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.Sc. (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.SC. 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.Sc. (BIOTECHNOLOGY)

PROGRAMME EDUCATIONAL OBJECTIVES:

The course aims to provide an advanced understanding of the core principles and topics of Modern day Biotechnology, 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:

- To provide strong fundamentals of biotechnology and its industrial application.
- To discover in depth knowledge of animal and plant biotechnology, and also broad area of biochemistry, Immunology and molecular biology
- It will provide the students to develop independent learning skills all biochemical and biotechnology studies.
- This course will provide the students to apply their knowledge and skills in their future professional areas.
- This course will help in contributing to the education of academics which impart its effect for university to play an active role in other advanced studies

PROGRAMME OUTCOMES:

After successfully completing this course, the student should be able to:

- Understand the basic knowledge and concepts of biotechnology and other related areas.
- Understand the ability to apply their knowledge for practical which they can conduct independently.
- Apply their knowledge in other advanced subject area like nanobiotechnology, immunotechnology, and animal and plant biotechnology for the betterment and advancement of their professional career.
- Learn the theoretical and practical exposure to the basic and the advanced fields of biotechnology.

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

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
14.	Arabic and Islamic Studies	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with Aalim Sanad / 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 oncerned, 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	Weightage of 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.Sc.BIOTECHNOLOGY

CURRICULUM FRAMEWORK, REGULATIONS 2022

(Choice Based Credit System)

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	LSE 6101	Plant and Animal Physiology	3	0	0	3
2.	PCC	LSE 6102	Advanced Biochemistry and Metabolic Regulation	4	0	0	4
3.	PCC	LTE 6105	Cell and Molecular Biology	3	0	0	3
4.	PCC	LSE 6105	Laboratory I (Biochemistry/ Microbiology/ Cell and Molecular Biology)	0	0	4	2
5.	CEC	ENE 6182	Professional Communication	2	1	0	3
6.	PEC		Professional Elective I	3	0	0	3
7.	PEC		Professional Elective II	3	0	0	3
			Credits				**21**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.		GEE 6202	Research Methodology and IPR	3	0	0	3
2.	PCC	LSE 6241	Bioinformatics	4	0	0	4
3.	PCC	LSE 6202	Immunotechnology	3	0	0	3
5.	PCC	LSE 6203	Genetics	3	0	0	3
6.	PEC	LSE 6204	Laboratary II (Bioinformatics/ Immunotechnology/ Genetics)	0	0	4	2
7.	PEC		Professional Elective III	3	0	0	3
8.	PEC		Professional Elective IV	3	0	0	3
			Credits				**21**

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	LSE 7101	Developmental Biology and Stem Cell Technology	3	0	0	3
3.	PCC	LSE 7102	Ecology and Environmental Biotechnology	3	0	0	3
4.	PCC	LSE 7103	Advanced Instrumentation	3	0	0	3
5.	PCC	LSE 7104	Laboratory III (Stem Cell Technology/ Environmental Biotechnology/ Bioinstrumentation)	0	0	4	2
6.	PEC		Professional Elective V	3	0	0	3
7.	PEC		Professional Elective VI	3	0	0	3
8.	PCC	LSE 7201	Project Work Phase I	0	0	12	4**
9.	PCC		MOOC course (related to the project)	0	0	0	0
10.		LSE 7105	Industry Internship #	0	0	2	2
			Credits				**22**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	LSE 7201	Project Work Phase II	0	0	32	16
			Total Credits				**4 + 16= 20**

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

LIST OF PROFESSIONAL ELECTIVE COURSES

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
			Semester I				
1.	PEC	LSEY101	Biostatistics	3	0	0	3
2.	PEC	LSEY102	Biosafety, Bioethics, Bioentrepreneurshipand IPR)	3	0	0	3
3.	PEC	LSEY103	Recombinant DNA Technology	3	0	0	3
4.	PEC	LSEY104	Medical Biotechnology	3	0	0	3
5.	PEC	LSEY105	Food Biotechnology	3	0	0	3
6.	PEC	LSEY106	Bioprocess Technology	3	0	0	3
			Semester II				
1.	PEC	LSEY201	Molecular Diagnostics	3	0	0	3
2.	PEC	LSEY202	Plant and Animal Biotechnology	3	0	0	3
3.	PEC	LSEY203	Protein Engineering	3	0	0	3
4.	PEC	LSEY204	Biofuels and Bioenergy	3	0	0	3
5.	PEC	LSEY205	Industrial Biotechnology	3	0	0	3
6.	PEC	LSEY206	Pharmaceutical Biotechnology	3	0	0	3
			Semester III				
1.	PEC	LSEY111	Nanobiotechnology	3	0	0	3
2.	PEC	LSEY112	Medical Coding	3	0	0	3
3.	PEC	LSEY113	Gene Manipulation	3	0	0	3
4.	PEC	LSEY114	Biomedical Instrumentation	3	0	0	3
5.	PEC	LSEY115	Tissue Engineering	3	0	0	3
6.	PEC	LSEY116	Antibody Engineering	3	0	0	3

LIST OF OPEN ELECTIVE COURSES OFFERED TO M.S.C. PROGRAMMES UNDER REGULATIONS 2022

Sl. No.	Course Code	Course Title	L	T	P	C	Offering Department / School
1.	OEEY 731	Advanced Materials for Energy Applications	3	0	0	3	Physics
2.	OEEY 732	Alternative Energy Resources	3	0	0	3	Chemistry
3.	OEEY 701	Analytical Techniques	3	0	0	3	Chemistry
4.	OEEY 733	Biomass for Energy Applications	3	0	0	3	Chemistry
5.	OEEY 703	Biomaterials	3	0	0	3	Physics
6.	OEEY 704	Biomedical Instrumentation	3	0	0	3	Physics
7.	OEEY 705	Biophotonics	3	0	0	3	Physics
8.	OEEY 734	Corrosion and Corrosion Control	3	0	0	3	Chemistry
9.	OEEY 735	Corrosion Science and Technology	3	0	0	3	Physics
10.	OEEY 736	Environmental Chemistry	3	0	0	3	Chemistry
11.	OEEY 737	Fuel Cells for Sustainable Energy Production	3	0	0	3	Chemistry
12.	OEEY 738	Green and Sustainable Chemistry	3	0	0	3	Chemistry
13.	OEEY 739	Industrial Pollution Control	3	0	0	3	Chemistry
14.	OEEY 740	Introduction to Embedded System	3	0	0	3	ECE
15.	OEEY 741	Matlab Programming	3	0	0	3	ECE
16.	OEEY 710	Nanotechnology and Catalysis	3	0	0	3	Chemistry
17.	OEEY 715	Structural Interpretation of Materials	3	0	0	3	Chemistry
18.	OEEY 742	Surface Coating Technology	3	0	0	3	Chemistry
19.	OEEY 743	Thin Film Science and Technology	3	0	0	3	Physics

SEMESTER I

LSE 6101	PLANT AND ANIMAL PHYSIOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Tolearnabouttransport of minerals, ions and water.

COB2: To knowabout transpiration, assimilation of nitrogen, photosynthesis and respiration in plants.

COB3: To have an idea about plant metabolites, biotic and abiotic stresses

COB4: To understand the different physiological (circulation, nervous, digestion and excretion) pathways in animals.

COB5: To understand the physiology of digestive and excretory processes in animals

MODULE I TRANSPORT IN PLANTS 9

Uptake, transport and translocation of water, ions solutes and nutrients by plants from soil. Transport through cells, across membranes, through xylem and phloem; Ascent of sap and transpiration, Essential nutrients, deficiencies and plant disorders, Physiology of assimilation of nitrate and ammonium, biological nitrogen fixation

MODULE II PHOTOSYNTHESIS AND RESPIRATION 9

Photosynthesis: Basic principles of light absorption, excitation energy transfer, Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways. Respiration: Glycolytic pathway, anaerobic respiration, Krebs cycle, Pentose phosphate pathway. Oxidative electron transport: Redox potential, electron carriers, Mechanism of oxidative electron transport and Oxidative phosphorylation. Mechanism of synthesis of ATP.

MODULE III PLANT STRESS PHYSIOLOGY 9

The abiotic environment and its Biological impact on plants, Water Deficit and Flooding, Temperature, high light and salinity stresses. Developmental and physiological mechanisms that protect plants against environmental extremes. Response of plant to biotic stresses(insects, pests, bacterial, fungal and viral pathogens)

MODULE IV PHYSIOLOGY OF CIRCUALTORY AND NERVOUS SYSTEM IN ANIMALS 9

Introduction of Circulatory system: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Vision, hearing and tactile response.

MODULE V PHYSIOLOGY OF DIGESTION AND EXCRETION IN ANIMALS 9

Patterns of digestion and absorption in animals, Role of digestive enzymes, Digestion, absorption and assimilation of various food stuffs, Functions of kidney, Types of nitrogenous wastes in different animal groups and their excretion, Urea production – Hans Krebs and Kurt Henseleit cycle, Urine formation, Osmoregulation.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. William S.Hoar- General and Comparative Physiology, prentice hall of India ltd.
2. Taiz, L., & Zeiger, E. (1991). *Plant physiology*. Redwood City, Calif: Benjamin/Cummings Pub. Co.
3. Wood E.W. Principle of Animal physiology
4. NagbhushnumR.,Sarojini R., Kodarkar M.S. –Animal Physiology

COURSE OUTCOMES:

CO1: Understandtheprincipleandconceptsrelatedtouptake and translocation of water, nutrients, and biomolecules from soil etc.

CO2: Getknowledgeabout energy metabolism (photosynthesis and respiration) in plants.

CO3: Understandthe effect of bioticandabioticfactorson growth and physiology of plants.

CO4: Familiar with concept blood circulation, blood groups and nervous system in animals

CO5: Understanddifferentpattern of digestion, digestive enzymes, excretory system of animals, kidney structure, function and osmoregulation process.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note:L- Low Correlation M -Medium Correlation H -High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of plant and animal biotechnology can help in the development of better crops and livestock that can contribute to good health and well being.

SDG15: Life on Earth

Statement: This course gives knowledge about the ways to create better plant, crop varieties and livestock that can contribute all the levels of life in the earth.

LSE 6102	ADVANCED BIOCHEMISTRY AND METABOLIC REGULATION	L	T	P	C
SDG: 3, 15		4	0	0	4

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 understand the regulation of metabolic pathways

MODULE I AMINO ACIDS & PROTEIN: STRUCTURE AND FUNCTIONS **12**

Amino acids- Classification, structure and function, proteins- primary, secondary, tertiary and quaternary structure, Ramachandran plot, super secondary structures and helix loop.

MODULE II ENZYMOLOGY **12**

Classification of enzymes. How do enzymes work: activation energy, substrate specificity. Enzyme-substrate interaction: Lock and Key mechanism and Induced Fit mechanism. Effect of temperature and pH on enzyme action. Enzyme Kinetics: Michaelis-Menten Equation, Km, Measurement of Km and Vmax (Lineweaver-Burk equation). Kinetics of multisubstrate reaction: Sequential reactions and ping-pong reactions. Enzyme inhibition: reversible (competitive, uncompetitive and mixed) and irreversible. Allosteric regulation of enzyme activity. Multienzyme complex and multifunctional enzymes.

MODULE III ENERGY PRODUCTION AND OXIDATIVE PHOSPHORYLATION **12**

Introduction to metabolism: Anabolism, catabolism, metabolic pathways. Characteristics of metabolic pathways

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.

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.

Lipid metabolism: Hormonal regulation of the mobilization of triglycerides from adiposities. Transport of fatty acid into mitochondria. Beta oxidation of saturated fatty acid (both even and odd). Regulation. Energetic.

Electron Transport Chain: structure and function of Electron carriers: Complex I—V. 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 METABOLIC INTERRELATIONSHIP 12

Starve-Fed cycle. Glucose homeostasis. Switching of metabolism of liver between starve and fed cycle. Metabolic relationship of tissues in various nutritional and hormonal states—insulin resistance, diabetes, exercise, pregnancy, lactation, stress, liver and renal diseases, alcohol consumption.

MODULE V REGULATORY MECHANISMS OF METABOLIC PATHWAYS 12

Feedback inhibition by allosteric modulation of enzymes. Covalent modifications of enzymes. Isozymes. Propetolytic cleavage. Regulationg the amount of enzyme—regulation gene expression in prokaryotes and eukaryotes.

L – 60; TOTAL HOURS –60

TEXT BOOKS:

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

COURSEOUTCOMES:

CO1: Various metabolic processes occurring in biological system and their role in governing homeostasis and normal physiology.

CO2: The importance of enzymes as a regulatory molecule in metabolism.

CO3: The interrelationship of metabolic pathways different physiological conditions.

CO4: The role of liver in regulating metabolism.

CO5: To understand the basic regulation of metabolic pathways

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note:L- Low Correlation M -Medium Correlation H -High Correlation

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 6105	CELL AND MOLECULAR BIOLOGY	L	T	P	C
SDG: 3		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 9

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.

MODULE II MEMBRANE TRANSPORT 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

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:

CO1: Appreciate the basic organization of organisms and living being

CO2: Understand the machinery of the cell that is ultimately responsible for various daily activities

CO3: Understand the basic organization of DNA

CO4: Appreciate the core genetic process of synthesis of mRNA and proteins

CO5: Acquire knowledge about biological problems that requires engineering expertise to solve them

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	M	H	M	L	L	-	L	-	-	-	L
CO2	H	M	H	M	L	L	-	L	-	-	-	L
CO3	H	M	H	M	L	L	-	L	-	-	-	L
CO4	H	M	H	M	L	L	-	L	-	-	-	L
CO5	H	M	H	M	L	L	-	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSE 6105	LABORATORY I(BIOCHEMISTRY/ MICROBIOLOGY/ CELL AND MOLECULAR BIOLOGY)	L	T	P	C
SDG: 3		0	0	4	2

COURSE OBJECTIVES:

COB1: To learn basic techniques in biochemistry, molecular biology, microbiology, plant and animal physiology

COB2: To study and to characterize biomolecules, extraction, identification and quantification

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

COB4: To estimate various biomolecules by biochemical assays

COB5: To estimate the effect of hormones on the biochemical assays

EXPERIMENTS

1. 1. Laboratory safety guidelines; Estimation and separation of proteins by
2. Beer- Lambert's Law - U UV-Vis Spectrophotometry – electrophoretic method (SDS-PAGE)
3. Isolation and purification of DNA & RNA from microbial system -quantitation- visualization
4. Polymerase Chain Reaction (PCR)
5. Sterilization techniques; Gram's staining and hanging drop for motilitytest
6. Selective media, enriched media, enrichment media and differentialmedia for isolation and characterization of microbes
7. Spore staining, Capsule staining and LPCB mount
8. Kirby-Baur antibiotic sensitivity test
9. To demonstrate osmosis in living plant cells by potato osmoscope.
10. To demonstrate the process of plasmolysis in onion cells.
11. Separation of plant pigments (chlorophyll) by Thin layerchromatography
12. Blood pressure measurement.
13. Observation of pulsation of the external jugular vein
14. Detection of Sugar According to Nylander and Fehling
15. The Effect of Insulin on Blood Glucose Level- Oral glucose

toleranceTest (OGTT).

P – 60; TOTAL HOURS – 60

TEXT BOOKS:

1. Michel R. G and Sambrook J. Molecular Coning- A laboratory manual. Cold spring harbor laboratory press, 2012.
2. Laboratory Exercises in Microbiology, Fifth Edition by Harley−Prescott, The McGraw−Hill Companies, 2002
3. Wilson K and Walker J, Principles and Techniques in PracticalBiochemistry, 5th Ed., Cambridge University Press, 2000
4. Holtzhauer M, Basic Methods for the Biochemical Lab, Springer, 2006. Nigam, Lab Manual in Biochemistry: Immunology and Biotechnology, Tata McGraw-Hill Education,2007.

