio- processing **Filtration:** Principles, filter aids, Types of filtrations,depth filtration, constant volume filtration, constant pressure filtration, specific cake resistance, equivalent cake thickness, filtration equipments viz; plate and frame filter press, vacuum filters, leaf filters.	8
III	**REFOLDING &SEPARATION:;** Extraction process and principles, phase equilibrium and distribution, batch and continuous extraction, co-current and counter current extraction processes, L-L-E equipment. Applications in bio-technology. Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.	8
IV	**PRODUCT CRYSTALLIZATION: Crystallization**: Principles of crystallization, crystallization equipment. Applications in bio-processing.	8
v	**SCALE-UP AND SCALE DOWN OF DOWNSTREAM PROCESSING:** Scale-up of chromatographic processes. Scale-down of filtration and chromatographic process.	8

Reference Books/ Text Book / Cases:

1. Genekopolis, Transport phenomena and Unit Process Third edition.
2. Bailey and Ollis, Biochemical Engineering Principles, Second Edition
3. Blanch, Biochemical Engineering, Second Edition,1996
4. Mc Cabe and Smith, Unit Operations in chemical Engineering Seventh Edition
5. Principles of Fermentation Technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Publications. Second Edition

Outcome:

CO1: At the end of this unit students will be able to know about the fundamentals downstream purification steps, role of bioprocess economics and cell disruption methods.

CO2: At the end of this unit students will be able to know about solid liquid separations techniques

CO3: At the end of this unit students will be able to know about refolding, separation process

CO4: At the end of this unit students will be able to know about evaporation, crystallization, and drying methods.

CO5: At the end of this unit students will be able to know about scale-up and scale down of downstream processing.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	L	H	M	H	L	M	H
CO2	H	M	L	L	L	H	H	M
CO3	L	M	H	M	H	H	H	M
CO4	M	L	M	L	M	H	H	H
CO5	L	H	H	L	H	L	H	M

H = Highly Related; M = Medium; L = Low

MTBT-205 BIOCHEMICAL REACTION ENGINEERING

Objective:

The course focus on the development of familiarity with chemical reaction kinetics, types of reactions, giving basic concepts of reactor design and reactor operations.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**OVERVIEW OF CHEMICAL REACTION ENGINEERING:** Classification of reactions, variables affecting the rate of reaction, concept of order, molecularity of a reaction, definition of reaction rate, Temperature dependent term of rate equation.	8
II	**INTERPRETATION OF BATCH REACTOR DATA:** Introduction, Interpretation of Batch Reactor Data - Constant volume batch reactor, Integral and differential method of analysis of data.	8
III	**INTRODUCTION TO REACTOR DESIGN:** Single ideal reactors – Ideal batch reactor, steady state mixed flow reactor, plug flow reactor.	8
IV	**DESIGN FOR SINGLE AND MULTIPLE REACTIONS:** Size comparisons of single reactors, mixed versus Plug flow reactors, 1st and 2nd order reactions multiple reactor system – Plug flow reactors in series and parallel, equal size mixed reactors in series.	8
v	**NON ISOTHERMAL REACTIONS:** Heat of reaction, equilibrium constants from thermodynamics, equilibrium conversion, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations.	8

Reference Books/ Text Book / Cases:

1. Octave Levenspiel, "Chemical Reaction Engineering" Second Edition, Wiley Publishers.
2. K.A. Gavhane, "Chemical Reaction Engineering-I" Nirali Prakashan Publishers.
3. Introduction to Biochemical Engineering by D G Rao, Tata Mc Graw Hill, New Delhi.

Outcome:

CO1: At the end of this unit students will familiar with types of reactions & chemical reaction kinetics.

CO2: At the end of this unit students attain the knowledge about data analysis part in the Batch reactors.

CO3: At the end of this unit students will familiar with Ideal, mixed flow and plug flow reactor operations.

CO4: At the end of this unit students attain the knowledge about single and multiple reactor design.

CO5: At the end of this unit students will calculate operating parameters (size, flow rates, conversion etc.) for isothermal and non-isothermal operation of non-ideal reactors.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	M	M	H	H	M	H
CO2	H	M	L	L	L	H	H	M
CO3	H	M	H	L	H	H	L	M
CO4	H	L	H	L	M	H	H	H
CO5	H	H	H	L	H	L	L	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

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MTBT-206 TISSUE ENGINEERING & STEM CELL TECHNOLOGY

Objective:

