B.S. Abdur Rahman ™
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2022
Curriculum and Syllabi
(Updated upto April 2023, as per 20th Academic Council)

M.Tech. (Biotechnology)

B.S. Abdur Rahman Crescent Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2022

CURRICULUM AND SYLLABI

(Updated upto April 2023, as per 20th Academic Council)

M.TECH.
BIOTECHNOLOGY

VISION AND MISSION OF THE INSTITUTION

VISION

B.S.Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

SCHOOL OF LIFE SCIENCES

VISION AND MISSION

Vision

To attain new heights in biotechnology education and research, shaping life sciences into a premier precision tool for the future for creation of wealth and ensuring social justice-specially for the welfare of the socially weaker group

Mission

- The mission of the school of life sciences is to maximize the benefits of Biotechnology to the Institute, the nation and the globe
- Being an excellent quality, comprehensive, multidisciplinary school that supports, coordinates, disseminates knowledge to the community
- Apply biotechnology in the areas of social welfare and entrepreneurship

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M.TECH BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES:

The course aims to provide an advanced understanding of the core principles and topics of Biotechnology and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a lecture series and a research project. Hence, the main objectives of the program are:

PEO1: Graduates will have advanced knowledge of biological sciences and research aptitude

PEO2: Graduated will have excellent leadership qualities and able to address issues in ethical, innovative and responsive manner

PEO3: Graduates will able to contribute to organizational success and create entrepreneurship initiatives.

PROGRAMME OUTCOMES:

On successful completion of the programme, the graduates will be able to

PO1: Independently carry out research /investigation and development work to solve practical problems

PO2: Write and present a substantial technical report/document

PO3: Demonstrate a degree of mastery over the various branches of biotechnology.

PO4: Identify the societal challenges and provide solutions by innovative research and product development

PO5: Apply modern biotechnological tools to protect environment and to develop products for sustainable agriculture, food and medicine

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS 2022

M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)

ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.

iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare and discipline in the campus.

viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **"Dean of the School"** means the Dean of the School of the department concerned.

x) **"Head of the Department"** means the Head of the Department concerned.

2.0 PROGRAMMES OFFERED AND ADMISSION REQUIREMENTS

2.1 Programmes Offered

The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

2.2 ADMISSION REQUIREMENTS

2.2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 DURATION, ELIGIBILITY AND STRUCTURE OF THE PROGRAMME

3.1. The minimum and maximum period for completion of the programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

3.1.1 Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.

3.1.2 Medium of instruction, examinations and project report shall be in English.

3.2 ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO PROGRAMMES

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	Aeronautical Engineering	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	Civil Engineering	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.
		M. Tech. (Construction Engineering and Project Management)	B.E. / B.Tech. in Civil Engineering / Structural Engineering / B.Arch. or Equivalent degree in relevant field.
3.	Mechanical Engineering	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
		M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
7.	Information Technology	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
8.	Computer Applications	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2level or equivalent degree in relevant field.
9.	Mathematics	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	Physics	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	Chemistry	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
		M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.
13.	Commerce	M.Com	B.Com. / BBA
14.	Arabic and Islamic	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or)

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
	Studies		Any under graduate degree with Part 1 Arabic (or)Any under graduate degree with AalimSanad / Diploma / Certificate in Arabic or Islamic Studies.

3.3. STRUCTURE OF THE PROGRAMME

3.3.1 The PG. programmes consist of the following components as prescribed in the respective curriculum:

i. Core courses
ii. Elective courses
iii. Laboratory integrated theory courses
iv. Project work
v. Laboratory courses
vi. Open elective courses
vii. Seminar
viii. Mini Project
ix. Industry Internship
x. MOOC courses (NPTEL- Swayam, Coursera etc.)
xi. Value added courses

3.3.2 The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

3.3.3 For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

3.3.4 The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Range of credits
M.Tech.	76 - 80
MCA	86
M.Sc.	77 - 85
M.Com.	88
M.A.	72

3.3.5 Credits will be assigned to the courses for all programmes as given below:

❖ One credit for one lecture period per week or 15 periods of

lecture per semester.

- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

3.3.6 The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

3.3.7 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

3.3.8 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

3.3.9 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, aliter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

3.4. ONLINE COURSES

3.4.1 Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the

Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

3.4.2 Students shall undergo project related online course on their own with the mentoring of the project supervisor.

3.5 PROJECT WORK

3.5.1 Project work shall be carried out by the student under the supervision of a faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work and shall re-register in the subsequent semester.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School

of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

5.0 COURSE COMMITTEE

5.1 Each common theory / laboratory course offered to more than one group of students shall have a “Course Committee” comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

6.0 CLASS COMMITTEE

6.1 A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted in every semester:

6.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department
ii) Faculty members of all courses of the semester
iii) All the students of the class
iv) Faculty advisor and class advisor
v) Head of the Department – Ex officio member

6.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages

for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

6.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi of courses.

6.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

7.0 REGISTRATION AND ENROLLMENT

7.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

7.2 Change of a Course

A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.4 A student can enroll for a maximum of 32 credits during a semester including Redo / Predo courses.

8.0 BREAK OF STUDY FROM PROGRAMME

8.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

8.1.1 Medical or other valid grounds

8.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

8.1.3 Debarred due to any act of indiscipline

8.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

8.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

8.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT WORK

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded “I” grade in that course.

10.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

10.3 If a student secures attendance between 65% and less than 75% in any course in a semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the institution approved events, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examination of that course. In all such cases, the students shall submit the required documents immediately after joining the classes to the class advisor, which shall be approved by the Head of the Department / Dean of the School. The Vice Chancellor, based on the recommendation of the Dean (Academic Affairs) may approve the condonation of attendance.

10.4 A student who has obtained an “I” grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall repeat all the courses of the semester in the subsequent academic year. However, he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

10.5 The student awarded “I” grade, shall enroll and repeat the course when it is offered next. In case of “I” grade in an elective course either the same elective course may be repeated or a new elective

course may be taken with the approval of the Head of the Department / Dean of the School.

10.6 A student who is awarded “U” grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to redo the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains “U” grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

10.7 If a student with “U” grade, who prefers to redo any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier “U” grade and continuous assessment marks shall continue.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the department concerned, based on the availability of faculty members, and subject to a specified minimum number of students registering for each of such courses.

11.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is no provision for any substitute examination and withdrawal from a redo course.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightageof Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.4 Laboratory Integrated Theory Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

12.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.6 Industry Internship

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

In the case of project work, a committee of faculty members constituted by the Head of the Department / Dean of the School will carry out three periodic reviews. Based on the project report submitted by the students, an oral examination (viva voce) shall be

conducted as semester end examination by an external examiner approved by the Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. There shall be no arrear or improvement examination for lab components.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 SUPPLEMENTARY EXAMINATION

14.1 Final Year students can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of three courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

15. PASSING, DECLARATION OF RESULTS AND GRADE SHEET

15.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall preferably meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
I	0

"I" denotes inadequate attendance and hence prevented from appearing for semester end examination

"U" denotes unsuccessful performance in the course.

15.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

15.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department/Dean of School and it shall be declared by the Controller of Examinations.

15.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fees to the Controller of Examinations. Subsequently the Head of the Department/ Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as convener, the faculty member of the course and a senior faculty member knowledgeable in that course as members. The committee shall meet within a week to re-evaluate the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

15.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

"I" grade is excluded for calculating GPA.

"U" and**"I"** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks is as follows:

Percentage Equivalent of Marks = CGPA X 10

15.6 After successful completion of the programme, the Degree shall be awarded upon fulfillment of curriculum requirements and classification based on CGPA as follows:

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the minimum prescribed period.
First Class	6.50 and above and completing the programme within a minimum prescribed period plus two semesters.
Second Class	Others

15.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the PG programme within the minimum prescribed period of study (except clause 8.1.1)

15.6.2 Eligibility for First Class

A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 8.1.1)

15.6.3 The students who do not satisfy clause 15.6.1 and clause 15.6.2 shall be classified as second class.

15.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

16.0 DISCIPLINE

16.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

16.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean shall be referred to a Discipline

and Welfare Committee constituted by the Registrar for taking appropriate action.

17.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

17.1 A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the stipulated time.
ii. No disciplinary action is pending against him/her.
iii. Enrolled and completed at least one value added course.
iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

17.2 The award of the degree must have been approved by the Institute.

18.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

M.TECH. BIOTECHNOLOGY

CURRICULUM AND SYLLABI, REGULATIONS 2022

(Choice Based Credit System)

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	FCC	LTE 6101	Applied Biostatistics for Biotechnologists	4	0	0	4
2.	PCC	LTE 6102	Advanced Biochemistry and Metabolic Regulation	3	0	0	3
3.	PCC	LTE 6103	Immunotechnology	3	0	0	3
4.	PCC	LTE 6104	Microbial Biotechnology	3	0	0	3
5.	PCC	LTE 6105	Cell and Molecular Biology	3	0	0	3
6.	PCC	LTE 6106	Laboratory I (Biochemistry/ Immunotechnology/ Microbial Biotechnology)	0	0	4	2
7.	PEC		Professional Elective I	3	0	0	3
8.	CCE	ENE 6181	English for Career Development	1	1	0	2
			Credits				**23**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.		GEE 6201	Research Methodology and IPR	2	0	0	2
2.	PCC	LTE 6201	Genomics and Proteomics	4	0	0	4
3.	PCC	LTE 6202	Bioprocess and Fermentation Technology	3	0	0	3
4.	PCC	LTE 6203	Computational Biology	4	0	0	4
5.	PCC	LTE 6204	Laboratory II (Fermentation Biotechnology/ Genomics and Proteomics/ Computational Biology)	0	0	4	2
6.	PEC		Professional Elective II	3	0	0	3

7.	PEC		Professional Elective III	3	0	0	3
8.	PEC		Professional Elective IV	3	0	0	3
			Credits				**24**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	OEC		Open Elective I	3	0	0	3
2.	PCC	LTE 7101	Plant and Animal Biotechnology	3	0	0	3
3.	PCC	LTE 7102	Laboratory III (Plant and Animal Biotechnology Lab)	0	0	4	2
4.	PEC		Professional Elective V	3	0	0	3
5.	PCC	LTE 7103	Industry Internship	0	0	2	2
6.			Project Work Phase I	0	0	18	6**
7.			MOOC course (related to project)	0	0	0	0
			Credits				**13**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.		LTE 7201	Project Work Phase II	0	0	36	18**
			Total Credits				**6 + 18= 24**

Overall Total Credits – 84

\# Industrial training will be undertaken during first year summer vacation for 30 days. The credit will be awarded in the 3rd Semester.

** Credits for project work phase I in III semester to be accounted along with project work phase II in IV semester

Note:

- Enrollment in at least one value added course is mandatory.
- The students shall pursue a MOOC course related to project in the third semester and the progress in this regard, shall be monitored during Project Phase – I reviews.
- The students shall be motivated to pursue the courses in the curriculum [upto 40% of credits in a semester (except project semester)] through NPTEL under SWAYAM.

LIST OF PROFESSIONAL ELECTIVE COURSES

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
			SEMESTER I				
1.	PEC	LTEY 021	Genetic Engineering	3	0	0	3
2.	PEC	LTEY 022	Structural Biology	3	0	0	3
3.	PEC	LTEY 023	Biocatalysis and Enzyme Reaction	3	0	0	3
4.	PEC	LTEY 024	Biomedical Instrumentation Technology	3	0	0	3
5.	PEC	LTEY 025	Aromatic and Medicinal Plants	3	0	0	3
6.	PEC	LTEY 091	Functional Foods and Nutraceuticals	3	0	0	3
			SEMESTER II				
1.	PEC	LTEY 086	Food Processing Technology	3	0	0	3
2.	PEC	LTEY 028	Industrial and Pharmaceutical Biotechnology	3	0	0	3
3.	PEC	LTEY 029	Environmental Biotechnology	3	0	0	3
4.	PEC	LTEY 030	Molecular Diagnostics	3	0	0	3
5.	PEC	LTEY 096	Dairy Technology	3	0	0	3
6.	PEC	LTEY 032	Tissue Engineering and Regenerative Medicine	3	0	0	3
			SEMESTER III				
1.	PEC	LTEY 033	Computational and Structural Biology	3	0	0	3
2.	PEC	LTEY 034	Regulatory Affairs for Biotechnology	3	0	0	3
3.	PEC	LTEY 035	Biosensors and Biochips	3	0	0	3
4.	PEC	LTEY 036	Ethical Issues in Biotechnology and Engineering	3	0	0	3
5.	PEC	LTEY 037	Bioreactor Design and Analysis	3	0	0	3
6.	PEC	LTEY 038	Nano biotechnology	3	0	0	3

LIST OF OPEN ELECTIVE COURSES – III SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	Offering Department / School
1.	OEEY 701	Analytical Techniques	3	0	0	3	Chemistry
2.	OEEY 702	Artificial Intelligence and IoT	3	0	0	3	CSE
3.	OEEY 703	Biomaterials	3	0	0	3	Physics
4.	OEEY 704	Biomedical Instrumentation	3	0	0	3	Physics
5.	OEEY 705	Biophotonics	3	0	0	3	Physics
6.	OEEY 706	Data Science and Machine Learning	3	0	0	3	IT
7.	OEEY 707	Electric Vehicle and Battery Storage Technology	3	0	0	3	EEE
8.	OEEY 708	Green Building and Energy Management	3	0	0	3	Civil Engineering
9.	OEEY 709	Industry 4.0 and Applications	3	0	0	3	ECE
10.	OEEY 710	Nanotechnology and Catalysis	3	0	0	3	Chemistry
11.	OEEY 711	Project Management	3	0	0	3	Mechanical
12.	OEEY 712	Real Time Embedded Systems	3	0	0	3	ECE
13.	OEEY 713	Robotic Technology	3	0	0	3	Mechanical
14.	OEEY 714	Soft Computing Techniques	3	0	0	3	EEE
15.	OEEY 715	Structural Interpretation of Materials	3	0	0	3	Chemistry

LTE 6101	APPLIED BIOSTATISTICS FOR BIOTECHNOLOGISTS	L	T	P	C
SDG: 4		4	0	0	4

COURSE OBJECTIVES:

COB1: Students will be able to make informed decisions based on data

COB2: Students will be able to correctly apply a variety of statistical procedures and tests

COB3: Students will know the uses, capabilities and limitations of various statistical procedures

COB4: Students will be able to interpret the results of statistical procedures and tests.

COB5: To learn about analysing the survey results

MODULE I CONCEPTS IN STATISTICS 12

Population and sample, qualitative and quantitative data, nominal, ordinal, ratio, interval data; cross sectional and time series data; discrete and continuous data. Descriptive statistics and Random variables; Measures of central tendency: mean, median, mode; the uses of measure of central tendency, Measures of spread: range, percentile, standard deviation, some properties of variance and standard deviation, the coefficient of variation, group data.

MODULE II INFERENTIAL STATISTICS 12

Displaying data: frequency table, line graph, bar chart, histograms, stem and leaf plots, dot plot, scatter plot, box plots, frequency distributions; definition of probability, rules for calculating probability, definition from epidemiology, Bayes'theorem, probability in sampling, Bernoulli, Binomial, Poisson; Geometric distributions; Continuous random variables: Normal; Exponential distributions; Standard normal distribution. Counting and Probability, Permutations; Combinations.

MODULE III INTERVAL ESTIMATION 12

Prediction, confidence and tolerance Intervals, distribution free interval, confidence interval based on normal distribution, confidence interval and samplesize, Point and interval estimates; the relation between population and sample, Random-Number tables, randomized clinical trials, estimation of the Mean of Distribution, estimation of -variance of distribution, binominal distribution and poisson distribution.

MODULE IV HYPOTHSIS TESTING 12

Hypothesis testing: null and alternative hypotheses, decision criteria, critical values, type I and type II errors, Meaning of statistical significance; Power of a test; One sample hypothesis testing: Normally distributed data: z, t and chisquare tests; Binomial proportion testing, nonparametric hypothesis testing, Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sumtest; Kruskal-Wallis test;

MODULE V CURVE FITTING AND ANOVA 12

Regression and correlation: simple linear regression; Least squares method; Analysis of enzyme kinetic data; Michaelis-Menten; Lineweaver-Burk and the direct linear plot; Logistic Regression; Polynomial curve fitting. Analysis of variance: One-way ANOVA, two-way ANOVA. Fixed effect model, Random effect model, the intra class correlation coefficient.

L – 60; TOTAL HOURS – 60

TEXT BOOKS:

1. Gupta.S.C. Fundamentals of Applied Statistic, Sultan Chand &Sons ,New Delhi 2014.
2. Norman T J Bailey, ‖Statistical Methods in Biology — (3rd Edition), Cambridge University Press 1995
3. Gerald van Belle, L.D. Fisher, P.J. Heagerty, and T. Lumney, —Introduction to Biostatistics‖ Second Edition, John Wiley & Sons, New Jersey 2004
4. Wong Limsoon, ‖Essence of biostatistics ‖, NUS Lecture Notes Series 2003.

COURSE OUTCOMES:

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

CO1: Apply the concept of statistics to analyze the various types of data.

CO2: Estimate about population and draw the conclusion based on the sample data.

CO3: Determine the possible interval of values for an unknown population parameter

CO4: Evaluate the hypotheses about relationships between factors and to draw conclusions from collected data.

CO5: Apply the knowledge of curve fitting and ANOVA to determine the relationship and difference among different variables

Board of Studies (BoS) :	**Academic Council:**
9th BoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 4: Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Statement: Learning of various mathematical tools like Matrices, Calculus and Numerical methods will lead to knowledge of applications in biological fields

LTE 6102	ADVANCED BIOCHEMISTRY AND METABOLIC REGULATION	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: The diversity of metabolic processes occurring in biological system.

COB2: The effect of the structural and functional role of the enzymes governing the metabolic processes.

COB3: Importance of the metabolic pathways in maintaining homeostasis in biological system

COB4: The clinical implications of the metabolic pathway.

COB5: To provide the knowledge on regulatory mechanisms metabolic pathways

MODULE I BIOENERGTICS AND METABOLISM 9

Bioenergetics and Thermodynamics, Thermodynamics –First law of thermodynamics, second law of thermodynamics, Gibbs free energy, endergonic & exergonic reactions. Standard state free energy changes Chemical Logic and Common Biochemical Reactions, Phosphoryl Group Transfers and ATP, Biological Oxidation-Reduction Reactions. Introduction to metabolism: Anabolism, catabolism, metabolic pathways. Characteristics of metabolic pathways.

MODULE II CARBOHYDRATE METABOSLIM 9

Glycolysis: glycolytic pathway. Molecular mechanism of action of the glycolytic enzymes. Energetic of glycolysis. Glycolysis and cancer biology—Warburg Hypothesis and PET scanning. Fates of Pyruvate under anaerobic conditions: alcohol and lactic acid fermentation. Importance of lactic acid fermentation. Regulation of Glycolysis in Liver and Muscle.

MODULE III TCA CYCLE AND OXIDATIVE PHOSPHORYLATION 11

TCA Cycle: Formation of Acetyl CoA and reactions of citric acid cycle. Molecular mechanism of pyruvate dehydrogenase complex and enzymes involved in Kreb's cycle. Energetic of TCA cycle and substrate level phosphorylation. Regulation of Krebs cycle

Passage of electrons from complex I to IV. Mitchell's chemiosmotic hypothesis and proton gradient. Structure of complex V or ATP synthase, Catalytic sites of ATP synthesis. Mechanism of ATP generation by Boyer's binding change mechanism—rotational catalysis. Energetic of ATP synthesis and efficiency of ATP synthase.

MODULE IV LIPID METABOLSIM 9

Lipid Metabolism Introduction. Hydrolysis of Triacylglycerols, transport of fatty acids into mitochondria, β-oxidation of saturated and unsaturated fatty acids, ATP yield from fatty acid oxidation. Biosynthesis of saturated and unsaturated fatty acids. Cholesterol metabolism. Hormonal regulation of the mobilization of triglycerides from adipocytes.

MODULE V HORMONAL REGULATION AND INTEGRATION OF METABOLISM 7

Tissue-Specific Metabolism: The Division of Labor, Hormonal Regulation of Fuel Metabolism, Obesity and the Regulation of Body Mass, Obesity, the Metabolic Syndrome, and Type 2 Diabetes

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Nelson D. L, Cox M. M. Lehninger's Principle of Biochemistry. 5th Ed., W.H. Freeman, 2008.
2. Biochemistry by Lubert Stryer 7th ed. W. H. Freeman & Company,2012.
3. Textbook of Biochemistry with Clinical Correlations. 4thEd.Thomas M. Devlin. Wiley-Lisspublication.1997.

COURSE OUTCOMES:

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

CO1: Apply the knowledge of thermodynamic to examine energy processes in living systems and to incorporate metabolism into the overall physiology of cells and organisms

CO2: Describe the pattern of carbohydrate metabolism in different organisms.