COURSE OUTCOMES:

CO1: To understand the importance of laboratory safety and standardoperating procedures of common laboratory equipment

CO2: The students will be trained in performing routine molecular microbial techniques

CO3: Students will be able to isolate culture and identify microbes and also to efficiently use light microscope

CO4: The students will be trained in studying both plant and animal physiology

CO5: The students will be trained in estimating the effect of hormones on the biochemical assays

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

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	M	H	M	L	L	-	L	-	-	-	L
CO2	H	M	H	M	L	L	-	L	-	-	-	L
CO3	H	M	H	M	L	L	-	L	-	-	-	L
CO4	H	M	H	M	L	L	-	L	-	-	-	L
CO5	H	M	H	M	L	L	-	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

ENE 6182	PROFESSIONAL COMMUNICATION	L	T	P	C
SDG: 4 and 8		2	1	0	3

COURSE OBJECTIVES:

COB1: To enhance the Employability and Career Skills of students

COB2: To orient the students towards grooming as a professional

COB3: To make them Employability Graduates

COB4: To train students making effective presentations and discussionson various topics.

MODULE I COMMUNICATION AT WORKPLACE 6+1

Language and communication-Communication at the workplace- Formal and informal communication- Direction of flow of communication- Non-verbal communication- Communication and organizational culture-Communication and inter- personal relations- Importance of the 'U' in communication

MODULE II PRESENTATION SKILLS 6+5

(This module focuses more on the practical aspects of communication for career development.)

Importance of presentation skills-Overcoming the fear of public speaking towards making effective presentations- A step-by-step approach to presentations –planning the presentation-Gathering feedback- Making the presentation

MODULE III CORRESPONDENCE AT WORK 6+3

Importance of workplace correspondence-Types of correspondence-Mechanics of effective business correspondence-Tips for effective correspondence-The seven Cs of communication- Writing effective emails-Email etiquette-Personal touch in business communication

MODULE IV TEAMWORK 6+5

(This module focuses more on the practical aspects of communication for career development.)

Importance of team work-Understanding team behavior-Team as an employability skill- Team formation and development-Pooling competencies in a team- Significance of team spirit-How to be an effective team player – Group Discussion

MODULE V WORKPLACE ETIQUETTE 6+1

Etiquette in modern workplace- Workplace etiquette- global and local Culture sensitivity-Gender sensitivity- importance of grooming-Etiquette in interaction-Netiquette

L - 30, T - 15, TOTAL HOURS - 45

REFERENCES:

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. Interact English Lab Manual for Undergraduate Students,OrientBalckSwan: Hyderabad, 2016.
3. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
5. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010.

COURSE OUTCOMES:

CO1: Identify the flows of communication
CO2: Make effective presentations
CO3: Write effective business correspondences.
CO4: Participate in group discussions and teamwork confidently.
CO5: Follow appropriate workplace etiquette

Board of Studies (BoS) :	**Academic Council:**
15thBoS of the Department of English held on 14.6.2022	19th Meeting of the 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.

SEMESTER II

		L	T	P	C
GEE 6202	**RESEARCH METHODOLOGY AND IPR**				
SDG: 4, 9, 11 & 15		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

Students will be trained to

COB1: Basic concepts of Research.

COB2: Select and Define a research problem

COB3: Analyze and Interpret the Results

COB4: write Scientific and Technical reports & thesis

COB5: Apply the Copyrights, Patents and Intellectual Property Rights.

MODULE I INTRODUCTION TO RESEARCH METHODOLOGY 9

Research: Objectives, Motivation and types - Approaches, Significance of Research, Research process, Criteria of good research, Problems encountered by researchers - Introduction to ethics, scientific conduct and misconduct, misconduct and why it occurs, fabrication, authorship issues, The investigation and punishment of scientific misconduct (Erratum).

MODULE II RESEARCH FORMULATION AND DESIGN 9

Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, identifying gap areas from literature and research database, development of working hypothesis. Definition and importance of Journal Impact factor, Cite Scores and Citation Indexes.

MODULE III DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA 9

Observation and Collection of data, methods of data collection, sampling methods, data processing, analysis strategies and tools, data analysis with statistical tools (Sigma STAT, SPSS student, ANOVA), hypothesis testing. Importance and scientific methodology in recording results, importance of negative results, conceptions of error of measurement - absolute and relative errors, true score theory and generalisability theory. Measures of central tendency – mean median and mode.

MODULE IV SCIENTIFIC AND TECHNICAL WRITING 9

Different types of scientific and technical publications in the area of research - Technical writing skills for report, synopsis and thesis – organisation of contents and layout of the research reports, oral presentation, mechanics of writing a research report, precautions for writing research reports, conclusions. Preparing papers for international journals - software for paper formatting like LaTeX/MS Office, Grammarly - reference management software – Mendeley and detection of similarity index / plagiarism by Turnitin.

MODULE V INTELLECTUAL PROPERTY RIGHTS 9

The concept, Intellectual Property system in India, development of TRIPS complied regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, Commercialization, Copy Right, Royalty, Trade related aspects of Intellectual Property Rights (TRIPS); Geographical indications, Industrial designs, Enforcement of Intellectual Property Rights, Function of UNSECO in IPR maintenance. Patents, Patentable subject matter, Rights conferred, Exceptions, Term of protection, Conditions on Patent applicants, Process patents.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Cooper Donald R, Schindler Pamela S and Sharma JK., 2012. “Business Research Methods”, Tata McGraw Hill Education, 11e.
2. KothariC.R., “ResearchMethodology,MethodsandTechniques”, Wiley Eastern Ltd.,NewDelhi,1991.

REFERENCES:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
3. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes .
5. Essentials of Research Design and Methodology Geoffrey R. Marczyk, DavidDeMatteo,DavidFestinger,2005.JohnWiley&SonsPublishers,Inc
6. Biochemical Calculations: How to Solve Mathematical Problems in GeneralBiochemistry, 2nd Edition, Irwin H. Segel, 1976. John Wiley & Sons Publishers,Inc
7. RArora.EncyclopaediaofResearchMethodologyinBiologicalSciences., AnmolPublishing,2004.

8. CoghillM.andGardsonL.R.,TheACSStyleGuideEffectiveCommunicationofScientificInformation,3rdEdn.,OxfordUniversityPress,2006.

COURSE OUTCOMES:

The students will be able to

CO1: recognize the basic concepts of research and its methodologies

CO2:select and define appropriate research problem and parameters

CO3: apply packages for data collection, analyze and interpretation of data into reports.

CO4: write scientific report as journal article, thesis and technical proposal for funding.

CO5: propose research findings as publications, copyrights, trademarks and IPR.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO 1	PSO 2	PSO 3
CO1													M		
CO2			H					M						M	
CO3		H			M										
CO4													H		M
CO5										H			H		

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4 : Quality Education

SDG 9 : Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG 11 : Sustainable Cities and Communities

SDG 15 : Life on Land

Statement: The understanding of concepts of high quality research, innovative thinking, knowledge on sustainable development and service to the society and mankind through quality research.

LSE 6241	BIOINFORMATICS	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 TOBIOINFORMATICS AND DATABASES **10**

Introduction- scope- Historical account.Database Management Systems- Primary and Secondary databases- Genbank-EMBL- DDBJ -Sequence retrival, file formats and conversion tools, metabolic pathway databases Primer designing-tools and applications.

MODULE II MOLECULAR SEQUENCE ALIGNMENT **13**

Pair wise Alignment- Global Alignment- Local Alignment- Multiple Sequence Alignment methods. Phylogenetic Analysis: Construction of Phylogenetic trees - Distance Methods- Maximum Parsimony Method- Maximum likelihood method.

MODULE III OMICS, TYPES, METHODS AND APPLICATIONS **13**

Omics-Importance and applications Functional genomics- assigning the function, applications-Glycomics-databases and tools used and applications Lipidomics-role in disease and stress predictions, tools and applications Proteomics, metabolomics-tools and applications in bioinformatics

MODULE IV MOLECULAR MODELING AND DRUG DESIGNING **12**

Introduction to Protein Structure Prediction- Rational drug discovery- Recent advances in drug design methodologies- Structure-based drug design- Drug-receptor interactions- Structure-Activity Relationships.

MODULE V **RECENT ADVANCES IN COMPUTATIONAL BIOLOGY** **12**

Metagenomics-methods, prediction of new species,NGS-methods, applications and advantages, Cancer informatics-diagnostics and treatment of cancer Gene ontology-methods, databases, classifications, systems biology-introduction, databases and applications, Microarray-Types, methods, applications, databases and tools

L – 60; TOTAL HOURS –60

TEXT BOOKS:

1. Claverie J. M, Notredame C. Bioinformatics, Wiley Publishing, Inc. 2003
2. Dan.E.K, Michael L. R. Fundamental concepts in Bioinformatics. Ist Ed., Pearson Education. 2006.
3. David Mount. Bioinformatics: Sequence and Genome Analysis. CSHL Publisher, 2001.
4. Andreas D. Baxevanis& B.F. Francis Ouellellette. Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins, John Wiley & Sons, UK, 1998.
5. Higgins. D andTaylor W. Bioinformatics Sequence, Structure databanks.OUP Oxford, 2000.
6. Silberschatz A, Korth H. F, Sudarshan S. Database System Concepts. 3rd Ed., mcgraw-Hill, 2010.

COURSE OUTCOMES:

On completion of the course, the students will be able to understand the

CO1: history and importance of bioinformatics

CO2: Biological Databases and Data Retrieval,

CO3: Molecular Sequence Alignment

CO4: Grasp the principle involved Gene Prediction and

CO5: Phylogenetic Analysis and Molecular Modeling and Drug Designing.

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

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12
CO1	H	L	-	-	-	-			-	-	-	
CO2	H	L	-	-	-	-			-	-	-	
CO3	H	L	-	-	-	-			-	-	-	
CO4	H	L	-	-	-	-			-	-	-	
CO5	H	L	-	-	-	-			-	-	-	

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of bioinformaticswe can carry out data mining gene and protein expression patterns and modelling cellular 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 computer scientists in bioinformatics gives knowledge aboutrelation with all the levels of life in the earth.

LSE 6202	IMMUNOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: An understanding of immunity, history of immunology, cells and organ involved in immune system

COB2: An understanding of Antigen-Antibody interaction

COB3: An understanding of cytokines and complement system involved in immune system

COB4: An understanding of receptors, MHC class of molecules and regulation of immune response

COB5: Learning different techniques in immunology

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 antigenecity, 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 hematopoisesis. 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 immunocompetant cells, separation and purification of immunocompetant cells. Functional tests for immunocompetant cells and histocompatibility testing. Immunological assays complement fixation tests, In-vivo tests/ neutralization tests, immunodiffusion, immunoblotting, immunohistochemistry and immunofluorescenece techniques. Biosenor 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:

CO1: To learn the structural feature of the components of the immune system and their functions

CO2: Understanding the mechanisms involved in immune system development and responsiveness

CO3: To understand about how immunologist think and work

CO4: To learn clinical aspects of immunology

CO5: To learn regulation of immune responses

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	-	L	L	-	-	H	L	L	-	-	-	L
CO2	-	L	L	-	-	H	L	L	-	-	-	L
CO3	-	L	L	-	-	H	L	L	-	-	-	L
CO4	-	L	M	-	-	H	M	L	-	-	-	L
CO5	-	L	H	-	-	H	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of immunologywe 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 computer scientists in immunology gives knowledge aboutrelation with all the levels of life in the earth

LSE 6203	GENETICS	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basic concepts of genetics.

COB2: To appreciate Interactions and structural organization of genes and chromosome.

COB3: To emphasis significance of genetically important experimental organisms.

COB4: To understand the mechanism of genetic linkage, sex determination and mapping techniques

COB5: To acquire knowledge of Population genetics and evolutionary genetics. Manuscript discussion lectures will be designed to meet these criteria.

MODULE I INTRODUCTION TO GENETICS 9

Genetically important experimental organisms: Saccharomyces cerevisiae: Baker's Yeast, Arabidopsis thaliana: A Fast-Growing Plant, Drosophila melanogaster: The fruit fly. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid crosses, Law of segregation & Principle of independent assortment; test cross and back cross, chromosomal theory of inheritance.

MODULE II ALLELIC INTERACTIONS 9

Concept of dominance, recessive, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. Inheritance of linked genes - Coupling and Repulsion phase, gene mapping in Drosophila and maize using two point and three point test crosses with an emphasis on interference and coefficient of coincidence

MODULE III CHROMOSOME AND GENOMIC ORGANIZATION 9

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, gene function.

MODULE IV SEX DETERMINATION AND SEX LINKAGE 9

Genetic basis of sex determination in Drosophila and *S.alba*, Dosage

compensation; Sex -linked, sex-limited and sex-influenced characters, Extra-nuclear inheritance: Maternal effects; mitochondria and chloroplasts inheritance Male Sterility in plants and their applications.

MODULE V EXTRA CHROMOSOMAL INHERITANCE 9

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings. 5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

COURSE OUTCOMES:

CO1: Students will be able to understand basic concept of genetics and fundamental work of Mendel

CO2: Students will be able to understand how variation in traits appear and basic and higher order structural organization of gene.

CO3: Students will be able to understand the importance of repetitive sequence, mutation, and mechanistic detail of gene expression.

CO4: Students will know the role of mechanism of sex determination and chromosome mapping and linkage analysis.

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

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12

CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of geneticswe canunderstand the genetic basis of underlying diseases, 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 to geneticists that gives knowledge about relation with all the levels of life in the earth.

LSE 6204	LABORATORY II (BIOINFORMATICS/ IMMUNOTECHNOLOGY/ GENETICS)	L	T	P	C
SDG: 3, 15		0	0	4	2

COURSE OBJECTIVES:

COB1: To train in basic techniques involved in immunology, genetics and bioinformatics

COB2: To train the students involving antigen and antibody reactions

COB3: To engage students in the practical application of genetic principles

COB4: To inculcate skill of handling different bioinformatic database, plasmid construction, mappings and analysis

COB5: To train the students in protein structure prediction, sequence homology mapping.

EXPERIMENTS

1. Blood group mapping
2. Isolation of peripheral blood mononuclear cells
3. Identification of immune cells in a blood smear
4. Immunodiffusion – Ouchterlony Double Diffusion, Radial Immuno diffusion and Immunoelectrophoresis
5. Enzyme Linked ImmunoSorbent Assay (ELISA) - detection of antigens and antibodies - DOT ELISA
6. Study of divisional stages in Mitosis and meiosis
7. Estimation of amount of chlorophyll present in the leaf tissue
8. DNA isolation and Polymerase Chain Reaction (PCR)
9. Restriction Enzyme Digestion and Gel Electrophoresis
10. Bacterial Transformation
11. Human Karyotype analysis
12. Simple Mendelian traits in humans and pedigree analysis
13. Plasmid Construction/Restriction Mapping
14. PCR Primer Designing
15. Sequence Retrieval and Format Conversion
16. Homology Search/ Multiple Sequence Alignment
17. Motif finding in DNA and Protein Sequences
18. Protein Secondary Structure Prediction

P – 60; TOTAL HOURS –60

TEXT BOOKS:

1. Rose et al., Manual of Clinical laboratory Immunology, 6th Ed ASM Publications, 2002.

2. Lefkovis and Pernis. Immunological methods. Academic Press, 1978
3. Hudson L. and Hay F.C. Practical Immunology. Black Well publishers, 1989
4. G. Koliantz and D.B. Szymanski. Genetics A Laboratory Manual, 2nd edition Spi Lab Edition, 2009.
5. Rashidi H, Buehler L. K. Bioinformatics Basics: Applications in Biological Science and Medicine. 2nd Ed., CRC Press, 2005.
6. 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.
7. Krawetz S. A, Womble D. D. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana press, 2003

COURSE OUTCOMES:

CO1: Students will develop the skill to perform diagnostics assays involving antigen antibody reaction.