The course covers the principles underlying strategies for employing selected cells, biomaterial scaffolds, soluble regulators or their genes and mechanical loading and culture conditions for the regeneration of tissues and organs *in vitro* and *in vivo*. This also focuses on differentiated cell types and stem cells and contrasted for this application, as are natural and synthetic scaffolds.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**STEM CELLS & TISSUE ENGINEERING:** Introduction to Tissue Engineering, Cell sources and stem cells. Embryonic and adult stem cells, Cell isolation and selection; Tissue preservation.	8
II	**STRUCTURE AND ORGANIZATION OF TISSUES:** Extracellular matrices; Cell-matrix interactions. Cell synthetics surface interactions and the ensuing effects on cell growth, cell adhesion, cell migration, and cell-cell communication.	8
III	**PROPERTIES OF BIOLOGICAL TISSUES:** Cell and Tissue Culture, Cell characterization, cell separations, Mechanical properties of biological tissues. Transport properties of biological tissues.	8
IV	**CELL BIOMATERIAL INTERACTIONS & TRANSPLANTATION:** Cell-Biomaterial Interactions and Host Integration. Biomaterial processing for TE, Scaffolds and Tissue Engineering. Transplantation of engineered cells and tissues, Immunomodulation and Immunoisolation.	8
v	**THE DESIGN OF BIOMIMETIC ENVIRONMENTS:** Introduction, Scale Up/Reactor Design, Artificial skin, Artificial blood vessels, vascular grafts, and cardiac prostheses, Bone repair, Repair of cartilage, tendon and ligaments, Artificial liver, Nerve regeneration.	8

Reference Books/ Text Book / Cases:

1. Bioengineering of the Skin: Methods and Instrumentation, Volume III [Hardcover] enzo Berardesca (Editor), Peter Elsner (Editor), Klaus P. Wihelm (Editor), Howard I. Maibach (Editor).
2. Composite Tissue Transplantation (Tissue Engineering Intelligence Unit-II) [Hardcover] Charles W. Hewitt (Editor), Kirby S. Black (Editor).
3. ""Future Strategies for Tissue and Organ Replacement" edited by Julia M Polak (Imperial College School of Medicine Hammersmith Hospital, UK) Larry L Hence (Imperial College, UK) & P Kemp (Intercytex, Etherley Dene House, UK).
4. Principles of Tissue Engineering by Robert P. Lanza (Editor), Robert Langer (Editor), William L. Chick (Editor).
5. Tissue Engineering Methods and Protocols (Methods in Molecular Medicine, 18) by Jeffrey Robert Morgan (Editor), Martin L. Yarmush (Editor),
6. Tissue Engineering [Hardcover] Bernhard O. Palsson (Author), Sangeeta N. Bhatia (Author).
7. Tissue Engineering (Academic Press Series in Biomedical Engineering) by Clemens van Blitterswijk, Peter Thomsen, Jeffrey Hubbell and Ranieri Cancedda (Apr 8, 2008)
8. Tissue Engineering: Engineering Principles for the Design of Replacement organs and Tissues by W. Mark Saltzman (Jul 15, 2004).
9. Tissue Engineering by John P. Fisher, Antonios G. Mikos and Joseph D. Bronzino (May 30, 2007).

Outcome:

CO1: At the end of this unit students will familiar with basic concepts of Stem cells and Tissue engineering

CO2: At the end of this unit students attain the knowledge about cell-cell communication and structure, organization of tissues.

CO3: At the end of this unit students will familiar with cell, tissue culture and transport phenomena of tissues.

CO4: At the end of this unit students attain the knowledge about scaffolds, cell biomaterial interactions and transplantation.

CO5: At the end of this unit students will understand the design of biomaterials like artificial liver, bone repair etc.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	M	M	H	H	M	H
CO2	L	H	L	L	L	L	H	M
CO3	H	M	H	L	M	H	L	L
CO4	L	H	M	L	M	H	H	H
CO5	H	H	H	L	H	L	L	H

H = Highly Related; M = Medium; L = Low

MTBT-207 RESEARCH METHODOLOGY AND COMMUNICATION SKILLS

Objective:

To use the framework of these methodologies for understanding effective lab practices and scientific communication - To use the framework of these methodologies to understand and appreciate scientific ethics.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	History of Science and Science Methodologies Empirical science; The scientific method; Interrogative perturbation experiments and controls; Deductive and inductive reasoning; Descriptive science; Reductionist vs holistic biology.	8
II	Preparation for Research Choosing a mentor, lab and research question; maintaining a lab notebook with date-wise entry.	8
III	Process of Communication Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding repetitions & breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non-verbal communication Interpreting.	8
IV	Presentation skills - Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point slides with clearly legible fonts without crowding the content; Defending Interrogation; Scientific poster preparation & presentation.	8
v	Scientific Communication Technical Writing Skills - Types of reports; Layout of a formal report; Scientific writing skills - Importance of communicating science; Problems while writing a scientific document; Plagiarism; Scientific publication writing: Elements of a scientific paper including Abstract, Introduction, Materials & Methods, Results.	8

Reference Books/ Text Book / Cases:

1. Valiela, I. (2001). Doing science: Design, analysis, and communication of scientific research. Oxford: Oxford University Press.
2. On being a scientist: A guide to responsible conduct in research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing. American Scientist, 78(Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English effectively. Delhi: Macmillan India. Movie: Naturally Obsessed, The Making of a Scientist.