CO3: Summarize the relationships of glycolysis, the citric acid cycle, and oxidative phosphorylation in terms of their inputs and outputs.

CO4: Demonstrate how lipids digested by the human body and the process of lipogenesis and ketogenesis.

CO5: Apply the knowledge on hormonal regulation in various human diseases.

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of biochemistry can contribute to good health and well being.

SDG15: Life on Earth

Statement: This course gives knowledge about the ways to create strategies that can contribute all the levels of life in the earth.

LTE 6103	IMMUNOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To provide a foundational understanding of the components and organization of the immune system.

COB2: To enable students to understand the structure, properties, and diversity of antigens and antibodies, and their interactions.

COB3: To impart knowledge of the molecular and cellular mechanisms governing B and T lymphocyte development, activation, and differentiation

COB4: To develop understanding of clinical immunology, including hypersensitivities, autoimmunity, immune tolerance, immune response to pathogens, cytokine biology, complement system, and related immune disorders.

COB5: To introduce and provide hands-on familiarity with modern immunological techniques

MODULE I **IMMUNOLOGY: CONCEPT AND COMPONENTS OF IMMUNE SYSTEM** **9**

Overview and Concepts, Discovery of humoral and cellular immunity, Components of innate and acquired immunity, Hematopoiesis, Organs and cells of the immune system- primary and secondary lymphoid organs, Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid Tissue (MALT&CALT); Mucosal Immunity.

MODULE II **ANTIGENS & ANTIBODY: BASIC PROPERITIES AND THEIR INTERACTIONS** **9**

Properties of antigens and antibodies, Epitopes, Haptens, Immunogenicity versus antigenicity, Antibody structure, classes and subclasses of immunoglobulin, Theories of antibody formation. Structural basis of antibody diversity; properties of immunoglobulins, subtypes. Immunoglobulins as antigens, monoclonal antibody techniques Hybridoma, Production of murine hybridoma, antigen antibody interactions.

MODULE III **REGULATION OF IMMUNE RESPONSE BY B AND T LYMPHOCYTES** **9**

Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing, Cellular distribution of MHC molecule, Antigen processing and presentation – exogenous and endogenous antigen processing. Self -MHC restriction of T cells. Presentation of non-peptide antigens. B-cell receptor; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and

differentiation and T-cell receptors; Functional T Cell Subsets.

MODULE IV UNDERSTANDING CLINICAL IMMUNOLOGY 9

Cellular Immunity, Immune Tolerance and suppression, Immunity to infection: Bacteria, viral, fungal and parasitic infection. Hypersensitivity Reactions, Types of Hypersensitivity, Autoimmunity, Immune Dysfunction and Its component Cytokines -Properties, receptors, antagonists, diseases, Cytokine secretion by TH1and TH2 subsets therapeutic use of Cytokines. Cytokine related diseases, Cytokines in hematopoiesis. Complement system-Activation, Regulation, Biological consequence of complement activation and Complement deficiency, inflammation, and opsonization

MODULE V IMMUNOTECHNIQUES 9

Introduction: scope of Immunotechnology, Strength of antigen and antibody reaction- cross reactivity, precipitation and agglutination reactions, Radioimmunoassay and ELISA, Markers of immunocompetent cells, separation and purification of immunocompetent cells. Functional tests for immunocompetent cells and histocompatibility testing. Immunological assays complement fixation tests, In-vivo tests/ neutralization tests, immunodiffusion, immunoblotting, immunohistochemistry and immunofluorescence techniques. Biosensor assays for assessing ligand – receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology,6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippenco

COURSE OUTCOMES:

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

CO1: Identify the components of the immune system and their functions.

CO2: Demonstrate the structure of antibodies and the principles of antigen-antibody specificity and binding affinity.

CO3: Apply the knowledge of immunotechniques in the diagnosis of autoimmune diseases, infections, and hypersensitivity reactions

CO4: Differentiate between various immune disorders, including autoimmune diseases,

hypersensitivities (allergies), immunodeficiencies, and transplant rejection

CO5: Apply the knowledge of immunotechniques in the diagnosis of autoimmune diseases, infections, and hypersensitivity reactions

Board of Studies (BoS) :

9thBoS of SLS held on 20.08.2022

Academic Council:

19th Meeting of the Academic Council held on 29.09.2022

SDG 3: Good Health and Well Being

Statement: Understanding of the fundamentals of immunology we can understand interactions and processes, that will help in good health and well being

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to computer scientists in immunology gives knowledge about relation with all the levels of life in the earth

LTE 6104	MICROBIAL BIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES

COB1: To learn the microbial growth kinetics, isolation and screening

COB2: To understand the principles of bioprocess

COB3: To get the protein expression strategies &recombinant production

COB4: To give basic idea on metagenomics & risk management

COB5: To inform students about application in microbial biotechnology

MODULE I MICROBIAL GROWTH KINETICS, ISOLATION AND SCREENING 9

Microbial growth kinetics: batch cultures, continuous cultures, fed-batch culture. Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.gF. antibiotics, enzymes or recombinant proteins. Biofilms, immobilized enzymes and immobilized cells as biocatalysts.

MODULE II PRINCIPLES OF BIOPROCESS 9

Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products. Thermo-bacteriology: Thermal microbial destruction kinetic. Decimal reduction time.

MODULE III PROTEIN EXPRESSION STRATEGIES &RECOMBINANT PRODUCTION

Overview of protein expression strategies – choosing a heterologous host. Protein folding and inclusion bodies – the problem of protein refolding. Protein expression in *E. coli* and other Gram negative hosts. Recombinant protein production in microbes ; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast).

MODULE IV METAGENOMICS & RISK MANAGEMENT 9

Culture Collections and Gene Banks. Microbial resources. Establishment of culture collections. Taxonomic Terminology. How are the strains preserved? Patent depository. Seed lot and cell bank system. Metagenomics in Biotechnology: understanding and exploiting microbial diversity. Risk management solutions to indoor biological contamination. Risk management solutions to indoor biological contamination.

MODULE V APPLICATION IN MICROBIAL BIOTECHNOLOGY 9

Pathways of microbial biotech product development, compliance, and regulation. Microbial monitoring during bacterial vaccine manufacturing processes and rapid microbial identification in a pharmaceutical **Q**uality **C**ontrol (QC) microbiology laboratory. Industrial enzymes for biopolymer degradation: starch, pectin, biomass applications. Industrial biocatalysis: sweetener, detergent, textile, lipid hydrolysis applications. Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Basic Biotechnology, Third Edition 2006. Colin Ratledge, Bjo Kristiansen Editors.ISBN 0521840317, Cambridge University Press.
2. Demain AL, Davies JE, editors in chief 1999. Manual of Industri Microbiology and Biotechnology. ASM Press Washington, D.C. secon edition.
3. Microbial Biotechnology, Second Edition, 2007. Alexander N. Glaze HiroshiNikaido. ISBN 9780521842105, Cambridge University Press.

COURSE OUTCOMES:

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

CO1: Apply knowledge of growth kinetics and screening to optimize microbial processes for maximum yield and productivity in biotechnological applications..

CO2: Analyze the relationship between microbial growth and product formation.

CO3: Discuss the factors involved in selecting an appropriate host system for the expression of recombinant proteins and strategies to improve protein solubility and proper folding.

CO4: Categorize the role of metagenomics in uncovering the genetic diversity of microorganisms and develop strategies for mitigating the potential risks in biotechnological applications of metagenomics.

CO5: Determine the challenges and strategies for scaling up microbial biotechnology processes from the laboratory to industrial scale.

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of microbial biotechnology we can understand interactions and processes,that will help in good heath and well being.

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to bioprocess technology gives knowledge about relation with all the levels of life in the earth

LTE 6105	CELL AND MOLECULAR BIOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES

COB1: To get overview of classes of cells and structural and function aspects of plasma membrane and cell organelle.

COB2: To develop skill to understand molecular aspects of cell cycle and cell division.

COB3: To get familiar with transcription and translation in details.

COB4: To understand the signaling pathways in cell functioning.

COB5: To understand energy conservation and conversion phenomenon in cells.

MODULE I INTRODUCTION TO CELL 10

Basic properties of cell, Different classes of cell: Prokaryotic, animal and plant cell. Plasma membrane- structure and function, Chemical composition of membranes, membrane lipids and proteins, fluid mosaic model, Transport across the membranes- diffusion, osmosis, facilitated diffusion, passive and active transport; membrane potential and nerve impulses, membrane transport.

MODULE II CELL ORGANALLES 9

Endoplasmic Reticulum, Golgi complex- glycosylation, Vesicle transport- COPI and COPII; Lysosomes-autophagy; Endocytic pathway- endocytosis and phagocytosis, transport of proteins into peroxisomes, mitochondria and chloroplast;

MODULE III ENERGY CONVERSION 8

Structure of mitochondria and organization of respiratory chain; Proton Pump and ATP generation in mitochondria; Structure of chloroplast and Photosynthesis, photorespiration; Genetic system of mitochondria and chloroplast.

MODULE IV BASIC GENETIC MECHANISMS 9

The structure and function of DNA, DNA packaging and Chromosomes, chromatin structure and function, DNA replication mechanisms, DNA damage and repair and homologous recombination and transposable elements, Telomeres, telomerase and end replication. Role of telomerase in aging and cancer.

MODULE V TRANSCRIPTION AND TRANSLATION 9

Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases- general and specific transcription factors- regulatory elements- mechanism of transcription, Transcription termination Post transcriptional modification- splicing- editing- nuclear export of mRNA- mRNA stability; Translation- Genetic code, Mechanism of initiation- elongation andtermination- Regulation of translation.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Molecular Biology of Cell by Alberts et.al. John Wiley & Sons, 6Ed, 2015
2. The Cell by Cooper. ASM Press, 4Ed, 2007
3. Cell and Molecular Biology by Karp. John Wiley & Sons, 7Ed, 2013
4. Lodish H. F.Cell and Molecular Biology. W.H. Freeman & Co Ltd, 7Ed, 2000

COURSE OUTCOMES:

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

CO1: Describe the basic properties of cells and transport system across membranes.

CO2: Explain about the cell organelles and protein transportation inside the cells.

CO3: Demonstrate the role of mitochondria and chloroplast in the energy conversion.

CO4: Compare the differences in DNA replication processes between prokaryotic and eukaryotic organisms.

CO5: Apply the knowledge of transcription and translation to study the regulation of gene expression.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of cell biology live organisms can help in maintain systems to promote good health and well being.

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to cell biology gives knowledge about relation with all the levels of life in the earth

LTE 6106	LABORATORY I (BIOCHEMISTRY/ IMMUNOTECHNOLOGY/ MICROBIAL BIOTECHNOLOGY)	L	T	P	C
SDG: 3, 15		0	0	4	2

COURSE OBJECTIVES:

COB1: To learn basic techniques in molecular biology

COB2: To study and differentiate the electrochemical properties of nucleic acids

COB3: To learn the preliminary methods in biochemistry by preparing buffer and adjusting pH.

COB4: To estimate various biomolecules by biochemical assays.

COB5: To learn cell biology techniques

EXPERIMENTS

1. Laboratory safety guidelines.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer-Lambert's Law.
3. Effect of temperature on enzyme activity.
4. Separation techniques for amino acids and sugar: (a) paper chromatography (b) thin layer chromatography.
5. Separation of proteins by native and SDS-PAGE.
6. Preparation of slides from onion root tip for mitosis
7. Isolation & Purification of genomic DNA from bacteria
8. Isolation & Purification of plasmid DNA
9. Isolation of RNA
10. Agarose gel electrophoresis of chromosomal & plasmid DNA
11. Restriction Digestion of chromosomal & plasmid DNA
12. Isolation of DNA fragment from agarose gel
13. Competent cell preparation
14. Transformation and Efficiency of competent cells
15. SDS PAGE
16. Polymerase Chain Reaction
17. Isolation of Genomic DNA from Plants

P – 60; TOTAL HOURS –60

TEXT BOOKS:

1. MichelR.GandSambrookJ.MolecularConing-Alaboratorymanual.Coldspringharborlaboratorypress,2012.
2. Laboratory Exercises in Microbiology, Fifth Edition by Harley−Prescott, TheMcGraw−HillCompanies,2002
3. Wilson K and Walker J, Principles and Techniques in Practical

Biochemistry,5thEd.,CambridgeUniversityPress,2000.
4. Holtzhauer M,Basic Methods for the Biochemical Lab, Springer, 2006.
5. Nigam, Lab Manual in Biochemistry: Immunology and Biotechnology, TataMcGraw-HillEducation,2007.

COURSE OUTCOMES:

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

CO1: Discuss the relevance of biochemistry in fields such as medicine, biotechnology, and environmental science.

CO2: Apply the protein separation and quantification techniques in real-world scenarios such as analyzing protein expression in cells or tissues.

CO3: Analyze the DNA and RNA samples, isolated from various sources.

CO4: Illustrate how PCR is used in molecular biology to study gene expression, genetic variation, and disease diagnostics.

CO5: Design an experiment for bacterial transformation, including choosing the appropriate host strain, plasmid vector, and selection method.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintain systems to promote good health and well being.

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to that gives knowledge about relation with all the levels of life in the earth

ENE 6181	ENGLISH FOR CAREER DEVELOPMENT	L	T	P	C
SDG: 4 , 8		1	1	0	2

COURSE OBJECTIVES:

COB1: To enable students to learn about the job search, application, and interview process

COB2: To give them an opportunity to explore their global career path, build vocabulary and improve language skills to achieve professional goals

COB3: To produce a professional-looking resume

COB4: To understand networking and interview skills

COB5: To understand the key skills and behaviors required to facilitate a group discussion

Pre-requisites:

The students should have completed a course on English at their Undergraduate level.

MODULE I ENTERING THE JOB MARKET 3+2

Introduction to the Career Development -Job Search Overview-Identifying Your Interests and Skills

Language Focus: Vocabulary and Word Forms Related to Jobs-Choosing the Job that's the Best Fit

Language Focus: Verb Tenses (Present vs. Present Progressive) Understanding Job Descriptions: Reading a Job Advertisement

Language Focus: Phrases to Compare Similarities

Online Learning Opportunities to Extend Your Skills

MODULE II RESUMES 3+2

What is a resume? Why do you need one?

Parts of a Resume-Writing a Resume, Part 1: Name and Contact Information

Listening: Connecting Employers with Job Seekers in Today's Economy

Language Focus: Key Words

Writing a Resume, Part 2: Headline and Summary

Writing a Resume, Part 3: Work Experience

Writing a Resume, Part 4: Education

Language Focus: Action Verbs

Writing a Resume, Part 5: Complete your Resume

MODULE III WRITING A COVER LETTER 3+2

What is a Cover Letter?

Professional Writing: Letter Format
Cover Letter: Paragraph 1- Introducing Yourself
Cover Letter: Paragraph 2- Highlighting Your Skills in the Cover letter
Cover Letter: Paragraph 3- Closing
Language Focus – Present Perfect vs. Past Tense
Professional Writing: Level of Formality
Language Focus: Using Modal Verbs to Write politely
Writing a Cover Letter for a Specific Job

MODULE IV INTERVIEWING FOR A JOB 3+5

Overview of the Job Interview: Answering Typical Interview Questions Language Focus: Asking for Clarification in an Interview-
Sample Interview: Do's and Don'ts Part 1
Sample Interview: Do's and Don'ts Part 2
Sample Video: Responding to an Interview Question

MODULE V GROUP DISCUSSION 3+4

Introduction to Group Discussion - Participating in group discussions – understanding group dynamics - brainstorming the topic - questioning and clarifying - GD strategies- activities to improve GD skills

L-15;T-15;TOTAL HOURS - 30

REFERENCES:

1. R. Byrne, D. Teaching Oral Skill. London: Longman. 1975.
2. Byrne, D.Teaching Writing, London: Longman. 1975.
3. Rani Asoka, DeviVimala. English for Career development: ACourse in Functional English. Orient Longman Pvt. Ltd., India,2004.
4. Anderson, K., Maclean, J. & Lynch, T. Study speaking: A Course in Spoken English for Academic Purposes. Cambridge University Press, UK, 2004.
5. Withrow, J., Brookes, G.& Cummings, M.C.Inspired to write. Reading and Tasks to Develop Writing Skills. Cambridge University Press, U.K., 2004.

COURSE OUTCOMES:

At the end of the course, the students will be able to
CO1: Identify the steps in the job search process

CO2: Describe themselves and their experiences in a résumé

CO3: Build their job-related vocabulary

CO4: Write a clear cover letter that tells employers why they are the right person for the job

CO5: Take part in Group discussion confidently.

Board of Studies (BoS) :	**Academic Council:**
23rd BOS of ECE held on 13.07.2022	19th Academic Council held on 29.09.2022

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

GEE 6201	RESEARCH METHODOLOGY AND IPR	L	T	P	C
SDG: 4, 8, 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To apply a perspective on research

COB2: To analyze the research design, information retrieval and problem formulation techniques.

COB3: To select the appropriate statistical techniques for hypothesis construction and methods of data analysis and interpretation

COB4: To execute the effective communications of research findings and apply the ethics in research.

COB5: To describe the research findings as research reports, publications, copyrights Patenting and Intellectual Property Rights.

PREREQUISITES:

- Basics of core engineering, probability and statistics.
- Basics of flowchart and algorithm techniques.

MODULE I RESEARCH PROBLEM FORMULATION AND RESEARCH DESIGN **6**

Research - objectives – types - Research process, solving engineering problems -Identification of research topic - Formulation of research problem, literature survey and review. Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle, Design of experimental setup, Mathematical modeling - Simulation, validation and experimentation.

MODULE II DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA **8**

Sources of Data, Use of Internet in Research, Types of Data - Research Data Processing and analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision –limitations, Application of Computer in Research- Spreadsheet tool - Basic principles of Statistical Computation. Importance of statistics in research - Concept of probability - Popular distributions - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays.

MODULE III OPTIMIZATION TECHNIQUES 8

Use of optimization techniques - Traditional methods – Evolutionary Optimization Techniques. Multivariate analysis Techniques, Classifications, Characteristics, Applications - correlation and regression, Curve fitting.

MODULE IV INTELLECTUAL PROPERTY RIGHTS 8

The Research Report - Purpose of written report - Synopsis writing - preparing papers for International Journals, Software for paper formatting like LaTeX/MS Office, Reference Management Software, Software for detection of Plagiarism – Thesis writing, - Organization of contents - style of writing- graphs, charts and Presentation tool - Referencing, Oral presentation and defense - Ethics in research - Patenting, Intellectual Property Rights - Patents, Industrial Designs, Copyrights, Trade Marks, Geographical Indications-Validity of IPR, Method of Patenting, procedures, Patent Search.

L –30; TOTAL HOURS – 30

TEXT BOOKS:

1. Ganesan R., “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
2. George E. Dieter., “Engineering Design”, McGraw Hill – International edition, 2020.
3. Kothari C.R., “Research Methodology” – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2020.
4. Kalyanmoy Deb., “Genetic Algorithms for optimization”, Kangal report, No.2001002.
5. Rajkumar S. Adukia, “Handbook on Intellectual Property Rights in India”, TMH Publishers, 2020.
6. PrabhuddhaGanguli. ”Intellectual Property Rights”. 1st Edition, TMH Publishers, 2012.

REFERENCES:

1. Holeman, J.P., ”Experimental methods for Engineers, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2. Govt. of India, ”Intellectual Property Laws; Acts, Rules & Regulations”, Universal Law Publishing Co. Pvt. Ltd., New Delhi 2020.
3. R Radha Krishnan & S Balasubramanian, ”Intellectual Property Rights”. 1st Edition, Excel Books, 2012.
4. Derek Bosworth and Elizabeth Webster. ”The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2013.

COURSE OUTCOMES:

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

CO1: Formulate the research problem

CO2: Design and Analyze the research methodology

CO3: Apply statistical techniques for hypothesis construction

CO4: Analyze and interpret the data to construct and optimize the research hypothesis

CO5: Report the research findings as publications, copyright, trademarks and IPR

Board of Studies (BoS) :	**Academic Council:**
23rd BOS of ECE held on 13.07.2022	19th Academic Council held on 29.09.2022

SDG 4: Analysis and design of core field design promotes engineering skills and quality education.

Statement: This course enables the student to analyze the existing technology for further solution and its qualitative measures in terms of societal requirements.

SDG 8: Development of new technologies with core field design provides sustainable economic growth and productive employment.

Statement: To apply the hybrid techniques and concepts for different applications provides sustainable economic growth and productive employment.

SDG 9: Creative and curiosity of core field design fosters innovation and sustainable industrialization.

Statement: This course plays major roles through innovative ideas in industry towards modern infrastructures and sustainability.