CO2: They will also learn to perform the qualitative and quantitative analysis using antibodies.

CO3: Students will analyze and understand cell cycle, karyotyping, mendelian inheritance and pedigree charts

CO4: Students will be trained with various soft skills/tool used in bioinformatics

CO5: They will also become skilled to be able to analyze and interpolate data starting from PCR primer designing to structure predictions.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of techniques taughtwe canunderstand the genetic basis of underlying diseases, 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 to geneticists that gives knowledge about relation with all the levels of life in the earth.

SEMESTER III

LSE 7101	**DEVELOPMENTAL BIOLOGY AND STEM CELL TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 3, 15		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To understand the basic concepts of genetics.

COB2: To appreciate Interactions and structural organization of genes and chromosome.

COB3: To emphasis significance of genetically important experimental organisms.

COB4: To understand the mechanism of genetic linkage, sex determination and mapping techniques

COB5: To acquire knowledge of Population genetics and evolutionary genetics. Manuscript discussion lectures will be designed to meet these criteria.

MODULE I CONCEPTS OF DEVELOPMENT 9

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages.

MODULE II GAMETOGENESIS, FERTILIZATION AND EARLY DEVELOPMENT 9

Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryo sac development and double fertilization in plants; embryogenesis; seed formation and germination.

MODULE III MORPHOGENESIS AND ORGANOGENESIS IN PLANTS AND ANIMALS 9

Cell aggregation and differentiation; axes and pattern formation in Drosophila; organogenesis – vulva formation, limb development and regeneration in vertebrates; post embryonic development, metamorphosis; Organization of shoot and root apical meristem; shoot, root and leaf development; transition to flowering; Programmed cell death, aging and senescence.

MODULE IV INTRODUCTION TO STEM CELLS 9

Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells; types of stem cells: embryonic stem cell, adult stem cell; stem cell biology and therapy, culture and the potential benefits of stem cell technology module .

MODULE V THERAPEUTIC APPLICATION 9

Gene therapy: introduction, history and evolution of gene therapy, optimal disease targets, failures and successes with gene therapy and future prospects; Genetic perspectives for gene therapy, Gene delivery methods: viral vectors and non-viral vectors .

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Gilbert, S. F. (2010). *Developmental biology*. sinauer associates, Inc.
2. Marshak, D. R., Gardner, R. L., & Gottlieb, D. I. (Eds.). (2001). *Stem cell biology*. Cold Spring Harbour Laboratory Press.
3. Quesenberry, P. J., Stein, G. S., Forget, B. G., & Weissman, S. M. (Eds.). (1998). *Stem cell biology and gene therapy*. John Wiley & Sons.
4. Wolpert, L., Tickle, C., & Arias, A. M. (2015). *Principles of development*. Oxford University Press, USA.

COURSE OUTCOMES:

CO1: Students will be able to understand basic concept of genetics and fundamental work of Mendel

CO2: Students will be able to understand how variation in traits appear and basic and higher order structural organization of gene.

CO3: Students will be able to understand the importance of repetitive sequence, mutation, and mechanistic detail of gene expression.

CO4: Students will know the role of mechanism of sex determination and chromosome mapping and linkage analysis.

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

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of techniques taughtwe canunderstand the genetic basis of underlying diseases, that will help in good heath and well being.

SDG15: Life on Earth

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

LSE 7102	ECOLOGY AND ENVIRONMENTAL BIOLOGY	L	T	P	C
SDG: 13, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the fundaments of the environment

COB2: To understand ecological principles and flow of energy

COB3: To familiarize with different environmental regulations

COB4: To study the causes and effects of climate change

COB5: To study the contributions of microbes in the remediation of pollutants

MODULE I THE ENVIRONMENT 9

Physical environment, biotic environment, biotic and abiotic interactions; Habitat and Niche: Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

MODULE II POPULATION ECOLOGY 9

Characteristics of a population: population growth curves, population regulation, life history strategies (r and K selection); Species Interactions: types of interactions, interspecific and intraspecific competitions.

MODULE III COMMUNITY ECOLOGY 9

Nature of communities: community structure and attributes, levels of species diversity and its measurement, edges and ecotones; Ecological Succession: types, mechanisms, changes involved in succession; concept of climax; Ecosystem Ecology: ecosystem structure, ecosystem function, energy flow and mineral cycling, primary production and decomposition.

MODULE IV ENIRONMENTAL CONCERNS AND LAWS 9

Environmental pollution; global climate change; Biodiversity: status and monitoring, major drivers of biodiversity change; Environment protection Act: Environmental laws, Environmental policies; Environmental protection and conservation; Environmental Impact Assessment; Ecoplanning and Sustainable Development.

MODULE V BIOREMEDIATION 9

Biotechnology for clean environment; Metal microbe interactions: microbial systems for heavy metal accumulation, biosorption, molecular mechanisms of heavy metal tolerance; Biotechnology for hazardous waste management, POPs, xenobiotics, PAHs; Solid waste management: composting, vermicomposting,

landfilling, and incineration.

L –45 ; Total Hours –45

TEXT BOOKS:

1. Ecology: principles and applications. Chapman, J. L., & Reiss, M. J. Cambridge University Press, 1999.
2. Fundamentals of Ecology. Odum, E., & Barrett, G. W. Cengage Learning, 2004.
3. Ecology and environment. Sharma, P. D., & Sharma, P. D. Rastogi Publications, 2012.

COURSE OUTCOMES:

CO1: At the end of this course students are expected to understand the components of environment.

CO2: Should be able to understand the interactions between different life forms in an environment.

CO3: Comprehend and appreciate the key ecological processes.

CO4: Understand the causes and implications of climate change.

CO5: Able to use appropriate microbes for the remediation of pollutants.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of techniques taughtwe canunderstand the genetic basis of underlying diseases, that will help in good heath and well being

SDG15: Life on Earth

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

LSE 7103	ADVANCED INSTRUMENTATION	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the electrochemical techniques and principles of centrifugation and spectrophotometry.

COB2: To learn the principles of chromatography

COB3: To understand the information of radioactive methods, detection and measurement of radioactivity.

COB4: To learn the principles of microscopy

COB5: To learn the principles of electrophoresis

MODULE I ELECTROCHEMICAL TECHNIQUES 09

Basic principles of Electrochemical Techniques- - pH electrode, Ion selective-gas-sensing and oxygen electrodes- biosensors. Centrifugation- basic principles-instrumentation- Centrifugation- centrifugation units-types of centrifuges-colloidal nature of particles-centrifugation methods and accessories- sedimentation velocity-sedimentation equilibrium-cell fractionation methods.

MODULE II SPECTROPHOTOMETRY 09

Principles and techniques of colorimetry and spectrophotometry-Beer-Lamberts Law -instrumentation - qualitative and quantitative methods of analysis- hypo and hyper chromicity- coupled assays –Spectrofluorimetry-Turbidimetry - Flame and Atomic absorption Spectrophotometer and Mass spectrometer. Chromatography- types- column, thin layer, paper, adsorption, partition, gas, liquid, ion exchange, affinity, HPLC- principles of each type-instrumentation and accessories- detection methods and systems qualitative and quantitative aspects-applications.

MODULE III MICROSCOPY 09

Basic principles of Microscopy and application of Light, Compound, Phase contrast inverted microscopy; Scanning Electron Microscopy (SEM)-Transmission Electron Microscopy, (TEM)- Fluorescence Microscopy-Scanning Tunneling Microscopy-(STM)- Automated Fluorescence Microscopy - Confocal Microscopy.

MODULE IV ELECTROPHORESIS 09

Types of Electrophoresis- paper and gel-agarose and PAGE-pulsed field-

capillary - isoelectric focusing- 2 D electrophoresis; blotting methods-Western-Southern and Northern- application-methods in life sciences.

MODULE V RADIOACTIVE METHODS 09

Types of radioisotopes-half life- units of radioactivity- uses of radioisotopes in life sciences and biotechnology- detection and measurement of Radioactivity- liquid scintillation counting- solid state counting- Geiger counter - Radiation hazards Techniques and applications of Electron spin resonance- Nuclear magnetic resonance- Circular Dichroism (CD) - Optical Rotary Dispersion (ORD).

L –45 ; Total Hours –45

TEXT BOOKS:

1. Pierre C. ORD and CD in chemistry and biochemistry: An Introduction. Academic Press, 1972.
2. Paddock S. W. Confocal Microscopy methods & protocols.1st Ed., Human Press, 1999.
3. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st Ed., Wiley-Liss, 2001.
4. Horst F. Basic One and Two-dimensional spectroscopy. VCH Publisher, 1991.
5. West E. S, Todd W. R, Mason H. S, Bruggen J. Textbook of Biochemistry. 4th Ed, Oxford and IBH Publishing Co, 1995.
6. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd Ed., W.H. Freeman, 1982.

COURSE OUTCOMES:

CO1:understand the importance of laboratory safety and standard operating procedures of common laboratory equipment's

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

CO3: understand the importance of preparation of biological buffers and Regants

CO4: analyze and estimate biomolecules in normal and diseased conditions apply modern separation techniques for biomolecules

CO5: understand radioactive methods for disease diagnosis

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of techniques taughtwe canunderstand the genetic basis of underlying diseases, that will help in good heath and well being

SDG15: Life on Earth

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

LSE 7104	LABORATORY III(STEM CELL TECHNOLOGY/ ENVIRONMENTAL BIOTECHNOLOGY/ BIOINSTRUMENTATION)	L	T	P	C
SDG: 3, 15		0	0	4	2

COURSE OBJECTIVES:

COB1: To learn the developmental stages and life cycle of model organisms.

COB2: To familiarize with the embryonic and post embryonic developmental processes

COB3: To understand the developmental stages in plants.

COB4: To learn ecological sampling and analysis methods.

COB5: To familiarize with advanced instrumentation techniques.

EXPERIMENTS

1. Study of the developmental stages and life cycle of Drosophila from stock culture
2. Study of different sections of placenta (photo micropgraph/ slides)
3. Study of whole mounts and sections of developmental stages of frog/chicks through permanent slides
4. Developmental stages of dicot and monocot embryos using permanent slides.
5. Study of floral biology of monocots and dicots
6. Microsporogenesis and megasporogenesis
7. Study of pollen grains - pollen morphology, pollen germination and pollen sterility
8. Types monocot and dicot embryos
9. External and internal structures of monocot and dicot seeds; seed coat structure, preparation of seed albums and identification.
10. To determine the minimum requisite size of the Quadrat for phytosociological studies.
11. Determination of population density in a natural/hypothetical community by quadrate method
12. Estimation of pH, carbonates and bicarbonates in the given water sample
13. Determination of soil texture (composition of clay, sand silt etc.).
14. Study of the general soil profile.
15. Determination of the nutrient (NPK) and organic carbon in soil/compost.
16. Techniques:
    a. Western Blot

b. Southern Hybridization,
c. DNA Fingerprinting,
d. PCR,
e. DNA Microarrays

17. Demonstration of a) ELISA b) Immunoelectrophoresis

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Bewley, J. D., Black, M., & Halmer, P. (Eds.). (2006). *The encyclopedia of seeds: science, technology and uses*. Cabi.
2. Kalthoff (2008). *Analysis of Biological Development*, II Edition, McGraw-Hill Publishers.
3. Lewis Wolpert (2002). *Principles of Development*. II Edition, Oxford University Press.

COURSE OUTCOMES:

CO1: Students are expected to learn the developmental processes in plant and animals.

CO2: Students should be able to decide on environmental sampling and suitable analysis methods.

CO3: Familiarity with the application of developmental biology practical aspects

CO4: Students will be trained with various soft skills/tool used in molecular biology

CO5: They will also become skilled to be able to analyze and interpolate data starting from PCR primer designing to structure predictions.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of techniques taughtwe canunderstand the genetic basis of underlying diseases, that will help in good heath and well being

SDG15: Life on Earth
Statement: This course makes aware of the range of technologies available in the field that gives knowledge about relation with all the levels of life in the earth.

LSE 7201	**PROJECT WORK (PHASE 1)**	**L**	**T**	**P**	**C**
		0	0	12	4

COURSE OBJECTIVES:

COB1: 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 the 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 the 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:

Students will be able to

CO1: Apply their practical knowledge and skill in Biotechnology/ with a specialization in solving real-time problems

CO2: Prepare an appropriate documentation

MOOC COURSE

L	T	P	C
0	0	0	0

COURSE OBJECTIVES:

COB1: 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:

Students will be able to

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

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

CO3: Formulate the experimental / analytical methodology required for the project work

LSE 7105	INDUSTRY INTERNSHIP	L	T	P	C
		0	0	2	2

GENERAL GUIDELINES:

- It is one credit for four weeks of internship.
- Internship shall be of not less than two weeks duration and shall be
- organized by the Dean of the Department.
- Students should choose preferably, government agencies/ Central Government research Institutes/DBT/ICAR/IISER/CSIR/ICMR /IIT‘s/ NITs/major industries in their specialization to do their internship
- At the end of the industrial internship, the student shall submit a certificate and feedback from the organization. Students should also submit a brief report.
- The evaluation will be made based on this report and a Viva-Voce
- Examination, conducted internally by a Departmental Committee constituted by the Dean of the School of Life Sciences.

SEMESTER IV

LSE 7201 PROJECT WORK (PHASE 2)

L	T	P	C
0	0	32	16

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:

Students will be able to

CO1: Apply their practical knowledge and skill in Biotechnology with specialization in to solve real time problems

CO2: Prepare an appropriate documentation

PROFESSIONAL ELECTIVE COURSES

SEMESTER I

LSEY101	BIOSTATISTICS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: make informed decisions based on data.

COB2: correctly apply a variety of statistical procedures and tests

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

COB4: interpret the results of statistical procedures and tests

COB5: understand sampling techniques

MODULE I INTRODUCTION TO STATISTICS 9

Exploratory Data Analysis - Motivation, Population vs Sample," Scientific Method" - Definitions, Examples, Medical Study Designs – Graphical Displays: Dot plots, Stem plots, Pie chart, Histograms - Summary Statistics: Measures of Central tendency.

MODULE II MEASURES OF DISPERSION 9

Range, Quartile deviation, Mean deviation, Standard deviation, Variance, Coefficient of Dispersion: coefficient of variation, Moments: Relationship between raw and central moments, Effect of change of Origin and Scale, Pearson beta and gamma coefficients, Skewness: Measures of Skewness, Kurtosis.

MODULE III CORRELATION AND REGRESSION 9

Bi-variate data – Correlation and Regression coefficients and their relation, properties - Effect of change of origin and scale on correlation coefficient, Linear regression, Association and Independence of attributes.

MODULE IV PROBABILITY AND ITS DISTRIBUTIONS 9

Events - exhaustive, mutually exclusive and equally likely - Baye's theorem (without proof) - Binomial, Poisson, Exponential and Normal distributions - Simple properties of the above distributions (without derivation).

MODULE V SAMPLING TECHNIQUES 9

Concept of population and sample, Random sample, Methods of taking a simple random sample, Tests of Significance: Sampling distribution of mean and standard error, Large sample tests (test for an assumed mean and equality of two population means with known S.D.); small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, t-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Norman T J Bailey, ”Statistical Methods in Biology “ (3rd Edition), Cambridge University Press 1995
2. Gerald van Belle, L.D.Fisher, P.J.Heagerty, and T.Lumney, “Introduction to Biostatistics” Second Edition, John Wiley & Sons, New Jersey 2004
3. Wong Limsoon, ”Essence of biostatistics” , NUS Lecture Notes Series 2003.
4. Gupta.S.C and V.K.Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi 2002.
5. Gupta.S.C.,”Fundamentals of Applied Statistics”, Sultan Chand & Sons, NewDelhi 2014.
6. Ross,S.M.,”Probabilty and Statistics for Engineers and Scientists” John Wiley & Sons, New Jersey 2007

COURSE OUTCOMES:

CO1: The students will undesratnd the basics of statistics

CO2: The students will gain knowledge of measures of dispersion

CO3: The students will gain knowledge of correlation and regression

CO4: The students will gain knowledge of probability

CO5: The students will gain knowledge of sampling techniques

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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

LSEY102	BIOSAFETY, BIOETHICS,	L	T	P	C
SDG: 3, 15	BIOENTREPRENEURSHIP AND IPR	3	0	0	3

COURSE OBJECTIVES:

COB1: provide an understanding of the ethical issues underlying biotechnology research and innovation in addition to protection of the acquired intellectual property

COB2: The student will gain an understanding research methodology, the ethical issues underlying biotechnology research and the importance of protection of intellectual property

COB3: get an understanding of patents

COB4: interpret marketing startegies

COB5: understand intellectual property and laws pertaining to it

MODULE I ETHICS IN BIOLOGY 9

The legal and socioeconomic impacts of biotechnology - Public education of the processes of biotechnology involved in generating new forms of life for informed decision making - Biosafety regulation and national and international guidelines - rDNA guidelines

MODULE II BIOSAFETY 9

Experimental protocol approvals - levels of containment - Environmental aspects of biotech applications - Use of genetically modified organisms and their resistance in environment - Special procedures for r-DNA based product production

MODULE III MARKETING 9

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/Advertising; Services Marketing

MODULE IV INTELLUCTUAL PROPERTY RIGHTS 9

Intellectual property rights - TRIP International conventions patents and methods of application of patents - Legal implications - Biodiversity and farmers rights - Beneficial applications' and development of research focus to the need of the poor - Identification of directions for yield effect in

agriculture, aquaculture Bioremediation etc.

MODULE V PATENT SYSTEM 9

Objectives of the patent system - basic principles and general requirements of patent law - biotechnological inventions and patent law - legal development - patentable subjects and protection in biotechnology - The patentability of microorganisms - IPR and WTO regime - consumer protection and IPR - IPR and plant genetic resources - GATT and TRIPS.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Beier,F.K.,Crespi,R.S. and Straus,J. Biotechnology and Patent protection-Oxford and IBH Publishing Co.New Delhi, 1985.
2. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.
3. Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi, 1993.

COURSE OUTCOMES:

CO1: understand the nature of hazards related to biotechnology and the importance of biosafety in research.

CO2: debate on ethical issues related to biotechnology research.

CO3: understand methods used in scientific research and to emphasize on the importance of statistical concepts.

CO4: realize the importance of intellectual property and its protection under the constitution.

CO5: The students wiil understand patent system

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY103	RECOMBINANT DNA TECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the students to different vectors for genetic manipulation of cells

COB2: To give a working knowledge for techniques involved in DNA extraction, purification and manipulation

COB3: Make the students understand the principle of techniques used in the creation of recombinant DNA molecules and the selction of the cells harbouring them

COB4: To learn applications of Recombinant DNA Technology

COB5: To become theroritically familiar with rDNA techniques

MODULE I CLONING & CLONING VECTOR 9

Types of cloning vectors viz. Plasmids, cosmids, ssDNA Phages, Yeast cloning vectors, Animal viruses, Ti plasmids and Cauliflower Mosaic Virus. Structural and Functional Organization of Plasmids, Plasmid Replication, Stringent and Relaxed Plasmids, Incompatibility of Plasmid Maintenance.

MODULE II MANIPULATION OF PURIFIED DNA 9

Enzymes involved in DNA Manipulation- Nucleases, Ligases, Polymerases and DNA modifying enzymes, Restriction endonucleases-Types, Blunt and sticky ends, Liagtion- Mode of action of DNA Ligase.

MODULE III CONSTRUCTION OF RECOMBINANT DNA 9

Preparation of competent cell-Transformation, transfection – Recombinant selection and screening- Genomic DNA library- cDNA synthesis strategies - Linkers - Adapters - Homopolymer tailing- Making genomic and cDNA libraries in plasmids and phages. PCR product cloning (TA cloning). Cloning strategies in yeast, E. coli and B. subtilis.

MODULE IV HYBRIDIZATION TECHNIQUES & MUTAGENESIS 9

DNA hybridization, colony hybridization and in-situ hybridization (Southern, Northern and Dot blots and immunological techniques Western blotting), Mutagenesis - Deletion mutagenesis, Oligonucletoide derived mutagenesis, Site directed mutagensis - Its applications- Applications of rDNA technology in Diagnostics.

MODULE V APPLICATIONS OF rDNA TECHNOLOGY 9

Gene Cloning and DNA analysis in Agriculture, Forensic Science and Medicine- Production of Recombinant pharmaceuticals, identification of genes responsible for human disease, Genetic Finger printing, Gene Therapy, Plant Genetic engineering, Problems with Genetically modified plants.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. James D. Watson, Recombiant DNA, 2nd Edition,Scientific American; Second Edition edition, 1998.

2. T. A. Brown, Gene Cloning and DNA analysis: An Introduction, 7th edition,Willey-Blackwell, 2016.

COURSE OUTCOMES:

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, industry, etc.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of rDNA technology we can modify the live organisms that 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.

LSEY104	MEDICAL BIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the purpose of proteins as therapeutic agents

COB2: Prepare and use monoclonal antibodies

COB3: Understand the human diseases

COB4: Understand the concepts of different types of vaccines

COB5: Apply the new technologies in healthcare settings

MODULE I SIMPLE PROTEINS AND THERAPEUTIC AGENTS **9**

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins Engineering human interferons and human growth hormones Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis.

MODULE II MONOCLONAL ANTIBODY AS THERAPEUTIC AGENT **9**

Production of monoclonal antibodies Production of antibodies- Human monoclonal antibodies, its scope and limitations - Hybrid human – Mouse antibodies – in E.coli Approaches for producing HIV therapeutic agents.

MODULE III HUMAN DISEASE **9**

Viral and bacterial diseases - Diseases caused by protozoan and parasitic worms (helminths) - Emerging infectious diseases – Active and passive immunity – Autoimmunity- Rational of immunization - Diseases controllable by vaccination – Vaccines, designing vaccines adjuvants - Whole organisms vaccines - Attenuated viruses and bacteria - Inactivation of pathogenic organisms by heat and chemical treatment.

MODULE IV VACCINES **9**

Bacterial polysaccharides, proteins and toxins as vaccines – Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution.

MODULE V APPLICATION OF GENETIC ENGINEERING IN HEALTH CARE 9

Production of Recombinant Proteins having therapeutic and diagnostic applications, Recombinant vaccine.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Glick, B.R., Pasternak, J. J., Molecular Biotechnology, Principles and Application of Recombinant DNA, ASM press, Washington, 2nd Edition, 1998
2. Ratledge, C., Kristiansen, B., Basic Biotechnology, Cambridge University Press, USA, 2nd Edition, 2001.
3. David, E., Technology and Future of health care, Preparing for the Next 30 years, Jhon Wiley, Singapore, 2nd Edition, 2000.

COURSE OUTCOMES:

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

CO2: Demonstrate knowledge and understanding of selected medical biotechnologies

CO3: Describe in detail essential facts and theory in molecular biology and biotechnology when applied to medicine

CO4: Describe and critically evaluate aspects of current research in the biosciences with reference to reviews and research articles

CO5: With limited guidance, deploy established techniques of analysis and enquiry within the biosciences.

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

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY105	FOOD 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 the 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. Mirdula Mirajkar, Sreelatha Menon, Food Science and Processing Technology vol-2, Commercial processing and packaging, Kanishka publishers, New Delhi- 2002.

COURSE OUTCOMES:

Students will be able to acquire knowledge on

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) : 9th BoS of SLS held on 20.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY106	BIOPROCESS TECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the design and operation of fermenters and types of fermentation processes

COB2: To acquire knowledge about formulation of medium and its prerequisites

COB3: To interpret stoichiometry and energetics of cell growth and product formation

COB4: To analyze the modes of operation of bioreactor and its design equations

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 9

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

COURSE OUTCOMES:

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

CO2: Acquire knowledge about 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) : 9th BoS of SLS held on 20.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

Statement: Understanding of the fundamentals of bioprocesswe can carry out data mining gene and protein expression patterns and modelling cellular 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 computer scientists in fermentation gives knowledge aboutrelation with all the levels of life in the earth

SEMESTER II

LSEY201	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 9

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 9

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 Ascaris lumbricoides. Filariasis and Schistosomiasis. Diagnosis of chicken guinea and swine flu.

MODULE III CLINICAL GENETICS 9

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 9

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

CO1: Familiar with the theoretical working princllesof clinical biochemistry.
CO2: Understand the causes and spread of infection and design strategy to stop their spread.
CO3: Understand the aspects of genetic disease, their causes and design strategy to diagnose them at earlier stages.
CO4: Learners will be able to define basic terminology and describes basic concepts in molecular diagnostics
CO5: will know the importance and the relevance of molecular diagnostic techniques and applications of molecular diagnostics in various field including medical, forescenic, etc.

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CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY202	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 sepration

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: 4 edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

COURSE OUTCOMES:

CO1: Understand the principle and concepts related to totipotency, embryogenesis, protoplast culture, applications of somatic hybridization, etc

CO2: Get knowledge about agrobacterium mediated creation of transgenic plants.

CO3: Understand the effect of biotic and abiotic stress components on different life forms and know the techniques to create plants that can circumvent such conditions

CO4: The concept of animal cell culture, growth, media, maintenance, culture conditions

CO5: Understand different classes of vaccines and their production, protein productions, andadvanced animal breeding and animal transgenic technology.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
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CO2	H	L	-	-	-	-	-	-	-	-	-	-
CO3	H	L	-	-	-	-	-	-	-	-	-	-
CO4	H	L	-	-	-	-	-	-	-	-	-	--
CO5	H	L	-	-	-	-	-	-	-	-	-	-

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY203	PROTEIN ENGINEERING	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 sepration

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

MODULE I PROTEIN STRUCTURE AND ENGINEERING 9

Introduction, Overview of protein structure, Higher level structure, protein classification on the basis of structure, Protein structural stability, higher order structure prediction for secondary and tertiary structure, Chau and Fasman rule, protein folding, intrinsically disordered protein.

MODULE II POST-TRANSLATIONAL MODIFICATION 9

Introduction: post translational modification, types of post translational derivatives, types of post translational reactions, chaperones involved post translational modification, biological functions of post translational modification: regulation, cross links, covalent cofactors, membrane anchors, other functions.

MODULE III PROTEIN SOURCES 9

Recombinant versus non-recombinant production, Heterologous protein production in E.coli, bacteria other than E.coli, yeast and fungi, proteins from plants, animal tissue as protein source, Heterologous protein production in transgenic animals, Heterologous protein production in using cell culture.

MODULE IV PROTEIN PURIFICATION AND CHARACTERIZATION 9

Protein detection and quantification, Initial recovery of protein, removal of whole cells and cell debris, Concentration, chromatographic purification, Protein inactivation and stabilization, protein characterization.

MODULE V STABILIZATION AND MODIFICATION OF PROTEINS 9

Insertion of Foreign DNA into Host Cells; Transformation; Transfection, Transduction, Construction of libraries, Oligonucleotide directed mutagenesis, error prone PCR, random mutagenesis with degenerate, oligonucleotide primers, random insertion/deletion mutagenesis, mutant proteins with unusual amino acids, different methods of engineering the protein.

L – 45; TOTAL HOURS –60

TEXT BOOKS:

1. Proteins: Biochemistry and Biotechnology by Gary Walsh. (2002): John Wiley & Sons Ltd.
2. Proteins Analysis and Design. Ruth Hogue Angeletti, Albert Einstein College of Medicine of Yeshiva University Bronx, New York.
3. Protein Engineering in Industrial Biotechnology, Lilia Alberghina,harwood academic publishers.

COURSE OUTCOMES:

CO1: This Course will provide theoretical and methodological knowledge in Protein Engineering.

CO2: The student will get acquainted with enzyme kinetics, rational protein engineering

CO3: directed evolution of enzymes

CO4: In addition, student will get expertise in therapeutic protein and industrial enzymes widely used.

CO5: understand mechanisms behind protein stability

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CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY204	BIOFUELS AND BIOENERGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: The students will be introduced to the petroleum and bio-based fuels and their affect on the global carbon cycle

COB2: The students will be made familiar to the attributes of biofuels that make them suitable as a fuel for a specific application

COB3: The students will be made aware of limitations of biofuels

COB4: The students will be asked to report on global impacts of biofuels on food and energy supplies

COB5: The students will demonstrate understanding on technological advances and challenges to be overcome for wide-scale biofuel adoption

MODULE I BIOCHEMISTRY OF BIOMASS 9

biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Long-term sustainability and reliability of feedstock supply; feedstock quality, minimizing feedstock cost and regional/climatic considerations of the process chain. Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of lignocellulose by fungi and bacteria; degradation of lignin; the role of peroxidases; degradation of cellulose; trichoderma cellulases; bacterial cellulases; and comparison with degradation of high starch crops..

MODULE II BIO DIESEL 9

sources and processing of biodiesel (fatty acid methyl ester); nature of lipids, especially fatty acids and triglycerides. Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodisel (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Engineering, economics and environmental issues of biodisel; components and operation of a biodiesel processing system; standards for biodiesel quality; safety procedures needed to work with biodiesel in both domestic and shop environments; and major policies and regulations pertaining to the production, distribution, and use of biodiesel.

MODULE III BIOENERGY SYSTEMS 9

Course content includes overview of bioenergy systems from resource, conversion technologies to final product. Bioenergy conversion technologies and systems for heat, power, and bio-fuels. Cogeneration and polygeneration. Innovative cycles (such as biomass integrated gasification combined cycles, biomass air turbines, humid air turbines etc) for biomass resources. Evaluation of the bioenergy system performance. Economic and environmental assessments of bioenergy systems.

MODULE IV BIOFUELS & ALCOHOL TECHNOLOGY 9

Introduction to Alcohol Technology, Raw Material of AlcoholIndustry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeastproduction as single protein cell. Study of different recycling process, Biochemistry of alcoholproduction, The management of fermentation in the production of alcohol.

MODULE V POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY 9

Course content includes analysis of both current and future EU regulations and directives on biofuels and bioenergy. Tax regulations. Evaluation of different production alternatives to produce bioenergy; competitiveness of bioenergy alternatives in agriculture compared to other energy sources. Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide. Biomass feedstocks - how do we produce them cost-effectively and for which end-use? Biofuels for transportation - what will make them technically and economically competitive? Market penetration of biofuels - how do we remove barriers.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
2. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell (2008).

COURSE OUTCOMES:

CO1: How petroleum and bio-based fuels affect the global carbon cycle

CO2: The attributes of biofuels that make them suitable as a fuel for a specific application. Limitations of biofuels

CO3: Advancement of integrated technologies for the production of lingo cellulosic derived biofuel

CO4: Global impacts of biofuels on food and energy supplies

CO5: Technological advances and challenges to be overcome for wide-scale biofuel adoption

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

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY205	INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the industrial processes of traditional and modern biotechnology.

COB2: To elucidate the primary metabolites production process with the emphasis on commercial edge in biopharmaceutical industries

COB3: To differentiate the various upstream and downstream processes of secondary metabolites.

COB4: To familiarize the production processes of industrial enzymes.

COB5: To gain advanced knowledge about modern biotechnology product production processes

MODULE I INTRODUCTION TO INDUSTRIAL BIOTECHNOLOGY 9

Traditional and Modern Biotechnology- Production Strains, Production media, Types of Media, Carbon, Nitrogen Sources- Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

MODULE II PRODUCTION OF PRIMARY METABOLITES 9

Primary Metabolites- Production of commercially important primary metabolites: organic acids, amino acids and alcohols.

MODULE III PRODUCTION OF SECONDARY METABOLITES 9

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

MODULE IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.

MODULE V PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS 9

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell

culture.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999. 7. K.G.Ramawat& Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications
2. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2 nd Edition Cambridge University Press, 2001.
3. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.

COURSE OUTCOMES:

CO1: understand the industrial processes of traditional and modern biotechnology.

CO2: elucidate the primary metabolites production process with the emphasis on commercial edge in biopharmaceutical industries.

CO3: differentiate the various upstream and downstream processes of secondary metabolites.

CO4: familiarize the production processes of industrial enzymes.

CO5: gain advanced knowledge about modern biotechnology product production processes

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CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY206	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basic terms and concepts of used in pharmaceutical biotechnology

COB2: To appreciate concepts of drug metabolism

COB3: To establish a basic understanding of drug manufacturing process

COB4: To understand the role of different regulatory agencies in this field

COB5: To acquire knowledge of animal models, cell culture in drug development.

MODULE I INTRODUCTION TO BIOPHARMACEUTICALS 9

Development of drug and pharmaceutical industry, Therapeutic agents their use and economics - Regulatory aspects. Current status and future prospects, Biosimilar, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals.

MODULE II DRUG METABOLISM AND PHARMACOKINETICS 9

Definition, rationales, absorption, distribution and metabolism pathway. Factors governing, LD50, LC50, ED50, absorption of drug, Pharmacokinetics and Pharmacodynamics, Dose response relationship, interspecies scaling, In vitro studies, In vivo studies. Drug Toxicities, Animal Models in Biopharmaceutical Research.

MODULE III IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS 9

Bulk drug manufacturers-Type of reactions in bulk drug manufacture and processes - Special requirement for bulk drug manufacture.

MODULE IV MANUFACTURING PROCESSES & THEIR USE 9

Manufacturing Process for Tablets, Dry granulation process, Wet granulation process, manufacturing process of topical application - ointments, creams, suppositories. Dose conversion from preclinical studies to clinical studies, Route of administration of drugs, Angle of injections of drug, different phases of clinical trials of drugs.

MODULE V REGULATORY AGENCIES AND THEIR CONTROL 9

Role of Regulatory agencies in drug development, FDA guidelines for drug development, Patenting process in India, Possible therapeutic intervention against COVID-19, Scheduling process of Drugs, Amphetamines, Cannabinoids, Benzdizapines, CNS stimulant Drugs, Drug designing against apoptotic mediated diseases.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Curtis D. Klaassen, Casarett&Doull's Toxicology: The Basic Science of Poisons, 9th edition, 2004.
2. Pharmaceutical Biotechnology; Authors, S. P. Vyas, V. Dixit; Publisher, CBS Publishers & Distributors, 2018
3. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, andPatent Issues, CRC Press, 2006.
4. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1stEdition, Wiley Liss, 2003.

COURSE OUTCOMES:

CO1: Students will be able to understand to explain the therapeutic mode of action, and understand structural considerations of at least four classes of biopharmaceutical agents.

CO2: Students will be able to understand the process of drug absorption, distribution and metabolism.

CO3: Students will be able to outline the drug manufacturing process including the role of quality control.

CO4: Students will know the role of quality assurance in protecting the public, workers, and the environment.

CO5: Students will be able to understand the role of drug manufacturing. agencies and regulating agencies

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

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CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

SEMESTER III

LSEY111	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. 4. Mick Wilson, KamaliKannangara, 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 Burkhard Raguse, ―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:

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 AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

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SDG15: Life on Earth

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LSEY112	MEDICAL CODING	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce about medical coding and the role of coder.

COB2: To study the Anatomy of upper body parts such as the heart, lung, and skin

COB3: To study the Anatomy of upper body parts such as heart, lung and skin**.**

COB4: To study on ICD-10 coding for major diseases.

COB5: To introduce HCPCS

MODULE I OVERVIEW OF CODING-INTRODUCTION 9

Introduction-Medical coding, Role of Medical coder, Healthcare in India and US, Patient, Provider and Payers Relationship, Importance and significance of coding in today's world, Coding as a Profession, First Aid/CPR and Medical Law and Ethics

MODULE II OVERVIEW OF ANATOMY-I 9

Human body – Anatomical Position, Body Cavities, Dermatology, Ophthalmology, Otorhinolaryngology, Pulmonology and Cardiology

MODULE III OVERVIEW OF ANATOMY-II

Gastroenterology, Genitourinary system, Gynaecology and Obstetrics, Orthopaedics, Endocrinology, Immunology, Lymphatics, and Hematology.

MODULE IV ICD-10-CM 9

General Coding Guidelines, Infections and Parasitic Diseases, Neoplasms Diseases of Nervous system, Diseases of Sense organs, Diseases of Circulatory System, Diseases of Respiratory system, Diseases of Digestive system, Diseases of Genitourinary system, Complications of Pregnancy, and Childbirth and Puerperium.

MODULE V HCPCS (HEALTHCARE COMMON PROCEDURE CODING SYSTEM) 9

Introduction to HCPCS, Significance and Usage, Types of HCPCs, Modifiers Level II HCPCS

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Sandra L Johnson & Robin Linker. Understanding Medical Coding: A Comprehensive Guide. 4th Edition. Cengage Learning. 978-1305666122.
2. Buck's Step-by-Step Medical Coding, 2022 Edition 1st Edition. Elsevier. 978-0323790383
3. ICD-10-CM 2022 THE COMP OFF CO: The Complete Official Codebook With Guidelines (ICD-10-CM The Complete Official Codebook) Spiral-bound – Import, 30 September 2021. American Medical Association. 978-1640161559.

COURSE OUTCOMES:

After the completion of the course

CO1: Students understand the basis of medical coding and the role of coder.

CO2: Students understand the basic anatomy of heart, lungs, andOphthalmology

CO3: Students understand the basic anatomy of gastrointestinal system, Genitourinary system and Gynaecology

CO4: Students understand the ICD-10- coding for major diseases.

CO5: Understand about the HCPCS

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY113	GENE MANIPULATION	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1:

Tolearnaboutgeneticmanipulations,principlesinvolvedinmanipulating genesandDNA.

COB2: Toknowaboutcloning strategiesand expressionsystems.

COB3: To acquire basicunderstandingof techniquesin geneticengineering

COB4: To learn PCR and its variations

COB5: To understand the principles of gene alteration

MODULE I FUNDAMENTALS OF GENE MANIPULATIONS 9

Introduction to gene manipulation, Recombinant DNA by gene manipulation, Structure and functional properties of DNA. Different types of enzymes used in gene manipulation-RestrictionEnzymes,DNAligase,Klenowenzyme,T4DNApolymerase,Polynucleotidekinase,Alkalinephosphatase;Cohesiveandbluntendligation;Linkers;Adaptors;Homopolymerictailing;LabelingofDNA:Nicktranslation,Random priming,Radioactiveandnon-radioactiveprobes,Hybridizationtechniques:Northern,SouthernandColonyhybridization, Fluorescence in situ hybridization.

MODULE II CLONINGVECTORS 9

Plasmids;Bacteriophages;M13mpvectors;PUC19andBluescriptvectors,Phagemids;Lambdavectors;InsertionandReplacementvectors;Cosmids;Artificial chromosome vectors (YACs; BACs); Expression vectors, Plant based vectors, Tiand Ri as vectors, Yeastvectors,Shuttle vectors.

MODULE III TECHNIQUES OF GENE MANIPULATIONS

InsertionofForeignDNAintoHostCells;Transformation;Transfection,Transduction, Construction of libraries; Isolation of mRNA and total RNA; cDNAand genomic libraries; cDNA and genomic cloning; Yeast two hybrid system; Phage display; Principles inmaximizinggeneexpression.Methodstoconfirmcloningandreportergenesand proteins.

MODULE IV PCRAND ITSAPPLICATIONS 9

Primer design; Fidelity of thermostable enzymes; DNA polymerases;

Types ofPCR — multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR,hot start PCR, colony PCR, cloning of PCR products; Sitespecificmutagenesis;PCRinmoleculardiagnostics;Viralandbacterial detection; AutomatedDNAsequencing;RNA sequencing

MODULE V APPLICATIONSOFGENE MANIPULATION 9

Gene cloning and analysis in medicine: Production of recombinant pharmaceuticals, recombinant insulin. Synthesis of growth hormones in *E. coli,* recombinant factor VIII, Recombinant vaccines. Gene therapy and cancer. Gene manipulation in agriculture: plant genetic engineering, The endotoxins of Bacillus thuringiensis, Cloning endotoxin gene in maize, Countering insect resistance to endotoxin crops, Herbicide resistant crops, Gene subtraction-Antisense RNA and the engineering of fruit ripening in Tomato. Gene manipulation in Forensic Science- DNA analysis in the identification of crime suspects, Genetic fingerprinting by hybridization probing, DNA profiling by PCR of short tandem repeats

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.NicholIAnIntroductiontoGeneticEngineeringCambridgeUniversityPress2008

COURSE OUTCOMES:

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) : 9th BoS of SLS held on 20.08.2022

Academic Council: 19th AC held on 29.09.2022

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CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

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SDG15: Life on Earth

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LSEY114	BIOMEDICAL INSTRUMENTATION	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge about physiological system

COB2: To get exposed to basic components of biomedical instrumentation

COB3: To provide the latest ideas on devices of electrical and non-electrical devices.

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

COB5: To provide latest knowledge of medical assistance / techniques and therapeutic equipment.

MODULE I HUMAN PHYSIOLOGY 9

Cell and its structure –Nervous system: Functionalorganisation of the nervous system – Structure of nervous system-central and peripheral nervous system, neurons -Resting and Action Potential – synapse –transmitters and neural communication – Cardiovascular system –respiratory system- gas exchange – Systemic and respiratory circulation –Muscles of respiration. Structure of Muscles- Muscle contraction and relaxation

MODULE II ELECTRODES AND AMPLIFIERS 9

Basic components of a biomedical system - Transducers –selection criteria – Piezo electric, ultrasonic transducers –Temperaturemeasurements - Fibre optic temperature sensors.Electrodes –Limb electrodes –floating electrodes – pre-gelled disposableelectrodes - Micro, needle and surface electrodes – Amplifiers: Preamplifiers,differential amplifiers, chopper amplifiers – Isolation amplifier. Typical waveforms. Electricalsafety in medical environment: shock hazards – leakage currentInstruments forchecking safety parameters of biomedical equipments.

MODULE III ELECTRO AND NON-ELECTRICAL MEASUREMENTS 9

Electrocardiography – Electroencephalography– Electromyography – Electroretinography. Measurement of blood pressure – Cardiac output – Heart rate – Heart sound –Pulmonary function measurements – spirometer – Photo Plethysmography, BodyPlethysmography – Blood Gas analysers : pH of blood –measurement of bloodpCO_2, pO_2, finger-tip oximeter - ESR, GSR measurements.

MODULE IV MEDICAL IMAGING 9

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry
systems and patient monitoring – Introduction to Biometric systems.

MODULE V ASSISTING AND THERAPEUTIC EQUIPMENTS 9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy

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 Biomedical Instrumentation', Universities press (India)

REFERENCES:

1. Zou C, Wu B, Dong Y, Song Z, Zhao Y, Ni X, Yang Y, Liu Z. Biomedical photoacoustics: fundamentals, instrumentation and perspectives on nanomedicine. Int J Nanomedicine. 2016 Dec 22;12:179-195.
2. Pilling M, Gardner P. Fundamental developments in infrared spectroscopic imaging for biomedical applications. Chem Soc Rev. 2016 Apr 7;45(7):1935-57. doi: 10.1039/c5cs00846h.
3. Yamakoshi K. In the spotlight: BioInstrumentation. IEEE Rev Biomed Eng. 2013;6:9-12. doi: 10.1109/RBME.2012.2227703.

COURSE OUTCOMES:

Students will be able toacquire knowledge on

CO1:understand the basic physiological system

CO2: understand the basic components such as amplifiers and electrodes

CO3: understand the components and running conditions of electrical and non-electrical equipment's.

CO4: understand the applications of imaging instruments.

CO5:understand the functioning of therapeutic instruments

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

Academic Council:
19th AC held on 29.09.2022

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CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being
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SDG15: Life on Earth
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LSEY115	TISSUE ENGINEERING	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the fundamental and quantitative principles of tissue and the basic elements of the tissue engineering and tissue repairing approach.

COB2: Appreciate the important contribution of 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.

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

COB5: To get acquainted with biomaterials

MODULE I INTRODUCTION TO TISSUE ENGINEERING 9

Introduction to tissue engineering, Cells as therapeutic Agents with examples, 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 TISSUE ARCHITECTURE 9

Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Dynamic states of tissues, Homeostasis in highly prolific tissues and Tissue repair. VEGF/angiogenesis. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

MODULE III CELL-EXTRACELLULAR MATRIX 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 BIOMATERAILS 9

Biomaterials in tissue engineering: Properties of biomaterials, Surface, bulk,

mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

MODULE V CLINICAL APPLICATIONS 9

Stem cell therapy, Molecular therapy, *In-vitro* organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of tissue-engineered products, ethical issues.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications, Nova Science Publishers, 2008.
2. Raphael Gorodetsky, Richard Schäfer..Stem cell-based tissue repair. RSC Publishing, 2011.
3. 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.
4. R. Lanza, J. Gearhart et al., (Eds), Essential of Stem Cell Biology, Elsevier Academic press,2006.
5. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering &Regenrative Medicine" Artech House, INC Publications, 2008.
6. Naggy N. Habib, M.Y. Levicar, L. G. Jiao,.and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press,2007

COURSE OUTCOMES:

Students will be able to acquire knowledge on

CO1: The ability to execute the engineering design process: identify problem, identify design constraints on bioengineering problem, create solutions, and evaluate solutions with respect to these constraints.

CO2: 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.

CO3: Overall exposure to the role of tissue engineering and stem cell therapy in Organogenesis.

CO4: Understand the role and importance of biomaterials in tissue engineering

CO5: Ability to understand the clinical applications of tissue engineering

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

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

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.

LSEY116	ANTIBODY ENGINEERING	L	T	P	C
SDG: 3, 15		3	0	0	3

COURSE OBJECTIVES:

COB1: Understand the fundamental and quantitative principles of antibody engineering and the basic elements of the antibody engineering approach.

COB2: Appreciate the important contribution of antibody engineering in the production of humanized antibodies that can be used for therapeutic applications.

COB3: To discuss the gene organization of antibodies and expression in different systems

COB4: Application of antibody engineering in therapy, diagnosis and science.

COB5: Understand the role of antibody engineering in therapy

MODULE I INTRODUCTION TO ANTIBODY ENGINEERING 9

Introduction to antibody engineering, serum as the protection matrix, theories of antibody structure, Isotypes and allotypes, Origins of antibody diversity, Fc region and effector functions, Antibody engineering revolution.

MODULE II MONOCLONAL ANTIBODIES AND HYBRIDOMAS 9

Immunoglobulin Genetic Locus: Generation of antibody diversity, Antibody Discovery Methodologies: Hybridoma, Display, and Direct B-cell cloning technology, Antibody structure and function. Chimeric antibodies, humanized antibodies and fully human monoclonal antibodies

MODULE III ANTIBODY ENGINEERING

Antibody display systems- Phage display, yeast surface, mammalian, *E. coli*, Ribosome cDNA and B-Cell cloning. Transgenic animals for antibody production- transgenic strategies, knockout of endogenous Ig production, construction of IgH, Igλ and Igκ gene loci, HuMAb-Mouse and Xeno Mouse.

MODULE IV BISPECIFIC AND ANTIBODY-DRUG CONJUGATES 9

Bispecific antibodies (BsAbs) for bridging different cell types, signaling inhibition by receptor molecules, BiparatopicbsAbs, enzyme mimetics, different formats of BsAbs. Antibody-Drug conjugates (ADCs), milestone and developments, targets, cytotoxic ADC payloads, ADC linkers.

MODULE V APPLICATIONS 9

Application of antibodies in therapy, diagnosis, and Science-Cetuximab, Trastuzuman, rituximab, Nivoluman, Pembrolizumab, Adalimuman, Blinatumomab, Emicizumab. Immunoprecipitation, Western blotting, ELISA, Immunohistochemistry, Proximity ligation assay, Flow cytometry and Mass spectrometry. Immunomics-diagnosis, disease biomarkers, tools and applications.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Introduction to Antibody Engineering. Florian Rüker, Gordana Wozniak-Knopp, 2021. ISBN: 978-3-030-54629-8.
2. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
3. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002

COURSE OUTCOMES:

CO1: Skilled to identify and conduct thorough research on current antibody problems, and will ultimately work in teams to propose solutions to those identified problems.

CO2: To understand the structure, variation, genetic loci and gene structure of antibody molecules.

CO3: To understand the concepts and techniques utilized in antibody engineering.

CO4: To be able to learn new techniques for the therapy

CO5: To be able understand theoretical concepts behinfimmunotechniques

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12
CO1	H	L	-	-	-	-	L	L	-	-	-	L
CO2	H	L	-	-	-	-	L	L	-	-	-	L
CO3	H	L	-	-	-	-	L	L	-	-	-	L
CO4	H	L	-	-	-	-	M	L	-	-	-	L
CO5	H	L	-	-	-	-	H	L	-	-	-	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 3. Good Health and Well Being

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SDG15: Life on Earth

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OPEN ELECTIVE COURSES

OEEY 731	**ADVANCED MATERIALS FOR ENERGY APPLICATIONS**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To understand the fundamentals and basics of materials for solar energy.

COB2: To provide the knowledge of the synthesis of materials.

COB3: To understand about the characterization of materials.

COB4: To provide an understanding of energy harvesting materials.

COB5: To provide insights in to the energy storage materials.

MODULE I MATERIALS FOR PHOTOVOLTAICS 9

First generation solar cell materials; single and polycrystalline Silicon, amorphous silicon: growth and wafer processing, contact materials, materials for surface engineering. Second generation solar cell materials; CdSe, CdTe, Copper Indium Gallium Selenide (CIGS), Gallium Arsenide for applications in photovoltaics, Materials for thin film solar cells, Thin film processing, and properties. Contact materials for second generation solar cells. Third generation solar cell materials; Quantum Dots, Organic materials, Composites, Dyes, Perovskites and their synthesis, characterization and properties, Interface energetics, photoactive layers and their materials, role of electron transport, hole transport, electron blocking and hole blocking materials and their processing. Contact materials and processing of contact layers.

MODULE II RECHARGEABLE BATTERIES 9

Primary and secondary batteries, battery potential, charge figure of merit, energy and power in battery, polarization losses, thermodynamics of battery materials, tortuosity and porosity of battery materials, reversible and irreversible interfacial reactions, battery architecture and design guidelines, Lead–acid battery, Nickel–cadmium battery (NiCd), Nickel–metal hydride battery (NiMH), Lithium-ion battery, Lithium-ion polymer battery, Energy density, power density, price and market. Battery Management systems and System Performance

MODULE III SUPERCAPACITORS AND HYDROGEN 9

STORAGE

Basic components of super capacitors like types of electrodes like high surface area activated carbons, metal oxide and conducting polymers, aqueous and organic electrolytes Background and working of Fuel Cell, Hydrogen production processes, Hydrogen storage: Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, Carbon based materials for hydrogen storage.

MODULE IV MATERIALS FOR ENERGY HARVESTING **9**

Piezoelectric, Pyroelectric and Thermo-electrics materials, Electrostatic (capacitive) Energy Harvesting and materials, energy from Magnetic Induction, Metamaterial, energy from atmospheric pressure changes, electroactive polymers (EAPs), nanogenerators, Ambient radiation sources and nanoantenna, energy from noise.

MODULE V MATERIALS FOR ENERGY STORAGE **9**

Electrochemistry and electro-chemical Battery materials, Hydrogen Storage materials for fuel cells: Metal hybrids, Nanostructured metal hydrides, Non-metal hydrides, Carbohydrates, Synthesis of hydrocarbons, Aluminum, Liquid organic hydrogen carriers (LOHC), Ammonia, Amine borane complexes, Nano borohydrides and nano catalyst doping, imidazolium ionic liquids, phosphonium borate, Carbonite substances, Metal Organic frameworks, Activated Carbons, Carbon nanotubes, Clathrate hydrates, Glass capillary arrays.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Detlef Stolten,“Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications”, Wiley, 2010.
2. Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu,
3. “Electrochemical Technologies for Energy Storage and conversion”, John Wiley and Sons, 2012.
4. Francois Beguin and Elzbieta Frackowiak ,“Super capacitors”, Wiley, 2013.

5. Doughty Liaw, Narayan and Srinivasan, “Batteries for Renewable Energy Storage”, The Electrochemical Society, New Jersy,2010.

COURSE OUTCOMES:

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

CO1: analyze the different energy storage systems.

CO2: understand the concepts and design of batteries

CO3: get the insights into supercapacitors and hydrogen fuels

CO4: comprehend the ideas behind the materials used for energy harvesting.

CO5:get familiarized with the different materials used for energy applications.

Board of Studies (BoS) :

BOS of Physics was held on 30.6.22

Academic Council:

19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

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 732	ALTERNATIVE ENERGY	L	T	P	C
SDG: 7,9	RESOURCES	3	0	0	3

COURSE OBJECTIVES:

The students will be trained about the

COB1: Different types of batteries

COB2: Factors affecting battery performance

COB3: Selection and application of batteries

COB4: Application in photovoltaic cells

COB5: Various materials used in solar cells and PEC cells

MODULE I BATTERIES 9

Lithium-ion battery, The Principle carbonaceous anode materials, cathode material- The intercalative reactions, relationships between performance requirements and materials characteristics- Electrolyte, separator. Advanced Ni-MH Batteries: Improvement in hydrogen storage alloys, improvement in Cathode materials, improvement in separator and cell design.

MODULE II FACTORS AFFECTING BATTERY PERFORMANCE AND SELECTION OF BATTERIES 9

Factors affecting battery capacity, voltage level current drain of discharge, types of discharge continuous, intermittent, constant current, constant load, constant power, temperature of battery during discharge, service life, voltage regulation, changing voltage, effect of all design, battery age and storage condition, effect of battery design.

Major consideration in selecting a battery, battery applications, comparative features and performance characteristics, characteristics of batteries for portable equipment.

MODULE III PHOTOVOLTAICS 9

Basic of photovoltaics, homo and heterojunctions, preparation of single crystals and polycrystalline silicon solar cells, Metal-Insulator-Metal and semiconductors - Insulator-semiconductors solar cells, photovoltaic measurements - I-V characteristics, spectral response and capacitance measurements.

MODULE IV FUEL CELLS AND SUPER CAPACITORS 9

Introduction, Types of Fuel cells, figure of merit, electro catalysts for

hydrogen oxidation and oxygen reduction, electrochemical double layer capacitors, ruthenium oxide as capacitor electrode, manual capacitors with proton conducting solid polymer electrolytes.

Ultra capacitors: Double layer, Metal Oxide, conducting polymers energy and power densities, voltage limitation and self discharge.

MODULE V SOLAR CELLS AND PEC CELLS 9

Preparation of CdS/Cu_2S solar cells by screen printing technique and their characteristics, amorphous Si solar cells GaAs solar cells, Semiconductors electrolyte interface. Photoelectrochemical (PEC) cells for conversion of light energy to electrical energy, PEC cells based on CdSe Si and GaAs and their output characteristics, Estimation of flat band potential from Mott-Schottky plots.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Energy Storage Systems for Electronics Edited by Tetsuya Osaka, Department of Applied Chemistry, Wasuda University, Tokyo, Japan and Madhav Dutta, Intel Corporation, Hillsboro, USA, 2000.
2. Photoelectrochemical Solar Cell, Edited By K.S.V. Santhanam and M. Sharon, Elsevier Science Publishers, BV New York, 1995.
3. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London 1983.
4. W.E. Hatified and J.H. Miller (Editors), High Temperature Superconducting Materials, Marcel Dekker, New York 1988.
5. Lindar D., Handbook on Batteries and Fuel Cells, McGraw Book Co., New York, 2011.

COURSE OUTCOMES:

The students will have

CO1: A thorough understanding about batteries and their components

CO2: Understand the working mechanism of batteries.

CO3: Influence of various factors on performance of batteries and based on which selection of suitable batteries depending on application.

CO4: Testing in fuel cells.

CO5: Applications in solar cells and PEC cells.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		M			H										
CO2	H			H	M										
CO3		H				L									
CO4	M			H		L									
CO5	H				M										

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Affordable & Clean Energy
SDG 9: Industry, Innovation and Infrastructure

Statement:
SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all
SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

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:

The student 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M		M											
CO2	H	M		M											
CO3	H	M		M		H									
CO4	H	M		M	M	H									
CO5	H	M		M	M	H									

Note: L- Low Correlation M - Medium Correlation H -High Correlation

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 733	BIOMASS FOR ENERGY	L	T	P	C
SDG: 7	APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Structure, properties and applications of cellulose, hemicelluloses and lignin.

COB2: Types of biomass used as feedstock for energy applications

COB3: Various biomass pretreatment techniques.

COB4: Understand the chemistry and economics of biodiesel

COB5: Understand the conversion of lignocelluloses into alcohol and fuel.

MODULE I STRUCTURE AND PROPERTIES OF BIOMASS 9

Chemistry of polysaccharides, Structure and properties of cellulose, Addition and substitution reactions, Structure and properties of hemicelluloses, Hydrolysis of cellulose by acid and enzyme, Chemistry of lignin, Biosynthesis of lignin, Structure and properties of lignin, Isolation and application of lignin, Chemistry of extractives.

MODULE II BIOMASS FEEDSTOCKS 9

Availability and abundance, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, biomass as energy resources: dedicated energy crops, annual crops (maize, sorghum sugar beet, hemp), perennial herbaceous crops (sugarcane, switchgrass, miscanthus), short rotation woody crops (poplar, willow), oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, enhancing biomass properties for biofuels, challenges in conversion.

MODULE III BIOMASS PRETREATMENT 9

Biomass pretreatment - Physical pretreatment methods – milling, microwave, mechanical extrusion, pulse electric field; Chemical pretreatment methods - acid pretreatment, alkali pretreatment, Organosolv pretreatment, Ionic liquids pretreatment; Physico-chemical pretreatment - Steam explosion pretreatment, Ammonia fiber explosion (AFEX) pretreatment; CO_2 explosion, wet oxidation, sulphite pretreatment; Biological pretreatment

MODULE IV BIODIESEL 9

Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; standards for biodiesel quality; Energetics of biodiesel production and effects on greenhouse gas emissions Issues of ecotoxicity and sustainability with ; expanding biodiesel production

MODULE V BIOETHANOL 9

Biochemical conversion of lignocellulose to alcohol, Separate hydrolysis and fermentation process (SHF), Simultaneous saccharification and fermentation process (SSF), Consolidated Bioprocess (CBP), Pentose fermentation by yeast and bacteria. **Thermochemical conversion of biomass to liquid fuels**, Combustion, Pyrolysis process of lignocellulose to liquid fuels, Gasification process, Cogeneration and polygeneration. Innovative cycles (such as biomass integrated gasification combined cycles, biomass air turbines, humid air turbines etc) for biomass resources, Bioethanol production.

L – 45; Total Hours –45

REFERENCES:

1. Krzysztof J Ptasinski, Efficiency of Biomass Energy: An Exergy Approach to Biofuels, Power, and Biorefineries, John Wiley and Sons, 2015.
2. Kaltschmitt, Martin, Energy from Organic Materials (Biomass), A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition, 2019.
3. George W. Huber, Sara Iborra, AvelinoCorma, Synthesis of Transportation Fuels from Biomass: Chemistry, Catalysts, and Engineering, Chemical Review 2006, 106, 9, 4044-4098.

COURSE OUTCOMES:

Students will be able to

CO1: Identify the structure and properties of cellulose, hemicelluloses and lignin.

CO2: Find the significance of different biomass resources.

CO3: Illustrate biomass pretreatment techniques.

CO4: Synthesize the biodiesel at economical price.

CO5: Produce the bioethanol at economical price.

Board of Studies (BoS): **Academic Council:**

12th BoS of Chemistry held on 22.07.2022 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H	M	M	M	H									
CO2	M	H	M	M	M	H									
CO3	M	H	M	M	M	H									
CO4	M	H	M	M	M	H									
CO5	M	H	M	M	M	H									

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 7: Affordable & Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all.

Statement: Utilization of biomass for the energy need provide solution for affordable and sustainable energy for all.

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) : BOS of Physics was held on 30.6.22

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

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) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

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 734	CORROSION AND CORROSION	L	T	P	C
SDG: 9	CONTROL	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with the:

COB1: Causes and theories of corrosion.

COB2: Different types of corrosion.

COB3: Basic concepts to prevent corrosion and testing of corrosion by variousdiagrams.

COB4: Factors influencing corrosion.

COB5: Control of corrosion using various methods.

MODULE I CORROSION 9

Causes and effects of corrosion — theories of corrosion – Dry corrosion — oxidation — direct atmospheric effect – Hydrogen corrosion, liquid metal corrosion and corrosion by other gases-electrochemical corrosion – hydrogen evolution – presence and absence of oxygen – corrosion by gaseous reduction.

MODULE II FORMS OF CORROSION 9

Eight forms of corrosion- Galvanic bimetallic corrosion – differential aeration corrosion – concentration cell corrosion – erosion corrosion – pitting corrosion – underground soil corrosion – intergranular corrosion – stress corrosion: Types - seasonal cracking of alloys and caustic embrittlement – corrosion fatigue.

MODULE III CORROSION TESTING 9

Rate of corrosion – calculation of ΔG and other related thermodynamic parameters — potential measurement — electrochemical series — redox reactions — EMF measurement and corrosion current – anodic and cathodic behaviour of metals –passivity – testing of virgin metals – alloy – Pourbaix and Evans diagrams.

MODULE IV FACTORS INFLUENCING CORROSION 9

Nature of metal — over voltage — areas of anodic/cathodic — purity of metal — physical state of metals — passive nature of metal — solubility — volatility of corrosion products – corroding environment – influence of pH – Pourbaix diagrams- ions – formations of cells – polarization of electrodes.

MODULE V CORROSION CONTROL 9

Design – selection of materials – pure metals and alloys – annealing – elimination of galvanic action – cathodic protection – sacrificial anodic protection and impressed current cathodic protection — modification of environment: deaeration and dehumidification – corrosion inhibitors – protective coatings : preparation of surface before applying coatings – Classification: Inorganic coatings- metallic and non-metallic – organic coatings – special paints – varnish, enamel and lacquers.

L – ; TOTAL HOURS –45

TEXT BOOKS:

1. C.G. Munger and Louis D. Vincent, "Corrosion Prevention by Protective Coatings", Third Edition (e-Book), 2014.

REFERENCES:

2. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill BookCompany, New York, 1984.
3. J.H. Brophy, R.M. Rose and J. Walf, The Structure and Properties of Materials, Wiley Inter Science Inc., New York, 1984.
4. B.T. Kelly, Irradiation Diamagneto Solids, Pergamon Press, New York,1992.
5. D.R. Cross, Principles and Applications of Electrochemistry, Chapman andHall, UK, 1988.

COURSE OUTCOMES:

Students will become familiar with the

CO1: basic concepts of corrosion

CO2: Different types of corrosion and their mechanism of corrosion

CO3: Testing and evaluation of corrosion

CO4: Factors which influence the corrosion

CO5: Control of corrosion in real situation.

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					L										
CO2															
CO3		H						M							
CO4															
CO5										H					

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic understanding of corrosion and its prevention leads to construction of resilient infrastructure and sustainable industrialization.

OEEY 735	**CORROSION SCIENCE AND TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To enable the students understand principles behind corrosion science.

COB2: To expose the students to various instrumental techniques.

COB3: To familiarize the students with methods of coating

COB4: To help the students in the corrosion in selected environments

COB5: To make the students to understand various corrosion processes and engineering applications.

MODULE I CORROSION PROCESSES 9

Basic principles of electrochemistry and aqueous corrosion processes - Electrochemical Thermodynamics and Electrode Potential - Electrochemical Kinetics of Corrosion Cathodic and anodic behavior - Faraday's Law - Nernst equation; standard potentials Pourbaix diagram - Tafel equations, corrosion rate - Evans diagram - pitting, crevice and exfoliation corrosion; influence of deposits and anaerobic conditions; corrosion control; high temperature oxidation and hot corrosion; corrosion/mechanical property interactions.

MODULE II ORTHOPAEDIC MATERIALS 9

ray diffraction, TEM, SEM and EDX, WDX analysis, surface analysis by AES, XPS and SIMS, overview of other techniques.

MODULE III CARDIOVASCULAR MATERIALS 9

Electrodeposition; flame and plasma spraying; thermal, HV of detonation gun, gas dynamic spray, physical vapour deposition; chemical vapour deposition; HIP surface treatments devices, probability-internal conversion- nuclear isomerism.

MODULE IV DENTAL MATERIALS 9

Atmospheric Corrosion, Corrosion in Automobiles, Corrosion in Soils, Corrosion of Steel in Concrete, Corrosion in Water, Microbiologically Induced Corrosion, Corrosion in the Body, Corrosion in the Petroleum Industry, Corrosion in the Aircraft Industry, Corrosion in the Microelectronics Industry

MODULE V MATERIALS IN OPTHALMOLOGY 9

Abrasive, erosive and sliding wear. The interaction between wear and corrosion.

Coating systems for corrosion and wear protection; new coating concepts including multi-layer structures, functionally gradient materials, intermetallic barrier coatings and thermal barrier coatings.

L – 45; TOTAL HOURS –45

REFERENCES:

1. D.A. Jones, Principles and Prevention of Corrosion, 2nd Edition, Macmillan Publishing Co., 1995.
2. J.O.M. Bockris, B.E. Conway, E. Yeager and White, Electrochemical Materials Science in Comprehensive Treatise of Electrochemistry, Volume 4, Plenum press, 2001.
3. M.G. Fontanna and N.D. Greene, Corrosion Engineering, McGraw-Hill publishing, 1978
4. I.M. Hutchings, Tribology: Friction and Wear of Engineering Materials, CRC press, Boca Raton, 1992 D.O. Sprowds, Corrosion Testing and Evaluation, Corrosion Metals Hand book, vol. 13, 1986.

COURSE OUTCOMES:

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

CO1: various corrosion process involved in electrochemistry

CO2: working mechanism of various instrumentation techniques

CO3: various coating process,

CO4: applications of coatings towards environmental safety

CO5: industrial applications of coatings

Board of Studies (BoS) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

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 736	ENVIRONMENTAL CHEMISTRY	L	T	P	C
SDG: 13		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: Understand the issue of chemicals based pollution.

COB2: Understand the chemicals mobility in aquatic systems.

COB3: Understand contaminating chemicals in air and their fate.

COB4: Understand the type of soil contaminants and provide remediation.

COB5: Identify emerging environmental contaminants including speciation

MODULE I FUNDAMENTALS **9**

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product (Ksp) ,heavy metal precipitation, amphoteric hydroxides, CO_2 solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order- 12 Principles of green chemistry.

MODULE II AQUATIC CHEMISTRY **9**

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction , pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation

MODULE III ATMOSPHERIC CHEMISTRY **9**

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO2 capture and sequestration – acid rain- origin and composition of particulates. black carbon, air quality parameters determination.

MODULE IV SOIL CHEMISTRY **9**

Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

MODULE V EMERGING POLLUTANTS **9**

Heavy metals-chemical speciation –Speciation of Hg & As- endocrine

disturbing chemicals- Pesticides, Dioxins & Furan, PCBs ,PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites ,environmental applications.

L – 45; Total Hours –45

REFERENCES:

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird„ Environmental Chemistry, Freeman and company, New York, 5th Edition,2012.
3. Manahan, S.E., "Environmental Chemistry", Ninth Edition, CRC press, 2009.
4. Ronald A. Hites ,"Elements of Environmental Chemistry", Wiley, 2nd Edition,2012.

COURSE OUTCOMES:

Students will be able to

CO1: In solving environmental issues of chemicals based pollution.

CO2: To determine chemicals mobility in aquatic systems.

CO3: To identify contaminating chemicals in air and their fate.

CO4: Understand the type of soil contaminants and provide remediation.

CO5: Identify emerging environmental contaminants including speciation

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

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	M	M	H									
CO 2	M	H	M	M	M	H									
CO 3	M	H	M	M	M	H									
CO 4	M	H	M	M	M	H									
CO 5	M	H	M	M	M	H									

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 13: Climate Action: Take urgent action to combat climate change and its impacts

Statement: Understanding of environmental chemistry will lead to take necessary changes for maintaining a healthy environment.

OEEY 737	FUEL CELLS *F*OR SUSTAINABLE	L	T	P	C
SDG: 7,11	ENERGY PRODUCTION	3	0	0	3

COURSE OBJECTIVES:

The student will

COB1: familiar with the types of fuel cell

COB2: familiar with the components of fuel cells

COB3: understand the performance for fuel cells

COB4: learn the methods **of** production storage of hydrogen

COB5: learn the sustainability **and** applications of fuel cells

MODULE I INTRODUCTION AND TYPES OF FUEL CELLS 9

Introduction - definition - history - difference between batteries and fuel cells - chemistry of fuel cells - classification of fuel cell (based on temperature and electrolyte) - types of fuel cell: polymer electrolyte membrane or proton exchange membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), alkaline fuel cell (AFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC) and solid oxide fuel cells (SOFC)

MODULE II FUEL CELL COMPONENTS 9

Membrane electrode assembly components: membranes and ionomers, fuel cell electrodes and gas diffusion layer, fuel cell electrocatalysts (type and synthesis) - bi-polar plates, humidifiers and cooling plates - *phase-change materials* (PCMs) for thermal packaging - fuel cell stack - Balance of plant - Seals and insulation – Safety.

MODULE III FUEL CELLS PERFORMANCE AND APPLICATIONS 9

Thermodynamics of fuel cells - electrochemical kinetics of fuel cells - Fuel cell efficiency - performance characteristics: voltage efficiency - effect of voltage with current density for low and high temperature fuel cells - causes for voltage losses – introduction to fuel cycle analysis - Mass balance

MODULE IV PRODUCTION AND STORAGE OF HYDROGEN FUEL 9

Hydrogen as energy source - its merit as a fuel - hydrogen production: steam reforming, partial oxidation, coal gasification/thermal reforming, fuel cell technology based on bio-mass - hydrogen storage: compressed hydrogen, liquid hydrogen, metal hydrides, carbon fibers - safety and management of hydrogen

MODULE V FUEL CELL APPLICATIONS AND SUSTAINABILITY 9

Fuel cell material recycle, durability, lifetime issues - Critical issues, adoption, future technologies - distributed power generation - grid-connect applications - non-grid connect applications - combined heat and power (CHP) - economic and environmental analysis - Control of contaminants: CO and sulphur - future trends of fuel cells - Sustainability of Hydrogen Fuel Cell Electric Vehicles.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. R.H. Thring (Editor), Fuel Cells for Automotive Applications, Professional Engineering Publishing UK, 2004.
2. Gregor Hoogers (Editor), Fuel Cell Technology Handbook, SAE International, CRC Press, 2003.
3. Vladimir S. Bagotsky, Fuel Cells: Problems and Solutions, 2nd Edition, John Wiley and Sons, 2012.
4. B. Viswanathan and M. Aulice Scibioh, Fuel Cells: Principles and Applications, Taylor and Francis Group, 2007.
5. Supramaniam Srinivasan, Fuel cells: From Fundamentals to Applications, Springer, 2006.
6. Prospects for Hydrogen and Fuel Cells, International Energy Agency, OECD Publishing, 2005.

COURSE OUTCOMES:

The student will be able to

CO1: classify fuel cells and elaborate the different types of fuel cells.

CO2: explain the components of the fuel cells and can synthesise electrocatalysts for the system

CO3: calculate the open circuit voltage, efficiency and voltage losses, explain fuel cycle analysis and mass balance

CO4: suggest the suitable methods of production and storage of hydrogen for fuel cells.

CO5: find application of fuel cells for variety of application and practice on sustainable environment

Board of Studies (BoS):	**Academic Council:**
12th BoS of Chemistry held on 22.07.2022	19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	M													
CO2		M			M										
CO3		M		L											
CO4	M		L			M									
CO5			M												

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 7: ensure access to affordable, reliable, sustainable and modern energy for all.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

OEEY 738	GREEN AND SUSTAINABLE	L	T	P	C
SDG: 4, 7, 9	CHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: understand the principle and concepts of green chemistry

COB2: various alternative (non-traditional) reagents and chemicals for green synthesis.

COB3: understand the non-conventional energy sources for green synthesis

COB4: understand the uses of eco-benign solvents - alternative to organic solvents

COB5: synthesis of nanomaterials using green chemistry approaches

MODULE I INTRODUCTION, PRINCIPLE AND CONCEPTS OF GREEN CHEMISTRY 9

Need for green chemistry; Inception and evolution of green chemistry; Twelve principles of green chemistry with their explanations and examples; Designing a green synthesis using these principles; Green chemistry in day to day life.

MODULE II NON-TRADITIONAL GREENER ALTERNATIVE APPROACHES 9

Different approaches to green synthesis: (a) Uses of green reagents in organic synthesis - Dimethyl carbonate, polymer supported reagents - peracids and chromic acid; (b) Green catalysts, role of catalysis in sustainable development, homogeneous and heterogeneous catalysts; Introduction, advantages and applications of (i) Nanocatalysts, (ii) Phase transfer catalysts, (iii) Biocatalysts, (iv) Organocatalysts, in organic synthesis.

MODULE III APPLICATIONS OF NON-CONVENTIONAL ENERGY SOURCES 9

Introduction of microwave induced synthesis: Microwave activation, equipment, time and energy benefits, and limitations. Organic transformations under microwaves - Fries rearrangement, Diels-Alder reaction, decarboxylation, saponification of ester, alkylation of reactive methylene compounds; Heterocyclic synthesis - pyrrole, quinoline.

Introduction of ultrasound assisted green synthesis: Instrumentation,

physical aspects, applications in organic transformations.

MODULE IV ENVIRONMENTALLY BENIGN SOLUTIONS TO ORGANIC SOLVENTS **9**

Ionic liquids as green solvents: Introduction, properties and types of ionic liquids. Synthetic applications Diels-Alder reaction, epoxidation and Heck reaction.

Aqueous phase reactions: Enhancement of selectivity, efficiency. Synthetic applications - 1,3-Dipolar Cycloadditions, Carbon-Carbon bond-forming processes and bromination reactions.

Fluorous solvents in green chemistry: Scope, definition and their synthetic applicability. Role of supercritical carbon dioxide in green chemistry.

Ethyl lactate as a renewable green solvent: Properties and applications.

MODULE V GREENER SYNTHESIS OF NANOMATERIALS **9**

Greener synthesis of Nanomaterials— Microwave assisted synthesis of Quantum Dots (QD) and nano catalysts in aqueous medium, Magnetic Nanoparticles. Synthesis of Nanoparticles using Bacteria, Yeast, Algae and Fungus.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Green Chemistry – Environmentally benign reactions – V. K. Ahluwalia. Ane Books India (Publisher). (2006).
2. Green Chemistry – Designing Chemistry for the Environment – edited by Paul T. Anastas & Tracy C. Williamson. Second Edition, (1998).
3. Green Chemistry – Frontiers in benign chemical synthesis and processes- edited by Paul T. Anastas & Tracy C. Williamson. Oxford University Press, (1998).
4. Green Chemistry – Environment friendly alternatives- edited by Rashmi Sanghi & M. M. Srivastava, Narora Publishing House, (2003).
5. Sheldon, R.A., Arends, I., and Hannefed, U., Green Chemistry and Catalysis, Wiley-VCH Verlag GmbH and Co. (2007).
6. Anastas, P., and Williamson, T. C., Green Chemistry Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press (1999).
7. Ahluwalia, V. K., and Kidwai, M., New Trends in Green Chemistry, Anamaya Publishers (2004)

COURSE OUTCOMES:

The students will be able to

CO1: understanding of the 12 principles of green chemistry to improve the sustainability performance of the products/ materials

CO2: use various alternative reagents and chemicals for green synthesis.

CO3: apply non-conventional energy sources for the synthesis of organic compounds and materials.

CO4: use eco-begin solvents for the synthesis of organic compounds and materials

CO5: understand the synthesis of nanomaterials using greener methods

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

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H				L										
CO2			M												
CO3		H						M							
CO4		H													
CO5				L						H					

Note: L- Low Correlation M - Medium Correlation H -High Correlation

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

SDG 7 & Ensure access to affordable, reliable, sustainable and modern energy for all.

`SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement : The holistic understanding of green chemistry principles and concepts to sustainable development in the field of synthetic and materials chemistry.

OEEY 739	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
SDG: 6,7,9,11, 12,13 and 15		3	0	0	3

COURSE OBJECTIVES:

This course will enable students to:

COB1: understand the environmental pollution, environmental emission standards and the laws and rules.

COB2: understand the concept of pollution prevention.

COB3: Understand various air pollution control methods.

COB4: Understand various water pollution control methods of primary and secondary treatment.

COB5: understand the biological treatment, tertiary treatment and solid wastes disposal.

MODULE I EMISSION STANDARDS AND ENVIRONMENTAL LAWS **8**

Environment and environmental pollution from chemical process industries- Air pollutants and pollution and its effects- , characterization of emissions, water pollutants and pollution- and its effects- characterization of effluents- standards for ambient air, noise emission and effluents-Environmental Laws and rules : Air act 1981 and 1987, water act 1974,1977,1987, environmental protection act 1986, The hazardous wastes (management and handling) rules, 1989 & 2000, The manufacture, storage and import of hazardous chemical rules, 1989 & 2000, Public liability insurance act, 1991.The national environment tribunal act, 1995,The chemical accidents (emergency planning, preparedness and response rules, 1996, The recycled plastic manufacture and usage rules, 1999,The batteries (management and handling (draft) rules, 2000.

MODULE II POLLUTION PREVENTION **10**

Process modification: process change, technology change, better process control and product modification- alternative raw material - recovery of by-product from industrial emission effluents- waste reduction techniques: recycle and reuse of waste and volume reduction- energy recovery and waste utilization- Material and energy balance for pollution minimization- Water use minimization- Fugitive emission/effluents and leakages and their control- LDAR programmes- housekeeping and maintenance.

MODULE III AIR POLLUTION CONTROL 9

Introduction to air pollution control- Particulate emission control by mechanical separation: gravitational settling chambers, cyclone separators, fabric filters and electrostatic precipitator and wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers.

MODULE IV WATER POLLUTION CONTROL 10

Introduction to Water Pollution and Control - Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation Secondary treatment: Biological treatment- Anaerobic and aerobic treatment - Trickling filter, activated sludge and lagoons, aeration systems.

MODULE V TERTIARY TREATMENT AND SOLID DISPOSAL 8

Tertiary treatment: colour and odour removal - **Solids Disposal:** Sludge separation and drying- Solids waste disposal – composting, landfill, briquetting / gasificationand incineration.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Paul N Cheremisinoff, Air pollution control and design for industry, 2018.
2. Rao. C.S, Environmental Pollution control Engineering, 2007.

REFERENCES:

1. Thomas T. Shen, Industrial Pollution Prevention, Springer, 1999.
2. Nancy J. Sell, Industrial Pollution Control: Issues and Techniques, 2nd Edition,Wiley, 1992.
3. Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest, Government of India, 2006.
4. www.moef.nic.in.

COURSE OUTCOMES:

Students will be able to describe

CO1: environmental pollution and the environmental standards.

CO2: the concept of pollution prevention.
CO3: various air pollution control methods.
CO4: The pre and secondary treatment of water pollution control methods.
CO5: various tertiary treatment and solid wastes disposal methods.

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

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			H												
CO2			H			M									
CO3					M										
CO4					M										
CO5					M										

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7 : Ensure access to affordable, reliable, sustainable and modern energy for all

Statement: The holistic understanding of recycling materials and technology leads to provide modern renewable energy and sustainable industrialization.

OEEY 740	**INTRODUCTION TO EMBEDDED SYSTEM**	**L**	**T**	**P**	**C**
SDG: 4,9		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To describe the embedded system concepts with its hardware and software architectures.

COB2: To analyze the significance of memory and interrupts in an embedded system

COB3: To discuss the software development tools necessary for embedded systems.

COB4: To interpret the programming model in embedded system

COB5: To compare the concepts of OS and RTOS.

PREREQUISITES: Basics concepts of Microprocessor

MODULE I INTRODUCTION OF EMBEDDED SYSTEM 9

Introduction –Embedded Systems vs. General computing systems- Fundamental Components of embedded systems- Characteristics- Challenges-Examples- Embedded System design process.

MODULE II EMBEDDED COMPUTING PLATFORM 9

Overview of Processors and hardware units in an embedded system-CPU buses – Memory devices –Memory types- I/O devices – Interrupts and types.

MODULE III EMBEDDED SOFTWARE DEVELOPMENT PROCESS and TOOLS 9

Development process of an embedded system-software modules and tools for implementation of an embedded system- Integrated development environment- Host and target machines-cross compiler-cross assembler-Debugging mechanisms.

MODULE IV PROGRAM MODELING IN EMBEDDED SYSTEMS 9

Program Models – Data Flow Graph model-control DFG model-Synchronous DFG model- Finite state machines- UML modeling – UML Diagrams.

MODULE V REAL TIME OPERATING SYSTEMS (RTOS) 9

Overview of Operating Systems (OS) concepts – Real time systems –Types -Need for RTOS in Embedded Systems -Compare OS and RTOS- Multiple Tasks and Multiple Processes-Priority-Based Scheduling- Real time scheduling algorithm – Inter process Communication Mechanisms- Case study.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Marilyn Wolf, "Computers as components ", Elsevier, 2016.
2. K.V. Shibu , Introduction to Embedded Systems, McGraw Hill Education India Private Limited; Second edition, 2017.

REFERENCES:

1. Qing Li and Carolyn Yao, "Real-Time Concepts for Embedded Systems", CMP Books, 2003.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: identify the suitable processor and peripherals for embedded applications

CO2: discuss the software development tools and process.

CO3: draw the programming model for embedded systems

CO4: analyze the role of RTOS for embedded applications

CO5: design real time embedded application.

Board of Studies (BoS) : 24th BOS of ECE held on 08.02.2023.

Academic Council: 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO2	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO3	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO4	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO5	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

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 741	MATLAB PROGRAMMING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To create the mathematical model for specific systems

COB2: Discuss the computer tools to solve mathematical models for specific systems.

COB3: Develop models to solve linear and non linear differential equations

COB4: To define the system or process through MATLAB

COB5: To describe MATLAB graphic feature and its applications.

PREREQUISITES: Mathematics

MODULE I INTRODUCTION TO MATLAB AND DATA PRESENTATION 9

Introduction to MATLAB-Vectors, Matrices -Vector/Matrix Operations & Manipulation Functions vs scripts- Making clear and compelling plots-Solving systems of linear equations numerically and symbolically.

MODULE II ROOT FINDING AND MATLAB PLOT FUNCTION 9

Linearization and solving non-linear systems of equations- The Newton-Raphson method- Integers and rational numbers in different bases- Least squares regression - Curve fitting-Polynomial fitting and exponential fitting.

MODULE III LINEAR AND NON-LINEAR DIFFERENTIAL EQUATIONS 9

Numerical integration and solving first order, ordinary differential equations (Euler's method and Runge-Kutta)- Use of ODE function in MATLAB-Converting second order and higher ODEs to systems of first order ODEs-Solving systems of higher order ODEs via Euler's method and Runge-Kutta)-Solving single and systems of non-linear differential equations by linearization-Use of the function ODE in MATLAB to solve differential equations - Plot Function –Saving & Painting Plots.

MODULE IV INTRODUCTION OF SIMULINK **9**

Simulink & its relations to MATLAB – Modeling a Electrical Circuit- Modeling a fourth order differential equations- - Representing a model as a subsystem- Programme specific Simulink demos.

MODULE V APPLICATION OF MATLAB **9**

Linear algebraic equations – elementary solution method – matrix method for linear equation – Cramer's method – Statistics, Histogram and probability – normal distribution – random number generation – Interpolation – Analytical solution to differential equations – Numerical methods for differential equations.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. Attaway, Stormy. Matlab: a practical introduction to programming and problem solving. Butterworth-Heinemann, 2013.
2. Chapra, Steven. EBOOK: Applied Numerical Methods with MATLAB for Engineers and Scientists. McGraw Hill, 2011.
3. Singh, Harendra, Devendra Kumar, and DumitruBaleanu, eds. Methods of mathematical modelling: fractional differential equations. CRC Press, 2019.

REFERENCES:

1. Hossain, Eklas. "Introduction to Simulink." In MATLAB and Simulink Crash Course for Engineers, Springer International Publishing, 2022.
2. Sumathi, Sai, and Surekha Paneerselvam. Computational intelligence paradigms: theory & applications using MATLAB. CRC Press, 2010.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: analyze mathematical model for specific systems

CO2: develop a code for specific tasks.

CO3: write MATLAB programs for solving linear and nonlinear systems

CO4: model a specific system using simulink

CO5: apply built in functions for the wide range of applications

Board of Studies (BoS) : 24th BOS of ECE held on 08.02.2023.

Academic Council: 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO2	PSO3
CO 1	H	H	M	M	L	L	L	L	L	L	L	L	H	H	H
CO 2	M	H	M	M	L	L	L	L	L	L	L	L	H	H	H
CO 3	M	M	L	M	L	L	L	L	L	L	L	L	H	H	H
CO 4	H	M	M	M	L	L	L	L	L	L	L	L	H	H	H
CO 5	H	H	M	M	L	L	L	L	L	L	L	L	H	H	H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement : Describes the methodology to apply modern tools for solving the mathematical models which promotes sustainable industrialization and foster innovation

OEEY 710 NANOTECHNOLOGY AND CATALYSIS L T P C
SDG: 6,7,9,15 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:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		L		M	H	H									
CO2	M			H	M	H									
CO3					H	M									
CO4															
CO5															

Note: L- Low Correlation M - Medium Correlation H -High Correlation

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 715	STRUCTURAL INTERPRETATION	L	T	P	C
SDG: 4, 9	OF 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 thermos analytical 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:

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 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M		H	M	H									
CO2	H	M		H	M	L									
CO3	H	L		H	M	M									
CO4	H	L		H	M	H									
CO5	H	L		H	M	L									

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Quality Education
SDG 9: Industry and Innovation

Statement:
SDG9: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.

OEEY 742	SURFACE COATING	L	T	P	C
SDG: 9	TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic principles of surface chemistry

COB2: various coating techniques including CVD

COB3: industrial coatings and sputtering techniques

COB4: surface coating resins and emulsions

COB5: techniques like laser alloying and electron beam coating

MODULE I SURFACE CHEMISTRY OF ALLOYS 9

Basic physical chemistry, surface chemistry, pretreatment principle - technology and control of electro deposition systems such as alloy plating, electrolysis, composites.

MODULE II METHODS OF COATING I 9

Hot dip coatings - principle, surface preparation, methods, applications, Diffusion coatings - Principle - Cementation - Cladding - case hardening - structures.

Chemical vapor deposition - classification-techniques, metal organic type, plasma assisted, layer assisted, applications.

MODULE III METHODS OF COATING II 9

Industrial coatings like Enamels, Primers, Putties, Lacquers, Water based paints, Inks, HDPCs, Conversion coatings.

Sputtering techniques, methods, applications, plasma treatments, nitriding, carbonizing, boriding, titanizing methods and applications.

MODULE IV SURFACE COATING RESINS 9

Synthesis & characterization of various surface coating resins like Hard resins, Alkyds, Varnishes, Polyesters, Epoxies, Polyamides, Acrylics, Amino resins, CNSL resin, emulsions & water reducible resins.

MODULE V LASER ALLOY AND ELECTRON BEAM COATING 9

Laser alloying - sources, variables, methods, applications, Electron beam coating- evaporation materials, methods, applications.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. G. Braco, Surface Science Techniques, Springer-Verlag Berlin and Heidelberg GmbH & Co. K, 2000.
2. T.S. Sudarsan, Surface Modification Technologies, Marcel Dekker Inc., 1989
3. D.R. Gabe, Principles of Metal Surfaces Treatment and Protection, Pergmon Press 1972.
4. Tracton, Coatings Technology, CRC press, 2006.

COURSE OUTCOMES:

The students will be familiar with

CO1: the pretreatment methods of electrodeposition

CO2: coating methods like, hot dipping, cementation, cladding. Advanced techniques like CVD, plasma assisted, layer assisted methods are also learnt by the students.

CO3: composition and characteristics of industrial coatings including enamels, primers etc.

CO4: synthesis and characterization of resins, emulsions etc

CO5: in detail knowledge about laser alloying, and electron beam coating and their applications in various fields.

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

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		H				M									
CO2		H			M										
CO3			L			H									
CO4	M				L										
CO5				M		H									

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9 : Industry, Innovation and Infrastructure

SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

OEEY 743	**THIN FILM SCIENCE AND TECHNOLOGY**	**L**	**T**	**P**	**C**
SDG: 4		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To familiarize with preparation and properties of thin films.

COB2: To understand the different kinetics of thin film nucleation.

COB3: To understand the characterization tools for thin films.

COB4: To study the different properties of thin films.

COB5: To apply the knowledge of thin film technology into applications.

MODULE I PREPARATION OF THIN FILMS 9

Kinetic aspects of gases in a vacuum chamber – classifications of vacuum ranges – production of vacuum - pressure measurement in vacuum systems– thin film (epitaxy) – definition – types of epitaxy. Different Growth Techniques: Liquid phase epitaxy – vapour phase epitaxy – molecular beam epitaxy – metal organic vapour phase epitaxy – sputtering (RF & DC) – pulsed laser deposition. Thickness Measurement: Microbalance technique – photometry-ellipsometry– interferometry.

MODULE II KINETICS OF THIN FILMS 9

Nucleation Kinetics: types of nucleation – kinetic theory of nucleation – energy formation of a nucleus – critical nucleation parameters; spherical and non spherical (cap, disc and cubic shaped) Growth Kinetics: Kinetics of binary (GaAs, InP, etc.), ternary (Al1-xGaxAs, Ga1-xInxP, InAs1-xPx, etc.) and quaternary (Ga1-xInxAs1 -yPy, etc.) semiconductors – derivation of growth rate and composition expressions.

MODULE III CHARACTERIZATION 9

X-ray diffraction – photoluminescence – UV-Vis-IR spectrophotometer – Atomic Force Microscope – Scanning Electron Microscope – Hall effect – Vibrational Sample Magnetometer – Secondary Ion Mass Spectrometry – X-ray Photoemission Spectroscopy.

MODULE IV PROPERTIES OF THIN FILMS 9

Dielectric properties – experimental technique for the determination of dielectric properties – optical properties – experimental technique for the determination of optical constants – mechanical properties – experimental technique for the determination of mechanical properties of thin films – magnetic and superconducting properties.

MODULE V APPLICATIONS 9

Optoelectronic devices: LED and Solar cell – Micro Electromechanical Systems (MEMS) – Fabrication of thin film capacitor – application of ferromagnetic thin films; data storage, Giant Magnetoresistance (GMR) – sensors – fabrication and characterization of thin film transistor and FET – quantum dot - Cryptography.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Goswami. A, Thin Film Fundamentals, New Age International (P) Limited, New Delhi, 1996.
2. AichaEishabini-Riad, Fred D. Barlow and ISHN, Thin film Technology Handbook, McGraw-Hill Professional Publishers, 1997.
3. Krishna Seshan, Handbook of Thin Film Deposition, William Andrew Publishers, 2012.
4. Donald Smith, Thin-Film Deposition: Principles and Practice, McGraw-Hill Professional Publishers, 1995.
5. K.L.Chopra, “Thin Film Phenomena”, Malabar: Robert E. Krieger Publishing Company, 1979.

COURSE OUTCOMES:

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

CO1: the basic concepts about the thin film technology

CO2: the different kinetics of thin film nucleation.

CO3: the characterization tools for thin films.

CO4: Structural, optical, dielectric and mechanical properties of thin films

CO5: applications of thin films in optoelectronics

Board of Studies (BoS) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PS O2	PS O3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

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.