Outcome:

CO1: By the end of this course student will develop an awareness of methodologies used to do research

CO2: By the end of this course student will develop good understanding of methodology for proper initiation and execution of research

CO3: By the end of this course student will acquire knowledge of effective communication methods

CO4: By the end of this course student will acquire knowledge of proper presentation skills

CO5: By the end of this course student will get good knowledge of scientific communication and technical writing

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	L	M	H	H	M	H
CO2	L	H	L	L	L	L	M	M
CO3	H	M	H	M	M	H	L	L
CO4	M	M	L	L	L	H	H	H
CO5	H	H	H	L	H	L	L	H

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

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MTBT208: BIOETHICS, BIOSAFETY & REGULATAROY AFFAIRS

Objective:

To use the framework of these methodologies for understanding effective lab practices and scientific communication - To use the framework of these methodologies to understand and appreciate scientific ethics.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	**BIOETHICS: PRINCIPLES OF BIOETHICS, ETHICS IN CLINICAL RESEARCH:** History structure regulation impact of Ethics in all aspects of health care, historical cases, negligence, informed consent, mental competence, Bioethics in Microbial (Bioterrorism), Plant (GMO) & Animal (Stem Cells, Cloning, human embryos and IVF), shared responsibilities for decisions and the understanding of the risk.	8
II	**BIOSAFETY CONCEPTS & REGULATIONS:** Definition of Biosafety, Biosafety for human health and environment, Assessment of Biological hazard, Levels of biosafety for microbes, plants & animals, Cartagena protocol, Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products. International dimensions in Biosafety. Biotechnology and food safety. Case study – Bt Cotton, Bt Brinjal.	8
III	**LICENSING GUIDELINES:** Licensing authorities-roles and responsibilities, Data Protection Act & Regulations, Declaration of Helsinki 2000 amendment and financial disclosure; Regulation of drug preparation and packaging, structure regulation impact of ICH GCP recent development with regard to the INDIA;/USA/EU Clinical Trial directive.	8
IV	**QUALITY ASSURANCE GUIDELINES:** Definitions of GCP, auditing, monitoring and inspection; GCP auditing requirements from a regulatory perspective; GCP compliance and audit certificates; GCP audit team structure and SOPs' GCP audit planning; GCP audit conduct; Reporting GCP audit findings; GLP guidelines	8

v	**ICH GUIDELINES:** Latest developments in ICH; Purpose; Implications; Guidance notes; Inspections. INDIAN/USA/EU Ethics approval system: Overview; Recent developments. Confidentiality issues; Medicines for human use (clinical trials) regulations 2003;	8

Reference Books/ Text Book / Cases:

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007.
3. Deborah E. Bouchoux, Intellectual Property for Paralegals – The law of Trademarks, Copyrights,
4. Patents & Trade secrets, 3rd Edition, Cengage learning, 2012
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.

Outcome:

CO1: At the end of this unit students will familiar with basic principles of bioethics in health care sector, pharma and bio industries.

CO2: At the end of this unit students attain the knowledge about Biosafety guidelines and case studies r-DNA based products.

CO3: At the end of this unit students will familiar with licensing guidelines with different government agencies.

CO4: At the end of this unit students attain the knowledge about quality assurance guidelines like SOP, GCP and GLP.

CO5: At the end of this unit students will understand the ICH guidelines related to clinical research.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	H	M	H	H	M	H
CO2	M	H	L	L	L	L	H	M
CO3	H	M	H	M	M	H	L	L
CO4	L	L	L	H	L	H	L	H
CO5	H	H	H	L	H	L	L	H

H = Highly Related; M = Medium; L = Low

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MTBT-209 BIOINFORMATICS AND SYSTEMS BIOLOGY

Objective:

This course is formulated to provide students an in depth knowledge of biological data analysis using compilation methods. It is also useful for investigating molecular biology Problems from computational perspective. To enhance knowledge about protein structural predictions, molecular docking and evolutionary relationships between organisms.