LTE 6201	GENOMICS AND PROTEOMICS	L	T	P	C
SDG: 3, 15		4	0	0	4

COURSE OBJECTIVES:

COB1: To provide information about genomics and proteomics and

COB2: To offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes

COB3: To understand the basic proteomics and its potential application of both genomics and proteomics

COB4: To assemble and annotate genomes by identifying genes.

COB5: To identify proteases for treatment of diseases

MODULE I INTRODUCTION **12**

Genomics classification, Prokaryotic and Eukaryotic genome; mitochondrial and chloroplast genome; DNA sequencing-principles and methods, Sanger Dideoxy and fluorescence method; coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

MODULE II GENOME SEQUENCING PROJECTS **12**

Gene database for Microbes, plants and animals; Accessing and retrieving genome project; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

MODULE III PROTEOMICS TECHNIQUES **12**

Introduction to proteomics; Protein separation techniques: chromatography- ion-exchange, size-exclusion and affinity chromatography; Protein analysis-Polyacrylamide gel electrophoresis, Isoelectric focusing (IEF),Two dimensional PAGE for proteome analysis and image analysis of 2D gels; measurement of protein concentration, amino-acid composition, N-terminal sequencing.

MODULE IV PROTEIN ENGINEERING **12**

Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system. High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.

MODULE V FUNCTIONAL GENOMICS AND PROTEOMICS 12

Recombinant DNA technology: Fundamentals of DNA cloning, Polymerase chain reaction, Human genome project; Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays.

L – 60; TOTAL HOURS –60

TEXT BOOKS:

1. Brown TA, Genomes, 3rd Edition. Garland Science 2006
2. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
3. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Ed, Blackwell, 2006.
4. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

COURSE OUTCOMES:

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

CO1: Describe the structure, function, and organization of genomes and how they are studied using high-throughput sequencing technologies.

CO2: Explain the process of sample preparation, library construction, sequencing, and data generation.

CO3: Describe and perform basic proteomics techniques

CO4: Apply the knowledge of protein engineering in environmental sustainability and industrial process.

CO5: Integrate data from genomics and proteomics to gain a holistic view of biological processes.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth

Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

LTE 6202	BIOPROCESS AND FERMENTATION TECHNOLOGY	L	T	P	C
SDG:		3	0	0	3

COURSE OBJECTIVES:

COB1: To develop skills in the area of bioprocess technology and downstream processing

COB2: To understand different types of fermenters

COB3: To develop the skills the separation and isolation steps involved in downstream process

COB4: To develop the skills for methods in product purification and formulation.

COB5: To evaluate the kinetics and mechanism of microbial growth by using various models

MODULE I BIOPROCESS TECHNOLOGY 9

Design features of bioreactors / fermenters, Fundamentals of bioprocess technology, Principles underlying product formation, Principles underlying product recovery and purification, Large scale production of fermentation products, Fermentation kinetics: Reaction kinetics, Scale up of fermentation process, Downstream processing, Biosynthetic pathways for some secondary metabolites.

MODULE II MODELING AND DESIGN OF FERMENTATION PROCESSES 9

Principles of model building for biotechnological processes, modeling of recombinant systems. biomass growth and product formation, Kinetics of substrate utilization, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation, Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies should deal with medium design, reactor design & process optimization etc.

MODULE III DOWNSTREAM PROCESSING

Introduction-downstream processing, biomolecules and bioprocesses, biomass removal and disruption technique- centrifugation, sedimentation, flocculation, ficrofiltration, sonication, Homogenizers, chemical lysis, enzymatic lysis , pretreatment and stabilisation of bioproducts.

MODULE IV SEPERATION AND ISOLATION 9

Unit operations for solid-liquid separation - filtration and centrifugation. Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Pervaporation; Perstraction Adsorption and chromatography: size, charge,

shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds).

MODULE V PRODUCT PURIFICATION AND FORMULATION 9

Ammonium Sulfate-precipitation, solvent), Chromatography, principles, instruments and practice, adsorption, reverse phase, ionexchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromatographic techniques. Crystallization, drying and lyophilization in final in product formulation.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. P.A. Belter, E.L. CusslerAnd Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pub. (1988).
2. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology
   By Open Learning Series, Butterworth-Heinemann (1992).
3. Shuler, M.L. and Kargi, F. Bioprocess Engineering: Basic concepts, 2nd ed., Prentice-Hall, 2002.
4. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
5. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
6. Blanch, H.W and Clark D.S., “Biochemical Engineering”, Marcel Dekker,1997.

COURSE OUTCOMES:

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

CO1: Demonstrate the design and operation of fermenter and types of fermentation process

CO2: Apply the knowledge about the formulation of medium and its prerequisites

CO3: Interpret stoichiometry and energetics of cell growth and product formation

CO4: Analyze the modes of operation of bioreactor and its design equations

CO5: Evaluate the kinetics and mechanism of microbial growth by using various models

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of bioprocess we can carry out data mining gene and protein expression patterns and modelling cellular interactions and processes, that will help in good health and well-being.

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to computer scientists in fermentation gives knowledge about relation with all the levels of life in the earth

LTE 6203	COMPUTATIONAL BIOLOGY	L	T	P	C
SDG: 3, 15		4	0	0	4

COURSE OBJECTIVES:

COB1: To understand the programming languages applied in computational biology.

COB2: To understand the methods and applications for sequence analysis, Phylogenetics and Protein modelling.

COB3: Understanding of alignment tools and techniques

COB4: Understanding of Phylogenetic analysis methods

COB5: Understanding of Predictive models and methods

MODULE I INTRODUCTION TO PROGRAMMING LANGUAGE 12

Introduction –Programming languages – Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging - Basic Perl Data Types, File handle and File Tests – Perl Modules – SQL.

MODULE II PROGRAMMING IN C, C++ AND OOPS 12

C language Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Structure of a 'C' program - Expression – Data types – Control Statement - C++programming – Object Oriented Concept: Encapsulation, Inheritance, Polymorphism.

MODULE III COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS 12

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

MODULE IV PHYLOGENETICS 12

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

MODULE V PROTEIN STRUCTURE, MODELLING AND SIMULATIONS 12

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

L – 60; TOTAL HOURS –60

TEXT BOOKS:

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles and Applications, Second Edition, Prentice Hall.
6. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
7. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002

COURSE OUTCOMES:

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

CO1: Demonstrate the fundamental and universal concepts in programming languages.

CO2: Apply the concepts of C, C++ AND OOPS programming to solve problems.

CO3: Design the experiment to analyses the protein structure and interpretation of data leading to publication

CO4: Apply the knowledge to handle phylogenetic data and application part

CO5: Analyze Protein structure, sequence analysis which can be used in analyzing the binding effect of drugs on proteins.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of bioinformatics we can carry out data mining gene and protein expression patterns and modelling cellular interactions and processes, that will help in good health and well-being.

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to computer scientists in bioinformatics gives knowledge about relation with all the levels of life in the earth.

LTE 6204 SDG: 3, 15	LABORATORY II (FERMENTATION BIOTECHNOLOGY/ GENOMICS AND PROTEOMICS/ COMPUTATIONAL BIOLOGY)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

COB1: To train student to archive available databases in bioinformatics

COB2: To inculcate skill of plasmid construction, mappings and analysis.

COB3: To train the students in protein structure prediction, sequence homology mapping

COB4: To train in basic tools used for gene and protein expression studies

COB5: To train student in modern techniques applied for purification and separation

EXPERIMENTS

1. Exploring different databases –NCBI and beyond NCBI
2. Sequence retrieval, format conversion, BLAST (Basic Local Alignment Search Tool) and its types
3. Pairwise and multiple sequence alignment
4. Use of PAUP for Phylogenetic analysis based on RAPD and RFLP Data
5. Primer designing and Pharmacokinetic analysis
6. NEB cutter and Plasmid mapping
7. Exploring the Gene expression databases like GEO (Gene Expression Omnibus)
8. Assembling and editing of genomic data; Genome alignment and analysis tools-BWA (Burrows Wheeler Alinger), SAM tools, GATK (The Genome Analysis Tool kit) and IGV (IntegratieGenommics Viewer).
9. Molecular visualization tools; 3D representation
10. Structural analysis, domain and motif identification, ligplotinterations
11. Molecular docking
12. Basic molecular dynamics (MD) simulation with Gromacs
13. Solid separation methods-filtration, sedimentation and centrifugation.
14. Cell disruption by sonication and enzymatic method.
15. Protein precipitation methods salt precipitation (PEG, ammonium sulphate).
16. Aqueous two-phase extraction for clarification, concentration and partial purification.
17. Product preservative methods -chemical, physical and natural.

L – 60; TOTAL HOURS –60

TEXT BOOKS:

1. Rashidi H, Buehler L. K. Bioinformatics Basics: Applications in Biological Science and Medicine. 2nd Ed., CRC Press, 2005.

2. Baxevanis A. D, Ouellette B. F. F. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 3nd edition Wiley, John & Sons, Incorporated, 2004.
3. Krawetz S. A, Womble D. D. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana press, 2003.
4. K. Wilson and J. Walker, "Principles and Techniques of Practical Biochemistry", 7th edition, Cambridge Publication, 2010. 4. R. Eisenthal and N.J. Danson, "Enzyme Assays- A Practical Approach", 1st edition, IRI Press, Oxford, UK, 1992.

COURSE OUTCOMES:

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

CO1: Apply the knowledge of various soft skills/tool used in bioinformatics

CO2: Analyze the sequences using different alignment tools.

CO3: Identify and resolve problems in fermentation processes

CO4: Interpret genomic sequences

CO5: Develop hypotheses about molecular mechanisms and interactions for supporting experimental design using molecular visualization tools

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of techniques taught we can understand the genetic basis of underlying diseases, that will help in good health and well being

SDG15: Life on Earth

Statement: This course makes aware of the range of technologies available to to geneticists that gives knowledge about relation with all the levels of life in the earth.

SEMESTER III

LTE 7101	**PLANT AND ANIMAL BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 3, 15		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn about embryogenesis and other type of hybridization techniques.

COB2: To know about genetic transformation and techniques about gene delivery.

COB3: To have an idea about gene mapping and cloning and different type of biotic and abiotic stress.

COB4: To familiar with different animal tissue culture techniques and methods of separation

COB5: To understand about artificial breeding in animals, transgenic and their applications

MODULE I PLANT TISSUE CULTURE 9

Totipotency, organogenesis, somatic embryogenesis, artificial seed production, Micropropagation, somaclonal variation, Germplasm conservation and cryopreservation. Protoplast Culture and Somatic Hybridization Protoplast isolation-its culture and usage, Somatic hybridization and its applications.

MODULE II AGROBIOLOGY 9

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer, Genetic Transformation Agrobacterium-mediated gene delivery, Direct gene transfer - PEG- mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers, Characterization of transgenics, Gene targeting.

MODULE III MOLECULAR MAPPING & MARKER ASSISTED SELECTION (MAS) 9

Resistance, grain quality and grain yield, Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map, Gene mapping and cloning, strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

MODULE IV ANIMAL TISSUE CULTURE 9

Tissue culture- definition, concept and significance, maintenance of sterility and use of antibiotics, detection of various biological contaminations, cross contamination,

formulation of tissue culture media- serum and synthetic media, Balance salt Solution, Primary culture and Types, Cryopreservation of cell
lines. role of growth factors in cell culture, various methods of cell separation, Cell cloning, transformation, transfection, micro-manipulation, nuclear transplantation

MODULE V APPLIED ANIIMAL BIOTECHNOLOGY 9

Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin, production of vaccines and proteins of pharmaceutical relevance, recombinant protein production, harvesting and purification. Artificial breeding – in vitro fertilization and embryo transfer technology, artificial insemination, germ cell storage, transgenic animals- fish, mice and sheep, gene targeting and transfer, mouse models for human genetic disorder and diseases, knock-out and knock-in mice.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
2. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
3. R. Ian Freshney. Culture of Animal cells, 5th Edition, 2010. A John Wiley & Sons, Inc.,Publications, USA
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

COURSE OUTCOMES:

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

CO1: Demonstrate plant tissue culture techniques for the mass propagation and to enhance synthesis of secondary metabolites

CO2: Apply various transformation and transfection techniques for creating transgenic plants and animals.

CO3: Uilize transgenic technology to create resistant crops to withstand biotic and abiotic stress conditions

CO4: Illustrate the different techniques involved in animal cell culture

CO5: Apply the knowledge to develop experimental animal models, innovative diagnostics, and reproductive biotechnology.

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3: Good Health and Well Being
Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth
Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

LTE 7102	LABORATORY III (PLANT AND ANIMAL BIOTECHNOLOGY)	L	T	P	C
SDG: 3, 15		0	0	4	2

COURSE OBJECTIVES:

COB1: To establish animal cell line cultures

COB2: To test drugs toxicity in the cultured cells

COB3: T To study cell morphology and also to perform different staining procedures

COB4: Identify the active status of the cells.

COB5: To learn molecular biology tools and techniques

EXPERIMENTS

1. MTT assay
2. Morphological characterization of cell death
3. Acridine orange/Ethidium bromide staining
4. Biochemical characterization of cell death
5. Isolation of proteolytic organism from soil sample
6. Glucose assay by DNS method
7. Evaluations of enzyme kinetic parameters
8. Enzyme activity calculation
9. Determination of optimum pH for enzyme
0. Determination of optimum temperature for an enzyme
1. Enzyme immobilized by alginate gel method
2. Hydrolysis of starch by immobilized method
3. Effect of substrate concentration on biomass yield
4. Solvent extraction techniques for product recovery
5. Micropropagation of plant by leaf disc culture
6. Electroelution of insert DNA from agarose gel slice.
17. Molecular analysis of putative transformed plants by Polymerase Chain Reaction

P – 60; TOTAL HOURS –60

TEXT BOOKS:

1. Yadav P. R, Tyagi R. Biotechnology of Animal Tissues, Discovery Publishing House, 2006.
2. Freshney R. I, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Edition, John Wiley & Sons, Inc. 2010.

COURSE OUTCOMES:

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

CO1: Apply the knowledge on plant tissue Culture techniques and explore their applications

CO2: Employ advanced techniques in plant biotechnology such as gene manipulation and molecular genetics.

CO3: Discuss and appreciate the potential applications of plant biotechnology for the benefit of mankind

CO4: Design experiments to test hypotheses about enzyme kinetics and immobilization effectiveness.

CO5: Evaluate the environmental conditions for maximal enzyme activity

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being
Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth
Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

PROJECT WORK (PHASE 1)

L	T	P	C
0	0	18	6

COURSE OBJECTIVES:

To learn and experiments handled on their own by the students to exhibit their capacity in executing a project work and provide a fruitful solution to a research problem or improving the health and wealth of human beings in the field of Biotechnology.

GENERAL GUIDELINES:

- At post-graduate level, project work shall be carried out by the student individually
- Student shall select a project topic of his/her interest relevant to Biotechnology and approach any faculty member of the School of Life Sciences with expertise in that field and get his willingness to supervise the project.
- Students are permitted to carry out their project in an Industry / Research organization, with the approval of the Dean of the School of Life Sciences. In such cases, the project work shall be jointly supervised by a faculty of the school and a professor/ Scientist from the organization. Proper permission and approvals should be obtained from the industry and documented.
- The information related to the proposed topic and the faculty member willing to act as a guide shall be informed to the project coordinator within 15 days from the commencement of the semester.
- Supervisor identified by the student shall be approved by the dean of the School of Life Sciences considering the guidelines followed in the School of Life Sciences to allot supervisor for student projects.
- The project coordinator, in consultation with Professor in-charge shall give initial approval to start the project.
- A project review team comprising minimum of two senior faculty members of the department preferably doctorates shall be appointed by the Dean of the School of Life Sciences.
- Project review schedules, weightage for each review, and rubrics for evaluation will be prepared by the project coordinator in line with the academic calendar and informed to the students in advance. A minimum of three reviews shall be conducted to evaluate the progress of the students. All the members of the review committee shall evaluate the students individually and the mean value shall be taken for grading.

- Students should meet the supervisor periodically and attend the review committee meetings for evaluating the progress. Proper documents shall be maintained by the supervisor to ensure the attendance and progress of the students.
- In the project phase I, students are expected to identify a suitable topic, draw the need for present study and scope of the investigation, review at least 25 journal papers in the related field, formulate the experimental/analytical methodology and conduct preliminary studies.
- At the end of project work phase I, students should submit a report based on the preliminary studies and the future work to be carried out.

COURSE OUTCOMES:

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

CO1: Deeper knowledge on the basic principles and concepts related to the topic of his/her project work.

CO2: Utilization of knowledge gained in the field of study to perform literature review with ease.

CO3: Designing of the experimental / analytical methodology required for the project work

CO4: Understanding, interpret and draw conclusion on the data obtained from the performed experiment and also to effectively communicate to the scientific community

CO5: Effectively transform the project outcome to patent, publication and product development for the welfare of the world

MOOC COURSE

L	T	P	C
0	0	0	0

COURSE OBJECTIVES:

To learn the basics principles and concepts of the topic in which a project work is undertaken by the student.

GENERAL GUIDELINES:

- Students shall identify a MOOC course related to his/her project topic in consultation with the project supervisor.
- Student shall register for a MOOC course with minimum two credit offered by any recognized organization during the project phase I.
- Selection and completion of MOOC course by the students shall be endorsed by Head/Dean of the Department.

COURSE OUTCOMES:

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

- Familiarize the basic principles and concepts related to the topic of his/her project work.
- Utilize the knowledge gained in the field of study to perform literature review with ease.
- Formulate the experimental / analytical methodology required for the project work

LTE 7201	PROJECT WORK (PHASE 2)	L	T	P	C
		0	0	36	18

COURSE OBJECTIVES:

- To learn and experiments handled on their own by the students to exhibit their capacity in executing a project work and provide a fruitful solution to a research problem or improving the health and wealth of human beings in the field of Biotechnology.

GENERAL GUIDELINES:

- Project work phase II is a continuation of phase I following the same guidelines.
- The project co-ordinator shall arrange to conduct three reviews to ascertain the progress of the work and award the marks based on the performance.
- Detailed experimental investigation / in-depth analytical study /
- Preparation of specimens / testing has to be performed in-line with the scope of the investigation.
- The students are expected to analyse the obtained results and Elaborately discuss the same by preparing necessary Figures/Graphs/Tables/Illustrations/images to get an inference.
- The important conclusions need to be drawn and scope for further research also to be highlighted.
- The outcome of project work shall be published in journals / conference of National or International importance.
- At the end, students should submit a report covering the various
- aspects of the Project work.
- The typical components of the project report are the Introduction, Need for present study, Scope of the Investigation, Literature review, Methodology / Experimental investigation/development of software packages, Results & discussion of experimental and analytical work, Conclusions, References etc.
- The deadline for submission of final Project Report / Thesis /
- Dissertation is within 30 calendar days from the last Instructional day of the semester.
- The project co-ordinator, in consultation with the head of the department and controller of examination, shall arrange for an external expert member to conduct the final viva-voce examination to ascertain the overall performance of the students in Project work.

COURSE OUTCOMES:

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

CO1: Deeper knowledge on the basic principles and concepts related to the topic of his/her project work.

CO2: Utilization of knowledge gained in the field of study to perform literature review with ease.

CO3: Designing of the experimental / analytical methodology required for the project work

CO4: Understanding, interpret and draw conclusion on the data obtained from the performed experiment and also to effectively communicate to the scientific community

CO5: Effectively transform the project outcome to patent, publication and product development for the welfare of the world

PROFESSIONAL ELECTIVE COURSES

SEMESTER I

LTEY021	GENETIC ENGINEERING	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn about genetic engineering, principles involved in manipulating genes and DNA.

COB2: To know about cloning strategies and expression systems.

COB3: To acquire basic understanding of techniques in genetic engineering.

COB4: To learn PCR and its variations

COB5: To understand the principles of gene alteration

MODULE I BASICS CONCEPTS 9

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions.

MODULE II CLONING VECTORS 9

Plasmids; Cosmids, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMal; GST; pET-can be omitted vectors; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors. Criteria for selection of vectors.

MODULE III CLONING METHODOLOGIES

Insertion of Foreign DNA into Host Cells; Transformation; Transfection, Transduction, Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression. Methods to confirm cloning and reporter genes and proteins.

MODULE IV PCR AND ITS APPLICATIONS 9

Primer design; Thermostable enzymes; DNA polymerases; Types of PCR – multiplex, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis detection. Different Sequencing methods.

MODULE V APPLICATION OF GENETIC ENGINEERING 9

Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array. Ethics in genetic engineering and global policy.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of GeneManipulation.6thEdition,S.B.UniversityPress,2001.
2. Brown TA: Gene Cloning and DNA Analysis: 6th Edition, Wiley-Blackwell, pages 338, 2010.
3. Brown TA,Genomes,3rded. GarlandScience2006
4. Selectedpapers fromscientificjournals.
5. DesmondS.T.Nicholl.AnIntroductiontoGeneticEngineeringCambridgeUniversityPress2008

COURSE OUTCOMES:

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

CO1: Familiarize with the basic concepts and principles of utilization of different expression vectors for cloning in prokaryotic and eukaryotic organisms

CO2: Understand the different strategies of gene cloning and construction of genomic and cDNA libraries for applications of recombinant DNA technology

CO3: Familiarize the concepts of structural and functional genomics

CO4: Understand utilization and principle of mutagenesis studies and hybridization probes

CO5: will be skilled enough to use these techniques in different fields, such as forensic science, agriculture, medicine, etc.

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth

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LTEY 022	STRUCTURAL BIOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To achieve understanding of behaviour of proteins in solution

COB2: To achieve understanding how the properties of proteins change with change in environment

COB3: To achieve understanding of protein purification techniques

COB4: To achieve understanding of different protein states

COB5: To achieve knowledge of protein conformations in crystal

MODULE I STRUCTURAL STATES OF PROTEINS - I 9

Chemical nature of polypeptide chains, Secondary structure, beta structure, collagen triple helix, higher structure determination, prediction of secondary structure, Domains and super secondary structures.

MODULE II STRUCTURAL STATES OF PROTEINS - II 9

Association of protein subunits, helical or continuous protein polymers. The quaternary structure of closed aggregates - oligomeric enzymes, biological implication of quaternary structure, surface accessibility.

MODULE III CRYSTALLOGRAPHY 9

Diffraction methods, X-ray crystallography, crystallization, resolution, temperature factors, electron density maps, NMR methods for protein structure determination

MODULE IV PROPERTIES OF MACROMOLECULES IN CRYSTALLINE STATE 9

Protein crystal, physical properties, chemistry of crystalline proteins, chemical reactivity, enzymatic and biological activities, crystal versus solution NMR studies, Crystallographic temperature factors, structural heterogeneity in protein crystals

MODULE V CONFORMATIONAL STATES IN CRYSTAL AND NUCLEAR MAGNETICRESONANCE STRUCTURES 9

Comparison of two conformational states, Oxygenation of hemoglobin: two crystals conformation, Hydrogen Bonds and Water Molecules in Crystalline Proteins- hydrogen bonding positions in proteins, water molecules observed in crystalline proteins, the distribution of protein bound water, water network in crystalline proteins.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Chadha, K.L. &Pareek, O.P. (Eds.). 1996: Advances in Horticulture, Vol. IV. Malhotra Publ. House, Kriti Nagar, Delhi.
2. Giridhari, Lal, Siddappa, G.S., &Tandon, G.L. 1998: Preservation of Fruits and Vegetables, Publication and Information Division, ICAR.
3. Srivastava, R.P., Sanjeev, Kumar.2006: Fruits and Vegetable Preservation, International book distributing Co Lucknow.
4. Sudheer, K. P. Indira, V. 2007: Postharvest Technology of Horticultural Crops, New India Publishing, Delhi.
5. Verma, L. R & Joshi, V. K. 2000: Postharvest Technology of Fruits and Vegetables, Indus Publishing House, Delhi.

REFERENCES:

1. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.), 2nd Edition, 2002
2. Foundations of Structural Biology by Leonard J. Banaszak (2000) Academic Press, 1st Edition, 2000

COURSE OUTCOMES:

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

CO1: Describe the chemical nature and hierarchical structural organization of proteins, including secondary and supersecondary structures.

CO2: Analyze the quaternary structure of proteins and explain the functional implications of subunit associations in oligomeric enzymes and protein polymers.

CO3: Explain the principles and methods used in determining protein structures through X-ray crystallography and NMR spectroscopy.

CO4: Compare the physical and chemical properties of macromolecules in crystalline versus solution states, highlighting enzymatic and biological activities.

CO5: Evaluate conformational states of proteins using crystallographic and NMR data, with emphasis on hydrogen bonding, water distribution, and structural heterogeneity

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Academic Council:
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SDG15: Life on Earth

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LTEY023	BIOCATALYSIS AND ENZYME REACTION	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: The diversity of metabolic processes occurring in biological system.

COB2: The effect of the structural and functional role of the enzymes governing the metabolic processes.

COB3: Importance of the metabolic pathways in maintaining homeostasis in biological system

COB4: The clinical implications of the metabolic pathway.

COB5: To provide the knowledge on regulatory mechanisms metabolic pathways.

MODULE I EXTRACTION AND PURIFICATION OF MICROBIAL ENZYME **9**

Importance of Enzyme purification, Different sources of enzyme, Extracellular and Intracellular enzyme, Physical and Chemical methods used for cell disintegration, Enzyme fractionation by precipitation (using Temperature, Salt, Solvent, pH etc.), Liquid-liquid extraction, Ionic Exchange, Gel electrophoresis, Affinity chromatography and other special purification methods, Enzyme crystallization technique, Criteria of purity of enzyme, Pitfalls in working with pure enzyme.

MODULE II KINETICS OF SINGLE AND MULTI SUBSTRATE REACTIONS **9**

The Henri and Michaelis-Menten Equations and its significance, Lineweaver-burk Plot, Eadiehofstee and Hanes Plots, The Eisenthal and Cornish-bowden plot, haldane relationship for reversible reactions, Rapid reaction kinetics, Possible mechanisms of multisubstrateenzymes(Ping-pong, random order and Compulsory order).

MODULE III ENZYME INHIBITION

Competitive inhibition, Uncompetittive inhibition, Non- competitive inhibition, Mixed inhibition, partial inhibition, substarte inhibition, Allosteric inhibition and Irreversible inhibition. Types of allosteric regulation and their significance in metabolic regulation and their kinetics study (Hills equation).

MODULE IV CHEMICALNATUREOFENZYMECATALYSIS **9**

Mechanisms of catalysis- Acid base catalysis- Electrostatic catalysis- Covalent catalysis- Proximity and Orientation effects, Enzyme catalysis- Mechanisms of reactions catalyzed by enzymes without cofactors- Metal activated enzymes and metallo enzymes. Mechanism of Reactions catalyzed by Ribonuclease, carbonic

anhydrase, Lysozyme, Triose phosphate Isomerase and Lactate dehydrogenase, Involvement of Coenzymes in enzyme catalyzed reactions.

MODULE V APPLICATIONS AND INSTRUMENTS INVOLVED IN ENZYMATIC CATALYSIS 9

Applications in Medicine- Assay of Plasma Enzymes, Enzymes in Inborn errorsin metabolism, Application of enzymes in food industry, Forensic Science andothers Large-scale production and purification of enzymes, Synthesis of artificialenzymes,Immobilizationofenzymes,itspreparation,propertiesandapplications. Principles of – Manometry– Spectrophotometry – Spectrofluorimetry– Electrochemical methods – Enthalpimetry– Radio chemical methods – Automationinenzymaticanalysis.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. TrevorPalmer, Enzymes IInd Horwood PublishingLtd, 2nd Edition, 2008
2. A Enzymes by Robert A.Copeland,2nd edition, 2000
3. Biochemical Engineering by Harwey W.Blanch and Douglas S.Clark,2nd Edition, 1996.
4. Wiseman,Enzyme Biotechnology, EllisHorwood Pub,1977

COURSE OUTCOMES:

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

CO1: Compare methods for production, purification, characterization and immobilization of enzymes

CO2: Apply biochemical calculation and plot graphs for enzyme kinetics

CO3: Understand the fundamentals of enzyme properties and distinguish based on reaction mechanism

CO4: Understand various application of enzymes that can benefit human life

CO5: Understand various intruments involved in enzyme catalysis

Board of Studies (BoS) :
9th BoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

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SDG15: Life on Earth

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LTEY024	BIOMEDICAL INSTRUMENTATION TECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the application of biomedical instrumentation

COB2: To introduce the student to the various devices of electrical origin and non electrical origin.

COB3: To provide awareness of electrical safety of medical equipments.

COB4: To know the important and modern methods of imaging techniques.

COB5: To know the important and modern therapeutic methods.

MODULE I FUNDAMENTALS OF MEDICAL INSTRUMENTATION 9

Role of technology in medicine, landmark developments in biomedical instrumentation, physiological systems of the body, sources of biomedical signals, basic medical instrumentation system, performance requirements of medical instrumentation systems, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, Basic components of a biomedical system, Transducers, Piezoelectric, ultrasonic transducers, Temperature measurements, Fibre optic temperature sensors. Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers Isolation amplifier.

MODULE II BIOELECTRIC SIGNALS AND ELECTRODES 9

Origin of bioelectric signals, recording electrodes, silver-silver chloride electrodes, Electrodes, Limb electrodes, floating electrodes, pregelled disposable electrodes, electrodes for ECG, electrodes for EEG, electrodes for EMG, electrical conductivity of electrode jellies and creams, microelectrodes, Micro, needle and surface electrodes, Typical waveforms, Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters.

MODULE III BIOMEDICAL RECORDER 9

Measurement of blood pressure, Heart rate, Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analysers : pH of blood measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements, Electrocardiograph, vectorcardiograph (VCG) , phonocardiograph (PCG),digital stethoscope, electroencephalograph (EEG), electromyography, other biomedical recorders, biofeedback instrumentation.

MODULE IV CLINICAL INSTRUMENTS AND PATIENT MONITORING SYSTEMS 9

Medical diagnosis with chemical tests, spectrophotometry, spectrophotometer type instruments, colorimeters, spectrophotometers, clinical flame photometers, selective-ion electrodes based electrolytes analyser, automated biochemical analysis systems, Radio graphic and fluoroscopic techniques, Computer tomography, MRI, Ultrasonography, X-ray Machines and Digital Radiography, Blood cell counter.

MODULE V THERAPEUTIC EQUIPMENTS AND PATIENT SAFETY 9

Audiometers and Hearing Aids, Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart – Lung machine, Dialysers, Lithotripsy, electric shock hazards, leakage currents, safety codes for electromedical equipment, electrical safety analyzer, testing of biomedical equipment.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. R.S.Khandpur, ‘Hand Book of Bio-Medical instrumentation’, McGraw Hill Publishing Co Ltd. 2003
2. M.Arumugam, ‘Bio-Medical Instrumentation’, Anuradha Agencies, 2003.
3. L.A. Geddes and L.E.Baker, ‘Principles of Applied Bio-Medical Instrumentation’, John Wiley & Sons, 1975.
4. J.Webster, ‘Medical Instrumentation’, John Wiley & Sons, 1995.
5. C.Rajarao and S.K. Guha, ‘Principles of Medical Electronics and Bio-medical Instrumentation’, Universities press (India)

COURSE OUTCOMES:

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

CO1: understand the importance of laboratory safety and standard operating procedures of common laboratory equipment’s used in medical sciences

CO2: theoretically trained to with working knowledge of different instruments and be able design experiments

CO3: understand the importance of measurement of blood pressure, ECG and other instruments used as biomedical recorder

CO4: Learn the importance and gain working knowledge of medical test and instruments used in patient monitoring systems

CO5: Understand the principle and working of therapeutic instruments such as hearing aids, vision aids etc and learn about patient safety protocols

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
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SDG15: Life on Earth

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LTEY 025	AROMATIC AND MEDICINAL PLANTS	L	T	C
SDG: 3, 15		3	0	3

COURSE OBJECTIVES:

COB1: To learn the Medicinal and aromatic plants status in world and India

COB2: To know about habit and habitat, geographical and systematics of medicinal plants of India

COB3: To have an idea about important aromatic plants, their industrial uses

COB4: To understand the growth and development process of MAPs

COB5: To understand the cultivation and trade of MAPs

MODULE I INTRODUCTION TO MEDICINAL AND AROMATIC PLANTS **9**

MAPs: definition, history, importance and future prospects. Medicinal Plants – past and present status in world and India. MAPs as industrial crops -constraints and remedial measures. Medicinal plant diversity & local healthcare. Medicinal plant conservation – issues and approaches. Medicinal plant conservation areas (MPCA), Non-timber forest products (NTFP),

MODULE II IMPORTANT MEDICINAL PLANTS

Important medicinal plants of India with their systematics, geographical distribution and uses. Acoruscalamus, Adhatodavasica, Abrusprecatorius Aloe vera, Phyllanthusamarus, Stevia rebaudiana, Belladona and Cinchona.

MODULE III INTRODUCTION AND SYSTEMATIC OF AROMATIC PLANTS **9**

Important aromatic plants of India with their systematics, geographical distribution and uses. Introduction and historical background of aromatic plants. Aromatic and cosmetic products. Rawmaterial for perfumes etc. Cosmetic Industries. Major, minor and less known aromatic plants of India. Taxonomic descriptions and uses of important aromatic plants–citronella, davana,damask rose, geranium, khus grass, large cardamom, lavender, lemon grass, mentha, holybasil, patchouli, rosemary Palmarosa, vetiver, artemisia, eucalyptus, thyme, marjoram and oreganum. Aromatic spices - clove, cinnamon, nutmeg, ajwain, dill, celery, tamarind, garcinia,curryleafandsaffron.

MODULE IV GROWTH AND DEVELOPMENT OF MAPS

Growth and development of MAP crops; Phases of growth; Factors affecting growth and development; Juvenile and reproductive phases; Physiology of flowering; Photoperiodism; Vernalisation; Maturation and ripening; respiratory

climacteric and non-climacteric; physiology and biochemistry of ripening. Senescence; Tuberization, formation of bulbs, rhizomes, corms etc. Role of plant growth regulators with special reference to MAPs; Integrated nutrient management; Weed management; Irrigation systems.

MODULE V CULTIVATION & TRADE OF MAPS

History, present status and future prospects of MAPs cultivation in India Development of agro-techniques of MAPs – including domestication, improved varieties, cultivation packages and economical viability. Selection of elite germ plasm for domestication. Appropriate harvesting techniques and season.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Cultivation of Medicinal and Aromatic Plants by A. A. Farooqi, (2004).
2. Salisbury, F.B. and Ross, C.W.: Plant Physiology,
3. Handbook of Medicinal and Aromatic Plants by S.K. Bhattacharjee (2004).
4. Indian Medicinal Plants by P.C. Trivedi (2009).
5. Hudsont: Plant propagation principles and practices

COURSE OUTCOMES:

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

CO1: Explain the significance, diversity, and conservation strategies of medicinal and aromatic plants in India and globally.

CO2: Identify and classify important medicinal and aromatic plants based on their taxonomy, geographical distribution, and ethnobotanical uses.

CO3: Discuss the systematics and industrial applications of aromatic plants, including their role in the production of cosmetic and perfumery products.

CO4: Analyze the physiological processes involved in the growth and development of MAP crops and the influence of environmental and hormonal factors.

CO5: Evaluate the cultivation practices, domestication strategies, and trade prospects of MAPs with emphasis on agro-techniques, economic viability, and germplasm selection.

Board of Studies (BoS) :	**Academic Council:**
9th BoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

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SDG15: Life on Earth

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LTEY 091	FUCNTIONAL FOODS AND NUTRACEUTICALS	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Students will be exposed to definition and marketing and regulatory aspects of functional foods and Nutraceuticals

COB2: Students will learn the basics of probiotics and its applications

COB3: Students will learn about the polyphenols and Phytoestrogens

COB4: Students will learn about active biodynamic principles in spices

COB5: Students will learn the non-nutrient effect of specific nutrients

MODULE I INTRODUCTION TO FUNCTIONAL FOODS AND NUTRACEUTICALS 9

Introduction to Functional Foods and Nutraceuticals: Eight categories of Functional foods Definition, History and Classification Perceived Effects of Functional Foods, Marketing and regulatory issues for functional foods and nutraceuticals Recent developments and advances in the area of nutraceuticals and functional foods.

MODULE II NUTRACEUTICAL CATEGORIES 8

Fortified Nutraceutical, Farmaceuticals/ Recombinant Nutraceuticals, Medicinal Food Dietary Supplement**,** Probiotics.

MODULE III POLYPHENOLS, PHYTOESTROGENS AND ORGANOSULFUR COMPOUNDS 9

Polyphenols: Flavonoids, Catechins, Isoflavones, Tannins, Phytoestrogens, Phytosterols, Glucosinolates, Pigments: Carotenoids, Lycopene, Curcumin Organosulphur Compounds-Introduction to Anti-nutritional Factors, Phytates.

MODULE IV ACTIVE BIODYNAMIC PRINCIPLES IN SPICES 10

An introduction to Active Biodynamic Principles in Spices, Condiments and Plant extracts, Active Biodynamic Principles in Spices, Condiments and Plant extracts: Resveratrol, Kaempferol, Quercetin, Cinnamaldehyde, Crocin, Luteolin, Condiments and Plant extracts - Capsaicin, Piperine, Gingerol, Eugenol, Rosemarinicacid, Apigenine, Thymoquinone.

MODULE V NON-NUTRIENT EFFECT OF SPECIFIC NUTRIENTS 9

Non-Nutrient Effect of Specific Nutrients: Conjugated Linoleic Acid, Omega 3 Fatty acids, Proteins and Peptides and Nucleotides, Vitamins, Minerals. Negative Sides of Nutraceuticals

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Wildman, R. E. (2016). Handbook of Nutraceuticals and Functional Foods. CRC Press

2. Gibson, G. R. and Williams, M. C. (2001). Functional Foods Concept to Product. CRC Press.

3. Vattem, D.A. and Maitin V. (2016). Functional Foods, Nutraceuticals and Natural Products, Concepts and Applications. DEStech Publications, Inc

4. Gupta, R. C. (2016). Nutraceuticals: Efficacy, Safety and Toxicity. Academic Press

COURSE OUTCOMES:

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

CO1: At the end of the course students learn the definition for functional foods and nutrition and the recent developments in the area.

CO2: Student learn the importance of probiotics

CO3: Students learn the structure and key aspects of poly phenols and phytoestrogens

CO4: They will learn about active biodynamic principles in spices.

CO5: They learn about non nutrient effect of specific nutrients

Board of Studies (BoS) :

9thBoS of SLS held on 20.08.2022

Academic Council:

19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

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SDG15: Life on Earth

Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

SEMESTER II

LTEY086	FOOD PROCESSING TECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1:.To know the principles and methods involved in the processing of Perishable and non -perishable foods

COB2: To develop skills in the perishable food processing equipment's

COB3: To develop the knowledge on preserving meat and sea foods

COB4: To develop the knowledge on preserving cereals

COB5: To gain knowledge on preserving spices

MODULE I FRUIT AND VEGETABLE PROCESSING 9

Fruit & Vegetable Processing- Classification, Pre- Processing, Processing & Preservation- Size reduction, Mixing, Separation, Concentration, Freezing & Refrigeration, Drying & Dehydration, Chemicals, Processing by using Pulsed Light and Irradiation; Nutritional losses during Processing, Fruit & Vegetable Intermediate moisture products, Storage.

MODULE II DAIRY PROCESSING 9

Dairy Processing- Milk Pre-Processing; Processing & Preservation - Separation, Homogenization, Pasteurization, Standardization, Sterilization (UHT), Evaporation (Spray Drying), Chilling, Freezing & Refrigeration; Nutritional losses during Processing; Milk Product & By Products; Storage.

MODULE III MEAT AND SEA FOOD PROCESSING 9

Fleshy Food Processing – Meat, Poultry& Egg - Pre-Processing; Processing & Preservation- Smoking, Canning, Drying, Cooling, Canning Pulsed Electric Field processing; Nutritional losses during Processing; Storage.

Sea Food Processing – Types; Pre-Processing; Processing & Preservation- Dielectric, Ohmic and Infra-red heating- Nutritional losses during Processing; Storage.

MODULE IV CEREAL TECHNOLOGY 9

Cereal Technology- Rice- Parboiling and milling methods, High-Pressure Processing, by products of rice milling and their utilization; Wheat- Milling, by- products of milling, Nutritional losses during Processing; Storage. Conventional and nonconventional foods- Breakfast, Extruded products.

MODULE V SPICE TECHNOLOGY 9

. Spice Technology (Indian) - Classification, Anti-Microbial & Antioxidant Properties, Processing, By-Products of Spices – Extraction of Oleoresin, Essential oil & Spice Blends, Medicinal Value of Spices; Nutritional losses during Processing; Storage.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. P.J.Fellows, Food Processing Technology. Principles and Practices, Second Edition, Woodland Publishing Ltd, Cambridge,England,2002.
2. Avantina Sharma, Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP, 2006.
3. Sivasankar, Food Processing and Preservation, Prentice hall of India Pvt Ltd,
4. NewDelhi.IIIrd Printing, 2005.
5. 4. Peter Zeuthen and Leif Bogh-Sorenson, Food Preservation Techniques, Woodland Publishing Ltd, Cambridge, England, 2005.

REFERENCES:

1. NIIR Board of Food and Technologist, Modern Technology of Food Processing and Agro based industries, National Institute of Industrial Research, Delhi, 2005.
2. Peter zeuthenand Leif Bogh- Sorensen, Food Preservation Techniques, Wood Head Publishing Ltd., Cambridge, England, 2005
3. Suman Bhatti, Uma Varma, Fruit and vegetable processing organizations and institutions, CBS Publishing, New Delhi, 1st Ediion- 1995.
4. MirdulaMirajkar, Sreelatha Menon, Food Science and Processing Technology vol-2, Commercial processing and packaging, Kanishka publishers, New Delhi- 2002.

COURSE OUTCOMES:

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

CO1: Fruits and vegetable processing

CO2: Dairy products processing

CO3: meat and sea food processing

CO4: processing of different type of cereals

CO5: processing of various types of spices

Board of Studies (BoS) :

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Academic Council:

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SDG 3. Good Health and Well Being

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SDG15: Life on Earth

Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

LTEY028	INDUSTRIAL AND PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basic principles of genetic variation in treatment response.

COB2: To learn the molecular and cellular biology to explain the genetic basis of variability in drug response

COB3: To understand the concept of pharmacogenomics in different therapeutic areas.

COB4: To identify important sources and reliable databases with pharmacogenomics knowledge base.

COB5: To understand pharmacogenomics in the therapeutic areas

MODULE I GENOMIC APPROACHES TO BIOLOGY 9

Introduction to ba

sic concept of pharmacogenomics. Importance, clinical application and challenges in Pharmacogenomics. Principles of Human Genomics, Application of Population Genomics to Genomic Medicine, Genomic Approaches to Complex Disease, Identifying Common and Rare Genomic Variations in the Population, Relating DNA Variation to Phenotypes, Human Health and Disease.

MODULE II EPIGENETICS AND THE ENVIRONMENT 9

DNA Methylation Patterns - Chromatin Modification and State of Activity of Genes, Epigenetics and Human Disease, Systems Biology and the Emergence of Systems Medicine, Multi -parameter Blood-borne Biomarkers Technology Platforms for Genomic medicine - DNA Sequencing for the detection of Human Genome Variation and Polymorphism Genome-Wide Association Studies and Genotyping, Copy Number Variation and Human Health.

MODULE III PROTEOMICS: THE DECIPHERING OF THE FUNCTIONAL GENOME 9

Gel-based and Solution-based Proteomics, Impact of Proteomics on Understanding Diseases, Comprehensive Metabolic Analysis for Understanding of Disease Mechanism: NMR-based Metabolic Profiling, Mechanisms Examples of NMR-based Metabolic Profiling in Disease Research, MS Methods for Targeted Metabolic Profiling, Examples of Targeted MS-based Metabolic Profiling for Understanding of Disease,

Comprehensive Analysis of Gene Function: RNA interference, Chemical Genomics and Gene Function Studies.

MODULE IV INFLUENCE OF PHARMACOGENOMICS BASED DRUG INTERACTIONS **9**

Introduction to proteins of importance in drug pharmacokinetics: Understanding the role of proteins involved in phase I drug metabolism, Proteins Involved in Pharmacogenetics: Pharmacogenetics of Phase I drug metabolizing enzymes, CYP2C9, CYP2D6, CYP2D19, Phase II Drug Metabolizing Enzymes, drug transporter pharmacogenetics, how genetic variation in drug transporters contribute to inter-individual differences in drug PK and PD.

MODULE V PHARMACOGENOMICS IN THERAPEUTIC AREAS **9**

Role of Pharmacogenomics in Drug Development: Pharmacokinetic profiles for metabolic CYP2D6 metabolizers (Metoprolol as Example Compound), Pharmacodynamic response profiles for metabolic CYP2D6 metabolizers (Metoprolol as Example Compound) Combined consideration and Clinical interpretation the of significance of CYP2D6 metabolizer status for metoprolol, Pharmacogenomics of Tamoxifin, Epidermal Growth Factor Receptors and KRAS.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. McLeod, et. al (eds.) (2009). Pharmacogenomics: Applications to Patient Care,2nd Ed. American Association of Colleges of Pharmacy.

COURSE OUTCOMES:

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

CO1: Interpret the parameters used in genomics and proteomics

CO2: Analyze the mechanism of epigenetics and Environment interaction.

CO3: Apply the principles and techniques like mass spectrometry, NMR, Metabolic Profiling for understanding of Disease Mechanisms, etc.

CO4: Evaluate the mechanism of action and clinical uses of few Pharmaceutical agents.

CO5: Create the therapeutic ideas using pharmacogenomics

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being
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SDG15: Life on Earth
Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

LTEY029	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the environment protection Act and Law related to environmental biotechnology

COB2: To give basic idea on environmental sample analysis

COB3: To understand the basic principles involved in waste water managemen

COB4: To get the information on usage of Bioremediation-biotechnology

COB5: To inform students about Biooxidation & microbial leaching

MODULE I INTRODUCTION TO ENVIRONMENTAL BIOTECHNOLOGY **9**

Water, Soil and Air: their sources and effects. Removal of Specific Pollutants : Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption& detoxification mechanisms. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Ecoplanning and Sustainable Development.

MODULE II ENVIRONMENTAL SAMPLE ANALYSIS **9**

Physicochemical and bacteriological analysis of soil and water, Problems associated with soil alkali soils, sodic soils, and solid waste, Fate of insecticides fungicides, pesticides in soil, use of genetically modified (insect- , pest- and pathogen resistant) plants. Ecotoxicology of soil pollutants, Municipal solid waste treatment strategies.

MODULE III WASTE WATER MANAGEMENT **9**

Waste water constituents, Analysis and selection of flow rates and loadings, Process Selection, Physical unit operations, Chemical unit operations, Fundamentals of biological treatment, Role of biotechnology in water purification systems. Types and kinetics of biological treatment, Advanced waste water treatment, Biological Processes for Industrial and domestic effluent, Treatment, Aerobic Biological Treatment, Anaerobic Biological Treatment.

MODULE IV BIOREMEDIATION-BIOTECHNOLOGY **9**

Bioremediation-Biotechnology for clean environment, Biomaterials as substitutes for non-degradable materials, Metal microbe interactions: Heavy

Metal Pollution and impact on environment, Microbial Systems for Heavy Metal Accumulation, Biosorption, molecular mechanisms of heavy metal tolerance Bioindicators and biosensors for detection of pollution. Biotechnology for Hazardous Waste Management, Persistent organic pollutants, Xenobiotics, Biological Detoxification of PAH, Biotechniques for Air Pollution Control. Solid Waste Management.

MODULE V BIOOXIDATION & MICROBIAL LEACHING 9

Biooxidation – Direct and Indirect Mechanisms – Biooxidation Kinetics; Bacterial oxidation of Sphalerite, Chalcopyrite and Pyrite.; Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology
2. Environmental Microbiology, W.D. Grant & P.E. Long, Blakie, Glassgo and London.
3. Microbial Gene Technology, H. Polasa (ED.) South Asian Publishers, Ne Delhi.
4. Biotreatment Systems, Vol. 22, D. L. Wise (Ed.), CRC Press, INC.
5. Standard Methods for the Examination of Water and Waste Water (14 Education), 1985. American Public health Association

COURSE OUTCOMES:

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

CO1: Describe pollutants and environmental laws for sustainable management of air, water, and soil.

CO2: Analyze environmental samples and assess impacts of agrochemicals and municipal waste on ecosystems.

CO3: Design wastewater treatment systems using physical, chemical, and biological biotechnological processes.

CO4: Evaluate bioremediation and biosensor strategies for detoxification of pollutants and heavy metals.

CO5: Assess microbial processes for metal extraction, petroleum recovery, and coal desulfurization.

Board of Studies (BoS) : 9thBoS of SLS held on 20.08.2022

Academic Council:
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29.09.2022

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LTEY 030	MOLECULAR DIAGNOSTICS	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Developing the basic concept of molecular diagnostics

COB2: Understanding the common procedures and which are used in disease diagnosis

COB3: To be familiar with various types of diseases diagnosis methods and progression of diagnosed disease.

COB4: Understand the concepts of different types of vaccines

COB5: Apply the new technologies in healthcare settings

MODULE I INTRODUCTION TO MOLECULAR DIAGNOSTICS 8

Collection, preservation and storage of clinical samples, biopsy, Principles, application and limitations of biological assays used in diagnosis- PCR, ELISA, FISH, gene sequencing, microarrays, protein arrays. GLP, SOP and ethics in molecular diagnostics.

MODULE II INFECTIONS 10

Infection and mode of transmission, types of infectious diseases- bacterial and fungal infections, diagnosis of infections caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium- diagnosis of fungal infections, major fungal diseases, Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses- pox virus, rhabdo virus, hepatitis; virus diagnosis of protozoan diseases- amoebiosis, malaria, trypanosomiosis, leishmaniasis- study of helminthic diseases- Fasciola hepatica and Ascarislumbricoides. Filariasis and Schistosomiasis. Diagnosis of chicken guinea and swine flu.

MODULE III CLINICAL GENETICS 10

Chromosomes chemistry and packaging, Cytogenetic, Structural and numerical abnormalities of chromosomes, Chromosome bands, banding techniques, mutation and polymorphism analysis, human genome project, cancer genetics- oncogenes, tumor suppressor genes- gene therapy, genetic counseling, nucleic acid hybridization techniques, Disease linked with mitochondrial DNA Genetic linkage and chromosome and genetic mapping in human diseases, Prenatal.

MODULE IV IMMUNODIAGNOSTICS 8

Introduction to immunodiagnostics, antigen-antibody reactions, antibody production, antibody markers, CD markers, FACS, Human Leukocyte Antigen (HLA) typing, agglutination (ABO/Bacterial), immunoprecipitation, immune diffusion, flocytometer.

MODULE V FORENSIC SCIENCE 9

Introduction to Forensic Science, DNA fingerprinting / DNA Profiling / DNA Testing in Forensic Science.; Ethics, Rules, and Procedures in DNA analysis. Autopsy and toxicological diagnosis. Determination of Paternity- Human identification and sex determination. semen analysis , Case study.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Carl A. Burtis, Edward R. Ashwood, Tietz Textbook of Clinical Chemistry, eds. Philadelphia, PA: WB Saunders, 1998
2. Lisa Anne Shimeld, Anne T. Rodgers, Essentials of Diagnostic Microbiology, Delmar Cengage Learning; New edition edition, 1998
3. John Crocker, David Burnett, The Science of Laboratory Diagnosis, Wiley, 2005

COURSE OUTCOMES:

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

CO1: Define the basic terminologies and concepts utilized in molecular diagnostics.

CO2: Recall the tools and techniques essential for disease diagnosis.

CO3: Interpret the structure of genome and its applications as diagnostics.

CO4: Explain the role of immunological assays in molecular diagnostics.

CO5: Identify the scientific applications of techniques used in molecular diagnostics.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

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LTEY 096	DAIRY TECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To acquaint with the properties and role of various constituents in milk, interaction and changes during processing.

COB2: To explore the importance of various processing techniques.

COB3: To understand the methods of the collection and transportation of milk to the dairy plant.

COB4: To know the processing and packaging materials and machineries for milk and milk products.

COB5: To study the chemistry of milk.

MODULE I INTRODUCTION 9

Definition, Indian Standards, Food and nutritive value of milk, Collection and transportation of Milk, Preservation at farm, Refrigeration. Colostrums and its properties and difference from normal milk, Legal standards of milk, Chemical test, Adulteration in milk and their detection, Elementary knowledge about indigenous and modern dairy products.

MODULE II DAIRY CHEMISTRY 9

Definition and structure of milk, factors affecting composition of milk, Physico-chemical properties of milk, Nutritive value of milk, Coagulation of milk with heat, acid, enzymes and alcohol. Nomenclature and classification of milk proteins, carbohydrates, lipids, Immmunoglobulin and other minor milk proteins, Milk enzymes.

MODULE III MILK PROCESSING TECHNOLOGY 9

Reception and treatment of milk at the dairy plant: Reception, Chilling, Clarification, Separation, Bactofugation and storage. Homogenization – Definition, Effect of homogenization on physical properties of milk.

MODULE IV THERMAL PROCESSING OF MILK 9

Definition, Theoretical basis of sterilization, Description of processes – Pasteurization, Thermization, Sterilization and Ultra-High-Temperature Processing (UHT), Process quality of sterilized milk.

MODULE V SPECIAL MILK 9

Manufacturing of Special Milk – Toned, Doubled Toned, Homogenized milk, Flavoured milk, standardized milk, rehydrated milk, recombinant milk, UHT milk.

L – 45; Total Hours – 45

TEXT BOOKS:

1. Jenness R and Patton S., Principles of dairy chemistry, John Wiley's, USA, 1959.
2. Khurody D. N., Dairying in India, Asia Publishing House, 1974.
3. Sukumar De, Outlines of Dairy Technology, Oxford University Press, India, 1980.
4. Modern Dairy Products, Lampert LH; Chemical Publishing Company. 1970.

REFERENCES:

1. P. F. Fox, Developments in Dairy Chemistry – Vol 1 & 2; Elsivier Applied Science Publishers, London & New York, 1985.
2. Khan A.Q, The technology of milk processing, 1991.
3. Manual for milk plant operations, Washington, 1957.
4. Kessler H.G., Food engineering and Dairy technology, 1981.

COURSE OUTCOMES:

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

CO1: Interpret the chemistry and composition of milk.

CO2: Analyze the chemical test required to test adulteration in milk.

CO3: Evaluate the methods of collecting and transporting milk to the dairy plant.

CO4: Analyze the techniques required for processing and packaging of different types of milk and milk products.

CO5: Apply the importance of various processing techniques in dairy industry.

Board of Studies (BoS) :
9th BoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

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LTEY 032	TISSUE ENGINEERING AND REGENERATIVE MEDICINE	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the fundamental and quantitative principles of cells, tissue and organs and the application of regenerative medicine.

COB2: Appreciate the important contribution of cell and tissue engineering in Producing / growing organs that can be used for therapeutic applications.

COB3: Discuss the use of stem cell in tissue engineering for wound healing and cell

COB4: Appreciate the need for compatible biomaterials to support growth and differentiation of stem cells into functional organ in clinical applications

COB5: Knowing the recent advancement in diagnosis, application and their patent and policies.

MODULE I INTRODUCTION TO CELLS, TISSUES AND ORGANS 9

Introduction to cells and tissue engineering, Cells and organs as therapeutic Agents with, current scope and developments; Cell numbers and growth rates. Measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

MODULE II CELL AND TISSUE ARCHITECTURE 9

Zygote formation, Anterior and posterior axis formation, formation of cells and organs. Tissue organization, Components and types. Tissue Dynamics, Homeostasis in highly prolific tissues and Tissue repair. VEGF/angiogenesis.

MODULE III INTERACTIONS 9

Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli. Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in-vitro, cryopreservation. Basis for Cell Separation, characterization of cell separation, methods of cell separation

MODULE IV ADVANCEMENT IN DIAGNOSIS 9

Neurotoxicity testing using stem cell-based screening assay; In-vitro models for cardiovascular diseases, neurological diseases. Biomaterials in tissue engineering, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials.

MODULE V CLINICAL APPLICATIONS 9

Stem cell therapy- Modelling endodermal diseases using stem cells, Molecular therapy, In- vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy. Stem cells and Gene therapy Physiological models, issue engineered therapies, Preservation –freezing and drying. Patent protection and regulation of tissue-engineered products, ethical issues

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Lanza, R, Atala, A. et al (eds) Principles of Regenerative Medicine, 3rd
2. Tissue Engineering", Bernhard O. Palsson, Sangeeta N. Bhatia, Pearson Prentice
Hall Bioengineering, 2003.
3. Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin,Lakshmi S. Nair, CRC Press, 2008.

REFERENCES:

1. Steinhoff, G. (ed). Regenerative Medicine, Springer, 2011.
2. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications, Nova Science Publishers, 2008.
3. Raphael Gorodetsky, Richard Schäfer..Stem cell-based tissue repair. RSC Publishing, 2011.
4. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two- Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004.
5. R. Lanza, J. Gearhart et al., (Eds), Essential of Stem Cell Biology, Elsevier Academic press,2006.
6. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine" Artech House, INC Publications, 2008.

COURSE OUTCOMES:

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

CO1: The ability to know the basics of cells, tissues and organs and also to execute the engineering design process

CO2: To identify problem, identify design constraints on bioengineering problem, create solutions

CO3: To evaluate solutions with respect to these constraints

CO4: Understanding and then execute key steps of the engineering design process, including identification of the problem, exploration of the problem, and design of a solution.

CO5: Overall, exposure to the role of tissue engineering and stem cell therapy in Organogenesis and for the development of human health

Board of Studies (BoS) :

9thBoS of SLS held on 20.08.2022

Academic Council:

19th Meeting of the Academic Council held on 29.09.2022

SEMESTER III

LTEY033	**COMPUTATIONAL BIOLOGY**	**L**	**T**	**P**	**C**
SDG: 3, 15		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: Understand the different level of Protein Structure.

COB2: The effect of the structural and functional role of the enzymes governing the metabolic processes.

COB3: Techniques involved in Structural Biology

COB4: In-silco methods to determine protein structure and analysis

COB5: Understanding of Predictive models and methods

MODULE I PROTEIN ARCHITECTURE 9

Bonds and energies in macromolecules- Covalent, Ionic, coordinate, hydrophobic and Vander walls interactions. Protein Architecture: amino acids structure and function, Primary, secondary, tertiary and quaternary structure of protein; Motifs and domains of protein structures; Conformational analysis, Protein Folding And Stability.

MODULE II ENZYMES 9

Enzymes: introduction to enzymes, how enzyme develop magic pockets, enzyme-ligand interaction, Structure-function relationship, Enzymes and Drug Design.

MODULE III BIOPHYSICAL TECHNIQUES 9

Rayleigh scattering, ultra-centrifugation, viscometry. Electron microscopy (SEM-TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, Mass spectrometry, LCMS, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials).

MODULE IV SPECTROSCOPIC TECHNIQUES 9

X-ray diffraction: structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy (structure determination). ORD/CD, UV, IR, Laser Raman, ESR/EPR.

MODULE V IN-SILICO PROTEIN STRUCTURE PREDICTION 9

Introduction to PDB data, RCSB, reading PDB files, Computational methods in protein Secondary structure prediction, Computational methods in protein

Tertiary structure prediction- Homology modelling, Visualization of macromolecules using Pymol and Coot

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Introduction to protein structure, C. Branden and J. Tooze
2. X-Ray Structure Determination: A Practical Guide, 2nd Edition, by George H. Stout, Lyle H. Jensen.
3. Principles of Protein Structure by G. E. Schulz., Springer 2009

REFERENCES:

1. Structural Bioinformatics, Philip E. Bourne, Helge Weissig, Wiley Publication
2. Crystallization of Biological Macromolecules, A. McPherson, Cold Spring Harbor Laboratory Press

COURSE OUTCOMES:

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

CO1: Levels of Protein Structure

CO2: Spectroscopic and Computational methods involved in structural biology

CO3: Importance o structure of proteins in Dug Design

CO4: skilled to handle phylogenetic data and application part

CO5: students will be able to analyze Protein structure, sequence analysis which can be used in analyzing the binding effect of drugs on proteins.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

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LTEY 034	REGULATORY AFFAIRS FOR BIOTECHNOLOGY	L	T	P	C
SDG: 3		3	0	0	3

COURSE OBJECTIVES:

COB1: To demonstrate through presentations and in discussions their understanding of different international policies, regulations and agreements that govern the use of biotechnology and show how these can be used as a framework for developing national Biosafety laws.

COB2: To understand the role of various authorities governing the research on biotechnology and production of biotechnology products

COB3: To get a deep understanding of public acceptance and controversial issue on biotechnology and genetically modified foods.

COB4: To discuss the influence of politics and science in the regulation of biotechnology.

COB5: To get familiarised with various standards and regulatory issues pertaining to biotechnology.

MODULE I INTRODUCTION 9

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation. ISO 9000 Series & International Harmonization & their effect upon GMP's.

MODULE II REGULATORY AUTHORITIES –INTERNATIONAL AND NATIONAL 9

Introduction on the regulatory system, International regulations on biotechnology, role of UNO, WHO. Cartagena Protocol on Biosafety, Convention on Biological Diversity (Biodiversity Convention) Treaty. FDA, CPSC, OSHA, etc., Biotechnology Regulatory Authority of India Act, 2009. Environmental protection Act of India. The Biotechnology Regulatory Authority of India (BRAI).

MODULE III RISK AND SAFETY APPROACHES 9

Concerns about genetically modified organisms- Socio-political attitudes and values- acceptance of particular applications of genetically modified foodsdemand for information about gm- issues of traceability of gm foods and

ingredients- non-involvement of public decision-making processes differences in food safety regulation in different jurisdictions- integrated assessment tools.

MODULE IV ETHICS 9

Ethical, Legal& Regulatory Aspects of the Biotechnology. International and national Food Regulations, Biomedical Software Regulation, Medical Device Regulation, Public awareness and acceptance of Biotechnology products. IPR on biologics.

MODULE V REGULATIONS 9

Regulations on production and marketing of rDNA products, GMOs, Biosimilars, and Biopharmaceuticals. Biotechnology-Based Cosmetics, National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and the Administrative Procedure Act (APA). Case study.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer to Consumer Sidney J. Willig, Marcel Dekker New York : Marcel Dekker, 2001
2. Quality Assurance & Regulatory Affairs for the Biosciencesm Jack O'Grady, Austin Community College, 2019
3. Publications of FDA,
4. Publications of CPSC
5. Publications of OSHA
6. The Regulatory Challenge of Biotechnology, Somsen, Han (EDT), Edward Elgar Pub2007
7. Publications of National Environmental Policy Act

COURSE OUTCOMES:

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

CO1: Demonstrate their understanding of different international policies, regulations and agreements that govern the use of biotechnology and show how these can be used as a framework for developing national biosafety laws.

CO2: Demonstrate using specific case-studies an understanding of the effectiveness and reliability of biosafety regulations in governing the use of biotechnology

CO3: Understand in written essays their understanding of consumer rights and why labelling of genetically modified foods has become such a controversial issue.

CO4: Discuss using presentations and in written essays the influence of politics and science in the regulation of biotechnology.

CO5: Explain in written assignments the risks and benefits of genetic modification from a regulatory perspective.

Board of Studies (BoS) :	**Academic Council:**
9thBoS of SLS held on 20.08.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

LTEY035	BIOSENSORS AND BIOCHIPS	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To provide the basic knowledge about the semiconductor and biological materials that can be used in bioelectronic devices.

COB2: To design circuits with operational amplifier for biomedical applications.

COB3: To provide the ability to design electronic instrumentation to assess physiological and molecular functions.

COB4: To interpret the specifications of MEMS used in various industries.

COB5: To design novel bio electronic devices with advanced features.

MODULE I BIOLOGY–MATERIALS INTERFACE: INTERFACIAL SCIENCE AND RECEPTOR INTEGRATION **9**

Immobilization of biomolecules by electropolymerized films, Scanning electrochemical microscopy for biomolecular immobilization and imaging, Modeling of Biosensor Interfaces

MODULE II MEASUREMENT IN BIO-SENSING MICROSYSTEMS **9**

Instrumentation for micro-sensors: Main electrical quantities measurement, voltmeter, ammeter, capacitance meter. Metrology : Uncertainty with the deterministic model, uncertainty propagation, instrumental uncertainty, systematic effects, errors, error corrections

MODULE III BIOMEMS AND NANOTECHNOLOGY **9**

Introduction to microelectro mechanical systems (MEMS), MEMS sensors, Intelligent sensors using MEMS: micro pump, micro cantilever beam; DNA Biosensors, multibiosensor, Lab-on-a-chip, nanosensors, nanoarrays and nanodevices, biochips; E-Nose, E-tongue; artificial auditory chips, artificial vision chips, artificial audio/ visual integrated systems based on brain information processing

MODULE IV TRANSDUCERS IN BIOSENSORS **9**

Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminiscene - based Biosensors.

MODULE V APPLICATIONS OF BIOSENSORS 9

Biosensors in clinical chemistry, health care, veterinary, agriculture and food. Low cost-biosensors for industrial processes for online monitoring; Biosensors for environmental monitoring. Design of enzyme electrodes and their application as medical biosensors.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons publishers, 1996.
2. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker,Inc, 1991.
3. Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.

REFERENCES:

1. Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes,1990.
2. Graham Ramsay - Commercial Biosensors, First edition, John Wiley &Sons,Inc. 1998.

COURSE OUTCOMES:

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

CO1: Identify appropriate semiconductor and biological materials for specific applications based on their characteristics.
CO2: Design circuits with operational amplifier for biomedical applications
CO3: Process the data for various bioelectronic industrial applications.
CO4: Interpret the specifications of MEMS used in various industries.
CO5: Design novel bioelectronic devices with advanced features.

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

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LTEY036	ETHICAL ISSUES IN BIOTECHNOLOGY AND ENGINEERING	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To demonstrate through presentations and in discussions their understanding of different international policies, regulations and agreements that govern the use of biotechnology and show how these can be used as a framework for developing national Biosafety laws.

COB2: Understanding the importance of following and maintaining laboratory safety guidelines

COB3: To get a deep understanding of public acceptance and controversial issue on biotechnology and genetically modified foods.

COB4: To discuss the influence of politics and science in the regulation of biotechnology

COB5: Developing a good work ethics and laboratory working condition

MODULE I ETHICS IN BIOLOGY 9

Principles and purpose of studying bioethics, legal, moral and ethical issues in biological research, human rights, privacy and justice, IPR and technology transfer

MODULE II BIOSAFETY 9

Biosafety in laboratory practices, laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, biosafety regulations in handling of recombinant DNA processes and products.

MODULE III ETHICAL ISSUES IN LABORATORY RESEARCH 9

Ethical issues and guidelines for research with laboratory animals, current uses of laboratory animals in biomedical research, animal experimentation using hazardous chemicals, animal care and maintenance, CPSEA guidelines for laboratory animals.

MODULE IV ETHICAL ISSUES IN CLINICAL RESEARCH 9

Ethical issues and guidelines for research with clinical samples and humans studies, Role of Institutional Human ethical board, ICMR's ethical guidelines and clinical trials registration in India and challenges in clinical trials.

MODULE V ETHICAL, LEGAL & REGULATORY ASPECTS OF THE BIOTECHNOLOGY 9

International and national Food Regulations, Biomedical Software Regulation, Medical Device Regulation, Public awareness and acceptance of Biotechnology products. IPR on biologics. Regulations on production and marketing of rDNA products, GMOs, Biosimilars, and Biopharmaceuticals.

L – 45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Thomas, J.A., Fuch, R.L. Biotechnology and Safety Assessment (3rd Ed). Academic Press, 2002
2. Fleming, D.A., Hunt, D.L. Biological safety Principles and practices (3rd Ed). ASM Press, Washington, 2000.
3. H.-J. Rehm and G. Reed, Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions, 2008
4. Biological Safety: Principles and Practices, 5th Edition Dawn P. Wooley (Editor), Karen B. Byers (Editor) Wiley, ASM Press, 2017
5. Biosafety in Microbiological Laboratories M. Muthuraj, B.Usharani, .S.Anbazhagi and C.K.Vidya Raj Notion Press; 1st edition (26 July 2019)

COURSE OUTCOMES:

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

CO1: an understanding of the legal, moral and ethical issues encountered in biological research.

CO2: an awareness regarding the safety protocols that need to be designed and followed in the laboratory setup

CO3: will get the knowledge regarding the Biosafety assessment fort the use of the genetically modified food crops through case studies

CO4: get the knowledge for gaining information on ethical clearance and· constitution of ethical committee for working on animal models

CO5: get the knowledge for gaining information on ethical clearance and constitution of ethical committee for working on clinical trials and human trials

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth

Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

LTEY 037	BIOREACTOR DESIGN AND ANALYSIS	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology.

COB2: To familiarize the basic concepts of bioreactor design.

COB3: To identify the issues and counter-act through design solutions during scale-up processes.

COB4: To elucidate the design principles of various modern bioreactors.

COB5: To model and simulate the processes in plant and animal cell bioreactors.

MODULE I CONVENTIONAL AND MODERN BIOREACTORS 9

Fundamentals of homogeneous reactions for batch / semi-batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor bubble column, air lift fermenter etc, stirred tank/mixed reactors., adiabatic and programmed reactors. Unconventional bioreactors: Hollow fiber reactor, membrance reactor, perfusion reactor for animal and plant cell culture.

MODULE II BIOREACTOR ANALYSIS 9

Analysis of ideal bioreactors: Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and wall growth, Ideal Plug-Flow Tubular reactor. Analysis of Nonideal Reactor Analysis: Concept of ideal and non-ideal reactor; residence time distribution; models of non-ideal reactors

MODULE III ENZYMATIC MEMBRANE REACTORS 9

Direct Contact Membrane Reactors, Diffusion Membrane Reactors, Multiphase Membrane Reactors. Applications of Enzymatic bioreactors: Hydrolysis of Macromolecules, Biotransformation of Lipids, Reactions with Cofactors, Biomedical Applications

MODULE IV COMPUTATIONAL FLUID DYNAMICS FOR BIOREACTOR DESIGN 9

Computational Fluid Dynamics modelling of multiphase flow, Eulerian–Lagrangian approach, Eulerian–Eulerian approach, Volume of fluid approach. Computational Fluid Dynamics simulations: Creation of Bioreactor Geometry, Meshing of Solution Domain, Solver.

MODULE V CHALLENGES IN MODERN BIOREACTOR DESIGN 9

Scale-up process issues and design solutions. design features: Bioreactors for Tissue engineering, Microbioreactors, Bioreactor-on-chip (BRoC), Single-use bioreactors

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Easter Ltd, New York, 5th Edition, 1999
2. Fogler, H. S., Elements of Chemical Reaction Engineering, Prentice Hall Pvt Ltd, 4th Edition, 2006

REFERENCES:

1. Smith, J.M., Van Ness, H.C., Abbott, M. M., Introduction to Chemical Engineering Thermodynamics , McGraw Hill, New York, 6th Edition, 2001.

COURSE OUTCOMES:

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

CO1: Gain advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology.

CO2: Familiarize the basic concepts of bioreactor design.

CO3: Identify the issues and counter-act through design solutions during scale-up processes.

CO4: Elucidate the design principles of various modern bioreactors

CO5: Model and simulate the processes in plant and animal cell bioreactors.

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth

Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

LTEY038	NANOBIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the basic concepts of Nanoscience relevant to the field of engineering

COB2: To provide an exposure about the importance of various synthesis method

COB3: To enrich the knowledge of students in various characterisation techniques

COB4: To make them to understand nanomaterials synthesis methods

COB5: To enrich the knowledge of students in various applications of nanomaterials

MODULE I INTRODUCTION & CLASSIFICATION OF NANOMATERIALS 9

Definition - Origin of nanotechnology - Difference between bulk and nanomaterialsTop-down and bottom-up processes - Size dependent properties (magnetic, electronic, transport and optical), Classification based on dimensional property - 0D, 1D, 2D and 3D nanostructures

MODULE II TYPES OF NANOMATERIALS 9

Metal oxides and metal nano particles - Ceramic nano particles - Semi conducting quantum dots - Core-shell quantum dots - Nanocomposites - Micellar nanoparticles.

MODULE III PRODUCTION OF NANOPARTICLES 9

Biosynthesis, Sol-gel, hydrothermal, solvothermal, Solution plasma, Plasma Arcing, Electro deposition, Pulsed laser deposition, Chemical vapour, deposition.

MODULE IV BIOMATERIALS 9

Biopolymers – Types and Classification, Structure and functions; Nanostructured polymers, Oligosaccharides, Peptides, Drug Delivery molecule, Targeted Drug delivery.

MODULE V CHARACTERISATION TECHNIQUES 9

Basic principles of scanning Electron Microscopy (SEM), Atomic force microscopy (AFM), Scanning tunneling microscopy (STM), Scanning probe

microscopy (SPM) and Transmission electron microscopy (TEM), Particle size analyzer, Luminescence techniques.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Hari Singh Nalwa, ―Handbook of Nanostructured Materials and Nanotechnology‖, Academic Press, 2000.
2. Guozhong Cao, ―Nanostructures and Nano materials-Synthesis, Properties and Applications‖, Imperial College Press (2011).
3. Zhong Lin Wang, ―Handbook of Nanophase and Nanomaterials (Vol 1 and II)‖, Springer, 2002.
4. Mick Wilson, Kamali Kannangara, Geoff smith, ―Nanotechnology: Basic Science and Emerging Technologies‖, Overseas press, 2005.

REFERENCES:

1. A. Nabok, ―Organic and Inorganic Nanostructures‖, Artech House, 2005.
2. C.Dupas, P.Houdy, M.Lahmani, Nanoscience: ―Nanotechnologies and Nanophysics‖, Springer-Verlag Berlin Heidelberg, 2007.
3. Mick Wilson, KamaliKannangara, Michells Simmons and BurkhardRaguse, ―Nano Technology – Basic Science and Emerging Technologies‖, 1st Edition, Overseas Press, New Delhi,2005.
4. M.S. Ramachandra Rao, Shubra SinghH, ―Nanoscience and Nanotechnology: Fundamentals to Frontiers‖, Wiley, 2013.

COURSE OUTCOMES:

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

CO1: Apply the knowledge of different types of nanomaterials for various engineering applications.

CO2: Acquire the knowledge of various methods of production of nanomaterials

CO3: Familiarize with various characterization techniques.

CO4: Familiarize with various synthesis of nanomaterials

CO5: Familiarize with various applications of nanomaterials

Board of Studies (BoS) :
9thBoS of SLS held on 20.08.2022

Academic Council:
19th Meeting of the Academic Council held on 29.09.2022

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of this course can help in maintains systems to promote good health and well being.

SDG15: Life on Earth

Statement: This course gives knowledge about the living and non living and relation with all the levels of life in the earth.

OPEN ELECTIVE COURSES

OEEY 701	ANALYTICAL TECHNIQUES	L	T	P	C
SDG: 6, 7		3	0	0	3

COURSE OBJECTIVES:

To make the students to understand the

COB1: basics in data analysis

COB2: basics and principles in volumetric and gravimetric analysis

COB3: types and principles of electro analytical methods

COB4: principles and analysis of spectroscopic techniques

COB5: the principle and methods in chromatography and thermal analysis

MODULE I DATA ANALYSIS 9

Precision and accuracy, Classification of errors, methods of minimization and elimination of errors Mean and standard deviation; absolute and relative errors; students t-test, F-test, linear regression for deriving calibration plots, covariance and correlation coefficient

Statistics for analytical experimentation: Probability, Regression analysis, Data analysis and signal enhancement.

MODULE II VOLUMETRIC METHODS OF ANALYSIS 9

Different methods of expressing concentration terms, Difference between titrimetic and volumetric analysis, Types and roles of indicators - Principle and reactions involved in neutralization, precipitation, complexometric and redox titrations, calculations involving stoichiometry – for all types of systems - Gravimetric analysis (volatilisation and precipitation methods)

MODULE III ELECTROANALYTICAL METHODS 9

Types of electrodes - Conductometric Titrations - Potentiometric titrations - pH-metry and ion-selective electrodes - Amperometric titrations - Coulometric Titrations, DM Electrode - polarography - electrogravimetry - voltammetry, cyclic voltammetry, impedance studies - Electrochemical sensors, ISFETs, CHEMFETs.

MODULE IV SPECTROPHOTOMETRIC TECHNIQUES 9

Quantitative applications of Colorimetric analysis – UV-Visible spectrophotometry – *Atomic absorption spectroscopy* (*AAS*) - atomic emission spectroscopy (AES), *Flame photometry*, ICP-AES - Fluorescence

spectroscopy, Stern Volmer Equation and quantum yield calculation.

MODULE V CHROMATOGRAPHIC TECHNIQUES AND THERMAL METHODS 9

Chromatography**:** Paper, TLC and column Chromatography – Detectors in Chromatography - GC, HPLC, (hyphenated techniques GC/MS, LC/MS) and GPC -– ion exchange chromatography – Electrochromatography**:** Capillary electrophoresis and gel electrophoresis

Thermal analytical techniques: TGA, DTA, DSC, DMA – Chemisorption Techniques – TPD, TPO, TPR, TPS.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., Fundamentals of Analytical Chemistry, 8th Edition, Thomson Brooks/Cole Publication., Singapore, 2004.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., Instrumental Methods of Analysis, 7th Edition, CBS Publication, New Delhi Reprint, 2004.
3. Skoog D.A., Holler F.J. and Nieman T.A., Principles of Instrumental Analysis, 5th Edition, Harcourt College Publication., Singapore, 1998.
4. Christian G.D., Analytical Chemistry, 6th Edition, John Wiley, Singapore, 2003.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
6. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004.

COURSE OUTCOMES:

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

CO1: analyse the numerical data without error

CO2: perform the volumetric and gravimetric analysis of chemical compounds and interpret the result

CO3: perform the electro analytical titrations and analyse the result

CO4: identify the appropriate spectral technique and do the spectral analysis and interpret the data

CO5: perform the chromatographic techniques and separate the compounds

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

SDG 6: Clean Water & Sanitation
SDG 7: Affordable and Clean Energy

Statement: Through various analytical methods, innovative, cheap and affordable materials can be developed and can be employed in the area of clean water, sanitation and energy

OEEY 702 ARTIFICIAL INTELLIGENCE AND IOT L T P C

SDG: 8 3 0 0 3

COURSE OBJECTIVES:

COB1: To learn the working of intelligent agents.

COB2: To study the various search techniques and optimization of search.

COB3: To represent knowledge in first order logic**.**

COB4: To know the fundamentals of IoT.

COB5: To learn the IoT architecture and protocol stack.

MODULE I ARTIFICIAL INTELLIGENCE INTRODUCTION 9

Artificial Intelligence Foundations - Artificial Intelligence History - Agents and Environments - Structure of Agents - Problem-Solving Agents - Search Algorithms - Uninformed Search Strategies - Informed (Heuristic) Search Strategies - Heuristic Functions.

MODULE II SEARCH OPTIMIZATIONS 9

Local Search and Optimization Problem - Continuous Spaces - Nondeterministic Actions - Partially Observable Environments - Online Search Agents and Unknown Environments - Constraint Satisfaction Problems – Backtracking Search – Adversarial Search and Games - Alpha Beta Search.

MODULE III KNOWLEDGE REPRESENTATION 9

Knowledge Based Agents – Propositional Logic – First Order Logic – Inference in First Order Logic – Forward Chaining – Backward Chaining.

MODULE IV IOT FUNDAMENTALS 9

Fundamentals of IoT – Characteristics of IoT – IoT architecture and Components – Logical Design of IoT – Communication Models – IoT Communication APIs.

MODULE V IOT ARCHITECTURE AND PROTOCOLS 9

Structure – Objectives – Three layer and Five Layer Architecture – Cloud and Fog based Architecture – IoT Network Protocol Stack - IoT Technology Stack – Case Study – Applications of AI in IoT.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, Fourth Edition, 2020. ISBN: 978-0134610993.

2. Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, Internet of Things (IoT): Principles, Paradigms and Applications of IoT, BPB Publications, First Edition, 2020, ISBN: ISBN: 978-9389423365.

REFERENCES:

1. S. Kanimozhi Suguna, M. Dhivya, Sara Paiva, Artificial Intelligence (AI): Recent Trends and Applications, CRC Press, 2021, ISBN: 978-0-367-43136-5.
2. Vlasios Tsiatsis, Stamatis Karnouskos, Jan, Internet of Things: Technologies and Applications for a New Age of Intelligence, 2nd Edition, Academic Press, 2019, ISBN: 978-0-12-814435-0

COURSE OUTCOMES:

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

- Identify the suitable search algorithms for solving problems.
- Employ AI adversarial game search techniques while evaluating the application of more real world problems.
- Use first order logic for wide variety of applications, from planning and diagnosis to knowledge representation and reasoning.
- Apply the technologies, standards, and protocols that are best suited for low-level sensor nodes.
- Determine the most appropriate IoT Devices and Sensors based on case Studies.

Board of Studies (BoS) :
21st BoS of CSE held on 27.02.2023

Academic Council:
20th AC held on 13.04.2023

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
Statement: The objective of AIoT is to improve human-machine interactions, IoT operations and data management and analytics.

OEEY 703	BIOMATERIALS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To enable the students understand importance of and properties of Biomaterials

COB2: To familiarize the students with different orthopaedic materials.

COB3: To understand different cardiovascular materials.

COB4: To help students study about materials in opthalmology

COB5: To make the students understand applications of various biomaterials

MODULE I BIOLOGICAL PERFORMANCE OF MATERIALS 9

Biocompatibility- Introduction to the biological environment – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – Host response: the inflammatory process - coagulation and hemolysis- approaches to thrombo- resistant materials development.

MODULE II ORTHOPAEDIC MATERIALS 9

Bone composition and properties - temporary fixation devices - joint replacement – Biomaterials used in bone and joint replacement: metals and alloys – Stainless steel, cobalt based alloys, titanium based materials – Ceramics: carbon, alumina, zirconia, bioactive calcium phosphates, bioglass and glass ceramics – polymers: PMMA, UHMWPE/HDPE, PTFE – Bone cement – Composites.

MODULE III CARDIOVASCULAR MATERIALS 9

Blood clotting – Blood rheology – Blood vessels – The heart – Aorta and valves – Geometry of blood circulation – The lungs - Vascular implants: vascular graft, cardiac valve prostheses, cardiac pacemakers – Blood substitutes – Extracorporeal blood circulation devices.

probability-internal conversion- nuclear isomerism.

MODULE IV DENTAL MATERIALS 9

Teeth composition and mechanical properties – Impression materials – Bases, liners and varnishes for cavities – Fillings and restoration materials – Materials for oral and maxillofacial surgery – Dental cements and dental amalgams – Dental adhesives.

MODULE V MATERIALS IN OPTHALMOLOGY 9

Biomaterials in ophthalmology – Viscoelastic solutions, contact lenses, intraocular lens materials – Tissue grafts – Skin grafts – Connective tissue grafts – Suture materials – Tissue adhesives – Drug delivery: methods and materials – Selection, performance and adhesion of polymeric encapsulants for implantable sensors-biomemtic materials-Technology from nature.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Sujata V. Bhat. Biomaterials, Narosa Publication House, New Delhi, 2002.
2. Jonathn Black. Biological Performance of Materials: Fundamentals of biocompatibility, Marcel Dekker Inc, New York, 1992.
3. D.F.Williams (editor). Materials Science and Technology: A comprehensive treatment, Volume 14. Medical and Dental Materials, VCH Publishers Inc, New York, 1992.
4. F.Silver and C.Doillon. Biocompatibility: Interactions of Biological and implantable materials. Volume I Polymers, VCH Publishers Inc, New York, 1989.
5. L.L.Hench and E.C.Ethridge. Biomaterials: An Interfacial Approach, Academic Press, 1982.
6. Joon Park, R. S. Lakes, Biomaterials. An Introduction, Springer, third edition, 2010. Springer

COURSE OUTCOMES:

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

CO1: importance and properties of biomaterial..

CO2: different classes of orthopaedic materials

CO3: different types of cardiovascular materials.

CO4: various types of materials used in ophthalmology.

CO5: applications of various biomaterials

Board of Studies (BoS) :	**Academic Council:**
BOS of Physics was held on 30.6.22	19th AC held on 29.09.2022

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 704	BIOMEDICAL INSTRUMENTATION	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the human physiological systems.

COB2: To know the different aspects of biosignal acquisition.

COB3: To understand the basics in biopotential recorders.

COB4: To know the importance methods, instruments available for biomedical field.

COB5: To analyze the special biomedical instrumentation systems.

MODULE I HUMAN PHYSIOLOGICAL SYSTEMS 9

Cells and their structure – Nature of Cancer cells – Transport of ions through the cell membrane – Resting and action potentials – Bio-electric potentials – Nerve tissues and organs – Different systems of human body. Biopotential Electrodes and Transducers Design of Medical instruments – components of the biomedical instrument system – Electrodes – Transducers.

MODULE II BIOSIGNAL ACQUISITION 9

Physiological signal amplifiers – Isolation amplifiers – Medical preamplifier design – Bridge amplifiers – Line driving amplifier – Current amplifier – Chopper amplifier – Biosignal analysis – Signal recovery and data acquisition – Drift Compensation in operational amplifier – Pattern recognition – Physiological Assist Devices. Pacemakers – Pacemakers batteries – Artificial heart valves – Defibrillators – nerve and muscle stimulators Heart – Lung machine – Kidney machine.

MODULE III BIOPOTENTIAL RECORDERS 9

Characteristics of the recording system – Electrocardiography (ECG) – Electroencephalography (EEG) – Electromyography (EMG) – Electroethinogrphy (ERG) and Electroculography (EOG) – Recorders with high accuracy – recorders for OFF line analysis.

MODULE IV OPERATION THEATRE EQUIPMENT 9

urgical diathermy- shortwave diathermy – Microwave diathermy – Ultrasonic disathermy – Therapeutic effect of heat – Range and area of irritation of different techniques – Ventilators – Anesthesia machine – Blood flowmeter – Cardiac

Output measurements – Pulmonary function analyzers – Gas analyzers – Blood gas analyzers – Oximeters – Elements of intensive care monitoring.

MODULE V SPECIALISED MEDICAL EQUIPMENTS 9

Blood Cell counter – Electron microscope – Radiation detectors – Photometers and colorimeters – digital thermometer – audiometers – X-rays tube – X-ray machine – image intensifiers – Angiography – Application of X-ray examination. Safety instrumentation: Radiation safety instrumentation – Physiological effects due to 50Hz current passage – Microshock and macroshock – electrical accident Hospitals – Devices to protect against electrical hazards – Hospitals architecture.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Arumugam M., Biomedical Instrumentation, Anurada Agencies Publishers, 1992.
2. Khandpur R.S., Handbook of Biomedical Instrumentation, Third Edition, Tata McGraw-Hill Education, 2014.
3. Shakti Chatterjee and Aubert Miller, Biomedical Instrumentation Systems, Cengage Learning Publisher, 2010.
4. Gromwell L., Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Second Edition, Prentice Hall, 1980.

COURSE OUTCOMES:

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

CO1: the human physiological systems.

CO2: the different aspects of biosignal acquisition.

CO3: different biopotential recorders such as EEG, ECG, EMG, EOG

CO4: biomedical instruments involved in advanced operation theatres

CO5: the application of biomaterials towards specialized medical equipment such as electron microscope and radiation detectors

Board of Studies (BoS) :	**Academic Council:**
BOS of Physics was held on 30.6.22	19th AC held on 29.09.2022

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 705	BIOPHOTONICS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To know the role of light and its interaction in the cells and tissues.

COB2: To understand the different imaging techniques for the biological systems.

COB3: To know the concepts of spectroscopy in biological applications.

COB4: To understand the optical force spectroscopy.

COB5: To understand the role of Biophotonic materials in applications.

MODULE I INTERACTION OF LIGHT WITH BIOLOGICAL SYSTEMS **9**

Interaction of light with cells, tissues, nonlinear optical processes with intense laser beams, photo-induced effects in biological systems.

MODULE II IMAGING TECHNIQUES **9**

Imaging techniques: Light microscopy, wide-field, laser scanning - confocal, multiphoton, fluorescence lifetime imaging, FRET imaging - Frequency-Domain lifetime imaging. Cellular Imaging - Imaging of soft and hard tissues and other biological structures.

MODULE III SINGLE MOLECULE SPECTROSCOPY **9**

Single molecule spectroscopy: UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics – IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

MODULE IV OPTICAL FORCE SPECTROSCOPY **9**

Optical Force Spectroscopy: Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems - single molecule biophysics, DNA protein interactions.

MODULE V BIOSENSORS **9**

Biosensors, Principles- DNA based biosensors – Protein based biosensors– materials for biosensor applications- fabrication of biosensors.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Prasad. P.N., Introduction to Biophotonics, John Wiley & Sons, 2003
2. Michael P. Sheetz, Laser Tweezers in Cell Biology (Methods in Cell Biology), Vol.55, Academic Press Publishers, 1997.
3. Ranier .W, Nanoelectronics and Information Technology, Wiley Publishers, 2012.
4. Drexler. K.E., Nanosystems: Molecular Machinery, Manufacturing and Computation, Wiley Publishers, 1992.

COURSE OUTCOMES:

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

CO1: Make clear insights into the applications of light interaction with biological systems.

CO2: Compare different imaging techniques

CO3: Understand and analyse the various spectroscopic techniques used in biological system.

CO4: Effectively grasp the usage of the optical force spectroscopy.

CO5: Get clear ideas and communicate about the importance of use of spectroscopy in design of bio-photonic devices.

Board of Studies (BoS) : BOS of Physics was held on 30.6.22

Academic Council: 19th AC held on 29.09.2022

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 706	DATA SCIENCE AND MACHINE LEARNING	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

CO1: To understand the needs of machine learning in Real Time.

CO2: To acquire knowledge about the data science in machine learning.

CO3: To study the Monte Carlo Sampling and processing.

CO4: To explore knowledge about real-time data analysis using various models.

CO5: To understand the deep learning.

MODULE I INTRODUCTION 9

Introduction to Artificial Intelligence - Machine Learning – Types of Machine Learning - Data preprocessing - Noise Removal - Data Transformation - Normalization - Importing, Summarizingand Visualizing Data – Statistics-Visualizing Data-Plotting Qualitative Variables and Quantitative Variables- Data Visualization in a Bivariate Setting

MODULE II MACHINE LEARNING ALGORITHMS 9

Introduction to Supervised and Unsupervised Learning-Linear Regression - Single Variable – Multivariate –Logistic - Naive Bayes - Decision Tree - Neural Network -Single Layer Perceptron - Multilayer BPN- Training and Test Loss-Statistical Learning-Estimating Risk-Modeling Data-Multivariate Normal Models-Bayesian Learning

MODULE III SAMPLING AND UNSUPERVISED LEARNING 9

Unsupervised Learning Algorithm -Clustering - Monte Carlo Sampling-Resampling-Markov Chain Monte Carlo-Monte Carlo Estimation-Monte Carlo for Optimization-Simulated Annealing – Cross-Entropy Method-Splitting for Optimization -Noisy Optimization-Risk and Loss in Unsupervised Learning – Expectation-Maximization (EM) Algorithm-EM Algorithm for Mixture Models-K-Means – KNN - Hierarchical

MODULE IV REGRESSION ANALYSIS AND REGULARIZATION 9

Linear Regression-Analysis via Linear Models-Model Selection and Prediction – Cross-Validation and Predictive Residual Sum of Squares-In-Sample Risk and Akaike Information Criterion-Inference for Normal Linear Models -Nonlinear Regression Models-Modeling Regularization-Reproducing Kernel Hilbert Spaces- Smoothing Cubic Splines- Gaussian Process Regression - Graphical Models - Bayesian Networks

MODULE V ADVANCED LEARNING 9

Semi-supervisory Learning - Reinforcement Learning Algorithm – Feed-Forward Neural Networks -Back-Propagation – QLearning-Methods for Training- Steepest

Descent- Levenberg–Marquardt Method - Limited-Memory BFGS Method- Adaptive Gradient Methods-Simple Polynomial Regression -Image Classification

L – 45 ; TOTAL HOURS – 45

REFERENCES:

1. Alex Smola, S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press, 2008.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Second Edition, Chapman & Hall/CRC, 2014.
3. Kroese, Dirk P., et al. Data science and machine learning: mathematical and statistical methods. Chapman and Hall/CRC, 2019.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: pre process the data

CO2: identify the suitable machine learning algorithm and apply the same to solve the given problem.

CO3: explain risk analysis and optimization algorithms.

CO4: apply the suitable regression method and regularization of data.

CO5: explore the applications of advanced learning.

Board of Studies (BoS):	**Academic Council:**
17th BoS of IT held on 28.02.2023	20th AC held on 13.04.2023

SDG 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work.

Statement: The Learning algorithms helps to design and develop solutions for solving real world application in any engineering domain.

OEEY 707	ELECTRIC VEHICLE AND BATTERY STORAGE TECHNOLOGY	L	T	P	C
SDG:8,9		3	0	0	3

COURSE OBJECTIVES:

COB 1: To study the concept of electric vehicles

COB2: To get familiarized with EV and PHEV Energy Storage Systems

COB3: To learn the basics of various electric drive trains

COB4: To study about sensors and electric vehicle control

COB5: To study about electric vehicle and its environmental impact.

MODULE I INTRODUCTION TO ELECTRIC VEHICLE (EV) 9

A Brief History -Technology, benefits and challenges in comparison with IC engine - EV classification and electrification levels - degree of hybridization - Concept of Hybrid Electric Vehicle (HEV) – Working Principle of an HEV drive train - concept of electric, hybrid electric and plug-in hybrid electric vehicles – HEV drive train topologies - plug-in HEV drive train topologies.

MODULE II EV AND PHEV ENERGY STORAGE SYSTEMS 8

Battery parameters - Types of Battery : Lithium – Nickel – Sodium – Zinc – Lead Acid - Coin cell - Rechargeable Battery sealing – Ideal model, Linear model, Thevenin model – Battery Cell Voltage Equalization – Onboard power electronics battery management – Equalizer chaining method. Electrical Modeling of Ultra capacitors, Flywheel Energy Storage Systems and Renewable Fuel Cell Power Sources.

MODULE III FUEL CELL AND HYBRID ELECTRIC VEHICLE DRIVE TRAIN 10

Component Stage Based Efficiency Analysis of Series and Parallel HEV Drive Trains - Varied Driving Patterns and Regenerative Braking Efficiency Analysis - Overall Electric Drive Train Efficiency Analysis - Fuel Cell HEV: Modeling and Control - Power Electronics Interface of Fuel Cell and Traction System - Concept of Fuel Cell Plug-in HEV (FC-PHEV).

MODULE IV SENSORS AND VEHICLE CONTROL 11

Introduction, Basic Sensor Arrangement, Types of Sensors, Oxygen Sensor, Cranking Sensor, Position Sensor, Engine Oil Pressure Sensor, Linear and Angle Sensor, Flow Sensor, Temperature and Humidity Sensor, Gas Sensor, Speed and Acceleration Sensor, Knock Sensor, Torque Sensor, Yaw Rate Sensors, Tire Pressure Sensor, Actuators.

Protocols: In vehicle Networking (IVN) - Local Interconnect Network(LIN) – Control Area Network (CAN) – Media Oriented System Transport (MOST) and FlexRay - Wireless Access in Vehicular Environment (WAVE).

MODULE V ENVIRONMENTAL IMPACT AND ENERGY MANAGEMENT 6

Vehicle pollution in context - alternative and sustainable energy used via the grid hybridization - V2G, G2V, V2B, V2H - energy consumption in braking and regeneration - brake system of EVs and HEVs.

L – 45; TOTAL HOURS:45

TEXT BOOKS:

1. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Springer, 2013.
2. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2nd edition, 2015.
3. M. Ehsani, Y. Gao, Stefano Lango, K.M.Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 3rd Edition,2018.

REFERENCES:

1. Tariq Muneer and Irene Illescas García, “The automobile, In Electric Vehicles: Prospects and Challenges”, Elsevier, 2017.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition, CRC Press, 2016.
3. Tom Denton, “Electric and Hybrid Vehicles” Routledge Publishers, 1st edition, March 2016.

COURSE OUTCOMES: At the end of the course, the student will be able to

CO1: identify the opportunities and challenges of advances in electric vehicles

CO2 : model battery system for any EV

CO3: model and choose a suitable drive scheme suitable for developing an EV

CO4: compute the performance parameter of sensors, actuators and to apply suitable technique for automotive communication

CO5: choose proper energy consumption method to integrate with grid

Board of Studies (BoS) : 18th BoS of EEE held on 10.02.2023

Academic Council: 20th AC held on 13.04.2023

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas to promote economic growth.

SDG No. 9 Industry, innovation and infrastructure

Statement:

The development of zero emission electric vehicles will meet out the desired needs such as new innovative systems for industry and establishing advanced infrastructure.

OEEY 708	GREEN BUILDING AND ENERGY	L	T	P	C
SDG: 11	MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

The objectives of the course are to impart knowledge on

COB1: the concept of green design

COB2: the basics of green design strategies

COB3: the elements of green building

COB4: the concept of green building materials

COB5: the concept of energy management.

MODULE I BASIC CONCEPTS 8

Green Design concepts and definitions - sustainability begins with climate - recent upsurge in the green building movement -incentives for building green - incentives and tax deductions-green building programs -defining sustainable communities-emerging directions- liability - spectacular landmarks

MODULE II DESIGN STRATEGIES 9

Conventional versus Green Delivery Systems- green design strategies- The Integrated Design Process (IDP) -the green-building project delivery process- the integrated multidisciplinary project team - design process for high-performance buildings -sustainable site selection-general considerations- site selection - development density and community connectivity –brown field redevelopment - alternative transportation -site development storm water design-heat-island effect - light-pollution reduction

MODULE III ELEMENTS OF GREEN BUILDING 9

Introduction to Green Building- Energy- Water- Materials and Resources - Sustainable Sites and Land Use - Indoor Environmental Quality- Life Cycle Assessment- Energy, water and materials efficiency- Commissioning process – fundamental commissioning –retro commissioning -enhanced commissioning

MODULE IV GREEN COMPOSITES FOR BUILDINGS 9

Concepts of Green Composites-low-emitting materials -adhesives, finishes, and sealants -paints and coatings- flooring systems- earthen building materials- building reuse -materials reuse- construction waste management-recycled materials regional materials- rapidly renewable materials- bamboo-cork - insulation- linoleum straw-

bale construction-wheat board - use and selection of green office equipment - certified wood- life-cycle assessment of building materials and products

MODULE V ENERGY MANAGEMENT 10

Energy Management – Definitions and significance – objectives – Characterising of energy usage – Energy Management program – Energy strategies and energy planning Energy Audit – Types and Procedure – Optimum performance of existing facilities – Energy management control systems- Low Energy Approaches to Water Management. Management of Solid Wastes.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Osman Attmann., “Green Architecture Advanced Technologies and Materials”, McGraw Hill, 2010.
2. Charles Kibert, J., “Sustainable Construction: Green Building Design and Delivery”, 2nd Edition, John Wiley and sons, 2007.
3. Moncef Krarti, “Energy Audit of Building Systems: an Engineering approach” CRC Press, LLC, Florida 2000.
4. “Alternative Building Materials and Technologies”. K.S.Jagadish, B.U. Venkataramareddy and K. S. Nanjundarao New Age International, 2007.

REFERENCES:

1. Doty S. and W. C. Turner, “Energy Management Hand book”, Fairmont Press, 2009.
2. LEED - Practices, Certification and Accreditation Handbook”. Sam Kubba, Butterworth-Heinemann, 2009.

COURSE OUTCOMES:

At the end of the course the student will be able to

CO1: describe the basics of green design concept.

CO2: explain the concepts of green design strategies.

CO3: illustrate the elements of green building.

CO4: summarize the different green building materials.

CO5: describe the concept of energy management.

Board of Studies (BoS) : 17th BOS of CE held on 10.08.2022

Academic Council: 20th AC held on 13.04.2023

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Statement : The understanding of basics of green concepts, materials, energy management and leads to the development of sustainable building

OEEY 709	INDUSTRY 4.0 AND APPLICATIONS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To describe the concepts, trends and the paradigm of Industry 4.0

COB2:To analyze the IoT technologies for practical IoT applications

COB3: To develop the ability to use Internet of Things related protocols and connectivity methods

COB4:. To elaborate the business issues in Industry 4.0.

COB5: To select the appropriate design concepts of Industrial IoT systems for various application

PREREQUISITES: Basic concepts in automation

MODULE I INTRODUCTION TO INDUSTRY 4.0 9

The Various Industrial Revolutions, Digitalization and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, The Journey so far: Developments in USA, Europe, China and other countries, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

MODULE II ROAD TO INDUSTRY 4.0 & RELATED DISCIPLINES 9

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics, Cyber physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Support System for Industry 4.0, Cyber Security.

MODULE III DATA INFORMATION AND COLLABORATION 9

Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0

MODULE IV BUSINESS ISSUES IN INDUSTRY 4.0 9

Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

MODULE V INDUSTRY 4.0 APPLICATIONS 9

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing the Digital Transformation”, Springer, 2017.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things" A press, 2017.
3. Deepak Gupta, Victor Hugo C. de Albuquerque, Ashish Khanna, Purnima Lala Mehta, "Smart Sensors for Industrial Internet of Things: Challenges, Solutions and Applications", Springer, 1st Edition, 2021.
4. Francis daCosta, “Rethinking the Internet of things: A Scalable Approach to Connecting Everything”, Apress, 2014.

REFERENCES:

1. Christoph Jan Bartodziej, "The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer, 2016.
2. Gary Smart, "Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, Web Sockets, and Python 3", Pckt Publishing, 2020

COURSE OUTCOMES:

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

CO1: apply the basic concepts and principles of Industry 4.0

CO2:identify, formulate and solve engineering problems using Industrial IoT

CO3:describe basics of cloud computing with IoT capability

CO4:discuss the challenges of the industry through IoT techniques

CO5:develop a domain specific IoT system

Board of Studies (BoS) :	**Academic Council:**
24th BOS of ECE held on 08.02.2023.	20th AC held on 13.04.2023

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation,

Statement: Able to apply the theoretical concepts for the various application in Industry 4.0

OEEY 710	NANOTECHNOLOGY AND	L	T	P	C
SDG: 6,7,9,15	CATALYSIS	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic knowledge on nanoscience and nanotechnology which includes the exotic properties of materials at nanoscale including various techniques for the processing of nanomaterials

COB2: various techniques available for the characterization of nanostructured materials

COB3: applications in selected fields and impacts of nanotechnology in ecosystem

COB4: Impart the basic concepts involved in catalytic processes.

COB5: Understand the importance of heterogeneous catalysis.

MODULE I INTRODUCTION AND PREPARATION OF NANOMATERIALS **9**

Introduction to nanomaterials, Properties of nanomaterials, Nanostructures: Zero-, One-, Two- and Three-dimensional structures, Surface Plasmon Resonance, Change of bandgap; Methods of preparation of nanomaterials, top-down approach and bottom-up: Chemical precipitation and coprecipitation; Sol-gel synthesis; Ball milling synthesis; lithography, Plasma Laser deposition (PLD) techniques, Thermolysis routes (Solvothermal, Hydrothermal and pyrolysis), Microwave assisted synthesis; Sonochemical synthesis; Electrochemical synthesis.

MODULE II CHARACTERIZATION TECHNIQUES **9**

Structural Characterization: X-ray diffraction, Scanning Electron Microscopy (SEM/HR-SEM/FE-SEM) with EDS, TEM (HR-TEM) and SAED analysis, Atomic force Microscopy (AFM). X-ray Photoelectron spectroscopy (XPS), Raman analysis. Introduction to advanced Scanning Probe Microscopy Techniques Scanning Tunnelling Mode (STM), Piezoelectric force microscopy (PFM). DLS and zeta potential analysis. BET surface area analysis, CHNSO micro analysis.

MODULE III APPLICATIONS AND ENVIRONMENTAL IMPACTS **9**

Current applications - Short-term Applications - Long - term Applications – Energy filed - solar cells, military battle suits. Biomedical applications – Photodynamic therapy in targeted drugs - quantum dot technology in cancer

treatment, MRI applications. Nanosensors: pH, heat, humidity, gas, toxic chemicals sensors and sensors for aerospace and defence – biosensors – water remediation - Environmental Impacts: toxicological health effects, relevant parameters in nanoparticles toxicology, integrated concept of risk assessment of nanoparticles.

MODULE IV CONCEPTS OF CATALYSIS 9

Acid-base catalysis – catalysis by transition metal ions and their complexes – supported transition metal complexes as catalysts – catalysis by enzymes – phase transfer catalysis - photocatalysis – adsorption – chemisorption on metals, metal oxides and semiconductors - kinetics of unimolecular and bimolecular surface reactions - Contact time - WHSV - time on stream - Catalyst deactivation and regeneration, TOF, TON.

MODULE V HETEROGENEOUS CATALYSTS 9

Metals, metal oxides, mixed metal oxides, supported metals, spinels, perovskites, super acids, hydrotalcites, zeolites and zeotypes (small, medium, large), shape selective catalysts, mesoporous materials (SBA, MCM, KIT, AlPOs, MOFs, COFs) Hydrothermal synthesis, sol-gel process, impregnation method, ion-exchange method - Operations in catalyst manufacture - drying, calcination, spray drying, Reactors- fixed bed and flow reactors.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill, New Delhi, 2007.
2. G. Cao, Nanostructures and Nanomaterials –Synthesis, Properties and Applications, Imperial College Press, London, 2004.
3. C. N. R. Rao, A. Muller and A. K. Cheetham, The Chemistry of Nanomaterials, Volume 1, Wiley –VCH Verlag GmbH & Co. KgaA, Weinheim, 2004.
4. G. A. Ozin, A. C. Aresnault, L. Cadematriri, Nanochemistry: A chemical approach to nanomaterials, RSC Publishing, 2008
5. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan Publishers India Limited, 2000.
6. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis

COURSE OUTCOMES:

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

CO1: differentiate the nanomaterials based on their dimensions and acquire knowledge of various synthetic methods

CO2: understand the components of instrumental techniques of and characterization techniques for structural and properties of nanomaterials

CO3: select the appropriate nanomaterials for specific applications in the interested arena

CO4: Find the fundamentals of catalysis

CO5: Evaluate significance of heterogeneous catalysts.

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

SDG 6: Clean Water and Sanitation
SDG 7: Affordable & Clean Energy
SDG 9 : Industry and Innovation
SDG 15 : Life on Land
Statement:
SDG 6, 7 & 9: Foundation to work in R&D of renewable energy and sensors sector and for teaching career.
SDG 15: R&D labs in API labs in the production novel materials for various applications

OEEY 711	PROJECT MANAGEMENT	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the concepts of organizational project management.

COB2: To acquire knowledge on leadership in project management.

COB3: To gain knowledge in stakeholder management and program management

COB4: To familiarize with the project scope and time management

COB5: To be conversant with project execution, monitoring and closing.

MODULE I INTRODUCTION – ORGANIZATIONAL PROJECT MANAGEMENT L:9

Introduction to Organizational Project Management- Organizational Project Management Framework- Project Linkages to Strategic Management - Relationships between Portfolio, Program, and Project Management - Organizational Issues and Project Management.

MODULE II PROJECT MANAGEMENT - LEADERSHIP L:9

Importance of Leadership in Project Management-Roles and Responsibilities of a Project Manager-Leadership vs. Management-Project Management Leader's Portfolio-Technical Management skills -Project Entrepreneurship skills- Project Leadership skills

MODULE III PROJECT STAKE HOLDER MANAGEMENT AND PROGRAM MANAGEMENT L:9

Project Stakeholder Management-Stakeholders Identification and Assessment - Stakeholders vs. Project Lifecycle - Stakeholders and Interested Parties- Program Management - Program Characteristics - Programs vs Projects - Programs vs Portfolios

MODULE IV PROJECT SCOPEAND TIME MANAGEMENT L:9

Project Scope: Planning, Defining, Verification and Change control -Project Activity sequencing -Precedence diagram method- Arrow diagram method – Project Activity Time Estimation -Tools for Activity Time Estimation -Schedule development – Resource levelling heuristics

MODULE V PROJECT EXECUTION,MONITORING AND CLOSING L:9

Execution phase overview-Delegating tasks -Assessing project status - Foreseeing future challenges - Managing progress and timeline adjustments Project execution guidelines - Monitoring phase overview - Key Performance Indicators -Evaluating progress-Assessing work quality -Setting quality assurance procedures -Monitoring risks -Closing phase overview -Obstacles in the closing phase -Evaluating project performance-Final reports and managing records -Project closing guidelines

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Projects: Planning, Analysis, Financing, Implementation and Review, Prasanna Chandra, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
2. Jack. R. Meredith, Samuel. J. Mantel & Scott. M. Shafer, Project Management in Practice, Fifth Edition, Bangalore: Wiley, 2015

REFERENCES:

1. Project Management and Control, Narendra Singh, Himalaya Publishing, New Delhi, 2015.
2. Bob Hughes, Mike Cotterrel “Software Project Management”, Tata McGraw-Hill, 2009
3. A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition, Author& publisher - Project Management Institute 2017
4. Lean Project Management: Philip Small, Arkham Publishing Limited, March 2020

COURSE OUTCOMES:

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

CO1:Explain the concepts of organizational project management

CO2: Discuss the leadership in project management.

CO3: Elucidate the stakeholder management and program management

CO4: Explain project scope and time management

CO5: Describe project execution, monitoring and closing

Board of Studies (BoS) :
21st BOS of Mechanical Engg. held on 10.02.2023.

Academic Council:
20th AC held on 13.04.2023

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The comprehensive understanding of Project management principles and techniques brings prosperity, create jobs, and build prosperous equitable societies across the country

OEEY 712	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
SDG: 4,9		3	0	0	3

COURSE OBJECTIVES:

COB1: To define the fundamental concepts of real time systems

COB2: To analyze the various uniprocessor and multiprocessor scheduling mechanisms

COB3: To develop knowledge on programming languages and tools for real time systems.

COB4: To discuss the overview of real time data bases

COB5: To classify the fault tolerance and evaluation techniques in real time systems.

PREREQUISITES: Embedded Systems, Operating Systems

MODULE I INTRODUCTION : EMBEDDED SYSTEMS & REAL TIME SYSTEMS **9**

Introduction –Embedded system - characterizing real time system -Performance Measures for Real Time Systems – Estimating Program Run Times – Task Assignment and Scheduling.

MODULE II PROGRAMMING LANGUAGES AND TOOLS **9**

Desired language characteristics – ADA language - Data typing – Control structures – Facilitating Hierarchical Decomposition- Packages- Run time Error handling – Overloading and Generics – Multitasking – Timing Specifications – Programming Environments – Run time support.

MODULE III REAL TIME DATABASES **9**

Basic Definition, Real time Vs General Purpose Databases- Main Memory Databases- Transaction priorities-Transaction Aborts-Concurrency control issues-Disk Scheduling Algorithms-Two – phase Approach to improve Predictability – Maintaining Serialization Consistency – Databases for Hard Real Time Systems.

MODULE IV REAL TIME COMMUNICATION **9**

Communications media, Network Topologies, Protocols- contention based, Token based, Stop-and-Go multihop, Polled Bus, Hierarchical Round Robin Protocol, Deadline-Based Protocols, Fault Tolerant Routing.

MODULE V FAULT TOLERANT AND EVALUATION TECHNIQUES 9

Fault Tolerance Techniques – Fault Types – Fault Detection-Fault and Error containment- Redundancy- Reliability Evaluation Techniques – Software error models.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. C.M. Krishna, Kang G. Shin, “Real – Time Systems”, McGraw – Hill International Editions, 2010.
2. Rajib Mall,”Real-time systems: theory and practice”, Pearson Education, 2007.

REFERENCES:

1. Xiaocong Fan, “Real-Time Embedded Systems: Design Principles and Engineering Practices”, Elsevier, 2015.
2. Albert M. K. Cheng, “Real-Time Systems: Scheduling, Analysis, and Verification“, Wiley publishers, 2003.
3. P. A. Laplante," Real-Time Systems Design & Analysis", Willey, 2011.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: describe the characteristics of real time system.

CO2: apply scheduling algorithms based on the application.

CO3: discuss about the programming language characteristics and tools of real time systems.

CO4: choose the appropriate real time communication protocols.

CO5: analyze the fault tolerance and evaluation techniques in real time systems.

Board of Studies (BoS) :
24th BOS of ECE held on 08.02.2023.

Academic Council:
20th AC held on 13.04.2023

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Statement: Understanding of the real time systems will bring practical knowledge on quality education.

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation
Statement: capable of promoting industrialization through the application of real-time system design principles.

OEEY 713	ROBOTIC TECHNOLOGY	L	T	P	C
SDG: 9		3	0	0	3

OBJECTIVES:

COB1: To study the basics of robotics technology.

COB2: To acquire knowledge about robot operating system.

COB3: To familiarize with robot assembly and aerial robots.

COB4: To learn about futuristic robots.

COB5: To know about the application of robots in various fields.

MODULE I INTRODUCTION L:6

Robot – Definition – Robot Anatomy – Co-ordinate Systems - Work envelope: Types and classification – Specifications – Pitch, Yaw, Roll, and Joint notations - Speed of motion - Pay load – Robot Parts and their functions – Need for robots.

MODULE II ROBOT OPERATING SYSTEM L:10

Master – Node – Topic – Messages – Subscriber – Publisher – Robot Operating System (ROS) packages – ROS file system – Services and actions – Custom publisher – Custom subscriber – ROS topic list and ROS topic information -ROS topic echo – ROS topic pub – Custom messages.

MODULE III ROBOT ASSEMBLY AND AERIAL ROBOTS L:12

Robotic assembly automation - Parts presentation methods - Assembly operations - Assembly system configurations - Design for robot assembly - Basics of aerial robots - Modelling and control of small Unmanned Aerial vehicles - Guidance and navigation of small range aerial robots.

MODULE IV FUTURE TECHNOLOGY L:9

Wheeled and legged Robot – Legged locomotion and balance – Arm movement, Gaze and auditory orientation control – Facial expression – Hands and manipulation – Sound and speech generation – Motion capture/Learning from demonstration.

MODULE V APPLICATIONS L:8

Implementation of Robots in Industries - Industrial application for material handling: machine loading and unloading, assembly, and inspection–Applications of robot in Arc welding, Spot welding, and Spray painting - Robots in Assembly operation, Cleaning and underwater applications –Applications of Robots in Agriculture, Mining, Defense, Nuclear, Medical, and Space.

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning.,2009.
2. Richard D. Klafter, Thomas. A, ChriElewski, Michael Negin, “Robotics Engineering an Integrated Approach”, Phi Learning.,2009
3. YoonSeokPyo, HanCheol Cho, RyuWoon Jung, TaeHoon Lim, ROS Robot Programming.
4. M.P.Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw Hill, 2001.

REFERENCES:

1. Bernard Hodges, “Industrial Robotics”, Second Edition, Jaico Publishing house, 1993.
2. Tsuneo Yohikwa, “Foundations of Robotics Analysis and Control”, MIT Press., 2003.
3. John J. Craig, “Introduction to Robotics Mechanics and Control”, Third Edition, Pearson,2008.
4. Craig.J. J, “Introduction to Robotics Mechanics and Control”, Addison-Wesley, 1999.Robotics Lab manual, 2007.

COURSEOUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of robots.

CO2: Elucidate robot operating system.

CO3: Discuss about robot assembly and aerial robots.

CO4: Describe the future robot technology.

CO5: Explain the applications of robots.

Board of Studies (BoS) :
21st BOS of Mechanical Engg. held on 10.02.2023.

Academic Council:
20th AC held on 13.04.2023

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic knowledge of robot technology, its operating system, and future robot helps in developing robots for various applications.

OEEY 714 SOFT COMPUTING TECHNIQUES L T P C
SDG:8,9 3 0 0 3

COURSE OBJECTIVES:

COB 1: To enumerate the strengths and weakness of soft computing
COB2 To focus on the basics of neural networks
COB3: To learn the basics of fuzzy systems and hybrid Neurofuzzy systems
COB4: To emphasize the role of evolutionary computing algorithms
COB5: To learn the ANN, FIS and GA tool boxes for various soft computing applications.

MODULE I BASICS OF SOFT COMPUTING 8

Soft computing – Hard Computing – Artificial Intelligence as the basis of soft computing – Relation with logic driven and statistical method driven approaches- Expert systems – Types of problems: Classification, Functional approximation, Optimizations – Modeling the problem – Machine Learning – Hazards of Soft Computing – Current and future areas of research.

MODULE II ARTIFICIAL NEURAL NETWORK 10

Artificial Neuron – Multilayer perceptron – Supervised learning – Back propagation network –Types of Artificial Neural Network: Supervised Vs Un Supervised Network – Radial basis function Network – Self Organizing Maps – Recurrent Network – Hopfield Neural Network – Adaptive Resonance Theory – Issues in Artificial Neural Network – Applications.

MODULE III FUZZY SYSTEMS 10

Fuzzy Logic – Membership functions – Operators – Fuzzy Inference systems – Other sets: Rough sets, Vague Sets – Fuzzy controllers - Cooperative Neuro fuzzy systems – Neural network driven fuzzy reasoning – Hybrid Neuro fuzzy systems – Construction of Neuro Fuzzy systems: Structure Identification phase, Parameter learning phase – Applications.

MODULE IV EVOLUTIONARY COMPUTING & ALGORITHMS 7

Overview of evolutionary computing – Genetic Algorithms and optimization – Genetic Algorithm operators – Genetic algorithms with Neural/Fuzzy systems – Variants of Genetic Algorithms– Population based incremental learning – Meta heuristic algorithms - Evolutionary strategies and applications.

MODULE V MATLAB TOOL BOX FOR SOFT COMPUTING 10

Artificial Neural Network (ANN) Toolbox - training and testing with different activation functions- controller design using ANN toolbox Fuzzy Inference System (FIS) Editor

and tool box- fuzzy controller design - Genetic Algorithm Toolbox - Application of ANN, FIS and GA tool box to various power system and control applications.

L – 45; TOTAL HOURS – 45

TEXT BOOK:

1. Samir Roy, “Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms”, Pearson, 2013

REFERENCES:

1. Anupam Shukla, Ritu Tiwari and Rahul Kala, “Real life applications of Soft Computing”, CRC press, 2010.
2. Fakhreddine O. Karray, “Soft Computing and Intelligent Systems Design: Theory, Tools and Applications”, Pearson, 2009
3. Matlab Simulink Manual

COURSE OUTCOMES: At the end of the course, the student will be able to

CO1: enumerate the theoretical basis of soft computing

CO2 : explain the Neural network architecture and different learning rules

CO3: apply the fuzzy systems and hybrid Neurofuzzy systems

CO4: demonstrate the different evolutionary and metaheuristic algorithms

CO5: demonstrate the most appropriate soft computing technique for a given situation using MATLAB tool box.

Board of Studies (BoS) :
18th BoS of EEE held on 10.02.2023

Academic Council:
20th AC held on 13.04.2023

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas to promote economic growth.

SDG No. 9 Industry, innovation and infrastructure

Statement:

The development of soft computing techniques will meet out the desired needs such as new innovative systems for industry and establishing advanced infrastructure.

OEEY 715	STRUCTURAL INTERPRETATION OF	L	T	P	C
SDG: 4, 9	MATERIALS	3	0	0	3

COURSE OBJECTIVES:

To use the concepts (basic and advanced level) of analytical methods for structure elucidation of materials and the students will be trained for the

COB1: Interpretation of electronic spectral data of materials

COB2: Interpretation of magnetic spectral data of materials

COB3: Interpretation of structural and morphological data of materials

COB4: Interpretation of thermoanalytical data of materials

COB5: Interpretation of electrochemical and XPS data of materials

MODULE I ELECTRONIC DATA 9

UV-visible, fluorescence and phosphorescence: Characteristic absorption of simple chromophoric groups, conjugated/ aromatic/ ligand systems, metal complexes and materials. FT-IR and Raman: Characteristic group frequencies of organic, inorganic molecules and various materials (polymer, nano, semiconducting) Interpretation of organic and inorganic and hybrid materials using combination of the spectral data.

MODULE II MAGNETIC AND MASS DATA 9

Solid-state nuclear magnetic resonance spectroscopy: Compounds containing ^{1}H, ^{13}C, ^{19}F,^{27}Al, ^{29}Si, and ^{31}P nuclei. Electron spin resonance (ESR): Simulation of ESR spectra of paramagnetic species, spin dynamics in solid and liquid. Mass spectrometry: The production and analysis of positive ions, molecular ions, application of isotopic abundance measurements, fragmentation modes and rearrangement of ions. Interpretation of organic, inorganic compounds and materials using combination of the spectral data.

MODULE III STRUCTURAL AND MORPHOLOGICAL DATA 9

Fundamental theoretical framework for diffraction (XRD) and imaging methods (SEM, TEM and AFM) used in structural and compositional characterization of materials in solid, film state etc.

MODULE IV THERMOANALYTICAL DATA AND SURFACE AREA 9

Interpretation of Differential Thermal Analysis (DTA), Thermo-gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC) data of various materials including inorganic complex, organic polymeric materials, composite, nano-composites etc; Surface area analysis; isotherms, types, BET surface area, pore dimensions, pore volume, etc.

MODULE V ELECTROCHEMICAL AND XPS DATA 9

Cyclic voltammetry for oxidation and reduction potentials, TAFEL polarization and Impedance spectroscopy for corrosion inhibitor behavior, chronoamperometry for charge or discharge of battery. X-ray photoelectron spectroscopy: Study the chemical composition and oxidation state of elements at the surface and interface. Applications of XPS in various arenas.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. R. S. Drago, Physical Methods for Chemists, W. B. Saunders,1992.
2. R. M. Silverstein, C. G. Bassler and T. C. Morril, Spectrophotometric Identification of Organic Compounds, 5th edition, Wiley, 1991.
3. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 3rd edition, McGraw Hill, 1980.
4. W. Kemp, Organic Spectroscopy, ELBS, 1979.
5. W. L. Jolly, The synthesis and characterization of inorganic compounds, Prentice-Hall, 1970.
6. John Wertz, Electron Spin Resonance: Elementary Theory and Practical Applications, Springer Science & Business Media, 2012.
7. R. F. Speyer, Thermal Analysis of Materials, CRC Press, 1994.
8. P.J. Goodhew, J. Humphreys and R. Beanland, Electron Microscopy and Analysis, Taylor & Francis, 2001.
9. John F Watts, John Woistenhoime, An introduction to surface analysis by XPS and AES, John Wiley and Sons, 2nd edition, 2003.
10. James, B. Condon, Surface Area and Porosity Determinations by Physisorption Measurement and Theory, Elsevier, 1st edition, 2006.

COURSE OUTCOMES:

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

CO1: Interpret electronic spectral data of materials

CO2: Interpret magnetic spectral data of materials

CO3: Interpret structural and morphological data of materials

CO4: Interpret thermo analytical data and porous nature of materials

CO5: Interpret electrochemical and XPS data of materials

Board of Studies (BoS):

12th BoS of Chemistry held on 2207.2022

Academic Council:

19th AC held on 29.09.2022

SDG 4: Quality Education
Statement: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.

SDG 9: Industry and Innovation
Statement: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.