Credits: 04 L-T-P: 3-1-0

Module No.	Contents	Teaching Hours
I	INTRODUCTION TO BIOINFORMATICS & SEQUENCING ALIGNMENT CONCEPTS: Need of Computers in Biotechnology Research; File Transfer Protocol (FTP), Bioinformatics- Introduction, Scope, Applications; Strings, Edit distance, Pair wise Alignment-Local, Global alignment; Gap- Gap penalty; Comparison of Pair wise and Multiple alignment.	8
II	BIOLOGICAL DATABASES AND DATAMINING: Biological Information on the web, Introduction to databases; Classification of Biological databases; Information retrieval from Databases; Sequence database search- FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM; Data Mining and Visualization (RASMOL).	8
III	GENOME MAPPING AND PREDICTION: Genome sequencing; Genome Mapping; Comparative Sequence Analysis; Gene Prediction Methods &Tools, Gene Annotation; Human Genome Mapping (HGP). RNA SEQUENCE	8
IV	PROTEIN STRUCTURE PREDICTION METHODS: Basics of Protein biology (Classification, Structural Organization, Domains & Motifs); Protein Structure Prediction Concepts : Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Abintio method, Threading methods).	8

v	INTRODUCTION TO SYSTEMS AND SYNTHETIC BIOLOGY: Genomics, transcriptomics, proteomics and metabolomics as a foundation for Systems Biology, Objectives of Systems Biology – holistic approach to solve biological problems, Strategies relating to *in silico* modeling of biological processes, Gene, protein and metabolic networks, Signal transduction pathways, Gene expression patterns, Synthetic Biology – Introduction and Artificial synthesis of DNA, peptides and chromosomes – Applications.	8

Reference Books/ Text Book / Cases:

1. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
2. Bioinformatics Basics, Applications in Biological Science and Medicine- Hooman
3. Bioinformatics: Genome and sequence analysis by David W Mount.
4. Bioinformatics: A practical guide to analysis of genes and proteins by Baxevanis, Andreas D Wiley – Interscience publishers.
5. Principles of biological Databases by P. B. Kavi kishor and L.N. Chavali.

Outcome:

CO1: At the end of this course students will understand the specific features of the subject as seen in relation to application across the two disciplines of computational and bioscience and they can learn the computational fundamentals which are useful for bioinformatics programming.

CO2: At the end of this course students will get good knowledge of different Databases, data retrieval process, data mining and important Visualization tools in Proteomics.

CO3: At the end of this course students will understand the evolutionary relationships between species and the sequence alignment tools and process for sequence comparisons to know the relationship between the species

CO4: At the end of this course students will obtain thorough knowledge of sequencing and Mapping of genomes and RNA design and development.

CO5: At the end of this course students will obtain thorough knowledge of System and synthetic Biology.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	H	M	H	H	L	H
CO2	M	H	L	L	H	L	H	M
CO3	H	L	L	H	M	H	L	L
CO4	L	M	H	H	M	H	H	H
CO5	H	H	M	L	M	H	L	H

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-210 BIOPROCESS ENGINEERING LABORATORY

OBJECTIVE:

The objective of this course is to impart hands on training in handling of enzymes and bioreactors.

Credits: 02 **LT-P: 0-0-4**

Sr. No.	Experiments
1	Growth kinetics in Batch culture.
2	Study of Enzyme kinetics of INVERTASE.
3	Determination of Enzyme activity for CELLULASE.
4	Effect of pH on Enzyme kinetics.
5	Enzyme inhibition.
6	Enzyme immobilization by different methods.
7	Sodium sulphite oxidation method for determination of Mass Transfer coefficient.
8	Dynamic gassing method for determination of Mass Transfer coefficient.
9	Ethanol production from ***Saccharomyces cerevesiae.***

10	Pre-treatment technique for ligno – cellulosic biomass for ETHANOL PRODUCTION.

OUTCOME:

CO1: After completion of the laboratory students will be able to study enzyme kinetics, handle bioreactors.

CO2: After completion of this course student will be able to perform optimize the process parameters.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	L	H	H	L	H
CO2	M	H	H	L	H	L	H	M

H = Highly Related; M = Medium; L = Low

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MTBT-212 PLANT BIOTECHNOLOGY LABORATORY

OBJECTIVE:

The objective of this course is to impart hands on training in handling of tissue, organ cultures and genetic transformation techniques in plants.

Credits: 02 **LT-P: 0-0-4**

Sr. No.	Experiments
1	Preparation of medium.
2	Surface sterilization.
3	Organ culture.
4	Cell suspension cultures.
5	Growth and production kinetics for secondary metabolite production and quantification.
6	Genetic transformation studies using *Agrobacterium*.

OUTCOME:

CO1: After completion of the laboratory students able to study about the sterilization of media.

CO2: After completion of the laboratory students able to study about the tissue culture.

Rama University Uttar Pradesh, Kanpur

Faculty of Engineering and Technology

Department of Biotechnology

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	M	H	M	H	H	L	H
CO2	H	M	H	L	H	M	H	M

H = Highly Related; M = Medium; L = Low

Convener

Signature: .....

Name : Dr. Ajay Kumar

Date :

Internal Members

Signature: 1..... 2.....

Name: Dr. Vivek Srivastava Dr. Anand Kumar

Date:

External Members

Signature: 1..... 2.....

Name: Prof. Nand Lal Prof. Vinay Diwedi

Date: