GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

DEEMED TO BE UNIVERSITY

VISAKHAPATNAM, HYDERABAD, BENGALURU

ACCREDITED BY NAAC WITH A^{+} GRADE

REGULATIONS AND SYLLABUS
OF
BACHELOR OF TECHNOLOGY
IN
BIOTECHNOLOGY
(W.e.f. 2019-20 Admitted Batch)

A University Committed to Excellence

GITAM University

Vision

To become a global leader in higher education.

Mission

To impart futuristic and comprehensive education of global standards with a high sense of discipline and social relevance in a serene and invigorating environment.

Quality Policy

To achieve global standards and excellence in Teaching, Research and Consultancy by creating an environment in which the faculty and students share a passion for creating, sharing and applying knowledge to continuously improve the quality of education.

GITAM Institute of Technology

Vision

To become a global leader in technical education.

Mission

To impart futuristic and comprehensive education of global standards with a high sense of discipline and social relevance in a serene and invigorating environment.

Department of Biotechnology

GITAM Institute of Technology

GITAM University

VISION

To become a global leader in Biotechnology education, research, and innovation.

MISSION

- **Mission 1**: To impart the concepts of science and engineering for solving problems related to biotechnology.
- **Mission 2:** To empower students with analytical abilities for solving the social problems in dynamic international scenario.
- **Mission 3:** To find innovative solutions to industrial, medical, agricultural and environmental problems by using tools and techniques developed by research in biotechnology.
- **Mission 4:** To motivate students to apply biotechnology for sustainable growth.

1. ADMISSION

1.1 Admission into B.Tech. program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

2.1 A first class in 10+2 or equivalent examination approved by GITAM (Deemed to be University) with subjects Physics, Chemistry and Mathematics/Biology.

2.2 Admission into B.Tech. will be based on an All India Entrance Test (GITAM Admission Test - GAT) conducted by GITAM/Specified rank holders of JEE mains/EAMCET(AP & TS). For Bengaluru CET and COMEDK instead of EAMCET (AP & TS) are considered. The rules of reservation of statutory bodies, wherever applicable, will be followed.

3. CHOICE BASED CREDIT SYSTEM

3.1 Choice Based Credit System (CBCS) was introduced with effect from the academic year of 2015-16 admitted batch and revised in 2019-20 academic year, based on guidelines of the statutory bodies in order to promote:

- Activity based learning
- Student centered learning
- Cafeteria approach
- Students to choose courses of their choice
- Learning at their own pace
- Interdisciplinary learning

3.2 Course Objectives, Learning Outcomes and Course Outcomes are specified, focusing on what a student should be able to do at the end of the course and program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program consists of humanities and social sciences, basic sciences, basic engineering, program core, program electives, open electives, interdisciplinary electives, industry internship, laboratory, mandatory courses and project work.

Course type	Details	
Core courses	Branch specific	*All core courses compulsory*
Elective courses	Program Electives	*Supportive to the discipline courses with expanded scope in a chosen track of specialization or cross track courses*
	Interdisciplinary Electives	*Interdisciplinary exposure to nurture the interests of a student in other department courses.*
	Open Electives	*Common to all disciplines that helps general interest of a student*

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week.

- One credit for each Lecture/Tutorial hour per week.
- One credit for two hours of Practical per week.

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register for the courses in each semester at the time specified in academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 85% in all the courses put together in any semester will not be permitted to attend the end semester examination and will not be allowed to register for subsequent semester of study. He/she has to repeat the same semester along with juniors.

7.2 However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance of the students whose attendance is between 75% and 84% on medical grounds and on payment of prescribed fee.

8. EVALUATION

8.1 Assessment of the performance of a student in theory courses shall be based on two components: Continuous Evaluation (40 marks) and Semester-end Examination (60 marks).

8.2 A student has to secure an aggregate of 40% in any theory course in the two components (ref 8.1) put together to be declared to have passed the course, subject to the condition that the student must have secured a minimum of 24 marks out of 60 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3 Practical courses are assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure pass grade.

8.4 The courses having theory and practical combined, 70% of the weightage will be given for theory component and 30% weightage for practical component. The student has to acquire 40% in the semester end theory examination. However, student must have secured overall 40% (Theory + Practical) to secure pass grade.

8.5 Project work/ Industrial internship courses are assessed under continuous evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure pass grade.

8.6 Mandatory courses are assessed for PASS or FAIL only. No grade will be assigned to these courses. If a student secures more than 40 out of 100 marks, he / she will be declared PASS, else FAIL. PASS grade is necessary to be eligible to get the degree.

8.7 Mandatory courses NCC/NSS/NSO/YOGA are assessed for satisfactory or not satisfactory only. No grade will be assigned. A student has to undergo two hours training per week in any one of the above courses in both I and II semesters and should obtain satisfactory grade to be eligible to get degree.

The details of Assessment Procedure are furnished in Table 1.

Table 1: Assessment Procedure

S.No	**Component of Assessment**	**Types of Assessment**	**Marks Allotted**	**Scheme of Evaluation**
1	Theory courses	Continuous Evaluation	40	(i) Thirty (30) marks for mid semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations.
		Semester end Examinations	60	Sixty (60) marks for semester end Examinations.
		Total	100	

2	Practical courses	Continuous Evaluation	100	(i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher.
3	Theory and Practical combined courses	(a) Theory component: continuous evaluation and semester end examination. (b) Practical component: continuous evaluation Total	100 100 200	70% of the weightage will be given for theory component. Evaluation for theory component will be same as S. No 1 as above. 30% weightage for practical components. Evaluation for practical component will be same as S. No 2 as above
4	Project work (VII & VIII Semesters)	Continuous Evaluation	100	i) Forty (40) marks for periodic evaluation on originality, innovation, sincerity and progress of the work assessed by the project supervisor. ii) Thirty (30) marks for mid-term evaluation by a panel of examiners. iii) Thirty (30) marks for final report presentation and Viva-voce by a panel of examiners.
5	Industrial Internship (VII Semester)	Continuous Evaluation	100	i) Thirty (30) marks for Project performance, assessed by the Supervisor of the host Industry/ Organization. Submission of Project Completion Certificate from host organization is mandatory. ii) Forty (40) marks for Report and Seminar presentation on the training, assessed by the Teacher Coordinator. iii) Thirty (30) marks for presentation on the training, before a panel of examiners.

6	Mandatory Courses	Continuous Evaluation	100	Sixty (60) marks for midterm semester examinations. Three midterm examinations shall be conducted for 30 marks each; performance in best two shall be taken into consideration Forty (40) marks for Quizzes, Assignments and Presentations

9. RETOTALING & REVALUATION

9.1 Retotaling of any theory answer script of the semester-end examination is permitted on request by a student by paying the prescribed fee within one week after the announcement of the results.

9.2 Revaluation of the theory answer scripts of the semester-end examination is permitted on request by student by paying the prescribed fee within one week after the announcement of the results.

9.3 A student who has secured 'F' grade in a theory course shall have to reappear at the subsequent examination held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

9.4 A student who has secured 'F' grade in a practical course shall have to attend special instruction classes held during summer.

9.5 A candidate who has secured 'F' grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examinations held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

9.6 A student who has secured 'F' Grade in project work / Industrial Training shall be permitted to submit the report only after satisfactory completion of the work and viva-voce examination.

10. PROVISION FOR VERIFICATION OF ANSWER BOOK AND CHALLENGE EVALUATION

10.1 If a student is not satisfied with his/her grade after revaluation, the student can apply for verification of answer book on payment of prescribed fee for each course within one week after announcement of revaluation results.

10.2 After verification, if a student is not satisfied with revaluation marks/grade, he/she can apply for challenge valuation within one week after announcement of answer book verification result or two weeks after the announcement of revaluation results, which

will be valued by the two examiners i.e., one Internal and one External examiner on payment of prescribed fee. The challenge valuation fee will be refunded, if the student is successful in the appeal by securing a better grade.

11. SUPPLEMENTARY EXAMINATIONS AND SPECIAL EXAMINATIONS.

11.1 The odd (I, III, V, VII) semester supplementary examinations will be conducted after conducting regular even semester examinations during April/May.

11.2 The even (II, IV, VI, VIII) semester supplementary examinations will be conducted after conducting regular odd semester examinations during October/November.

11.3 A student who has completed period of study and has "F" grade in final semester courses is eligible to appear for special examination.

12. PROMOTION TO THE NEXT YEAR OF STUDY

12.1 A student shall be promoted to the next academic year only if he/she passes 60% of the credits till the previous academic year.

12.2 Whenever there is a change in syllabus or curriculum he/she has to continue the course with new regulations after detention as per the equivalency established by the BoS to continue his/her further studies.

13. MASSIVE OPEN ONLINE COURSES

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (**MOOCs**) during the period of study. Students without any backlog courses upto fourth semester are permitted to register for MOOCs from fifth semester onwards up to a maximum of 15 credits from program elective/ interdisciplinary elective/ open elective courses. However the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency for these courses will be decided by the respective Board of Studies (BoS).

14. ELIGIBILITY FOR AWARD OF THE B. Tech. DEGREE

14.1 The curriculum of the eight semesters B.Tech. program is designed to have a total of 160 credits for the award of B.Tech. degree.

14.2 Duration of the program: A student is ordinarily expected to complete the B.Tech. program in eight semesters of four years. However, a student may complete the program in not more than eight years including study period.

14.3 However, the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.

14.4 A student shall be eligible for award of the B.Tech. Degree if he / she fulfils the following conditions:

i) Registered and successfully completed all the courses and projects as per the curriculum.

ii) Successfully acquired the minimum required credits as specified in the curriculum in the branch of his/her study within the stipulated time.

iii) Has no dues to the Institute, hostels, Libraries, NCC/NSS etc, and no disciplinary action is pending.

15. B. Tech (HONORS)

A student who secured 8.0 CGPA or above up to IV semester is eligible to register for B. Tech (Honors) degree. The student has to complete additional 20 credits (six theory courses + seminar) as approved by the respective Departmental Committee (DC) to secure B. Tech (Honors). The courses will be approved by DC of respective campuses.

16 GRADING SYSTEM

16.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades and Grade Points

S.No.	Grade	Grade Points	Absolute Marks
1	O (Outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

16.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, subject to securing CGPA of 5.0 at the end of the program to declare pass in the B. Tech program.

17. GRADE POINT AVERAGE

17.1 Grade Point Average (GPA) for a semester is calculated as follows:

$$GPA = \frac{\Sigma[\, C^{*}\, G\,]}{\Sigma\, C}$$

where, C = number of credits for the course.

G =grade points obtained by the student in the course.

17.2 The Cumulative Grade Point Average (CGPA), is calculated using the above formula considering the grades obtained in all the courses, in all the semesters up to that particular semester.

17.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for award of Class

Class	CGPA Required
First Class with Distinction	$\geq$8.0*
First Class	$\geq$ 6.5
Second Class	$\geq$ 5.5
Pass Class	$\geq$ 5.0

* In addition to the required CGPA of 8.0 or more, a student must have necessarily passed all the courses in the first attempt.

18. BETTERMENT OF GRADES

18.1 A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations only in eight theory courses of his/her choice, conducted in summer vacation along with the special examinations.

18.2 Betterment of Grades is permitted 'only once', immediately after completion of the program of study.

19. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice-Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

PROGRAM OBJECTIVES

The students of B. Tech. Biotechnology, after completion of the program will be able to:

PO 1	**Apply the principles of biotechnology**
PO 2	**Integrate the concepts of biotechnology in the fields of medicine and healthcare**
PO 3	**Implement the concepts of biotechnology in agriculture**
PO 4	**Introduce the concepts of biotechnology in industry and environment**
PO 5	**Design a pilot plant for implementing a commercial bioprocess**
PO 6	**Adapt to changing professional and societal needs by practicing the art of lifelong learning**
PO 7	**Formulate and design end-to-end solutions for biotechnology industries**
PO 8	**Implement ethical principles in biotechnology practices**
PO 9	**Manage a team of professionals in different fields of biotechnology**
PO 10	**Take up higher studies in core and interdisciplinary fields.**
PO 11	**Carry out research in the field of biotechnology and related multidisciplinary specializations.**
PO 12	**Become an entrepreneur and contribute to industrialization in solving problems of societal relevance**

PROGRAM OUTCOMES

PO1	**ENGINEERING KNOWLEDGE: Apply the knowledge of Mathematics, Science, Engineering Fundamentals, and an Engineering specialization to the solution of Complex Engineering problems.**
PO2	**PROBLEM ANALYSIS: Identify, formulate, research literature, and analyze Complex Engineering problems reaching substantiated conclusions using first principles of Mathematics, Natural Sciences, and Engineering Sciences.**
PO3	**DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for Complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.**
PO4	**CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.**
PO5	**MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and Modern Engineering and IT tools including prediction and modeling to Complex Engineering activities with an understanding of the limitations.**
PO6	**THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Professional Engineering practice.**
PO7	**ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the Professional Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.**
PO8	**ETHICS: Apply ethical principles and commit to Professional Ethics and responsibilities and norms of the engineering practice.**
PO9	**INDIVIDUAL AND TEAM WORK: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**
PO10	**COMMUNICATION: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.**
PO11	**PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.**
PO12	**LIFE LONG LEARNING: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.**

PROGRAM SPECIFIC OUTCOMES

PSO 1 Acquire knowledge on the essentials of **Biology and Chemical engineering** for laying a strong foundation to understand the emerging and advanced **engineering** concepts in Biotechnology.

PSO 2 Acquire knowledge regarding applications of **Biotechnology** for enabling their applications in industry and research

PSO 3 Acquire ability to apply **Biotechnology** to develop products with improved characteristics thereby increasing farmers' income, improving human health and decreasing environmental pollution.

Department of Biotechnology

(Effective from the academic year 2019-20 admitted batch)

Semester I

S.No	Course Code	Course Title	Category	L	T	P	C	Remarks
1.	19EMA103/ 19EBT101	Mathematics for Biotechnology-I/ Introduction to Biology	BS	3	0	0	3	Branch specific
2.	19EHS131	Communicative English-I	HS	2	0	3	3.5	Common to all
3.	19ECY135	Chemistry for Biotechnology	BS	3	0	3	4.5	Branch specific
4.	19EID131/ 19EEE131	Problem Solving and Programming/ Basic Electrical and Electronics Engineering	ES	3	1	3	5.5	Common to all
5.	19EME121/ 19EME131	Workshop/ Engineering Graphics	ES	0/1	0	3	1.5/2.5	Common to all
6.	19EMC181	NCC/NSS/NSO/YOGA	MC	0	0	2	0	Common to all
Total							**18/19**	

Semester II

S.No	Course Code	Course Title	Category	L	T	P	C	Remarks
1.	19EMA106	Mathematics for Biotechnology-II	BS	3	0	0	3	Branch specific
2.	19EHS132	Communicative English-II	HS	2	0	3	3.5	Common to all
3.	19EPH 135	Physics for Biotechnology	BS	3	0	3	4.5	Branch specific
4.	19EEE131/ 19EID131	Basic Electrical and Electronics Engineering / Problem Solving and Programming	ES	3	1	3	5.5	Common to all
5.	19EME131/ 19EME121	Engineering Graphics/ Workshop	ES	1/0	0	3	2.5/1.5	Common to all
6.	19EBT122	Biotechnology Workshop	CE	0	0	3	1.5	
7.	19EMC181	NCC/NSS/NSO/YOGA	MC	0	0	2	0	Common to all
Total							**20.5/19.5**	

Semester III									
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**A**	**C**	**Remarks**
1	19EMA207	Mathematics for Biotechnology III	BS	3	0	0		3	
2	19EID132/ 19EID134	Design Thinking / AI Tools	ES	2	0	2		3	Common to all
3	19EBT201	Process Calculations	PC	2	0	0		2	
4	19EBT231	Biochemistry	PC	3	0	2		4	
5	19EBT233	Microbiology	PC	2	0	2		3	
6	19EBT203	Genetics and Molecular Biology	PC	3	0	0		3	
7	19EBT235	Fluid mechanics and Mechanical Operations	PC	2	0	2		3	
8	19EMC281/ 19EMC282	Constitution of India / Environmental Sciences	MC	3	0	0		0	Mandatory Course
9	19EHS221	Comprehensive Skill Development II	HS	0	0	0	6	1	
Total								22	

Semester IV									
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**A**	**C**	**Remarks**
1	19EMA208	Mathematics for Biotechnology-IV	BS	3	0	0		3	Branch specific
2	19EID232	Internet of Things	ES	2	0	2		3	Common to all
3	19EBT232	Heat and Mass Transfer	PC	3	0	2		4	
4	19EBT234	Genetic Engineering	PC	3	0	3		4.5	
5	19EBT202	Instrumental methods of analysis	PC	2	0	0		2	
6	19EBT204	Biochemical Thermodynamics	PC	3	0	0		3	
7	19EBT2XX	Program Elective I	PE	3/2	0	0/2		3	
8	19EMC282/ 19EMC281	Environmental Sciences / Constitution of India	MC	3	0	0		0	Mandatory Course
9	19EBT292	Comprehensive Skill Development III	PW	0	0	0	6	1	
Total								23.5	

Semester V									
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**A**	**C**	**Remarks**
1	19EBT331	Bioprocess Engineering	PC	3	0	2		4	
2	19EBT333	Biochemical reaction Engineering	PC	3	0	2		4	
3	19EBT335	Immunotechnology	PC	3	0	2		4	
4	19EID132	Design Thinking	ES	2	0	2		3	
5	19EID3XX	Interdisciplinary Elective I	ID	3/2	0	0/2		3	
6	19EHS302	Engineering Economics and Management	HS	3	0	0		3	Common to all
7	19EBT392	Comprehensive Skill Development IV	PW	0	0	0	6	1	
Total								22	

Semester VI									
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**A**	**C**	**Remarks**
1	19EBT332	Bioinformatics	PC	3	0	2		4	
2	19EBT334	Process dynamics and control	PC	3	0	2		4	
3	19EBT302	Bioseparation Technology	PC	2	0	2		3	
4	19EBT3XX	Program Elective II	PE	2	0	2		3	
5	19EBT3XX	Program Elective III	PE	2	0	2		3	
6	19EID3XX	Open Elective II	OE	3	0	0		3	
7	19EMC382	Engineering Ethics	MC	3	0	0		0	Mandatory Course
8	19EBT392	Comprehensive Skill Development V	PW	0	0	0	6	1	
Total								21	

Semester VII									
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**A**	**C**	**Remarks**
1	19EBT433	Plant Biotechnology	PC	2	0	2		3	
2	19EBT403	Animal Biotechnology	PC	2	0	0		2	
3	19EBT4XX	Program Elective IV	PE	2	0	2		3	
4	19EBT4XX	Program Elective V	PE	3/2	0	0/2		3	
5	19EID4XX	Interdisciplinary Elective II	ID	3/2	0	0/2		3	
6	19EHS407	Project Management and Entrepreneurship	HS	3	0	0		3	
7	19EBT493	Project Phase I	PW	0	0	2		1	
8	19EBT491	Internship*	PW					1	
9	19EBT495	Comprehensive Skill Development VI	PW	0	0	0	6	1	
Total								20	

*Industrial Training / Research Projects in National Laboratories / Academic Institutions

Semester VIII								
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks**
1	19EID4XX	Interdisciplinary Elective III	ID	3/2	0	0/2	3	
2	19EBT4XX	Program Elective VI	PE	3/2	0	0/2	3	
3	GSS115	Gandhi for the 21st Century	HS				1	
4	19EBT492	Project Phase II	PW	0	0	12	6	
Total							13	

Total Number of Credits

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	**19**	**19.5**	**22**	**23.5**	**22**	**21**	**20**	**13**	**160.0**

Category and Credits

Category	Category Code	Courses	Credits GITAM	Credits suggested by AICTE
Humanities & Social Sciences	HS	Communicative English	11.5	12
		HS1 and HS2 (elective)		
		Gandhi for the 21st Century		
		Comprehensive Skill Development I & II		
Basic Sciences	BS	Physics for Biotechnologists	21	25
		Chemistry for Biotechnologists		
		Mathematics (4 Courses)		
Engineering Sciences	ES	Problem Solving and Programming	24	24
		Basic Electrical and Electronics Engineering		
		AI Tools		
		Engineering Graphics		
		Workshop		
		Design Thinking		
		Internet of Things		
Open Electives	OE	OE1 & OE2	15.5	18
Interdisciplinary Electives	ID	ID1, ID2, ID3		
Program Electives	PE	PE1 – PE6	18	18
Program Core	PC	PC1 – PC18	58	48
Project	PW	Venture Discovery	12	15
		Internship		
		Comprehensive Skill Development III - VI		
		Project Phase I		
		Project Phase II		
Mandatory	MC	Environmental Science, Constitution of India, Engineering Ethics	-	-
Total			**160**	**160**

Engineering Physics								
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks**
1	19EPH131	Engineering Physics	BS	3	0	3	4.5	Offered for ECE, CSE, EEE and IT
2	19EPH133	Applied Physics	BS	3	0	3	4.5	Offered for AE, CE and ME
3	19EPH135	Physics for Biotechnology	BS	3	0	3	4.5	Offered for BT

Engineering Chemistry								
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks**
1	19ECY131	Engineering Chemistry	BS	3	0	3	4.5	Offered for ECE, CSE, EEE and IT
2	19ECY133	Chemistry of Materials	BS	3	0	3	4.5	Offered for AE, CE and ME
3	19ECY135	Chemistry for Biotechnology	BS	3	0	3	4.5	Offered for BT

OPEN ELECTIVES

Open Elective –I

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EOE301	Japanese for Beginners	OE	3	0	0	3
2	19EOE303	French for Beginners	OE	3	0	0	3
3	19EOE305	Biotechnology and Society	OE	3	0	0	3
4	19EOE307	Contemporary Relevance of Indian Epics	OE	3	0	0	3
5	19EOE309	Indian National Movement	OE	3	0	0	3
6	19EOE313	Personality Development	OE	3	0	0	3
7	19LOE301	Fundamentals of Cyber Law	OE	3	0	0	3
8	19MOE303	Introduction to International Business	OE	3	0	0	3
9	19EOE319	Introduction to Music	OE	3	0	0	3
10	19EOE321	Environment and Ecology	OE	3	0	0	3
11	19EOE323	Indian History	OE	3	0	0	3
12	19EOE327	Professional Communication	OE	3	0	0	3
13	GEL244	English for Higher Education	OE	3	0	0	3
14	19EOE224	Virtual Reality	OE	3	0	0	3

Open Elective –II

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EOE302	German for Beginners	OE	3	0	0	3
2	19EOE304	Chinese for Beginners	OE	3	0	0	3
3	19EOE306	Analytical Essay Writing	OE	3	0	0	3
4	19EOE308	Indian Economy	OE	3	0	0	3
5	19EOE310	Public Administration	OE	3	0	0	3
6	19EOE312	Environmental Management	OE	3	0	0	3
7	19EOE327	Professional Communication	OE	3	0	0	3
8	19MOE301	Basics of Finance	OE	3	0	0	3
9	19LOE301	Fundamentals of Cyber Law	OE	3	0	0	3
10	19EOE313	Personality Development	OE	3	0	0	3
11	19MOE305	Basics of Marketing	OE	3	0	0	3
12	GEL 345	Work Place Communication-Basic	OE	3	0	0	3
13	GEL 347	Work Place Communication-Advanced	OE	3	0	0	3

PROGRAM ELECTIVES

Program Elective I

S. No	Stream	Course Code	Course Title	Category	L	T	P	C
1	Industrial Biotechnology	19EBT242	Industrial Fermentation Technology	PE	2	0	2	3
2	Cellular and molecular Biotechnology	19EBT244	Advanced cell biology	PE	2	0	2	3
3	Food Biotechnology	19EBT246	Food science and Technology	PE	2	0	2	3
4	Medical and Pharmaceutical Biotechnology	19EBT248	Biophysics	PE	3	0	0	3

Program Elective II

S. No	Stream	Course Code	Course Title	Category	L	T	P	C
1	Industrial Biotechnology	19EBT342	Environmental Biotechnology	PE	2	0	2	3
2	Cellular and molecular Biotechnology	19EBT344	Genomics and Genome engineering	PE	2	0	2	3
3	Food Biotechnology	19EBT346	Biotechnology of fermented foods	PE	2	0	2	3
4	Medical and Pharmaceutical Biotechnology	19EBT348	Systems Biology	PE	2	0	2	3

Program Elective III

S. No	Stream	Course Code	Course Title	Category	L	T	P	C
1	Industrial Biotechnology	19EBT352	Marine Biotechnology	PE	2	0	2	3
2	Cellular and molecular Biotechnology	19EBT354	Proteomics and Protein Engineering	PE	2	0	2	3
3	Food Biotechnology	19EBT356	Food processing Technology	PE	2	0	2	3
4	Medical and Pharmaceutical Biotechnology	19EBT358	Pharmaceutical Biotechnology	PE	2	0	2	3

Program Elective IV

S. No	Stream	Course Code	Course Title	Category	L	T	P	C
1	Industrial Biotechnology	19EBT441	Bioprocess plant design	PE	2	0	2	3
2	Cellular and molecular Biotechnology	19EBT443	Metabolomics and metabolic engineering	PE	2	0	2	3
3	Food Biotechnology	19EBT445	Sea and dairy food processing	PE	2	0	2	3
4	Medical and Pharmaceutical Biotechnology	19EBT447	Molecular modeling and drug design	PE	2	0	2	3

Program Elective V

S. No	Stream	Course Code	Course Title	Category	L	T	P	C
1	Industrial Biotechnology	19EBT451	Applied biocatalysis and biotransformation	PE	3	0	0	3
2	Cellular and molecular Biotechnology	19EBT453	Artificial neural networks	PE	2	0	2	3
3	Food Biotechnology	19EBT455	Food handling, packaging and storage	PE	3	0	0	3
4	Medical and Pharmaceutical Biotechnology	19EBT457	Molecular diagnostics	PE	2	0	2	3

Program Elective VI

S. No	Stream	Course Code	Course Title	Category	L	T	P	C
1	Industrial Biotechnology	19EBT452	Modelling and simulation in bioprocesses	PE	2	0	2	3
2	Cellular and molecular Biotechnology	19EBT454	Stem cells and tissue engineering	PE	3	0	0	3
3	Food Biotechnology	19EBT456	Food safety and quality management	PE	3	0	0	3
4	Medical and Pharmaceutical Biotechnology	19EBT458	Nanobiotechnology	PE	3	0	0	3

INTERDISCIPLINARY ELECTIVES

Interdisciplinary Elective I									
S. No.	**Stream**	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks** Offered by
1	Professional Courses	19ECY371	Chemical aspects of Biomolecules	ID	2	1	0	3	Chemistry
2		19EEI477	Industrial Automation	ID	2	1	0	3	ECE
3		19EMA371	Numerical Methods, Probability and Statistics	ID	2	1	0	3	MATHS
4	Computer Oriented Courses	19ECS371	Introduction to Database Management Systems	ID	2	1	0	3	CSE
5		19ECS373	Object Oriented Programming with C++	ID	2	1	0	3	CSE
6		19ECS375	Introduction to Programming with JAVA	ID	2	1	0	3	CSE
7	Management Courses	19EME456	Optimization Techniques	ID	2	1	0	3	ME
8		19EHS405	Operations Research	ID	2	1	0	3	ME

Interdisciplinary Elective II									
S. No.	**Stream**	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks** Offered by
1	Professional Courses	19EME361	3D Printing	ID	2	1	0	3	ME
2		19EEI371	Sensors and Signal Conditioning	ID	2	1	0	3	ECE
3	Computer Oriented Courses	19ECS471	Introduction to Operating Systems	ID	2	1	0	3	CSE
4		19ECS473	Introduction to Software Engineering	ID	2	1	0	3	CSE
5		19ECS475	Introduction to Web Technologies	ID	2	1	0	3	CSE
6		19ECS477	Fundamentals of Data Structures	ID	2	1	0	3	CSE
7	Management Courses	19EME349	Total Quality Management	ID	2	1	0	3	ME
8		19EME356	Enterprise Resource Planning	ID	2	1	0	3	ME

Interdisciplinary Elective III									
S. No.	**Stream**	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks** Offered by
1	Professional Courses	19EEI475	Medical Instrumentation	ID	2	1	0	3	ECE
2		19EEC475	Microcontrollers and Interfacing	ID	2	1	0	3	ECE
3		19ECY471	Chemical analysis of agricultural materials	ID	2	1	0	3	Chemistry
4	Computer Oriented Courses	19ECS480	Introduction to Machine Learning	ID	2	1	0	3	CSE
5		19ECS472	Introduction to Augmented Reality and Virtual Reality	ID	2	1	0	3	CSE
6		19ECS474	Introduction to Cloud Computing	ID	2	1	0	3	CSE
7		19ECS476	Introduction to Big Data	ID	2	1	0	3	CSE
8		19ECS478	Introduction to Data Science	ID	2	1	0	3	CSE
9	Management Courses	19EME357	Supply Chain Management	ID	2	1	0	3	ME
10		19EME371	Quantitative Techniques for management	ID	2	1	0	3	ME

19EMA103: MATHEMATICS FOR BIOTECHNOLOGY-I
(Partial fractions, Trignometry and Calculus)

L	T	P	C
3	0	0	3

This course is exclusively designed for the students of Bio-Technology as a bridge course to gain knowledge on splitting to partial fractions, basic concepts of Trigonometry and Calculus.

Course Objectives:

- To teach the concepts of partial fractions techniques.
- To explain the concepts of Trigonometry.
- To familiarize with the complex numbers and their properties.
- To teach the concepts of permutations and combinations.
- To familiarize with the basic concepts of limits, continuity and differentiation.

Unit I: Partial Fractions **8 hr**

Introduction, resolving $\frac{f(x)}{g(x)}$ into partial fractions when $g(x)$ contains non repeated linear factors, repeated linear factors, repeated and non-repeated irreducible quadratic factors.

Learning Outcomes:

At the end of this unit, the student will be able to

- find a fractional function and resolve it into partial fractions (L3)
- make use of resolving techniques of repeated and non repeated linear factors (L3)
- apply this technique in evaluation of integrals (L3)

Unit II: Trigonometry **8 hr**

Trigonometric functions, periodicity, trigonometric ratio of compound angles, multiple and sub multiple angles, transformations, brief introduction of inverse trigonometric, hyperbolic and inverse hyperbolic functions.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify trigonometric functions and their properties (L3)
- apply the trigonometric ratio techniques of compound angles, multiple and sub multiple angles in calculations (L3)
- find inverse trigonometric and hyperbolic functions (L3)

Unit III: Complex Numbers **8 hr**

Complex number as an ordered pair of real numbers, representation of $z=(a,b)$ in the form $(a+ib)$, conjugate complex numbers, modulus and amplitude of a complex number, geometrical representation of a complex number, Argand plane, Argand diagram.

Learning Outcomes:

At the end of this unit, the student will be able to

- solve the problems in complex numbers (L3)
- find conjugate modules and amplitude of complex number (L3)
- demonstrate complex number and Argand plane (L3)

Unit IV: Permutations **8 hr**

Definition of linear and circular permutations, number of permutations of n dissimilar things taken r at a time, number of permutations on dissimilar things taken r at a time when repetition of things is allowed any number of times, number of circular permutations of different things taken all at a time, number of permutations of n things taken all at a time when some of them are alike and the rest are dissimilar number of combinations of n dissimilar things taken r at a time.

Learning Outcomes:

At the end of this unit, the student will be able to

- find the number of permutations of n dissimilar things (L3)
- apply the techniques of repetition of things in permutations. (L3)
- solve the dissimilar number of combinations of n dissimilar things (L3)

Unit V: Differential Calculus **10 hr**

Limits and Continuity: Definition of right hand limit, left hand limit and limit, limits of $f+g$, $\frac{f}{g}$, fog (without proof), standard limits

1) $\lim_{x \to a} \frac{x^n - a^n}{x - a}$ 2) $\lim_{\theta \to 0} \frac{\sin\theta}{\theta}$ 3) $\lim_{n \to 0} \left(1+\frac{1}{n}\right)^n$ 4) $\lim_{x \to 0} \frac{e^x - 1}{x}$ 5) $\lim_{x \to 0} \frac{a^x - 1}{x}$ (without proofs), definition of continuity

and simple illustrations.

Differentiation: Introduction, definition, differentiation of a function at a point and on an interval, derivative of a function, differentiation of sum, difference, product and quotient of functions, differentiation of algebraic, exponential, logarithmic functions, composite, implicit, parametric, hyperbolic, inverse hyperbolic functions, logarithmic differentiation, derivative of a function with respect to another function, derivatives of first and second order.

Learning Outcomes:

At the end of this unit, the student will be able to

- find derivative of sum, difference, product and quotient of functions (L3)
- apply differentiation techniques in different forms of functions (L3)

Text Books:

1. Text book for Intermediate Mathematics, Board of Intermediate Education, AP, Volumes IA, IB & IIA, 2018.
2. NCERT class XI and XII (part 1) Mathematics text books.

References:

1. V. Venkateswara Rao, N. Krishna Murthy, B.V.S. Sharma, Intermediate Mathematics, S.Chand & Company Ltd., Volume I & II.
2. Chandrika Prasad, A first Course in Mathematics.
3. Text book for Intermediate Mathematics, Deepti Publications.

Course Outcomes:

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

1. Learners will be able to explain the concepts of partial fraction techniques.
2. Learners will be able to explain the concepts of trigonometry.
3. Learners will be able to understand complex numbers and their properties.
4. Learners will be able to explain the concepts of permutations and combinations.
5. Learners will be able to understand the basic concepts of limits, continuity, and differentiation.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									1	1	1	1		1	
CO2						1	1	1	2	2	2	1	1	2	
CO3									1	1	1	1	1	1	1
CO4				1			1		1	1	1	1	1	1	
CO5				1		1	2	1	2	2	2	2	2	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT101: INTRODUCTION TO BIOLOGY

L	T	P	C
3	0	0	3

This course introduces the student, to the basics of biology such as cell structure, biomolecular structure and function, metabolism, inheritance and basic concepts of recombinant DNA technology.

Course Objectives

- Introduce the molecular basis of life.
- Provide the basis for classification of living organisms.
- Describe the transfer of genetic information**.**
- Introduce the techniques used for modification of living organisms**.**
- Describe the applications of biomaterials

Unit I **6 hour**

Introduction to Biology: Comparison of eye and camera, flying bird and aircraft, Biological observations and major discoveries- genera, species and strains, and Classification of living organisms: Cellularity, Ultrastructure, carbon and energy sources, excretion, habitat and molecular taxonomy.

Learning Outcomes:

After completing this unit, the student will be able to

- summarize the basis of life. (L2)
- distinguish prokaryotes from eukaryotes. (L3)
- compare biological organisms and manmade systems. (L2)
- classify organisms. (L2)

Unit II **8 hour**

Water, Biomolecules: sugars, starch and cellulose, Amino acids and proteins, lipids, Nucleotides and DNA/RNA, structure and functions of proteins and nucleic acids, hemoglobin, antibodies and enzymes, Industrial applications of enzymes, Fermentation and its industrial applications

Learning Outcomes:

After completing this unit, the student will be able to

- outline the importance of water. (L2)
- explain the relationship between monomeric units and polymeric units (L2)
- explain the relationship between the structure and function of proteins. (L2)
- interpret the relationship between the structure and function of nucleic acids. (L2)
- summarize the applications of enzymes in industry. (L2)
- explain the applications of fermentation in industry. (L2)

Unit III **10 hour**

Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation, Mechanism of photosynthesis, Human physiology, neurons, synaptic and neuromuscular junctions

Learning Outcomes:

After completing this unit, the student will be able to

- apply thermodynamic principles to biological systems. (L2)
- explain the mechanism of respiration and photosynthesis. (L2)
- summarize the principles of information transfer and processing in humans. (L2)

Unit IV **6 hour**

Mendel's laws, gene mapping, Mitosis and Meiosis, Epistasis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation

Learning Outcomes:

After completing this unit, the student will be able to

- define Mendel's laws. (L1)
- demonstrate the mapping of genes. (L2)
- explain interactions among genes and their significance

- differentiate the mitosis and meiosis. (L3)
- explain the medical importance of gene disorders. (L2)
- identify DNA as a genetic material in the molecular basis of information transfer. (L2)

Unit V **10 hour**

Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.

Learning Outcomes:

After completing this unit, the student will be able to

- outline the principles of recombinant DNA technology. (L2)
- appreciate the potential of recombinant DNA technology.(L2)
- summarize the use of biological materials for diagnostic devises. (L2)

Text books:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2018.
2. Arthur T Johnson, Biology for Engineers, CRC press, 2011

Reference Books:

1. Alberts Et.Al. The molecular biology of the cell, 6/e, Garland Science, 2014
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
3. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012

19EHS 131: COMMUNICATIVE ENGLISH– I
(Common to all)

L	T	P	C
2	0	3	3.5

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking/ Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners improve their communication skills which are crucial in an academic environment as well as professional and personal lives.

Course Objectives

- To enable students develop listening skills for better comprehension of academic presentations, lectures and speeches.
- To hone the speaking skills of students by engaging them in various activities such as just a minute (JAM), group discussions, oral presentations and role plays.
- To expose learners to key reading techniques such as Skimming and Scanning for comprehension of different texts.
- To acquaint the students with effective strategies of paragraph writing, essay writing and formal correspondence such as e-mails, letters and resume.
- To provide students with the critical impetus necessary to forge a path in an academic environment, on the job, and in an increasingly complex, interdependent world.
- To enable learners understand the universality of human experience in literary texts and have a more significant insight into human values.

Unit I **14 hr**

Reading: "Of Studies" by Francis Bacon. **Writing:** Principles of writing: clarity, simplicity, brevity, single focus, organization of thoughts. **Grammar, Vocabulary & Pronunciation:** Sentence Structure: use of phrases & clauses in sentences; punctuation, word formation, word families: nouns, verbs, adjectives adverbs. **Listening & Speaking (English Language Laboratory & Activity Lab):** Introduction to Phonetics: Vowels, Introducing Oneself.

Unit II **14 hr**

Reading: "Scientist in Training: The Oxford Years" Stephen Hawking's Biography. **Writing:** Note Making- organizing techniques: providing a suitable title, headings and sub headings; methods of sequencing. **Grammar, Vocabulary & Pronunciation:** Articles, standard abbreviations. **Listening & Speaking (English Language Laboratory & Activity Lab):** Introduction to Phonetics: Consonants; JAM (Just – A – Minute speaking sessions)

Unit III **14 hr**

Reading: "The Teenage Years' by Sarah Gray. **Writing:** Paragraph Writing-Organization : topic sentence, supporting sentences, the concluding sentence, creating coherence. **Grammar, Vocabulary & Pronunciation:** Tense; prefixes & suffixes. **Listening & Speaking (English Language Laboratory & Activity Lab):** Listening for intonation, stress and rhythm & pronunciation; Common everyday situations: conversations and dialogues.

Unit IV

14 hr

Reading: "Unlock Your Own Creativity" by Robert Von Oech. **Writing:** Paraphrasing **-t**echniques of paraphrasing: Replacement of words and phrases, change of sentence structures. **Grammar, Vocabulary & Pronunciation:** Subject-verb agreement; Synonyms. **Listening & Speaking (English Language Laboratory & Activity Lab):** Listening comprehension: listening for the main idea, listening for specific information; Discussion in pairs and small groups.

Unit V

14 hr

Reading: "A Talk on Advertising" by Herman Wouk Reading Comprehension: skimming & scanning. **Writing:** Writing Essays -writing introduction, body and conclusion .**Grammar, Vocabulary & Pronunciation:** Prepositions, antonyms. **Listening & Speaking (English Language Laboratory & Activity Lab):** Listening to discussions: focus on language devices; group discussions.

Text Book(s): Avenues I: A Course Book for Enhancing Language Skills by Orient BlackSwan Private Limited, India, 2019.

1. References:
2. C Muralikrishna and Sunita Mishra, Communication Skills for Engineers, Dorling Kindesley Pearson Education, India, 2014.
3. Adair, John. Effective Communication. London: Pan Macmillan Ltd., 2003.
4. Andrea J. Rutherford, Basic Communication Skills for Technology, 2nd Edition, Pearson India, 2001.
5. Mamta Bhatnagar and Nitin Bhatnagar, Communicative English for Engineers and Professionals, Dorling Kindesley Pearson Education, India, 2010

Course Outcomes

By the end of the course, the learners will be able to:

1. Think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
2. Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
3. Comprehend and analyze different academic texts.
4. Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing.
5. Effectively handle formal correspondence like e-mail drafting and letter writing.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2													
CO2						1									
CO3							2								
CO4										3					
CO5										3					

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19ECY135 - CHEMISTRY FOR BIOTECHNOLOGY
(For Biotechnology)

L	T	P	C
3	0	3	4.5

This course enables the students to gain knowledge on various aspects of chemical bonding, analytical & electro chemistry, carbohydrates, amino acids, proteins, peptides and stereo chemistry.

COURSE OBJECTIVES

- To familiarize the students with different types of chemical bonding.
- To introduce fundamental approaches to molecular orbital diagrams
- To create awareness on the principles of analytical & electrochemistry.
- To acquaint with the principles of Stereochemistry.
- To familiarize with the classification of carbohydrates.
- To impart knowledge on types of Amino acids, Peptides, Proteins

Unit I **8T**

Chemical Bonding
Types of bonds, VSEPR theory , Molecular orbital theory – shapes and sign convention of atomic orbital, modes of overlapping, criteria for forming molecular orbital from atomic orbital, LCAO Concept, Types of molecular orbitals – bonding, anti-bonding and non-bonding. Molecular orbital treatment for, N_2, O_2, NO and CO.
Coordination Compounds: Werner's theory – Sidgwick's theory, valence bond theory,– effective atomic number (EAN).
Learning outcomes:
After the completion of the Unit I, the student will be able to

- **define** various types of chemical bonding. (**L-1)**
- **list** the types of theories. **(L-1)**
- **classify** bonding in molecular orbital theory. (**L-2)**
- **explain** MO diagrams of N_2 ,CO molecules. (**L-2)**

Unit II **8T**

Analytical Chemistry & Electrochemistry
Analytical Chemistry: Titrimetric analysis, Classification of reactions in titrimetric analysis – Accuracy and Precision, Errors - classification of errors. Determinate and Indeterminate errors, absolute and relative error. Minimization of errors, significant figures –average, mean and standard deviation-Percent RSD [relative standard deviation].

Electrochemistry: Single electrode potential - Reference Electrodes – Normal Hydrogen electrode and Calomel electrode . Conductance – Molar and equivalent conductivities - Kohlraush's Law.

Learning outcomes:
After the completion of the Unit II, the student will be able to

- **list** the types of titrations. (**L-1)**
- **define** accuracy, precision, errors, mean and standard deviation. (**L-1)**
- **explain** the principle of reference electrodes. (**L-2)**
- **identify** the conductivities of various solutions. (**L-3)**

Unit III **8T**

Stereochemistry
Stereoisomerism, E & Z notation for geometrical isomers, chiral center & optical activity, the polarimeter, specific rotation, enantiomers & enantiomerism, racemic modification. Configuration, R & S notation, Cahn - Ingold - Prelog's sequence rules. Diastereomers & Diasteriomerism.

Learning outcomes:
After the completion of the Unit III, the student will be able to

- **define** stereoisomerism, optical activity. (**L-1)**
- **list** the sequence rules. (**L-1)**
- **label** the chiral centers by sequence rules. (**L-1)**
- **classify** enantiomers & diastereomers. (**L-2)**

Unit IV **9T**
Carbohydrates
Introduction – Classification of carbohydrates- D- and L- Sugars; Relative configurations of sugars-examples. D-(+)- Glucose- Reactions to support open chain structure and cyclic structure of Glucose; Killiani Fischer's synthesis- Ruff degradation. D-(-)- Fructose: Structure of fructose – open chain and cyclic structure of fructose. Sucrose and its structure.
Learning outcomes:
After the completion of the Unit IV, the student will be able to

- **define** carbohydrates. (**L-1)**
- **label** the configuration of carbohydrates. **(L-1)**
- **classify** carbohydrates. (**L-2)**
- **identify** the structures of glucose and fructose. (**L-3)**

Unit V **9T**
Amino acids, Peptides & Proteins
Amino acids: Introduction-Classification of amino acids based on the chemical nature and based on nutritional importance-Zwitter ions and isoelectric point.
Synthesis of amino acids- Gabriel phthalimide synthesis.
Peptides: Introduction- Classification of Peptides- Merrifield solid phase poly peptide synthesis.
Proteins: Introduction- Structure of proteins. Classification - fibrous and globular proteins- Denaturation of proteins.

Learning outcomes:
After the completion of the Unit V, the student will be able to

- **classify** Amino acids & Proteins. (**L-2)**
- **explain** the synthesis of amino acids. (**L-2)**
- **identify** the structure and bonding of peptides. (**L-3)**
- **analyze** Merrifield synthesis of poly peptides. (**L-4)**

Text Book(s)

1. B.R.Puri, L.R.Sharma, K.C.Kalia, Principles of Inorganic Chemistry, 33/e, Milestone Publishers & Distributors, (2017).
2. P.W.Atkins, Elements of Physical Chemistry, 3/e, Oxford University press, (2000).
3. B.Mehta and M. Mehta, Organic Chemistry, PHI, (2005).

References

1. L.G. Wade, Organic Chemistry, 6/e, Pearson education, (2005)
2. F.A. Carey, Organic Chemistry, Tata McGraw Hill, (2008)

Course Outcomes

By the end of the course, the learners will be able to:

1. Students will define various types of chemical bonding, including ionic, covalent, and metallic bonds, understanding their mechanisms and properties.
2. Students will explain the principles of analytical and electrochemistry, including techniques such as titration, spectrometry, and electrochemical methods, and their applications in chemical analysis.
3. Students will classify enantiomers and diastereomers, understanding their stereochemical relationships and differences in spatial arrangement.
4. Students will identify the structures of glucose and fructose, understanding their molecular compositions and configurations as monosaccharides.
5. Students will analyze the Merrifield synthesis of polypeptides, understanding the solid-phase peptide synthesis method and its applications in peptide and protein synthesis.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														2
CO2	2														2
CO3	1														2
CO4	1														2
CO5	1														2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19ECY135: CHEMISTRY LABORATORY
(For Biotechnology)

This course enables the students to gain knowledge on various methods in identification of functional groups by qualitative analysis and preparation of organic compounds and estimation of substances by volumetric analysis and determination of physical properties of liquids.

COURSE OBJECTIVES

- To familiarize the functional groups of organic compounds.
- To demonstrate the identification of functional groups by qualitative analysis.
- To train the students for the preparation of simple organic compounds.
- To acquaint with the estimation of substances by volumetric analysis.
- To impart knowledge on the determination of physical properties of liquids like surface tension and viscosity.

CHEMISTRY LABORATORY – PART I

1. Estimation of Sodium Hydroxide using Hydrochloric acid
2. Estimation of Mohr's salt using potassium permanganate
3. Estimation of Hydrogen Peroxide using potassium permanganate
4. Estimation of potassium dichromate using sodium thiosulphate
5. Estimation of copper using sodium thiosulphate.

DEMONSTRATION EXPERIMENTS

6. pH metric titration - Estimation of Sodium Hydroxide using Hydrochloric acid.
7. Potentiometric titration - Estimation of Ferrous Iron using Potassium dichromate.
8. Determination of Viscosity of a Liquid.
9. Determination of Surface Tension of a Liquid.
10. Preparation of TLC

Learning Outcomes:
After the completion of Part-I, the student will be able to

- **list** the types of titrations in volumetric analysis. **(L-1)**
- **classify** volumetric titrations. **(L-2)**
- **explain** the estimation of substances in titrametry. **(L-2)**
- **demonstrate** the surface tension and viscosity. **(L-2)**

CHEMISTRY LABORATORY- PART II

QUALITATIVE ANALYSIS

Identification of the following functional groups in at least SIX organic compounds by adopting a systematic qualitative analysis:

a) Carboxylic acids
   a) Phenols
   b) Aldehydes and Ketones
   c) Esters
   d) Carbohydrates
   e) Hydrocarbons and Ethers
   f) Primary, Secondary and Tertiary amines
   g) Amides and imides
   h) Nitro groups.

PREPARATION OF ORGANIC COMPOUNDS

Preparation of a minimum of three simple organic compounds involving the following Reactions:

a) Acetylation : Acetanilide from aniline and aspirin from salicylic acid
b) Benzoylation : Benzanilide from aniline
c) Nittration : p – nitroacetanilide from acetanilide
d) Methylation : β - naphthyl methyl ether from β-naphthol
e) Sulphonation : Sulphanilic acid from aniline
f) Oxidation : p-benzoquinone from hydroquinone,

Learning Outcomes:

After the completion of Part-II, the student will be able to

- **explain** the preparation of simple organic compounds. (**L-2)**
- **identify** the functional groups of organic compounds. (**L-3)**
- **apply** theoretical knowledge to do practical's in the laboratory. (**L-3)**

Course outcomes

After the completion of Part-I and Part-II, the student will be able to

- **list** the types of titrations in volumetric analysis. **(L-1)**
- **classify** volumetric titrations. (**L-2)**
- **explain** the estimation of substances in titrametry. **(L-2)**
- **identify** the functional groups of organic compounds. (**L-3)**
- **apply** theoretical knowledge to do practical's in the laboratory. (**L-3)**

Text Books:

1. A. I. Vogel, Elementary Practical Organic Chemistry: Qualitative Organic Analysis, Part 2, 2/e, Pearson Education, (2010)

Text Book(s)

2. G. Svehla, Vogel's Quantitative Inorganic Analysis, 7/e, PEI, (2008).

19EID131: PROBLEM SOLVING AND PROGRAMMING
(Common to all branches)

L	T	P	C
3	1	3	5.5

The course is designed to enable the student to write programs for problem solving. After an introduction to program logic design using algorithms and flowcharts, converting the logic into programs is taught. The features of structured programming are explained with the C programming language as an example. This course lays the foundation both for developing program logic and for writing programs in C according to the developed logic.

Course Objectives

- Familiarize the student with the steps involved in writing and running a compiled program.
- Enable the student to build program logic with algorithms and flowcharts.
- Explain with the features and constructs of C programming such as data types, expressions, loops, functions, arrays, pointers and files.
- Demonstrate the handling of variables and input-output operations in C.
- Train the student to convert program logic into C language code using a top-down approach.

UNIT I **9L+3P**

Introduction to Computer Problem-Solving– Introduction, The Problem-Solving Aspect, Top-Down Design, Implementation of Algorithms.

Fundamental Algorithms – Exchanging the values of two variables, Counting, Summation of a Set of Numbers, Factorial Computation, Sine Function Computation, Generation of the Fibonacci Series. Basics of Flow Charts.

Introduction to C Language – Structure of a C Program, Keywords, Identifiers, Data Types and Variable declaration, Constants, Input / Output.

Learning Outcomes:

The student will be able to

- understand a problem and build an algorithm/flowchart to solve it [L2]
- list the steps involved in writing and running a program [L2]
- interpret the structure of C program and various key features of C [L2]

UNIT II **9L+3P**

Operators, Expressions, Precedence and Associativity, Expression Evaluation, Type conversions.

Control Structures:

Selection Statements (making decisions) – if, if-else, nested if, else if ladder and switch statements.
Repetition statements (loops)-while, for, do-while statements, Nested Loops.
Unconditional statements-break, continue, goto.
Pointers – Pointer variable, pointer declaration, Initialization of pointer, Accessing variables through pointers, pointers to pointers, pointers to void.

Learning Outcomes:

The student will be able to

- translate mathematical expressions to C notation using operators [L2]
- construct C programs using various conditional statements [L3]
- develop C programs using loops and nested loops [L6]
- demonstrate the usage of pointers[L3]

UNIT III **9L+3P**

Arrays – Declaration and Definition of Array, accessing elements in array, Storing values in array, linear search, binary search, bubble sort, Two – dimensional arrays, multidimensional arrays. Arrays and Pointers, Pointer Arithmetic and arrays, array of pointers.
Strings – Declaration and Definition of String, String Initialization, arrays of strings, string manipulation functions, string and pointers, unformatted I/O functions.

Learning Outcomes:
The student will be able to

- develop programs for storing and managing collections of items using arrays [L3]
- make use of the in-built functions to manipulate strings [L3]
- solve problems related to arrays and strings [L3]

UNIT IV **9L+3P**

Functions-Designing Structured Programs, user defined function- function definition, function prototype, function call, Types of functions. Parameter Passing by value, parameter passing by address, Passing array to function. Recursive functions. Dynamic Memory allocation Functions, pointers to functions. Storage classes-auto, register, static, extern.

Learning Outcomes:
The student will be able to

- understand the concept of subprograms and recursion [L2]
- apply the in-built functions to develop custom functions for solving problems [L3]
- make use of parameter passing mechanisms [L3]
- infer the effect of storage classes on variables [L2]

UNIT V **6L+2P**

Structures–Declaration, initialization, accessing structures, operations on structures, structures containing arrays, structures containing pointers, nested structures, self referential structures, arrays of structures, structures and functions,structures and pointers, unions.
Input and Output – Concept of a file, Opening and Closing files, file input / output functions (standard library input / output functions for text files).

Learning Outcomes:
The student will be able to

- develop programs using structures and unions for storing dissimilar data items [L6]
- compare the utilization of memory by structures and unions [L5]
- make use of files and file operations to store and retrieve data [L3]

Text Books:

1. R.G. Dromey, How to Solve it By Computer, 1/e, Pearson Education, 2006. (for Unit I).
2. B. A. Forouzan and R. F. Gilberg, Computer Science: A Structured Programming Approach Using C, 3/e, Cengage Learning, 2007.

Reference Books:

1. Jeri R Hanly, Elliot B Koffman, Problem Solving and Program Design in C, 7/e, Pearson Education, 2012.
2. P. Dey and M Ghosh, Programming in C, 2/e, Oxford University Press, 2011.
3. B.W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2/e, Pearson Education, 1988.
4. B. Gottfried, Programming with C,3/e, Schaum's outlines, McGraw Hill (India), 2017.

PROBLEM SOLVING AND PROGRAMMING LAB

1. Conversion of an upper-case character to a lower-case character.
2. Print sizes and ranges of different data types.
3. Find Roots of a Quadratic Equation using 'if'.
4. Find minimum among three numbers.
5. Check whether the given number is perfect
6. Print Twin Primes up to a Specified limit.
7. Find GCD of two numbers.
8. Swap two numbers using pointers.
9. Performs all the five arithmetic operations using Pointers.
10. Implement linear search.
11. Sort an array in descending order.
12. Reverse the given string without using String handling functions.

13. Sort strings in dictionary order.
14. Uses a function to perform addition and multiplication of two matrices.
15. Uses a function to perform transpose of a given Matrix
16. Read an array of elements of size 'n' and find the largest and smallest number using functions
17. Find the sum of digits of a number. Number must be passed to a function using pointers.
18. Print the first n Fibonacci numbers.
19. Reverse a string.
20. Store the data of 'n' employees in a file, where 'n' is given by the user.
21. Count number of characters, words and lines in a given file.
22. Calculate the percentage of marks of three different subjects of each student using array of structures.
23. Demonstrates the memory allocation done by a structure and a union (declare Structure and Union in the same program).
24. Demonstrate member access in a union (declare three different types of variables in union, assign values and print them).
25. Accepts the names of two files and copies the first file into the second, line by line using fgets() and fputs() functions

Text Book(s)

1. R.G. Dromey, How to Solve it By Computer, 1/e, Pearson Education, 2006. (for Unit I).
2. B. A. Forouzan and R. F. Gilberg, Computer Science: A Structured Programming Approach Using C, 3/e, Cengage Learning, 2007.

References

1. Jeri R Hanly, Elliot B Koffman, Problem Solving and Program Design in C, 7/e, Pearson Education, 2012.
2. P. Dey and M Ghosh, Programming in C, 2/e, Oxford University Press, 2011.
3. B.W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2/E, Pearson education, 1988.
4. B.Gottfried, Programming with C, 3/e, Schaum's Outlines, McGraw Hill, India, 2017.

Course Outcomes

By the end of the course, the learners will be able to:

1. Students will be able to work on programming through the visual programming tool Scratch.
2. Students will be able to obtain skills for problem-solving through the flowcharting tool Raptor.
3. Students will be able to elucidate problem-solving using the Python programming language.
4. Students will be able to work on function-oriented programming paradigm through Python.
5. Students will be able to develop solutions using modular concepts.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	3	2					1		3	1	1
CO2	2	2	2	1	3	2					1		3	1	1
CO3	2	2	2	1	3	2					1		3	1	1
CO4	3	2	3	3	3	2					1		3	2	1
CO5	3	2	3	3	3	2					1		3	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EME121: WORKSHOP
(Common to all branches)

L	T	P	C
0	0	3	1.5

The objective of this course is to exposure students to common tools in engineering. The course enables the students to gain hands on experience and skills necessary to perform basic operations such as carpentry, sheet metal working and fitting. It also familiarizes the students with basic electrical house wiring concepts.

Course Objectives

- Explain different tools used in carpentry.
- Impart the skills to do some carpentry operations.
- Demonstrate different types of tools used in fitting, soldering and braze.
- Train fitting, soldering and brazing jobs.
- Familiarize different types of basic electric circuit connections.

Wood Working:

Familiarity with different types of woods and tools used in wood working and make following joints

a) Half – Lap joint.
b) Mortise and Tenon joint.
c) Corner Dovetail joint or Bridle joint.

Sheet Metal Working:

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets

a) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing

Fitting:

Familiarity with different types of tools used in fitting and do the following fitting exercises

a) V-fit b) Dovetail fit c) Semi-circular fit
d) Bicycle tire puncture and change of two wheeler tire

Electrical Wiring:

Familiarities with different types of basic electrical circuits and make the following connections

a) Parallel and series b) Two way switch c) Godown lighting
d) Tube light e) Three phase motor f) Soldering of wires

Course Outcomes:

After completion of this lab the student will be able to:

1. Students will able to summarize the various carpentry operations needed to create products in real-time applications, including cutting, shaping, joining, and finishing wood components.
2. Students will able to develop different parts using metal sheets in real-time applications, involving processes such as cutting, bending, welding, and shaping.
3. Students will able to demonstrate fitting operations across various applications, including tasks like drilling, tapping, threading, and fastening components together.
4. Students will able to perform soldering and brazing operations to join metal components together using molten filler materials, essential in applications like electronics, plumbing, and HVAC systems.
5. Students will select appropriate types of electric circuits for practical applications, considering factors like voltage, current, resistance, and functionality to ensure efficient and safe operation of electrical systems.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2		1	1		1	1				2	2	3
CO2	2	3	2		1	1		1	1				2	2	3
CO3			2		1	1		1	1				2	2	3
CO4	2	3			1	1		1	1				2	2	3
CO5	2	3			1	1			1				2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EMA106: MATHEMATICS FOR BIOTECHNOLOGY-II
(Matrices, Integration & Co-ordinate Geometry)

L	T	P	C
3	0	0	3

This course is exclusively designed for the students of Bio-Technology as a bridge course to gain knowledge on theory of matrices,integration and straight lines and circles in co-ordinate geometry .

Course Objectives:

- To familiarize the students with basic concepts of matrices
- To explain the fundamental concepts of probability.
- To teach the evaluation of definite and indefinite integrals.
- To explain the concepts of straight lines and circles.

Unit I: Matrices **8hr**

Matrices , determinants, definition, types of matrices, algebra of matrices, properties of determinants of 2 X 2, 3 X 3 matrices, inverse of a matrix, solving simultaneous linear equations in two and three variables using matrix inverse method, Cramer's rule and Gauss Jordan method.

Learning Outcomes:

At the end of this unit, the student will be able to

- find determinants of matrices (L3)
- apply crammer's rule for solving linear equations (L3)
- find inverse of a matrix (L3)

Unit II: Probability **8 hr**

Introduction, random experiments, events, classical definition of probability, Axiomatic approach, addition theorem of probability, independent, dependent events, conditional probability, multiplication theorem and Baye's theorem.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify dependent and independent events(L3)
- apply multiplication theorem and Baye's theorem (L3)

Unit III: Indefinite Integrals **8 hr**

Integration as the inverse process of differentiation, standard forms, properties of integrals, integration by the method of substitution covering algebraic, trigonometric, exponential functions, integration by parts, logarithmic functions, inverse trigonometric functions.

Learning Outcomes:

At the end of this unit, the student will be able to

- solve simple integrals (L3)
- apply substitution and by parts techniques in evaluation of integrals (L3)
- find logarithmic, inverse trigonometric functions (L3)

Unit IV: Integrals of Special Types and Definite Integrals: **8 hr**

Integrals of the following types of functions:

$$\frac{1}{x^2 \pm a^2},\ \frac{1}{a^2 - x^2},\ \frac{1}{\sqrt{x^2 \pm a^2}},\ \frac{1}{\sqrt{a^2 - x^2}},\ \sqrt{x^2 \pm a^2},\ \sqrt{a^2 - x^2}$$

and integration of rational functions using partial fractions.

Definite Integrals: Definition of a definite integral and its properties (without proof), formulae of $\int_0^{\pi/2} Sin^n\theta\, d\theta$, $\int_0^{\pi/2} \cos^n\theta\, d\theta$ and $\int_0^{\pi/2} \cos^n\theta\ Sin^m\theta\, d\theta$ (without proofs).

Learning Outcomes:

At the end of this unit, the student will be able to

- find integrals of special functions (L3)

- apply partial fractions technique on evaluation of integrals of rational functions (L3)
- solve definite integrals in trigonometric functions (L3)

Unit V: Co-ordinate Geometry **10hr**

Straight lines: Recapitulation of general equation of a straight line, forms of equation of a straight line: slope intercept form, intercept form, point -slope form, two point form, normal form $x\cos\alpha + y\sin\alpha = p$, point of intersection of two straight lines, line passing through the point of intersection of two given lines, condition for concurrency of three straight lines, angle between two intersecting lines, condition for perpendicularity and parallelism, length of the perpendicular from a point to a straight line, distance between two parallel lines (without proofs).

Circles: Equation of a circle, standard form, centre and radius, equation of a circle with a given line segment as diameter, equation of a circle through three non collinear points, parametric equations of a circle, position of a straight line in the plane of the circle.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify the equation to straight line in different forms(L3)
- find the length of permutation from a point to a straight line(L3)
- find the equation of a circle passing through three non collinear points(L3)

Text Books:

1. Text book for Intermediate Mathematics, Board of Intermediate Education, AP, Volumes IB, IIA & IIB, 2018.
2. NCERT class XI and XII (part 1 & 2) Mathematics text books.

References:

1. V. Venkateswara Rao, N. Krishna Murthy, B.V.S. Sharma, Intermediate Mathematics, S. Chand & Company Ltd., Volume I & II.
2. Chandrika Prasad, A first Course in Mathematics.
3. Text book for Intermediate Mathematics, Deepti Publications.

Course Outcomes:

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

1. Learners will be able to explain the basic concepts of matrices.
2. Learners will be able to explain the fundamental concepts of probability.
3. Learners will be able to teach the evaluation of definite and indefinite integrals.
4. Learners will be able to explain the concept of using partial fraction techniques to evaluate integrals.
5. Learners will be able to explain the concepts of straight lines and circles.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1							1	1		1	1	1		1	
CO2								1	1	1	1	1		1	
CO3				1		1	2	1	1	2	2	1	1	1	1
CO4				1		1	1	1	1	2	2	2	1	2	1
CO5						1			1	1	1	1		1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EHS 132: COMMUNICATIVE ENGLISH– II
(Common to all)

L	T	P	C
2	0	3	3.5

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking/ Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners improve their communication skills which are crucial in an academic environment as well as professional and personal lives.

Course Objectives

- To enable students develop listening skills for better comprehension of academic presentations, lectures and speeches.
- To hone the speaking skills of students by engaging them in various activities such as just a minute (JAM), group discussions, oral presentations and role plays.
- To expose learners to key reading techniques such as Skimming and Scanning for comprehension of different texts.
- To acquaint the students with effective strategies of paragraph writing, essay writing and formal correspondence such as e-mails, letters and resume.
- To provide students with the critical impetus necessary to forge a path in an academic environment, on the job, and in an increasingly complex, interdependent world.
- To enable learners understand the universality of human experience in literary texts and have a more significant insight into human values.

Unit I **14 hr**

Reading: Mohammad Yunus' Speech at the Nobel Prize ceremony. **Writing:** E-mail: structure, etiquette. **Grammar, Vocabulary & Pronunciation:** Conjunctions and sentence connectors, adjective-noun collocations. **Listening & Speaking (English Language Laboratory & Activity Lab):** Note taking, JAM (Just **–** A **–** Minute speaking sessions).

Unit II **14 hr**

Reading: Biography of A. R. Rahman. **Writing:** Letter writing**:** letters of enquiry, seeking permission, complaint & adjustment. **Grammar, Vocabulary & Pronunciation:** Active and passive voice, foreign expressions in English. **Listening & Speaking (English Language Laboratory & Activity Lab):** Inference: inferring relationships, inferring meaning, formal presentations

Unit III

14 hr

Reading: "You Start Dying Slowly" by Pablo Neruda**. Writing:** Resume drafting & cover letter for job application. **Grammar, Vocabulary & Pronunciation:** Noun-pronoun agreement, verb-noun collocations. **Listening & Speaking (English Language Laboratory & Activity Lab): W**atching and listening to video clips; oral summarization of the videos

Unit IV **14 hr**

Reading: 'Most Beautiful' by Ruskin Bond**. Writing:** Précis writing**,** avoiding redundancies and clichés in written communication. **Grammar, Vocabulary & Pronunciation:** Misplaced modifiers**,** idiomatic expressions. **Listening & Speaking (English Language Laboratory & Activity Lab):** Watching & listening to interviews: job interviews, strategies and language for interviews, mock interviews.

Unit V

14 hr

Reading: "Film Making" by Satyajit Ray. **Writing:** Information transfer. **Grammar, Vocabulary & Pronunciation:** Editing short texts, correcting common errors in grammar and usage, words often confused. **Listening & Speaking (English Language Laboratory & Activity Lab):** Watching and listening to news and panel discussions; workplace communication -formal dialogues/ conversations.

Course Outcomes

By the end of the course, the learners will be able to:

- Communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
- Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
- Comprehend and analyze different academic texts.
- Effectively handle academic writing tasks such as paragraph writing, précis writing, paraphrasing and essay writing.
- Effectively handle formal correspondence like e-mail drafting and letter writing.
- Think critically, analytically, creatively and express ideas and content meaningfully.

Text Book(s): Avenues II: A Course Book for Enhancing Communication Skills by Orient BlackSwan Private Limited, India, 2019.

References:

1. Meenakshi Raman and Sangeeta Sharma, Professional Communication, Second Edition, Oxford University Press, India, 2017.
2. Marilyn Anderson, Critical Thinking, Academic Writing and Presentation Skills, Pearson India, 2010.
3. K. R. Lakshminarayanan and T. Murugavel , Challenges in Written English, Scitech Publications (India) Pvt Ltd, India, 2008.
4. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill Education, India, 2005.

19EPH135: PHYSICS FOR BIOTECHNOLOGY

L T P C
3 0 0 3

This course designed for students of Biotechnology to impart fundamentals of electromagnetism and optics in understanding the use in spectroscopy. It also introduces fundamentals of thermal properties – the essentials for understanding the behavior of materials. Principles of Newtonian mechanics will help the students in understanding the oscillatory behavior of materials. An introduction to sensors will be useful for all the branches as an application of modern technology.

Course objectives

- To **introduce** principles to **estimate** forces, fields and waves in electrostatics and magnetoststics (L2).
- To **use** principles of interference, diffraction and polarization. (L3)
- To **estimate** the thermal properties of materials and their use in some applications. (L2)
- To **apply** Newtonian laws of motion to macroscopic systems. (L3)
- To **outline** the principles and working of few common sensing devices. (L1)

Unit-I: Basics of Electromagnetics **9 hr**

Electrostatic Field: Coulombs law and Gauss law, derivation of Coulombs law from Gauss law, applications of Gauss law (line charge, thin sheet of charge and solid charged sphere), Gauss law of electrostatics in dielectric medium, divergence and curl of electric fields (qualitative only), electric potential, relation between potential and force.
Magnetostatic Field: Biot–Savart law, divergence and curl of magnetic fields (qualitative only), Faraday's and Ampere's laws in integral and differential form, displacement current, Maxwell's equations.

Learning outcomes
The students will be able to

- **apply** Coulomb's and Gauss' laws to electric field configurations from charge distributions (L3)
- **apply** the Biot-Savart law to derive magnetostatic field distributions (L3)
- **relate** the law of conservation of charge to continuity equation (L3)
- **evaluate** the Maxwell's equations, Maxwell's displacement current and correction of Ampere's law (L2)

Unit II Optics **10 hr**
Interference: Introduction, interference in thin films due to reflected light: interference in parallel-sided film and wedge shaped film, Newton's rings.
Diffraction: Introduction; Fraunhoffer diffraction at single slit (qualitative only), diffraction due to N-slits (diffraction grating) (qualitative only), determination of wavelength of light with a plane transmission grating.

Polarisation: Introduction; Double refraction – double refraction in calcite crystal, negative and positive crystals, Nicol's prism, Retarders (quarter and half-wave plates).
Learning outcomes
The students will be able to

- **apply** the principle of interference to thin film configurations (L3)
- **infer** the diffraction intensity profiles for single slit and transmission grating (L2)
- **use** the principle of polarization to understand birefringence (L3)

Unit-III: Thermal Properties **10 hr**
Transfer of heat energy; Thermal expansion of solids and liquids; Expansion joints - bimetallic strips; Thermal conduction, convection and radiation and their fundamental laws; Heat conductions in solids; Thermal conductivity - Forbe's and Lee's disc method: theory and experiment; Applications (qualitative only): heat exchangers, refrigerators, ovens and solar water heaters.

Learning Outcomes:

The students will be able to

- **explain** the process of thermal expansion in solids and liquids (L3).
- **distinguish** fundamental laws related to conduction, convection and radiation of *heat (L1).*
- **determine** the thermal conductivity of a material by *Forbes and Lee's disc method (L4).*
- **summarize** the working of heat exchangers, refrigerators, ovens and solar water heaters (L2).

Unit – IV: Mechanics **10 hr**

Basic laws of vectors and scalars; Rotational frames; Conservative and non-conservative forces; F = -*grad* V; Central forces; Elliptical, parabolic and hyperbolic orbits; Noninertial frames of reference; Centripetal acceleration; Harmonic oscillator; Damped harmonic motion; Forced oscillations and resonance. Degrees of freedom.

Learning outcomes

The students will be able to

- **explain** forces and moments in mechanical systems using scalar and vector techniques (L2)
- **interpret** the equation of motion of a rigid rotating body (torque on a rigid body) (L3)
- **apply** the Newton's second law for inertial and non inertial frame of reference (L3)
- **assess** harmonic motion in undamped, damped and forced oscillations (L5)

Unit – V: Sensors **8 hr**

Sensors (qualitative description only); Different types of sensors and applications; Strain and pressure sensors - Piezoelectric, magnetostrictive sensors; Fibre optic methods of pressure sensing; Temperature sensor - bimetallic strip, pyroelectric detectors; Hall-effect sensor; Smoke and fire detectors.

Learning Outcomes:

The students will be able to

- **describe** the principle of strain and pressure sensors (L1)
- **explain** the principle and working of magnetostrictive and piezoelectric sensors (L3)
- **illustrate** the fibre optic methods of pressure sensing (L3)
- **infer** the functioning of temperature sensors like bimetallic strip and pyroelectric detectors (L2)
- **outline** the principle and working of Hall-effect sensor, smoke and fire detectors (L2)

Text books:

1. David J. Griffiths, "Introduction to Electrodynamics"- 4/e, Pearson Education, 2014
2. A Textbook of Engineering Physics, Volume-I (For 1st Year of Anna University) By M.N. Avadhanulu & T.V.S. Arun Murthy S Chand
3. Ian R Sinclair, Sensor and Transducers 3rd eds, 2001, Elsevier (Newnes)

Reference books:

1. M.N. Avadhanulu, P.G.Kshirsagar "A Text book of Engineering Physics", 11th ed S. Chand Publications, 2019
2. M K Varma "Introduction to Mechanics"-Universities Press,2015
3. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11 *Sensors and Transducers,* Electrical and Electronics Measurements and Instrumentation, 1st eds., 2013 McGraw Hill Education (India) Private Limited.

Physics laboratory for Biotechnology

Learning Outcomes

The students will be able to

- **determine**
  a. thickness of thin material (L5)
  b. radius of curvature of planoconvex lens (L5)
  c. refractive indices of o and e rays of bi refringent material (L5)
  d. thermal conductivity of bad and good conductors (L5)
- **apply** resonance to
  a. **estimate** the frequency of a tuning fork (L3, L5)**.**
  b. **examine** the relation between frequency and volume of a cavity (L3, L4).
  c. an LCR circuit (L3).
- **demonstrate** diffraction of light and **calculate** wavelengths of diffracted lights (L2, L4)
- **evaluate** the acceptance angle and **determine** numerical aperture and bending loss of an optical fiber (L5).
- **identify** the type of semiconductor i.e., n-type or p-type using Hall effect (L3)
- **relate** damping and quality factor for simple pendulum (L4)
- **determine** resonant frequency of tuning fork using a sonometer (L5)
- **understand** damping using oscillating disc in different media (L2).

List of experiments

1. To determine thickness of a paper strip – wedge method.
2. To determine radius of curvature of a plano convex lens.
3. To calculate wavelengths of prominent lines using diffraction grating normal incidence.
4. To determine refractive indices (o and e) of a bi refringent material (Prism).
5. To determine the thermal conductivity of a bad conductor by Lee's disc method
6. To determine thermal conductivity of good conductors (Forbe's Apparatus)
7. To determine the frequency of electrically maintained tuning fork by Melde's method
8. To verify the relation between the volume of the air in the resonator and the frequency of the note.
9. To determine coefficient of damping and quality factor for damped simple harmonic motion of a simple pendulum
10. To Study of resonance in a LCR circuit.
11. To determine resonance frequency using a sonometer.
12. To study damping of an oscillating disc in air and water.

References

1. S. Balasubramanian ,M.N. Srinivasan "A Text book of Practical Physics" - S Chand Publishers, 2017.

Course Outcomes:

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

1. Students will demonstrate proficiency in estimating forces, fields, and waves in both electrostatics and magnetostatics.
2. Students will apply principles of interference, diffraction, and polarization to analyze wave behaviors effectively.
3. Students will be capable of calculating the thermal properties of materials, encompassing concepts such as conductivity, heat capacity, and thermal expansion.
4. Students will adeptly apply Newtonian laws of motion to analyze and predict the behavior of macroscopic systems.
5. Students will be able to select appropriate sensing devices from a range of commonly used options, considering factors such as sensitivity, accuracy, and applicability to specific scenarios.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2				2	1		1		
CO2						2				2	1		1		
CO3						2				2	1		1		
CO4						2				2	1		1		
CO5						2				2	1		1		

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EEE131 - BASIC ELECTRICAL AND ELECTRONICS ENGINEERING
(Common to all)

L	T	P	C
3	1	3	5.5

This course introduces the student, to the fundamental principles and building blocks of electrical and electronics engineering. The first three units cover the electric circuit laws, theorems and principles of electrical machines. The last two units cover semiconductor devices and their applications.

Course Objectives

1. To familiarize the basic DC and AC networks used in electrical and electronic circuits.
2. To explain the concepts of electrical machines and their characteristics.
3. To introduce the importance of transformers in transmission and distribution of electric power.
4. To impart the knowledge about the characteristics, working principles and applications of semiconductor diodes, metal Oxide semiconductor field effect transistors (MOSFETs).
5. To expose basic concepts and applications of Operational Amplifier and configurations.

Unit I **(10L + 6P)**

Basic laws and Theorems: Ohm's law, Kirchoff's Laws, series and parallel circuits, source transformations, delta-wye conversion. Mesh analysis, nodal analysis. Linearity and superposition theorem, Thevenin's and Norton's theorem with simple examples, maximum power transfer theorem with simple examples.

Learning Outcomes

Upon completion of the unit, the student will be able to

- state Ohm's law and Kirchhoff's Laws **(L1)**
- identify and analyze series and parallel connections in a circuit **(L1)**
- predict the behavior of an electrical circuit **(L2)**
- determine the current, voltage and power in the given electrical circuit**(L4)**
- apply various techniques to analyze an electric circuit**(L3)**

Unit II **(10L + 6P)**

DC Machines: Constructional features, induced EMF and torque expressions, different types of excitation, performance characteristics of different types of DC machines, Starters: 2-point, 3-point starters, losses and efficiency, efficiency by direct loading.

Learning Outcomes

Upon completion of the unit, the student will be able to

- describe the constructional features of DC machines**(L1)**
- analyze EMF and torque expressions of DC machine**(L4)**
- demonstrate the performance characteristics of different types of dc machines **(L3)**
- explain types of starters used for starting of dc motors **(L2)**
- estimate losses and efficiency of electrical machine**(L2)**

Unit III **(12L + 9P)**

Transformers: Constructional details, EMF equation, voltage regulation, losses and efficiency, open/short- circuit tests and determination of efficiency.**Three Phase Induction Motors**: Construction, working principle of three phase induction motor, Torque and Torque-Slip characteristics.

Learning Outcomes

Upon completion of the unit, the student will be able to

- describe the constructional details of transformers **(L1)**
- demonstrate voltage regulation of transformer **(L3)**
- discuss about open and short- circuit tests of transformer**(L2)**
- explain the working principle of three phase induction motor**(L5)**
- describe torque and torque slip characteristics **(L1)**
- estimate losses and efficiency of three Phase Induction Motors**(L2)**

Unit IV **(12L + 9P)**

Semiconductor Devices: p-n Junction diode **-** Basic operating principle, current-voltage characteristics, rectifier circuits (half-wave, full-wave, rectifier with filter capacitor), Zener diode as Voltage Regulator; Metal oxide semiconductor field effect transistor (MOSFET): Operation of NMOS and PMOS FETs, MOSFET as an amplifier and switch.

Learning Outcomes

Upon completion of the unit, the student will be able to

- describe the device structure and physical operation of a diode **(L1)**
- discuss V-I characteristics of diodes **(L2)**
- explain the use of diode as switch and in electronic circuits**(L2)**
- describe the construction and operation of *n*-channel and *p*-channel MOSFETs **(L1)**
- explain the use of MOSFET as an amplifier and bidirectional switch **(L2)**

Unit V (**10L + 6P)**

Operational Amplifiers: The Ideal Op-Amp, The Inverting Configuration, The closed loop gain, Effect of Finite open-loop gain, The Noninverting Configuration, The closed loop gain, Characteristics of Non Inverting Configuration, Effect of finite open loop gain, the voltage follower, Difference amplifiers, A Single Op-amp difference amplifier.

Learning Outcomes

Upon completion of the unit, the student will be able to

- list the characteristics of an ideal Op-Amp **(L1)**
- explain the Inverting and Noninverting configurations of Op-Amp **(L2)**
- construct a single Op-amp difference amplifier **(L3)**

List of Laboratory Experiments

1. Verification of Kirchhoff's Laws KVL and KCL.
2. Verification of DC Superposition Theorem.
3. Verification of Thevenin's Theorem and Norton's Theorem.
4. OCC and External characteristics of separately excited DC generators.
5. Swinburne's test on a DC shunt motor.
6. OC and SC Tests on single phase transformer.
7. Brake Test on DC shunt motor.
8. Current Voltage Characteristics of a p-n Junction Diode/LED.
9. Diode Rectifier Circuits.
10. Voltage Regulation with Zener Diodes.
11. Design of a MOSFET amplifier and MOSFET inverter/NOR gate
12. Inverting and Non-inverting Amplifier Design with Op-amps.
13. Simulation experiments using PSPICE
    (a) Diode and Transistor Circuit Analysis.
    (b) MOSFET Amplifier design.
    (c) Inverting and Noninverting Amplifier Design with Op-amps.

Text Books:

1. D.P.Kothari, I.J.Nagrath, Basic Electrical and Electronics Engineering, 1/e, McGraw Hill Education (India) Private Limited,2017.
2. B.L.Theraja, Fundamentals of Electrical Engineering and Electronics, 1/e, S.Chand Publishing,New Delhi, 2006.
3. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits 6/e, Oxford University Press, 2014.

References:

1. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011.
2. Dharma Raj Cheruku, B T Krishna, Electronic Devices and Circuits, 2/e, Pearson Education, 2008.
3. R.K.Rajput, Basic Electrical and Electronics Engineering, University Science Press, New Delhi, 2012.

Course Outcomes:

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

1. Student can able to Forecast and assess the behavior of electrical circuits.
2. Student can able to evaluate performance metrics like losses and efficiency, and discern applications of DC machines.
3. Student can able to describe the role of transformers in transmitting and distributing electric power, along with other

applications.

4. Student can able to illustrate the operation and diverse applications of various electronic devices.
5. Student can able to construct both inverting and non-inverting configurations of operational amplifiers.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2	3		2	2		1	3		1
CO2	3					2	3		2	2		1	3		1
CO3	3					2	3		2	2		1	3	2	1
CO4	3					2	3		2	2		1	3	2	1
CO5	3					2	3		2	2		1	3		1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EME131: ENGINEERING GRAPHICS

L	T	P	C
1	0	3	2.5

The course enables the students to convey the ideas and information graphically that come across in engineering. This course includes projections of lines, planes, solids sectional views, and utility of drafting and modeling packages in orthographic and isometric drawings.

Course Objectives

- Create awareness of the engineering drawing as the language of engineers.
- Familiarize how industry communicates, practices for accuracy in presenting the technical information.
- Develop the engineering imagination essential for successful design.
- Demonstrate utility of drafting and modeling packages in orthographic and isometric drawings.
- Train the usage of 2D and 3D modeling softwares.
- Impart graphical representation of simple components.

Manual Drawing: **(7 hour)**

Introduction to Engineering graphics: Principles of Engineering Graphics and their significance-Conventions in drawing-lettering - BIS conventions.

a) Conic sections - general method only,

b) Cycloid, epicycloids and hypocycloid

c) Involutes **(2L + 6P hour)**

Projection of points, lines and planes: Projection of points in different quadrants, lines inclined to one and both the planes, finding true lengths and angles made by line. Projections of regular plane surfaces. **(2L + 6P hours)**

Projections of solids: Projections of regular solids inclined to one and both the reference planes. **(1L + 3P hour)**

Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone. True shapes of the sections. **(1L + 3P hours)**

Development of surfaces: Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts. **(1L+ 6P hour)**

Computer Aided Drafting: **(6 Classes)**

Introduction to AutoCAD: Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions. Dimensioning principles and conventional representations. **(1L + 3P hour)**

Orthographic Projections: Systems of projections, conventions and application to orthographic projections. **(3L + 9P hour)**

Isometric Projections: Principles of isometric projection- Isometric scale; Isometric views: lines, planes, figures, simple and compound solids. **(2L + 6P hour)**

Text Book(s):

1. K.L. Narayana & P. Kannaiah, Engineering Drawing, 3/e, Scitech Publishers, 2012.
2. N.D. Bhatt, Engineering Drawing, 53/e, Charotar Publishers, 2016.

References:

1. Dhanajay A Jolhe, Engineering Drawing, Tata McGraw-Hill, 2009.
2. Shah and Rana, Engineering Drawing, 2/e, Pearson Education, 2009.
3. Venugopal, Engineering Drawing and Graphics, 3/e, New Age Publishers, 2000.
4. K.C. John, Engineering Graphics, 2/e, PHI, 2013.
5. Basant Agarwal and C.M. Agarwal, Engineering Drawing, Tata McGraw Hill, 2008.

Course Outcomes:

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

1. Students will able to utilize engineering graphics as the universal language of engineers.
2. Students will able to prepare drawings according to international standards.
3. Students will able to identify various engineering curves.
4. Students will able to solve plane geometry problems involving lines and plane figures.
5. Students will able to represent solids and sections graphically.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				2		2		2	2		2		2	2	3
CO2				2		2		2	2		2		2	2	3
CO3				2		2		2	2		2		2	2	3
CO4				2		2		2	2		2		2	2	3
CO5				3		3		3	2		3		2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT122 Biotechnology Workshop

L	T	P	C
0	0	3	1.5

Preamble: This laboratory course provides hands on training to the students in basic experiments of engineering biotechnology. The student will be familiarised with the usage of scientific calculator, calibration of pH meter & rotameter, concepts of rate and mass transfer, retrieving biological data, growth and division of cells.

Course Objectives:

This workshop aims to

provide fundamental concepts of microbiology, fermentation, bioinformatics, mass transfer and reaction engineering

demonstrate bioreactor and flow cytometer

understand and visualise different phases of mitosis

1. Applications of scientific calculator

After completion of this experiment, the student will be able to use the calculator for all mathematical and scientific calculations.

2. Determination of rate constant of a reaction by integral method

After completion of this experiment, the student will be able to determine the rate constant for any chemical or biochemical reaction

3. Measurement of oxygen diffused in water

After completion of this experiment, the student will be able to measure the amount of oxygen present in water.

4. Mitosis cell division in onion root tips

After completion of this experiment, the student will be able to observe mitotic cell division in onion root tips.

5. Estimation of sugar content by Brix meter

After completion of this experiment, the student will be able to estimate the sugar content in any liquid sample.

6. Calibration of pH meter and pH measurement.

After completion of this experiment, the student will be able to calibrate the pH meter for measuring pH of any given liquid sample.

7. Biological databases and information resources

After completion of this experiment, the student will be able to retrieve the required data from biological databases and information resources.

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8. Batch growth of yeast cells

After completion of this experiment, the student will be able to prepare the media and grow the yeast cells in a conical flask.

9. Biological production of Wine

After completion of this experiment, the student will be able to prepare wine using cells and raw materials.

10. Calibration of rotameter and measurement of flow rate.

After completion of this experiment, the student will be able to calibrate rotameter for flow measurement.

11. Demonstration of bioreactor operation and its control

After completion of this experiment, the student will be able to understand the operation and control of Bioreactor.

12. Demonstration of flow cytometry for animal cell counting

After completion of this experiment, the student will be able to understand the principle of Flow cytometry and its usefulness in counting animal cells.

Course Outcomes:

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

1. Apply scientific calculator and determination of rate constant of a reaction by integral method.
2. Discuss measurement of oxygen diffused in water and sugar content by Brix meter.
3. Understand principles of fermentor, microbial growth and biological production of wine.
4. Explain calibration of pH meter and rotaevaporator.
5. Apply usage of different biological databases and flow cytometry for animal cell counting.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1		1	1			3	2	3	3
CO2	3	3	3	2	1	1		1	1			3	2	3	3
CO3	3	3	3	2	3	1		3	1			3	2	3	3
CO4	3	3	3	2	2	1		1	1			3	2	3	3
CO5	3	3	3	2	3	1		2	1			3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EMA207: MATHEMATICS FOR BIOTECHNOLOGY-III

(Linear Algebra, Ordinary & Partial Differential Equations)

L	T	P	C
3	0	0	3

This course is designed to provide the foundation for matrix algebra, first order and higher order differential equations and partial differential equations. This foundation in Mathematics will be utilized in understanding the system stability and control of industrial bioprocesses.

Course Objectives:

- To explain the theory of matrices in linear algebra
- To familiarize with the first order differential equations and their applications
- To inculcate the basic concepts of Linear differential equations
- To impart the knowledge on partial differentiation and partial differential equations

Unit I: Linear Algebra **8hrs**

Rank of a matrix, elementary transformations, consistency of linear system of equations, system of homogeneous equations, eigen values and eigenvectors of matrices, Cayley Hamilton theorem (without proof), inverse and powers of matrix by Cayley Hamilton theorem.

Learning Outcomes:

At the end of this unit, the student will be able to

- solve system of linear equations using technology to facilitate rows reduction
- determine the rank, eigen values and eigenvectors of a matrix (L3)
- calculate the inverse and power of a matrix using Cayley-Hamilton theorem (L3)

Unit II: Differential Equations of First Order and Applications **8 hrs**

Formation of differential equations, equations of first order and first degree-variables separable, homogeneous equations, linear equations, Bernoulli"s equation and Newton"s law of cooling.

Learning Outcomes:

At the end of this unit, the student will be able to

- construct a differential equation (L3)
- solve homogeneous, linear and Bernoulli"s equations (L3)
- apply these techniques in Newton"s law of cooling (L3)

Unit III: Linear Differential Equations **8 hrs**

Definition, operator D, rules for finding complementary function, inverse operator, rules for finding particular integral, method of variation of parameters.

Learning Outcomes:

	After completing this unit, the student will be able to • analyze complementary function and particular integral (L3) • apply method of variation of parameters technique (L3) • interpret inverse operator function (L2)
Unit IV: Partial Differentiation	**8 hrs**
Introduction, Euler"s theorem, total derivative, differentiation of implicit functions, change of variables, Jacobians, tangent plane and normal to a surface.	
Learning Outcomes:	
	After completing this unit, the student will be able to • solve the partial fraction using Euler"s theorem (L3) • determine the total derivative of implicit functions (L3) • apply partial differentiation techniques (L3)
Unit V: Partial Differential Equations	**10 hrs**
Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.	
Learning Outcomes:	
	After completing this unit, the student will be able to • formulate partial differential equations • apply Lagrange's method for solving partial differential equations (L3) • find complementary function and particular integral (L3)
Text Books:	
	1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017. 2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
References:	
	1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley Eastern Pvt. Ltd., New Delhi, 2018. 2. N. P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, 9th edition, Laxmi Publications (P) Ltd., New Delhi, 2014.

Course Outcomes:

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

1. Apply properties of matrices for solving system of equations.
2. Develop the solution of first order differential equations.
3. Analyze the complete solution of a linear differential equations.
4. Make use of partial differentiation technique for finding Jacobian.
5. Solve partial differential equations.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO2	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO3	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO4	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO5	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EID134: AI TOOLS
(Common to all)
Effective for admitted batch 2019-20

L	T	P	C
2	0	2	3

The surge in the production of data has led to the development of various technologies. The term "Artificial Intelligence (AI)" has become ubiquitous in everyday applications from virtual assistants to self- driving cars. Several applications such as Healthcare, Finance, Bioinformatics etc. are benefitting from the advances in the domain. The global market for artificial intelligence is going to face a phenomenal growth over the coming years with organizations across the world capitalizing on the disruptive technologies that AI is offering. This course introduces the recent applications of AI namely, Virtual Assistants, Computer Vision, along with trending topics such as Deep Learning and Reinforcement Learning. The idea of the course is to introduce the basic concepts of AI as well as latest trends in the domain. This course is envisaged to provide a basic understanding on latest developments of AI to all disciplines engineering undergraduates.

Course Objectives:

- To provide a basic foundation on different concepts of Artificial Intelligence.
- To investigate various applications of AI such as Virtual Assistants, Computer Vision, as well as other Smart Applications.
- Explore the scope, advantages as well as limitations of intelligent systems.
- Experiment with different machine learning concepts such as Deep Learning and Reinforcement Learning
- To expose students to the AI-intensive computing and information system frameworks.

UNIT I **10L**

Introduction to Artificial Intelligence: Basics of AI Applications of AI.Advanced search Constraint satisfaction problems, Knowledge representation & reasoning, Non-standard logics, Uncertain and probabilistic reasoning.

Conceptual introduction to Machine Learning: Introduction to Neural Networks, Supervised, Unsupervised, and Semi-Supervised Learning Deep Learning, Reinforcement Learning Linear Regression.

Conceptual introduction to Natural Language Processing: Natural language Understanding Sentiment Analysis, Segmentation and recognition.

Conceptual introduction to Speech Recognition & Synthesis: Speech Fundamentals, Speech Analysis, Speech Modelling, Speech Recognition, Speech Synthesis, Text-to-Speech.

Conceptual introduction to Image Processing & Computer Vision: Introduction to Image processing, Image Noise, Removal of Noise from Images, Color Enhancement, Segmentation, Edge Detection, Optical Character Recognition, Feature Detection & Recognition

Learning Outcomes:

After completion of this unit, the student will be able to

- Recognize various domains in which AI can be applied(L2)
- Define machine learning and forms of learning(L1)
- describenaturallanguageprocessingandconceptsforconvertingspeechtodifferentforms(L2)
- identify the concepts of image processing(L3)

UNIT II **12L**

BOT Technologies and Virtual Assistants: Catboats: Introduction to a Chabot, Architecture of a Chabot. NLP in the cloud, NL Interface, how to Build a Chabot, Transform native user experience of

catboats, Designing elements of a Chabot, Best practices for Chabot development. NLP components. NLP wrapper to catboats. Audio bots and Music bots.
Virtual Assistants: Architecture of a Virtual Assistant.

Learning Outcomes:
After completion of this unit, the student will be able to
- analyze the architecture of a Chabot(L4)
- illustrate how to construct a Chabot(L2)
- differentiate various catboats(L4)
- interpret the architecture of a virtual assistant(L3)

UNIT III **12L**

Image Processing &Computer Vision: Image-Definition and Tagging. Classification of images. Tagging. Image formation, Deep Learning algorithms for Object detection & Recognition. Face recognition Instance recognition, Feature detection and matching, Segmentation, Recognition Databases and test sets Applications --Feature extraction, Shape identification. Fane detection.
Applications: Automation, Agriculture [Crop and Soil Monitoring, grading farm produce, Predictive Analytics], Retail and Retail Security[Amazon Go],Autonomous vehicles.

Learning Outcomes:
After completion of this unit, the student will be able to
- classify the properties of images(L3)
- interpret the concepts of image processing(L2)
- implement the methods in processing an image(L3)
- analyze and apply the concepts of image processing in automation and agriculture(L4)

UNIT IV **12L**

Reinforcement Learning: Introduction to Reinforcement Learning, Game Playing [Deep Blue in Chess, IBMWatson in Jeopardy, Google's Deep Mind in AlphaGo], Agents and Environment, Action-Value

Function, Deep Reinforced Learning
Applications: Robotics, Gaming, Diagnostic systems, Virtual Assistants.

Learning Outcomes:
After completion of this unit, the student will be able to
- illustrate reinforcement learning(L2)
- employ the reinforcement learning in game playing(L3)
- use reinforcement learning in agent based environment(L3)
- practice learning processsindiagnosticandvirtualassistantsystems(L3)

UNIT V **10L**

Smart Applications: Smart Manufacturing, Smart Agriculture, Smart Healthcare, Smart Education, SmartGrids, Smart Transportation and Autonomous Vehicles, Smart Homes, Smart Cities.

Learning Outcomes:
After completion of this unit, the student will be able to
- understand the application of intelligence in various domains(L2)
- apply the artificial intelligence in various applications(L3)
- correlate the intelligence to advanced applications(L4)

Text Book(s)

1. Tom Markiewicz &Josh Zheng, Getting started with Artificial Intelligence, O'Reilly Media,2017.
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach. Prentice Hall

References

1. Aurélien Géron, Handson Machine Learning with Scikit- Learn and Tensor Flow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media, 2017.

2. BuildanAIAssistantwithWolframAlphaandWikipediainPython.https://medium.com/@salisuwy/build-an-ai-assistant-with-wolfram-alpha-and-wikipedia-in-python-d9bc8ac838fe
3. JosephHowse,PrateekJoshi,MichaelBeyeler-Opencv_ComputerVisionProjectswithPython-Packt Publishing(2016).
4. CuratedDatasetsonKagglehttps://www.kaggle.com/datasets.

AI TOOLS LABORATORY

List of Practical Experiments:

1. Supervisely-PerformDataLabellingforvariousimagesusingobjectrecognition
2. Lobe.ai-BuildcustommodelsusingthevisualtoolforObjectrecognitionandsentimentanalysisthatcan convert facial expressions into emoticons
3. TeachableMachine-InBrowserObjectRecognitionthroughBrain.JS
4. Liv.ai-App for Speech recognition and Synthesis through APIs
5. Building a Chabot using AWS Lex, Pandorabots
6. Configure an existing Neural Network by manipulating various parameters involved
7. Build a virtual assistant for Wikipedia using Wolfram Alpha and Python
8. Build a Convolutional Neural Network for Cat vs. Dog Image Classification

Online Resources:
Pytorch:
https://pytorch.org/https://git hub.com/pytorch
Keras:
https://keras.io/https://github
.com/keras-team
Theano:
http://deeplearning.net/software/theano/https://github.com/T heano/Theano
Cafee2:
https://caffe2.ai/https://githu b.com/caffe2
Deeplearning4j:
https://deeplearning4j.org/
Scikit-learn:
https://scikit- learn.org/stable/https://github.com/scikit
-learn/scikit-learn

DeepLearning.Ai:
https://www.deeplearning.ai/
OpenCv:
https://opencv.org/https://github.com/q qwweee/keras-yolo3
YOLO:
https://www.pyimagesearch.com/2018/11/12/yolo-object-detection-with- opencv/
nVIDIA:CUDA:
https://developer.nvidia.com/cuda-math-library

Course Outcomes:

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

1. Grasp the concepts of artificial intelligence, machine learning, natural language processing, image processing.
2. Recognize various domains in which AI can be applied.
3. Implement the methods in processing an image.
4. Implement simple chatbots.
5. Identify smart applications.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2		3				2			2	3	2	2
CO2	2	2	2		3				2			2	2	2	2
CO3	2	3	2		1				2			2	2	2	2
CO4	2	3	2		3				2			2	3	2	2
CO5	2	2	2		1				2			2	2	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EID134: AI TOOLS
(Common to all)
Effective from admitted batch 2020-21 onwards

L T P C
2 0 2 3

The surge in the production of data has led to the development of various technologies. The term "Artificial Intelligence (AI)" has become ubiquitous in everyday applications from virtual assistants to self-driving cars. Several applications such as Healthcare, Finance, Bioinformatics etc. are benefitting from the advances in the domain. The global market for artificial intelligence is going to face a phenomenal growth over the coming years with organizations across the world capitalizing on the disruptive technologies that AI is offering. This course introduces the recent applications of AI namely, Virtual Assistants, Computer Vision, along with trending topics such as Deep Learning and Reinforcement Learning. The idea of the course is to introduce the basic concepts of AI as well as latest trends in the domain. This course is envisaged to provide a basic understanding on latest developments of AI to all disciplines engineering undergraduates.

Pre-Requisites:
Courser code: 19EID131
Course Name: Problem Solving and Programming

Course Objectives:

- Provide introduction to basic concepts of Artificial Intelligence.
- Explore applications of AI
- Explore the scope, advantages of intelligent systems
- Experiment with different machine learning concepts
- Exposure to AI-intensive computing and information system frameworks

Unit I **6L+6P**

Introduction to Artificial Intelligence: :Basics of AI. Agents and Environment, The Nature of Environment, Applications of AI:Game Playing [Deep Blue in Chess, IBM Watson in Jeopardy, Google's Deep Mind in AlphaGo]

Learning Outcomes:

After completion of this unit, the student will be able to

- recognize various domains in which AI can be applied (L2)

Unit II **6L+6P**

Conceptual introduction to Machine Learning:

Supervised, Unsupervised, and Semi-Supervised Learning, Reinforcement Learning, Introduction to Neural Networks, Deep Learning.

Learning Outcomes:

After completion of this unit, the student will be able to

- define machine learning and forms of learning (L1)
- identify types of machine learning(L1)

Unit III **7L+6P**

Image Processing & Computer Vision:

Introduction to Image processing, Image Noise, Removal of Noise from Images, Color Enhancement, Edge Detection, Segmentation, Feature Detection & Recognition. Classification of images. Face recognition, Deep Learning algorithms for Object detection & Recognition.

Learning Outcomes:

After completion of this unit, the student will be able to

- identify the concepts of image processing (L2)
- implement the methods in processing an image (L3)

Unit IV **6L+4P**

Conceptual introduction to Natural Language Processing: Speech Recognition & Synthesis: Speech Fundamentals, Speech Analysis, Speech Modelling, Speech Recognition, Speech Synthesis, Text-to-Speech, Sentiment Analysis, Segmentation and recognition.

Learning Outcomes:

After completion of this unit, the student will be able to

- illustrate how to construct a Chabot (L4)
- describe natural language processing and concepts for converting speech to different forms (L2)

Unit V **7L+6P**

BOT Technologies: Chatbots: Introduction to a Chatbot, Architecture of a Chatbot. NLP in the cloud, NL Interface, how to Build a Chatbot, Transformative user experience of chatbots, Designing elements of a chatbot, Best practices for chatbot development. NLP components. NLP wrapper to chatbots. Audiobots and Musicbots.

Smart Applications: Smart Manufacturing, Smart Agriculture, Smart Healthcare, Smart Education, Smart Grids, Smart Transportation and Autonomous Vehicles, Smart Homes, Smart Cities

Learning Outcomes:

After completion of this unit, the student will be able to

- understand the application of intelligence in various domains(L2)
- correlate Artificial Intelligence to advanced applications(L4)

Text Book(s)

1. Tom Markiewicz & Josh Zheng, Getting started with Artificial Intelligence, Published by O'Reilly Media,2017
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach.

References

1. AurélienGéron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems]. Published by O'Reilly Media,2017
2. Build an AI Assistant with Wolfram Alpha and Wikipedia in Python. https://medium.com/@salisuwy/build- an-ai-assistant-with-wolfram-alpha-and-wikipedia-in-python-d9bc8ac838fe
3. Joseph Howse, Prateek Joshi, Michael Beyeler - Opencv_ Computer Vision Projects with Python-Packt Publishing (2016).
4. Curated Datasets on Kagglehttps://www.kaggle.com/datasets.

AI TOOLS LABORATORY

List of Practical Experiments:

1. Supervisely - Perform Data Labelling for various images using object recognition
2. Teachable Machine - In Browser Object Recognition through Brain.JS
3. Lobe.ai - Build custom models using the visual tool for Object recognition and sentiment analysis that can convert facial expressions into emoticons
4. Haar Cascade Object detection for Eye and Face in Python using OpenCV
5. Text to Speech recognition and Synthesis through APIs
6. Sentiment Analysis and Polarity detection
7. Building a Chatbot using IBM Watson visual studio
8. Building a Chatbot using Pandora bots
9. Build a virtual assistant for Wikipedia using Wolfram Alpha and Python

Online Resources:

Pytorch: https://pytorch.org/ https://github.com/pytorch Keras: https://keras.io/ https://github.com/keras-team Theano:

http://deeplearning.net/software/theano/ https://github.com/Theano/Theano Cafee2:
https://caffe2.ai/ https://github.com/caffe2 Deeplearning4j:
https://deeplearning4j.org/ Scikit-learn:
https://scikit-learn.org/stable/ https://github.com/scikit-learn/scikit-learn
Deep Learning.Ai:
https://www.deeplearning.ai/ OpenCv:
https://opencv.org/ https://github.com/qqwweee/keras-yolo3 YOLO:
https://www.pyimagesearch.com/2018/11/12/yolo-object-detection-with-opencv/
nVIDIA:CUDA:
https://developer.nvidia.com/cuda-math-library

Course Outcomes:

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

1. Grasp the concepts of artificial intelligence, machine learning, natural language processing, image processing.
2. Recognize various domains in which AI can be applied.
3. Implement the methods in processing an image.
4. Implement simple chatbots.
5. Identify smart applications.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2		3				2			2	3	2	2
CO2	2	2	2		3				2			2	2	2	2
CO3	2	3	2		1				2			2	2	2	2
CO4	2	3	2		3				2			2	3	2	2
CO5	2	2	2		1				2			2	2	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT201: PROCESS CALCULATIONS

L	T	P	C
2	0	0	2

Large scale production in biotechnology industry involves a wide range of processes. This course introduces the concepts, laws and physico-chemical properties that are useful for bioprocess calculations. These calculations also enable the students to estimate the amount of heat released or absorbed in a bioprocess.

Course Objectives:

- To introduce the concepts of chemical calculations
- To provide the basis for chemical reactions
- To familiarize the concepts of material and energy balance
- To explain the material and energy balance calculations
- To expose the material and energy balance concepts to bioprocesses

Unit- I **6 hrs**

Basic chemical calculations: Mole, atomic mass, molar mass, equivalent mass, stoichiometric and composition relationships for solids, liquids, solutions, gases: Weight percent, volume percent and mole percent, density and specific gravity, Behaviour of ideal gases, application of the ideal gas law, Dalton and Amagat laws of gaseous mixtures, Composition of gases on dry and wet basis

Learning Outcomes:

At the end of this unit, the student will be able to

- apply ideal gas, Dalton and Amagat"s laws. (L3)
- estimate chemical masses, volumes and percentages. (L3)
- explain the relationship between reactants and products. (L2)
- apply ideal gas law. (L3)

Unit- II **8 hrs**

Gases, Vapours and Liquids: Equations of state, Vapor pressure, effect of temperature on vapor pressure: Clausius-Clapeyron equation, Antoine equation. Reference substance vapor pressure plots: Cox chart and Duhring"s plot, Vapor pressure of immiscible liquids, Ideal solutions and Raoult's law, non-volatile solutes, humidity, saturation, humid heat, humid volume, Dew point, humidity chart and its uses. Wet and dry bulb temperatures. Adiabatic vaporization and adiabatic saturation temperature.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the factors affecting vapour pressure. (L2)
- explain the relationship between the temperature and vapour pressure. (L2)
- Outline the concept of adiabatic saturation and thermodynamic wet bulb

	temperature • Interpret the humidity and dewpoint. (L2) • predict the physico-chemical properties of air. (L2)

Unit- III	**8 hrs**

Material balances: Process flow sheet, Material balance without chemical reactions, Degrees of freedom, Tie element basis for calculations. Material balance calculations involving drying, dissolution and crystallization, continuous filtration, batch mixing, Recycling and bypassing operations, Material balance with chemical reactions, concept of excess reactant, limiting reactant, conversion, yield, degree of completion.

Learning Outcomes:

	After completing this unit, the student will be able to • explain process flow diagrams (L2) • perform material balance for various unit operations. (L3) • estimate product yield and reactant conversion. (L3) • solve material balance for various unit processes with and without recycling. (L3)

Unit- IV	**10 hrs**

Energy balance: Components of energy balance equation, Concept of Enthalpy and heat capacity, Heat effects accompanying chemical reactions, standard heats of reaction, combustion and formation, Hess's law, effect of temperature on standard heats of reaction, steady state energy balance.

Learning Outcomes:

	After completing this unit, the student will be able to • identify various components of energy balance equation. (L1) • interpret the heat effects in chemical reactions. (L2) • predict the heat of combustion and heat of formation. (L3) • explain the medical importance of gene disorders. (L2) • apply Hess"s law for energy calculations. (L2)

Unit- V	**6 hrs**

Stoichiometry of microbial growth and product formation: Elemental balances, degree of reduction, yield coefficients, biomass yield, product stoichiometry, Theoretical oxygen demand, Maximum possible yield, Thermodynamics of microbial growth, Heat of reaction with oxygen as electron acceptor and without oxygen, Energy balance equations for fermentation and cell culture.

Learning Outcomes:

	After completing this unit, the student will be able to • outline the stoichiometry of microbial growth and product formation. (L2) • explain the importance of oxygen in energy balance calculations.(L2) • apply the material and energy balance concepts to fermentation and cell culture. (L2)

Text Books:	
	1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", 8/e., Pearson, 2015. 2. Bhatt, B. I., Vora, S. M., "Stoichiometry", 4/e Tata McGraw Hill, 2004.
References:	
	1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000 2. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Materi al & Energy Balances", Second Edition, CBS Publishers & Distributors, 2004 3. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, "Process Calculations", Second Edition, Prentice Hall of India. 4. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India. 5. Pauline M.Doran, Bioprocess Engineering Principles, 1/e, Academic Press, 2009.
Course Outcomes:	
	1. Explain the composition of solids and liquids, & behaviour of gases. 2. Understand the effect of temperature on vapour pressures of miscible and immiscible liquids. 3. Able to apply concepts of humidity and saturation. 4. Explain the process flow diagrams with material and energy transfers. 5. Perform material and energy balances for the bioprocesses.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1		1	1	1	1	3	2	
CO2	3	1	1	2	3	2	1		1	2		1	3	2	1
CO3	3	1	2	2	3	2	1		1	1	1	1	3	2	1
CO4	3	2	1	1	3	2	1		1	1	1	1	3	2	2
CO5	3	2	1	1	3	2	1		1	1	1	1	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT231: BIOCHEMISTRY

L	T	P	C
3	0	2	4

All living beings consist of assemblies of molecules. Few of these molecules serve as structural elements, others are responsible for production, storage and transfer of energy, encoding and decoding of genetic information. This course provides an introduction to the structure, properties and function of molecules that are the constituents of biological systems. This course is prerequisite for molecular biology and biochemical engineering.

Course Objectives:

- Introduce the biochemical basis of life from biomolecules.
- Impart knowledge of enzymes and kinetics
- Summarize structure and properties of biomolecules
- Explain the metabolic pathways with significance**.**
- Discuss the biological importance of lipids, proteins, nucleic acids and hormones.

Unit- I **8 hrs**

Introduction to Biochemistry: Organisation of life, Chemical foundations of biology, non covalent bonds

Amino acids and peptides: Structure and properties of amino acids, Classification of amino acids, peptide bond structure.

Proteins: Structure and classification of proteins, Structural organization of protein: primary structure of proteins, secondary structure of proteins –helix and pleated sheets, tertiary structure of protein. Structure and functions of haemoglobin.

Enzymes and Enzyme kinetics: Nomenclature, classification of enzymes, active site, Michaelis Menten approach to enzyme kinetics, Mechanism of enzyme action, Kinetics

Learning Outcomes:

At the end of this unit, the student will be able to

- explain organisation of life and chemical bonds in biological system (L2).
- explain the structure and properties of amino acids. (L2).
- outline the nomenclature and classification of enzymes (L1).
- explain enzyme kinetics and mechanism of enzyme action (L2).
- analyze the structure of proteins with one example (L3).

Unit- II **8 hrs**

Carbohydrates: Classification, structure and functions of monosaccharide (ribose, glucose), disaccharides (sucrose and lactose), polysaccharides (starch, cellulose and glycogen). Metabolic pathways: Glycogenesis and glycogenolysis, glycolysis and TCA cycle, HMP shunt pathway, Electron transport chain and Oxidative phoshorylation.

Learning Outcomes:	
	At the end of this unit, the student will be able to • recall the classification of structure of carbohydrates (L1). • explain the structure and functions mono, di and polysaccharides. (L2). • explain metabolic pathways in synthesis and degradation of carbohydrates (L2). • interpret the energy channelling to ATP through Electron transport chain (L3).
Unit- III	**8 hrs**
Lipids: Classification, structure and physiological functions of triglycerides, fatty acids, phospholipids, cerebrosides, gangliosides and cholesterol. Digestion and absorption of fats. Synthesis and degradation of fatty acids.	
Learning Outcomes:	
	After completing this unit, the student will be able to • recall the classification of lipids (L1). • summarize the biological properties and functions of lipids (L2). • explain the digestion, synthesis and degradation of fatty acids (L2).
Unit- IV	**6 hrs**
Nucleic acids: Structure of nucleic acids (DNA and RNA), structure and functions of purines, pyrimidines, nucleotides, Types of DNA and RNA. Biosynthesis and degradation of purine and pyrimidine nucleotides. Urea cycle.	
Learning Outcomes:	
	After completing this unit, the student will be able to • list the types of nucleic acids (L1) • relate the structure and conformation of nucleic acids (L1) • explain the synthesis and degradation of purines and pyramidines (L2)
Unit- V	**8 hrs**
Inborn errors of metabolism (amino acids, carbohydrates and nucleic acids), Classification of hormones and their functions. Nutritional aspects of proteins and fatty acids.	
Learning Outcomes:	
	After completing this unit, the student will be able to • explain the genetic disorders of metabolic pathways (L2). • summarise the hormones and their functions in human (L2). • explain nutritional aspects of proteins and fatty acids (L2).
Text Books:	
	1. D. Voet, C.W. Pratt and J.G. Voet, Biochemistry, 5/e, John Wiley, 2018. 2. David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, 6/e, W. H. Freeman, 2012
References:	
	1. R.K. Murray, D.A Bender, K.M. Botham , P.J. Kennelly, V.W. Rodwell , P. Anthony Weil, Harper's Illustrated Biochemistry, 28/e. McGraw-Hill's, 2009. 2. J.M. Berg, J.L. Tymoczko , L. Stryer , Biochemistry, 7/e, W.H. Freeman, 2011.

Course Outcomes:	
	1. Explain the structure and properties of amino acids, proteins, and enzymes. 2. Interpret carbohydrates and carbohydrate metabolism. 3. Discuss lipid structure and lipid metabolism. 4. Explain nucleic acids and nucleic acid metabolism. 5. Discuss nutritional biochemistry and hormones for human health.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1					1	2	2	1	1
CO2	3	3	3	3	3	1					1	2	2	2	1
CO3	3	3	3	3	3	1					1	2	2	2	1
CO4	3	3	3	3	3	1					1	2	2	2	1
CO5	3	3	3	3	3	3					3	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

BIOCHEMISTRY LABORATORY

This laboratory course provides knowledge and hands on experience in qualitative and quantitative experiments of biochemistry to the students. The student will be able to learn preparation of buffers, identification and quantification of bio molecules, assay of enzymes, enzyme kinetics, and chromatography and electrophoresis techniques.

Course Objectives:

This laboratory aims to:

- Provide concepts in preparation of buffers, tests for identification of bio molecules, quantification methods, enzyme assay, and enzyme kinetic parameters. Understand the separation of bio molecules by various chromatography techniques; visualize bio molecules in electrophoresis techniques. Demonstrate absorption spectra of proteins and nucleic acids.

1. Preparation of buffers: Acetate, Phosphate and Citrate buffers

   After completion of this experiment, the student will be able to prepare different buffers and calibrate the pH meter.

2. Qualitative analysis of mono and disaccharides

   After completion of this experiment, the student will be able to identify mono and disaccharides with various qualitative tests

3. Qualitative analysis of amino acids

   After completion of this experiment, the student will be able to identify amino acids with various qualitative tests

4. Estimation of total carbohydrates by Anthrone method

   After completion of this experiment, the student will be able to measure the carbohydrate by colorimetric method

5. Estimation of proteins by Biuret method

   After completion of this experiment, the student will be able to measure the proteins by colorimetric

method

6. Determination of Iodine value of lipids.

After completion of this experiment, the student will be able to determine iodine value of fats

7. Assay of amylase and determination of kinetic parameters

After completion of this experiment, the student will be able to assay enzyme and learn enzyme kinetics

8. Separation amino acids by paper chromatographic technique

After completion of this experiment, the student will be able to separate amino acids by paper chromatography

9. Separation of sugars / amino acids by thin layer chromatographic technique

After completion of this experiment, the student will be able to separate sugars / amino acids by thin layer chromatography

10. Separation of proteins by Gel filtration

After completion of this experiment, the student will be able to separate proteins by gel filtration

11. Absorption spectra of proteins and nucleic acids

After completion of this experiment, the student will be able to learn absorption spectra for proteins and nucleic acids

12. Demonstration of SDS-PAGE

After completion of this experiment, the student will be able to understand principle of SDS- PAGE and application of these techniques for identification of bio molecules.

Text Books:	
	1. D.T. Plummer, Introduction to Practical Biochemistry, 3/e, Tata-McGraw Hill, 2002. 2. S. K. Sawhney and Randhir Singh, Introductory Practical Biochemistry, 2/e, Alpha Science International, 2005.
References:	
	1. B. Shashidhar Rao and Vijay Deshpande, Experimental Biochemistry. I.K. International Publishing House, 2005.

19EBT233: MICROBIOLOGY

L	T	P	C
2	0	2	3

Microbes are a diverse group of organisms that are too small to be seen by the human eye. Some microbes possess unique physiological and biochemical properties that can be utilized for industrial production. Other microbes are responsible for human, agricultural and veterinary diseases. This course describes the applications of microbiology in food, agriculture and environmental technology.

Course Objectives:

- Impart knowledge of history, salient developments and key contributors in microbiology.
- Describe the morphological structure of Viruses, Yeast, Molds and Bacteria.
- Explore the effect of various parameters on microbial growth.
- Explain the role of microbes in industrial fermentation techniques.
- Describe the microbial decontamination techniques.

Unit- I **8 hrs**

History and development of Microbiology, Contributions of Nobel Laureates in Microbiology (Robert Koch, Emil, A. Von Behring, Ronald Ross and Barry Marshall). Microbial Taxonomy and diversity of Bacteria, Archea, Molecular approaches to Microbial Taxonomy. Physiology and significance of extremophiles (Thermophiles, Psychropiles, Halophiles and Methanogens).

Learning Outcomes:

At the end of this unit, the student will be able to

- Summarize the advancement of microbiological techniques over time (L1).
- Identify, group and classify the microorganism (L2).
- Understand the importance of extremophiles (L2)

Unit- II **8 hrs**

Morphology of Microbes, Viruses:

Morphology of Viruses ; size, shape, symmetry, replication of viruses- lytic and lysogenic cycle, Bacteria**:** Ultra structure of Bacteria, cell wall, cell membrane, flagella, pili, capsule, endospore, and cell inclusions, differences between prokaryotic and eukaryotic cell. Bacterial growth kinetics.

Yeasts and Molds: life cycle, economic importance of Yeast and *Aspergillus*.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the cellular details of various groups of microorganism.
- Analyze and prepare the model for microbial growth kinetics.
- Differentiate between prokaryotic and eukaryotic organisms

Unit- III **8 hrs**

Microbial nutrition: Nutrition requirements, nutritional types of bacteria, uptake of nutrients by cell. Microbial metabolism: Respiration, Photosynthesis and Nitrogen fixation.

Learning Outcomes:

After completing this unit, the student will be able to

- Classify microbes on the basis of nutrition
- Understand the role of symbiotic bacteria
- Apply the knowledge of metabolisms in growth and perpetuation in bacteria

Unit- IV	**8 hrs**

Control of microorganisms: Sterilization and Disinfection, effect of physical (moist and dry heat, radiation and filtration) and chemical agents. Antibiotics: classification, mode of action and resistance.

Applied Microbiology: Water, Food and Milk borne contamination and remedy. Basic microbial genetics - conjugation, transformation and transduction. Strain improvement of microbes of industrial importance.

Learning Outcomes:

After completing this unit, the student will be able to

- Differentiate disinfection and sterilization (L2)
- Explain control of microbial infections in humans (L2)
- Apply the knowledge of microbial genetics for the development of novel strains (L3)

Unit- V	**8 hrs**

Fermentation technology for production of alcohol, wine and beer. Role of microbes in bread making and bakery products, Production of enzymes (amylases and cellulases), Oil eating bacteria, Microbes in agriculture.

Learning Outcomes:

After completing this unit, the student will be able to

- Illustrate the production of alcohol and fuel (L2)
- Apply microbial technologies for the production of fermented foods and enzymes(L3).
- Utilize microorganisms for bioremediation and yield improvement (L3).

Text Books:

1. Pelczar, M.J.Jr., Chan, E.C.S. and Krieg, N.R. Microbiology: Application Based Approaches. Tata Mc Graw Hill, 2009.
2. Lansing M Prescott, Donald A Klein and John P Harley, Microbiology, 7/e, McGraw Hill, 2008.
3. Ananthanarayan and Paniker's Textbook of Microbiology Tenth edition with booklet June 2017.

References:

	1. Michael J Pelczar, JR. ECS Chan, Noel R, Krieg, Microbiology, 5/e , Tata Mc Graw Hill, 2007. 2. Stanier RY, Ingraham JL, Wheelis ML, Painter P, General Microbiology,5/e, The MacMillan Press Ltd, 2003. 3. Madigan MT, Martinko JM, Parker, Brock Biology of Microorganisms, 10/e, Prentice Hall, 2003. 4. Bergey"s Manual of systematic Bacteriology, Volumes 1-5, Springer, 2012.
Course Outcomes:	
	After the completion of the course the student should be able to 1. Gain the knowledge the techniques for microbial isolation and purification. 2. Understand morphological structure of Viruses, Yeast, Molds and Bacteria with its physiological pattern. 3. Able to understand effect of various parameters on microbial growth and its metabolic pathways. 4. Apply the microbial decontamination processes and techniques for healthcare. 5. Understand the role of microbes in industrial fermentation process and also in agriculture.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	1	1	2	2	1	1	1	1	2	2	2
CO2	2	2	1	1	2	2	2	2	2	1	1	2	2	2	2
CO3	3	2	2	1	1	1	2	2	1	1	2	2	3	2	3
CO4	2	2	2	2	2	1	2	2	1	1	1	2	2	2	2
CO5	3	3	3	2	3	1	3	2	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

MICROBIOLOGY LABORATORY

This laboratory experiments aims to understand the concepts of microbial cell' s nature and variation, culturing in laboratory conditions. Also able to perform the techniques for isolation, variation in structure and biochemical assays for finding the nature of microorganism. In total twelve experiments have been designed to train students.

Course Objectives:

- To prepare the media components and to study their effect on bacterial and fungal growth
- To understand the role of various media constituents.
- To handle to laboratory equipment
- To differentiate various types of bacterial groups
- To use the biochemical assays for bacterial identification
- To isolate bacteria from various sources
- To plan and execute production of bacterial metabolites

List of experiments

1. Preparation of nutrient broth, nutrient agar and inoculation of bacteria.

After completion of this experiment, students will be able to prepare the solid and liquid media and their utilization for growing bacteria and fungi.

2. Isolation of pure cultures.

After completion of this experiment, students will be able to isolate different microbes from natural sources.

3. Staining of microbes- simple staining, Gram staining, negative staining, capsule staining and spore staining.

After completion of this experiment, students will be able to use stains for differentiating different types of bacteria.

4. Motility of microbes.

After completion of this experiment, students will be able to distinguish motile and non motile organisms.

5. Morphology of fungi (*Aspergillus niger*)

After completion of this experiment, students will be able to understand the eukaryotic nature of fungi.

6. Morphology of yeast (*Saccharomyces cerivisiae*)

After completion of this experiment, students will be able to understand the differences between bacteria and yeast cells.

7. Biochemical tests - IMViC test, Amylase test, Hydrogen Sulphide production test.

After completion of this experiment, students will be able to perform the biochemical tests for microbial identification.

8. Testing of microbiological quality of milk.

After completion of this experiment, students will be able to test the quality of milk for its suitability.

9. Testing of microbiological quality of water.

After completion of this experiment, students will be able to test the quality of water for its suitability to drinking.

10. Microbial assay of antibiotics.

After completion of this experiment, students will be able to analyze the efficacy of antibiotics against bacterial and fungal infections.

11. Evaluation of disinfectant.

After completion of this experiment, students will be able to evaluate different types of disinfecting agents used for surface sterilization.

12. Production of alcohol.

After completion of this experiment, students will be able to produce alcohol using biochemical methods and quantify the produced alcohol.

Demonstration experiments

1. Bright field microscopy.

After completion of this demonstration, students will be able to use microscopes for viewing microorganisms and can calculate magnification power of microscope.

2. Fluorescent microscopy.

After completion of this demonstration, students will be able to use Fluorescent microscopes for observing plant and animal cells.

3. Flow cytometric Technique for quantification and differentiation of bacteria in milk.

After completion of this demonstration, students will be able to use Flow cytometry for estimating bacterial toxins.

Course Outcomes:

After the completion of the course the student should be able to

- prepare the media and use for bacterial and fungal growth
- understand the role of various media constituents.
- handle to laboratory equipment
- differentiate various types of bacterial groups
- perform biochemical assays for bacterial identification
- isolate bacteria from various natural sources
- plan and execute production of bacterial metabolites

Text Books:

1. James G Cappuccino and Natalie Sherman, Microbiology, A laboratory manual, 10/e, Benjamin Cummings, 2013.
2. Aneja KR, Experiments in Microbiology, Plant Pathology and Biotechnology, 4/e, New Age International, 2013.

References:

	1. Alberts Et.Al. The molecular biology of the cell, 6/e, Garland Science, 2014 2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009. 3. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012.

19EBT203: GENETICS AND MOLECULAR BIOLOGY

L	T	P	C
3	0	0	3

Genetics explains the transmission of characters from one generation to the next. Molecular biology explains the molecular basis for the transmission of this information. In addition, molecular biology also describes how genetic information is decoded by cellular machines made of molecular assemblies and how this information is utilized in biological systems. This course is prerequisite for genetic engineering.

Course Objectives:

- Describe the principles of genetics in inheritance of characters
- Provide knowledge in prokaryotic, eukaryotic cells and their organelles
- Describe Gene structure, function, cell cycle and signaling
- Describe DNA replication, gene expression and regulation at different levels
- Introduce the molecular basis of Mutations, DNA repair and genomics.

Unit- I **8 hrs**

Principles of Inheritance: Mendelian and non-Mendelian inheritance, linkage and crossing over, mapping of genes and cytoplasmic inheritance.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the segregation of chromosomes during meiosis (L2)
- Relate inheritance patterns and position on chromosomes. (L2)
- correlate the frequency of recombinant gametes with the frequency of crossfing-over. (L3)
- Map genes based on linkage groups (L3))

Unit- II **8 hrs**

Structure of cell membrane, cellular organelles and their structure and functions, organization of the chromosome, euchromatin and heterochromatin; nucleosome, cell division, cell cycle and its regulation; CDC mutants, protein kinases, cyclins; biochemistry of meiosis.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the importance of cell membrane and cell organelles (L2) (L2)
- distinguish the level of organization in prokaryotes and eukaryotes (L4)
- demonstrate the stages of cell cycle and its importance (L2)
- understand meiosis (L2)

Unit- III **8 hrs**

DNA structure and topology; enzymology and mechanism of replication in prokaryotes and eukaryotes, models of replication, nucleotide sequence composition; unique, middle and highly repetitive DNA, redundant DNA; genetic recombination, transposons; molecular basis of mutations, DNA repair mechanisms.

Learning Outcomes:

After completing this unit, the student will be able to

- explain DNA structure and its topological constraints (L2)
- explain the mechanism of replication in prokaryotes and eukaryotes (L2)
- summarize models of replication (L2)
- understand role of transposons in genetic recombination (L2)
- understand the molecular basis of mutations and repair (L2)

Unit- IV **8 hrs**

Principles of transcription: Structure and function of prokaryotic RNA polymerase, mechanism of transcription in prokaryotes and eukaryotes, post transcriptional processing. Operon concept, regulation of gene expression in E.coli. Biochemical control of gene expression in eukaryotes.

Learning Outcomes:

After completing this unit, the student will be able to

- describe the role of protein:DNA interactions in regulating transcription initiation (L2)
- Discuss the mechanism of transcription (L2)
- describe the process and significance of RNA processing in eukaryotes (L2)
- identify the similarities and differences in gene regulation in prokaryotes and eukaryotes (L3)

Unit- V **8 hrs**

General features of genetic code, structure and function of translation machinery in prokaryotic and eukaryotic systems, protein targeting and processing. Signal sequences, signal receptor protein and signal hypothesis.

Learning Outcomes:

After completing this unit, the student will be able to

- outline the features of genetic code
- understand its significance in central dogma (L2)
- describe the mechanism of protein synthesis (L2)
- explain the mechanisms of Protein targeting (L2)

Text Books:

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine and R. Losick, Molecular Biology of the Gene, 7/e, Pearson, 2014.
2. Robert Brooker, Genetics: Analysis and Principles, 5/e, McGraw-Hill Science Publishers, 2014.

References:	
	1. B. Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts and P. Walter, Molecular Biology of the Cell, 6/e, Garland Publishers, 2014. 2. EDP De Robertis, Cell and Molecular Biology, 8/e, Lippincott, Williams and Wilkins Publishers, 2010.
Course Outcomes:	
	After the completion of the course the student should be able to 1. Explain the concepts of gene structure and its function. 2. Summarize the inheritance of characters by mendelian and non-mendelian genetics. 3. Explain the molecular basis of mutations and DNA repair. 4. Explain the mechanism of gene regulation. 5. Summarize the importance of genetic code and central dogma.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2											1	3		
CO2	2	2		3								1	3	2	2
CO3	3												2	2	
CO4	2											1	3		
CO5	3												3		

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT235: FLUID MECHANICS AND MECHANICAL OPERATIONS

L	T	P	C
2	0	2	3

Fluid mechanics explains the relationships between force, pressure and fluid movement. Fluid mechanics can be used to understand the flow of fluids in pipes and mixing in bioreactors. Mechanical operations are applied in down-stream processing. This course introduces the principles of fluid mechanics and mechanical operations that are relevant for industrial biotechnology. The instruments used for measurement and control of fluid flow are also described.

Course Objectives:

- explain basic concepts of fluid flow
- Describe the devices for measurement of fluid flow
- Discuss the application of fluid mechanics to bioprocess industries
- Explain principles of mechanical operations
- Discuss construction and working of equipment for mechanical operations.

Unit- I **8 hrs**

Units and dimensions, types of fluids, hydrostatic pressure, pressure distribution in static fluids, pressure measuring devices, introduction to fluids in motion, concept of stream lines, stream tubes, viscosity, rheological properties of fluids.

Learning Outcomes:

At the end of this unit, the student will be able to

- Outline the basic principles of fluid mechanics (L1)
- Describe fluid Mechanics from a rational and fundamental point of view. (L2)
- Analyze pipe flow and fluid machinery. (Lf4)
- Examine the properties of equations of motion in fluids (L2)
- Describe the properties of non-Newtonian flow. (L2)

Unit- II **8 hrs**

Boundary layer formation and growth in tubes and on plates, Boundary layer separation and wake formation; Basic equations of fluid flow: continuity equation, momentum balance equation (concept of Navier-Stokes equation) and mechanical energy equation (Bernoulli equation).

Learning Outcomes:

At the end of this unit, the student will be able to

- Analyze fluid flow problems with the application of the momentum and energy equations (L4)
- Understand fluid particle systems and equipment (L2)
- Derive the conservation equations for flow of fluids (L2)

Unit- III **8 hrs**

Flow of incompressible fluids in pipes: relation between skin friction and wall shear, laminar flow in pipes: Hagen-Poiseulle equation, friction factor, friction from changes in velocity or direction. Drag, drag coefficient, flow through beds of solids, fluidization, mechanism of fluidization, applications of fluidization.

Learning Outcomes:

After completing this unit, the student will be able to

- Understand fluid flow through packed and fluidized bed (L2)
- Outline an approach for solving Fluid Mechanical problems.(L2)
- Explain the role of friction in fluid flow (L2)
- Understand fluidization techniques (L2)

Unit- IV	**8 hrs**

Transportation and metering of fluids: reciprocating, rotary, peristaltic and centrifugal pumps; flow measuring devices: venturi meter, orifice meter, rotameter, turbine meter and pitot tube. Mechanical Separations: Screening, differential and cumulative screen analysis, capacity and effectiveness of screens; screening equipment: grizzly, gyratory and vibratory screens.

Learning Outcomes:

After completing this unit, the student will be able to

- Identify suitable devices for flow measurement (L2)
- Use of pumps for fluid transportation (L2)
- Definition of particle and powder characteristics (L2)
- Select optimum solid-solid separation method (L2)
- Perform basic design calculations for screening operations (L2)

Unit- V	**8 hrs**

Characteristics of solid particles, principles of commin ution: laws of crushing (Rittinger"s, Bond"s, Kick"s laws); description and working of size reduction equipment: jaw, gyratory crush er, roll crushers, ball mill, hammer mill, and fluid energy mill.

Learning Outcomes:

After completing this unit, the student will be able to

- Discuss the mechanical properties of particles (L2)
- Select suitable size reduction equipment (L5)
- Identify microscopic mechanisms involved in particle processing (L2)

Text Books:

1. W.L. McCabe, J.C. Smith, and P. Harriot, Unit Operations of Chemical Engineering, 7/e, McGraw-Hill International Edition, 2005.

References:

1. J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Permagon Press, 1999.
2. G.G. Brown, Unit Operations, CBS Publishers, 2005.

Course Outcomes:	
	After the completion of the course the student should be able to 1. Capable of comprehending the principles of fluid statics and fluid flow in motion. capable of using the concepts of fluid statics to detect pressure in practical situations and bioprocess applications. 2. Capable of using Bernoulli's equation and pump calculations to solve fluid flow problems by applying mass, energy, and momentum balances. 3. Capable of analyzing fluid drag on particles. capable of computing the energy losses that occur when fluids are transported through pipelines, packed beds, and fluidized bed equipment. 4. Able to calibrate and use various flow measuring devices for calculation of flowrates in biochemical applications. Able to use various particle separation equipment for particle characterization studies. 5. Capable of determining the energy needs for a range of industrial size reduction applications and choosing appropriate size reduction equipment for particle characteristic investigations.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	3	1	2	1	2	2	3	3	3
CO2	3	3	2	3	3	2	3	1				2	3	3	2
CO3	3	3	3	2	3	2	3					2	3	3	2
CO4	3	3	2	1	2	2	2	1	1	1	2	2	2	2	2
CO5	3	3	3	3	2	2	3	1	1	1	2	2	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

FLUID MECHANICS AND MECHANICAL OPERATIONS LABORATORY

List of experiments

1. Calibration of Rotameter.
2. Determination of orifice coefficient.
3. Determination of venturi coefficient.
4. Verification of Bernoulli's equation.
5. Friction losses in fluid flow in pipes
6. Determination of pressure drops in a packed bed for different fluid velocities.
7. Determination of pressure drop and void fraction in a fluidized bed.
8. Determination of centrifugal pump efficiency
9. Sampling of materials (Riffle sampling and cone quartering sampling).
10. Determination of energy consumption in size reduction using roll crusher.
11. Determination of energy consumption in size reduction using ball mill.
12. Determination of effectiveness of a given screen.

References:

1. B. Majumdar, Fluid Mechanics with Laboratory Manual, PHI, 2013.
2. V.P. Gupta, K. Chandra, and K.S. Gupta, Laboratory Manual of Fluid Mechanics and Machines, CBS, 2009.

19EMC281: CONSTITUTION OF INDIA

L	T	P	C
3	0	0	0

Unit- I	**10 hrs**
Introduction to Indian Constitution: Constitutional history, constituent assembly, salient features of the constitution, significance of preamble, amending process of the constitution	
Unit- II	**8 hrs**
Rights and Duties: Citizenship, fundamental rights and directive principles, fundamental duties.	
Unit- III	**8 hrs**
Union Government: President and vice president, election, removal andpowers, prime minister and council of ministers, parliament, supreme court, union, state relations, emergency provisions	
Unit- IV	**8 hrs**
State and Local Governments: Governor, state legislature, assembly andcouncil, chief minister and council of ministers, high court, rural and urban local governments with special reference to 73rd and 74th constitutional amendment acts.	
Unit- V	**8hrs**
Other Constitutional and Statutory Bodies: Comptroller and auditor general, election commission, finance commission, attorney general and advocate general, union public service commission (UPSC), state public service commissions (SPSCs), tribunals, national human rights commission (NHRC).	
Text Books:	
1. J. C. Johari, Indian Government and Politics, Vishal Publications, Delhi, 2009. 2. M. V. Pylee, Introduction to the Constitution of India, 5/e, Vikas Publishing House, Mumbai, 2007.	
References:	
1. D.D. Basu, Introduction to the Indian Constitution, 21/e, Lexis Nexis, Gurgaon, India, 2011. 2. Subhas C. Kashyap, Our Constitution, 2/e, National Book Trust India, New Delhi, 2013.	

19EMC282 - ENVIRONMENTAL SCIENCES

L	T	P	C
3	0	0	0

The course enables the students to adapt eco-centric thinking and actions rather than human-centric thinking on natural resources, their utilization and conservation. The course also focuses on the importance of ecosystems, biodiversity and their degradation leads to pollution, finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.

Course Objectives:

- To familiarize the students about the importance of the environmental studies.
- To acquaint with different natural resources and their associated problems.
- To introduce various ecosystems, values of biodiversity and their conservation.
- To expose to today"s pollution levels and their impacts.
- To create awareness on different social issues such as conservation of water, green building concept.
- To impart knowledge on present population scenario, its impacts and role of informational technology on environment and human health.

Unit- I **10 hrs**

Introduction to environment and natural resources: Introduction to environment: Definition, scope and importance, multidisciplinary nature of environment, need for public awareness. Natural Resources: Renewable and non-renewable resources, natural resources and associated problems. Forest resources: Uses, Reasons for over-exploitation, deforestation effects, timber extraction, case studies. Water resources: Use and over−utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems. Mineral resources: Uses, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, Impacts of overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, use of renewable and non renewable energy sources, case studies. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Learning Outcomes:

At the end of this unit, the student will be able to

- list different renewable and non-renewable resources (L1).
- learn how the over-exploitation of natural resources impact human life (L1).
- demonstrate the role of an individual in the conservation of natural resources (L1).
- explain the equitable use of natural resources for sustainable lifestyles (L2).

Unit- II **8 hrs**

Ecosystems and biodiversity: Structure components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs, Ecological

pyramids, Energy flow in the ecosystem (10% law), Ecological succession. Biogeochemical cycle: (Nitrogen, carbon, Phosphorus cycle). Introduction, types, structure and function of the following ecosystem:- Forest ecosystem. Grassland ecosystem. Desert ecosystem. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Definition, Levels of biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega – diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: In– situ and Ex-situ conservation of biodiversity

Learning Outcomes:

At the end of this unit, the student will be able to

- learn how ecosystem functions (L1).
- explain the structure and function of terrestrial and aquatic ecosystems (L2).
- illustrate the values and threats to biodiversity (L2).
- explain the importance of conservation of biodiversity (L2).

Unit- III	**8 hrs**

Environmental pollution and control: Environmental Pollution: Definition, causes, effects and control measures: Air Pollution, Water pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards, Solid waste Management, e-waste, Hazardous waste management. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: floods, earthquake, cyclone and landslides.

Learning Outcomes:

After completing this unit, the student will be able to

- list causes, effects and control measures of pollution (air, water & soil) (L1).
- classify different types of pollutants (L2).
- explain disaster management of floods, earthquake, cyclone and landslides (L2).
- identify the pollution related case studies (L3).
- demonstrate the role of an individual in prevention of pollution (L3).

Unit- IV	**9 hrs**

Social issues and global environment problems and efforts: From unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management, Remote sensing and GIS methods. Resettlement and rehabilitation of people: its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions. Green building concept, Environmental Impact Assessment (Checklists, matrix methods), Environmental Management Plan, Climate change: global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Learning Outcomes:

After completing this unit, the student will be able to

- explain different water conservation methods (L2).

	• compare remote sensing and GIS methods (L2). • apply green building concept (L3). • demonstrate the consequences of global warming, acid rains and ozone layer depletion (L3). • analyze environmental impact assessment and management plan (L4).
Unit- V	**6 hrs**
Human population and environment legislation: Population growth, variation among nations. Family Welfare programme. Environment and human health. HIV/AIDS, Human rights. Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Environment Legislation. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Environmental Protection Act, Pollution prevention act. Issues involved in enforcement of environmental legislation. Public awareness. Project Work.	
Learning Outcomes:	
	After completing this unit, the student will be able to • compare population growth and variation among nations (L2). • apply value education (L3). • classify women and child welfare (L3). • Distinguish different environmental legislation acts and issues involved in enforcement of legislation (L4). • analyze the role of information technology in environment and human health (L4).
Course Outcomes:	
	After the completion of the course the student should be able to • explain about environment and natural resources (L2). • illustrate the values and threats to biodiversity (L2). • identify the pollution related case studies (L3). • demonstrate the consequences of global warming, acid rains and ozone layer depletion (L3). • analyze the role of information technology in environment and human health (L4).
Text Books:	
	1. Anubha Kaushik and C.P. Kaushik, Text book of environmental studies New Age International Publisher (2014). 2. Erach Barucha, Text book of environmental studies for undergraduates courses, published by – University Grants Commission, University Press (2005) 3. Anindita Basak, Environmental Studies. Pearson (2009).
References:	
	1. D.K. Asthana and Meera Asthana, A Text book of Environmental Studies, S. Chand (2010). 2. P.M Cherry Solid and Hazardous waste Management, CBS Publisher (2016).

	3. Charles H. Ecclestion, Environmental Impact Assessment, CRC Press (2011). 4. K.K. Singh, Natural Resources Conservation and Management, MD Publications (2008). 5. J. Jeffrey Peirce, Ruth F. Weiner and P. Aarne Vesilind, Environmental Pollution and Control, Butterworth-Heinemann (1998). 6. James Maclaurin and Kim Sterelny, What is Biodiversity, The University of Chicago Press (2008). 7. R.B. Mandal, Introductory Methods in Population Analysis, Concept Publishing Co, (2007).

19EHS221: COMPREHENSIVE SKILL DEVELOPMENT II

L T P A C
0 0 0 6 1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Course Outcomes:

On completion of the course, student will be able to–

1. Effectively communicate through verbal/oral communication and improve the listening skills
2. Write precise briefs or reports and technical documents, actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self-motivation and practicing creative thinking.
3. Student will be able to understand the problems and develop his competitive coding skills.
4. Apply the skills in various domains and will be able to solve complex problems faced by the industry.
5. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality

Part-1 **3**
Hours per week

A. Verbal and Soft Skills:

Communication Skills, Presentation Skills, Decision Making and Problem-Solving, Group Discussion.

Unit	Module/ Topics	Hrs
1.	Communication Skills	4
2.	Presentation Skills	4
3.	Decision Making and Problem-Solving	3
4.	Group Discussion	4
	Total	**15**

B. Quantitative Aptitude and Reasoning

Puzzles, Numbers, Arithmetic, Data Interpretation.

Unit	Module/ Topics	Hrs
1.	Non-Verbal Reasoning	5
2.	Data Sufficiency	2
3.	Analytical Reasoning	3
4.	Puzzles	5
	Total	15

Unit	Module/ Topics	Hrs
1.	Numbers [Number System, Divisibility rules, Remainders, LCM & HCF]	3
2.	Numerical Computation and Estimation-1 [i. Chain Rule ii. Ratio Proportions iii. Partnerships & Averages iv. Percentages v. Profit-Loss, and discounts vi. Mixtures]	6
3.	Data Interpretation [Pie diagrams, Line Graph, Bar Graph, Tabular forms, and Caselets]	3
4.	Progressions and Series	3
	Total	15

Part-2 **3**
Hours per week

Coding: Complex problem solving using Data Structures in terms of improving efficiency: Time Complexity and Space Complexity, Linked List, Stacks and Queues using Linked List, Binary Trees, Binary Search Trees, Trie, Representation of graphs, Breadth First Search, Depth First Search, Dynamic Programming.

Scheme of Evaluation

Internal Assessments by Assignments, Quizzes (multiple Choice questions). All the Students are expected to do at least 5 problems in each topic and they should submit the content written by them in each topic for final evaluation.

Type of Assessment	No.of Marks
At least 5 problems in each topic	15
Assignments	15
Content writing	10
Quizzes	10
Total	**50**

Late Work

Each homework is due in the beginning of the class meeting (that is, at 6:00pm) on the due date. If homework is submitted within seven days after this deadline, the grade will be reduced by 50%. Submission more than seven days after the deadline will not be accepted. If you have a serious reason for requesting an extension, such as illness or family emergency, you should discuss it with one of the instructors as soon as the problem arises, and definitely before the submission deadline.

References:-

The course does *not* have a required textbook. You may optionally use the following textbook and URLs to look up standard algorithms:

3. Data Structures and Algorithms made easy by Narasimha Karumanchi
4. Data Structure and Algorithmic Thinking with Python by Narasimha Karumanchi
5. Algorithm Design Techniques: Recursion, Backtracking, Greedy, Divide and Conquer and Dynamic Programming by Narasimha Karumanchi
6. Coding Interview Questions by Narasimha Karumanchi
7. Competitive Programming in Python- 128 Algorithms to develop your Coding Skills by Cristhop Durr & Jill-Jen Vie.
8. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests (Undergraduate Topics in Computer Science) *by* Antti Laaksonen

9. https://www.geeksforgeeks.org/competitive-programming-a-complete-guide/
10. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
11. https://codeforces.com/
12. https://leetcode.com/

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO2	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO3	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO4	2	2	2	1	2	2	2		1	1	1	1	2	2	2
CO5	2	2	1	1	2	2	1		1	1	3	1	1	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EMA208: MATHEMATICS FOR BIOTECHNOLOGY-IV

(**Complex variables, Fourier series, Laplace Transforms and Vector Calculus**)

L	T	P	C
3	0	0	3

This course is designed to familiarize the students with complex analysis, nature of a series

Laplace transforms of single valued functions and vector calculus.

Course Objectives:

- To familiarize with the basic concepts of complex valued functions.
- To impart the knowledge on series expansion of functions.
- To explain the basic concepts of Fourier series.
- To teach the concept of Laplace Transforms of elementary functions.
- To familiarize with the concepts of Vector differentiation and Integration.

Unit I : Calculus of Complex Functions — **10 hrs**

Functions of a Complex variable: Analytic functions, Cauchy-Riemann equations, harmonic functions, applications to flow problems.

Complex Integration : Cauchy's theorem, Cauchy's integral formula, Cauchy Residue theorem, calculation of residues (without proofs).

Learning Outcomes:

At the end of this unit, the student will be able to

- make use of Cauchy-Riemann equations (L3)
- apply Cauchy's theorem and Cauchy's integral formula for evaluating integrals (L3)
- find residues and apply residue theorem to evaluate integrals (L3)

Unit II: Infinite Series — **8 hrs**

Introduction, sequences, series, series of positive terms, integral test, comparison test, D' Alembert's ratio test, Cauchy's root test and alternating series: Leibnitz's test.

Learning Outcomes:

At the end of this unit, the student will be able to

- inspect whether a given series converges or diverges.(L4)

Unit III: Fourier Series — **8 hrs**

Periodic functions, Fourier series, conditions for a Fourier expansion, functions of any period, even and odd functions, half-range expansions.

Learning Outcomes:

After completing this unit, the student will be able to

- construct fourier series expansion for a given periodic function.(L3)

Unit IV: Laplace Transforms — **10 hrs**

Transforms of elementary functions, properties of Laplace transforms, existence conditions - transforms of derivatives, transforms of integrals, multiplication by t^n, division by t, inverse Laplace transforms, convolution theorem.	
Learning Outcomes:	
	After completing this unit, the student will be able to • apply Laplace transforms to elementary functions (L3) • find transforms of derivatives, integrals, multiplication and division (L3) • find inverse of a transformed function using Convolution theorem (L3)
Unit V: Vector Calculus	**10 hrs**
Vector Differentiation: Scalar and vector fields, gradient, directional derivative, divergence, curl, vector identities, irrotational and solenodial fields. **Vector Integration** : Line integral, surface integral, Green's theorem in plane, Stoke's theorem and Gauss divergence theorem (without proofs).	
Learning Outcomes:	
	After completing this unit, the student will be able to • Calculae the normal to a given surface, directional derivative and divergence, curl to given vector point functions.(L3) • evaluate line and surface integrals.(L3)
Text Books:	
	1 B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017. 2 R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
References:	
	1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley Eastern Pvt. Ltd. New Delhi, 2013. 2. N. P. Bali and Manish Goyal, Textbook of Engineering Mathematics, 8th edition, Laxmi Publications (P) Ltd., New Delhi, 2011.
Course Outcomes:	
	After the completion of the course the student should be able to: 1. Develop analytic function and Cauchy-Riemann equations. 2. Examine complex integrals. 3. Apply Laplace transform to derivatives and integrals. 4. Construct half range expansion. 5. Apply Z transform of discrete function.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO2	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO3	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO4	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO5	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EID232: INTERNET OF THINGS

(For 2020-21 Odd and Even Sems and 2021-22 Odd Sem only)

(Common to all)

L	T	P	C
2	0	2	3

The Internet of Things (IoT) is a network of a wide variety of devices like vehicles, humans, soil etc. These devices gather data using sensors, which can be used for monitoring or control. This course is an introduction to the embedded devices, communication protocols and APIs used in IoT.

Course Objectives

- Introduce the fundamental concepts of IoT and physical computing
- Expose the student to a variety of embedded boards and IoT Platforms
- Create a basic understanding of the communication protocols in IoT communications.
- Familiarize the student with application program interfaces for IoT.
- Enable students to create simple IoT applications.

UNIT I **5 L**

Overview of IoT: The Internet of Things: An Overview, The Flavor of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things? Design Principles for Connected Devices, Calm and Ambient Technology, Privacy, Keeping Secrets, Whose Data Is It Anyway? Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens On The Internet, Graceful Degradation, Affordances.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain IoT architecture(L2)
- interpret the design principles that govern connected devices(L2)
- summarize the roles of various organizations for IoT(L2)

UNIT II **6 L**

Embedded Devices - I: Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, Developing on the Arduino, Some Notes on the Hardware, Openness.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the basics of microcontrollers(L2)
- outline the architecture of Arduino(L2)
- develop simple applications using Arduino(L3)

UNIT III **6 L**

Embedded Devices - II: Raspberry Pi , Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness, Other notable platforms, Mobile phones and tablets, Plug Computing: Always-on Internet of Things.

Learning Outcomes:

After completion of this unit, the student will be able to

- outline the architecture of Raspberry Pi(L2)
- develop simple applications using Raspberry Pi(L3)
- select a platform for a particular embedded computing application(L3)

UNIT IV **6 L**

Communication in the IoT: Internet Principles, Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP), UDP, IP Addresses, DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, An Example: HTTP Ports, Other Common Ports, Application Layer Protocols- HTTP, HTTPS: Encrypted HTTP, Other Application Layer Protocols.

Learning Outcomes:

After completion of this unit, the student will be able to

- interpret different protocols and compare them(L2)
- select which protocol can be used for a specific application(L3)
- utilize the Internet communication protocols for IoT applications(L3)

UNIT V **5 L**

Prototyping Online Components: Getting Started with an API, Mashing Up APIs, Scraping, Legalities, writing a New API, Clockodillo, Security, Implementing the API, Using Curl to Test, Going Further, ReaLTime Reactions, Polling, Comet, Other Protocols, MQ Telemetry Transport, Extensible Messaging and Presence Protocol, Constrained Application Protocol.

Learning Outcomes:

After completion of this unit, the student will be able to

- select IoT APIs for an application(L3)
- design and develop a solution for a given application using APIs(L6)
- test for errors in the application(L4)
- judge the security issues in Real time applications. (L5)

INTERNET OF THINGS LABORATORY

List of Practical Experiments:

1. Select any one development board (Eg., Arduino or Raspberry Pi) and control LED using the board.
2. Using the same board as in (1), read data from a sensor. Experiment with both analog and digital sensors.
3. Control any two actuators connected to the development board using Bluetooth.
4. Read data from sensor and send it to a requesting client. (using socket communication)
   Note: The client and server should be connected to same local area network.
5. Create any cloud platform account, explore IoT services and register a thing on the platform.
6. Push sensor data to cloud.
7. Control an actuator through cloud.
8. Access the data pushed from sensor to cloud and apply any data analytics or visualization services.
9. Create a mobile app to control an actuator.

10. Identify a problem in your local area or college which can be solved by integrating the things you learned so far and create a prototype to solve it (Mini Project).

Text Book(s):

1. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley Publications, 2012.

References

1. ArshdeepBahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2014.
2. Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling technologies and use cases –CRC Press, 2017.

Web Sources

https://www.arduino.cc/

https://www.raspberrypi.org/

Course Outcomes:

After completion of this course, the student will be able to:

1. Student is able to understand the characteristics and challenges in IoT application areas.
2. Student is able to explain about sensors for measuring different physical quantities.
3. Student is able to explain about the role of different IoT protocols used for data communication between different IoT devices.
4. Student is able to understand and analyze an appropriate cloud service provider for an IoT application.
5. Student is able to understand the machine learning algorithms.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2			
CO2	2				3				1	2		1			
CO3	3				3				1	2		1			
CO4	2	3	2	2								2			
CO5	2	2										2			2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EID232: Internet of Things
(with effect from 2021-22 Even Semester)

L T P C
2 0 2 3

The Internet of Things (IoT) is a network of a wide variety of devices like vehicles, humans, soil etc. These devices gather data using sensors, which can be used for monitoring or control. This course is an introduction to the embedded devices, communication protocols and APIs used in IoT.

Course Objectives

- Introduce the fundamental concepts of IoT and its characteristics
- Expose the student to sensors used for sensing different physical quantities
- Create a basic understanding of the communication protocols in IoT communications.
- Familiarize the student with different application program interfaces for accessing Cloud services.
- Enable students to create simple IoT applications.

Unit I **5 Hours**

Introduction to Internet of Things (IoT): Introduction and Definition of Internet of Things, IoT Growth, Application Areas of IoT, Characteristics of IoT, Things in IoT, IoT Stack, Enabling Technologies, IoT Challenges, IoT Levels, IoT vs. Cyberphysical Systems, IoT vs WSN

Learning Outcomes:

After completion of this unit, the student will be able to

- describe IoT architecture and application areas (L2)
- interpret the design principles that govern connected devices(L2)
- summarize the different IoT levels and compare with different systems (L2)

Unit II **6 Hours**

Introduction to Sensors, Microcontrollers, and Their Interfacing: Introduction to Sensor Interfacing, Types of Sensors, Controlling Sensors through Webpages, Microcontrollers

Learning Outcomes:

After completion of this unit, the student will be able to

- list the different physical quantities and their sensing mechanisms (L1)
- describing the interfacing of sensors with embedded computing systems (like Arduino/Raspberry Pi and electrical signal relationships(L2)
- demonstrate the control of sensors using webpage interfaces (L4)

Unit III **6 Hours**

Protocols for IoT – Messaging and Transport Protocols: Messaging Protocols, Transport Protocols (Li-Fi, BLE), Protocols for IoT – Addressing and Identification: Internet Protocol Version 4 (IPv4), Internet Protocol Version 6 (IPv6), Uniform Resource Identifier (URI)

Learning Outcomes:

After completion of this unit, the student will be able to

- interpret different protocols and compare them(L2)
- select which protocol can be used for a specific application(L3)
- utilize the Internet communication protocols for IoT applications(L3)

Unit IV **5 Hours**

Cloud for IoT: IoT with Cloud – Challenges, Selection of Cloud Service Provider for IoT Applications, Introduction to Fog Computing, Cloud Computing: Security Aspects, Case Study: How to use Adafruit Cloud?

Learning Outcomes:

After completion of this unit, the student will be able to

- describe the cloud architecture for collecting data from different sensors and analyzing them (L2)
- choose a service provider for a specific IoT application(L3)
- analyze different case studies involving Cloud IoT and discuss the security aspects (L3)

Unit V **6 Hours**

Data Analytics – Visualizing the Power of Data from IoT, Data Analysis, Machine Learning, Types of Machine Learning Models, Model Building Process, Modelling Algorithms, Model Performance.

Application Building with IoT: Smart Perishable Tracking with IoT and Sensors, Smart Healthcare – Elderly Fall Detection with IoT and Sensors, IoT–Based Application to Monitor Water Quality Smart Warehouse Monitoring, Smart Retail

Learning Outcomes:

After completion of this unit, the student will be able to

- describe the architecture of IoT involving data collection and analysis
- list the types of machine learning models used to analyze collected data (L2)
- discuss different applications of IoT illustrating the use of different data analyses and machine learning algorithms (L3)

Text Book:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley India, 2019

List of Experiments (2 Hours each)

1. Blinking led with Arduino using software delay, LED Control with switch
2. Temperature measurement using LM35 and display both on LCD and serial monitor
3. Control DC motor with H-bridge and as well as PWM
4. Raspberry pi installation and led control
5. DHT11 sensor interfacing to Raspberry pi and Transfer the data to Thingspeak server
6. Interfacing camera and raspberry pi
7. Accelerometer ADXL345 with i2c with raspberry pi
8. Nodemcu to control LED with thinger.io
9. With Nodemcu HTTP protocol get and post
10. With nodemcu Webserver control led
11. MQTT protocol using Nodemcu
12. Blinky app with led control

Text Book(s)

1. Simon Monk, Programming Arduino: Getting Started with Sketches, Mc Graw Hill Publications, 2011
2. Simon Monk, Programming the Raspberry Pi, Getting Started with Python, Mc Graw Hill Publications, 2015
3. Simon Monk, Hacking Electronics: Learning Electronics with Arduino and Raspberry Pi, Mc Graw Hill Publications, 2017
4. Manoj R. Thakur, NodeMCU ESP8266 Communication Methods and Protocols : Programming with Arduino IDE Amazon Media, 2018.

Course Outcomes:

After completion of this course, the student will be able to:

6. Student is able to understand the characteristics and challenges in IoT application areas.
7. Student is able to explain about sensors for measuring different physical quantities.
8. Student is able to explain about the role of different IoT protocols used for data communication between different IoT devices.
9. Student is able to understand and analyze an appropriate cloud service provider for an IoT application.
10. Student is able to understand the machine learning algorithms.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2			
CO2	2				3				1	2		1			
CO3	3				3				1	2		1			
CO4	2	3	2	2								2			
CO5	2	2										2			2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT232: HEAT AND MASS TRANSFER

L	T	P	C
3	0	2	4

Many industrial processes in biotechnology involve heating and cooling. Although thermodynamics determines the direction of the flow of heat, knowledge of the modes of heat transfer enables us to estimate the time required for achieving the target temperature. This is critical for many biological processes that are highly sensitive to small changes in temperature.

Mass transfer involves concentration changes due to transfer of molecules from one phase to another. Mass transfer principles are used in biological processes and industrial biotechnology. This course is a prerequisite for bioprocess engineering and bioreactor design.

Course Objectives:

- To understand the physical phenomena associated with conduction and convection, Newton's law of cooling, and the significance of non dimensional parameters in convection heat transfer.
- To use empirical correlations to analyze external and internal, forced and free convection problems.
- Analyze theories to correlate interphase mass transfer
- Analyze continuous steady state distillation processes
- Analyze single and multistage extraction operations

Unit- I **8 hrs.**

Introduction: Modes of heat transfer. Basic laws of heat transfer. Analogy between heat flow and electrical flow. Conduction: The Fourier heat conduction equation. Steady state and one-dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces. Three-dimensional heat conduction equation. Unsteady state conduction: simplified case for systems with negligible internal resistance, basic equation, equation for different geometries.

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply law of conservation of mass and energy to a control volume or control surface.
- Understand the origin of Fourier's law
- Build a mathematical model based on boundary conditions
- Solve the general heat diffusion equation for one-dimensional steady-state problems
- Analyze transient problems using the lumped capacitance method

Unit- II **8 hrs.**

Convection: The convective heat transfer coefficient. Introduction to thermal boundary layer. Dimensionless numbers in heat transfer and their significance. Dimensional analysis. Forced convection: heat transfer by forced convection in laminar flow, turbulent flow, heat transfer in

transition region between laminar and turbulent flow. Analogy between momentum and heat transfer. Reynolds, Colburn and Prandtl analogies. Natural convection: natural convection from vertical and horizontal surfaces. Grashoff number. Plate and frame heat exchanger, shell and tube heat exchanger.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain convection and Newton's law of cooling
- Understand the significance of dimensionless parameters in convection heat transfer
- Apply dimensional analysis to determine heat transfer in forced and natural convection
- Apply empirical correlations to analyze external and internal, forced and free convection problems

Unit- III	**8hrs**

Introduction: Mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolar counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, theories of mass transfer. Interphase mass transfer: concept of equilibrium, diffusion between phases, material balances in steady state co-current and counter-current stage processes.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain the concept of mass transfer
- Solve problems of mass transfer in diffusion, chemical reaction, and convection
- Explain the equations for the calculation of diffusional flux
- Analyze theories of interphase mass transfer.

Unit- IV	**8 hrs.**

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, enthalpy concentration diagrams, flash vaporization, differential distillation (Rayleigh equation), steam distillation, continuous distillation, McCabe-Thiele method.

Learning Outcomes:

After completing this unit, the student will be able to

- Analyze continuous steady state distillation processes
- Explain pressure-composition diagrams for ideal solutions
- Explain enthalpy concentration diagrams
- Analyze material balance for distillation of binary mixtures
- Explain graphical procedure for calculating number of theoretical plates

Unit- V	**8 hrs.**

Liquid-liquid Extraction: Liquid-liquid equilibria, choice of solvent for extraction, analytical and graphical solutions for single and multistage operations, continuous counter current operation.

Equipment: Mixer settler cascades, Rotating disc contactor, Scheibel extractor, Pulsed column, Centrifugal extractor.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain separation of the constituents of a liquid solution by contact with another insoluble liquid
- Analyze Liquid-liquid equilibrium
- Explain concepts of single and multistage operations
- Select suitable equipment's for extraction and heat exchange

Text Books:

1. Warren L. McCabe, Julian C.Smith and Peter Harriott, Unit Operations Of Chemical Engineering, 7/e, McGraw Hill, 2005.
2. D.Q.Kern, Process Heat Transfer, Tata-McGraw Hill, 2001,
3. R.E. Treybal, Mass Transfer Operations, 3/e, McGraw Hill International Editions, 1981. B.K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall of India, 2007.

References:

1. J.M. Coulson and J.F. Richardson, Chemical Engineering Volume-1, 4/e, The English Language book society and Permagon Press, Oxford, 2005.
2. William McAdams, Heat Transmission, 3/e, McGrawHill, 1985.

Course Outcomes:

1. Understand and apply the fundamental laws and equations of heat transfer across different materials and geometries.
2. Analyze convective heat transfer processes and their efficiency using dimensional analysis and heat transfer coefficients.
3. Grasp the principles of mass transfer, including molecular diffusion and the application of Fick's laws in various systems.
4. Design and analyze distillation processes using phase diagrams, VLE data, and distillation methods such as the McCabe-Thiele technique.
5. Evaluate and optimize liquid-liquid extraction operations using equilibrium data and modern extraction techniques.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2	1									2		
CO2	2	1	3	2		1							1	2	
CO3	2	2	3		1	1								3	1
CO4	3	3		2	2		1	1		1			3	2	
CO5	3	3	2		2	1		2			1		2	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

HEAT AND MASS TRANSFER LABORATORY

This laboratory course will reinforce the students' understanding of the analysis of applications pertaining to Heat and Mass Transfer through suitably designed experiments. These experiments will demonstrate the operation and the design of unit operations that incorporate heat and mass transfer phenomena.

List of Experiments:

PART A

1. Determination of Thermal conductivity of metal rod (steady state conduction).
   After completing this experiment, the student will be familiar with the development of the general heat diffusion equation based on Fourier's law and the principle of conservation of energy.

2. Calculation of thermal conductance in a unsteady state heat exchange unit.
[After completing the experiment, the student is able to analyze transient problems]

3. Calculation of film and overall heat transfer coefficients in double pipe heat exchanger
[After completing the experiment the student is able to determine the effectiveness of double pipe heat exchanger]
4. Calculation of film and overall heat transfer coefficients in shell and tube heat exchanger
[After completing the experiment, the student is able to determine the effectiveness of Shell and tube heat exchanger]
5. Heat transfer through composite walls
[After completing the experiment, the student is able to determine the thermal conductivity of composite wall]
6. Unsteady state heat transfer unit
[After completing the experiment, the student is able to determine the heat transfer coefficient in unsteady state heat transfer]

PART-B

7. Ternary liquid –liquid system
[After completing the experiment, the student is able to determine the saturation isotherm (binodal curve) for the given system]
6. Liquid-liquid equilibrium system
[After completing the experiment, the student is able to Determine the equilibrium data for the given Liquid-Liquid system]
7. Vapor-Liquid Equilibrium experiment
[After completing the experiment, the student is able to analyze the vapor-liquid equilibrium system]
8. Steam distillation
[After completing the experiment, the student is able to determine the efficiency of steam distillation]

1.	2. Differential distillation 3. [After completing the experiment, the student is able to verify Rayleighs equation] 10 Arnolds cell 4. [After completing the experiment, the student is able to determine the diffusion coefficient of vapor through air film] 5. Liquid-liquid diffusion 6. [After completing the experiment, the student is Able to determine the diffusion coefficient of HCL in water] 7. Solid Liquid equilibrium experiment 8. [After completing the experiment, the student is able to determine the equilibrium distribution data for the given solid-liquid system]
Text Books:	
	1. N.S. Srinivas, Heat Transfer Laboratory Manual for Chemical Engineering Graduates, Create Space Independent Publishing Platform, 2014. 2. Abdul Matheen, Heat Transfer Laboratory Manual, 2/e, Laxmi Publications, 2007. Awais Ali, Heat and Mass Transfer Lab Manual, 2014.

19EBT234: GENETIC ENGINEERING

L	T	P	C
3	0	3	4.5

Genetic engineering consists of a set of techniques for manipulating the genes, which constitute the basis of inheritance. The basic paradigm of genetic engineering namely recombinant DNA technology involves cutting segments of DNA from one organism and pasting it into a vector, which is then transferred to the organism to be modified. This process enables transfer of genes and traits from one organism to another. Genetic engineering is applicable to microbes as well as higher level organisms such as plants, animals and human beings. The principles and techniques of genetic engineering as well as applications of genetic engineering in agriculture, medicine and industry are described in this course.

Course Objectives:

- Explain principles of recombinant DNA technology
- Discuss the methods, tools and techniques for gene cloning and genome analysis.
- Describe methods for production of recombinant proteins.
- Describe the molecular techniques and their applications.
- List applications of rDNA technology in medicine, agriculture, industry and animal husbandry

Unit- I: Basics of rDNA technology — **8 hrs**

Isolation and purification of nucleic acids. Manipulation of DNA– Restriction and modification enzymes (nucleases, polymerases, ligases and topoisomerases). Characteristics of cloning and expression vectors, vectors based on plasmids, lambda phage, Cosmides and artificial chromosomes BACs and YACs. Vectors for plant, yeast, and mammalian systems. Restriction mapping.

Learning Outcomes:

At the end of this unit, the student will be able to

- Describe DNA isolation, purification and manipulation (L2).
- Describe characteristics of cloning vectors (L2).
- Summarize use of restriction maps (L2)

Unit- II — **8 hrs**

Prokaryotic and expression host systems. Cloning strategies: construction of recombinant vectors. Introduction DNA into host systems (gene transfer methods for bacteria, plants and animals). Molecular techniques involved in study of expression of genes: Southern, Northern, Western, Dot and Slot blots, In-situ hybridization.

Learning Outcomes:

At the end of this unit, the student will be able to

- Select expression systems (L3).
- Describe strategies for construction of recombinant vectors (L1).

	• Describe strategies for cloning of recombinant vectors (L1). • Describe molecular techniques to analyze expression of genes (L1).
Unit- III	**8 hrs**
Construction of genomic and cDNA libraries. Screening of DNA libraries using probes and antisera. Preparation of labeled probes and primers. Maxam Gilbert, Sanger Coulson's, automated methods of DNA sequencing and Next Generation sequencing methods.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Construct and evaluate DNA libraries (L4 and L5). • Describe preparation of probes and primers (L2). • Apply molecular techniques for DNA sequencing (L3).
Unit- IV	**8 hrs**
Techniques for nucleic acid amplification and analysis: PCR, Nested PCR, inverse PCR, RT-PCR, Hot start PCR, Real time PCR, qPCR, Molecular beacons, DNA finger printing, RAPD, RFLP and AFLP. Site directed mutagenesis.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Describe methods for amplification of DNA and RNA (L2). • Apply molecular techniques to understand gene expression profiling (L3). • Describe the principles and applications of DNA finger printing(L1).
Unit- V	**8 hrs**
RNA silencing: design and applications of siRNA and anti-sense RNA. Applications of genetic engineering in medicine, agriculture, animal husbandry, environmental management and industry. Achievements, limitations and negative aspects of genetic engineering.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Illustrate RNA silencing methods (L2). • Describe applications of rDNA technology in medicine, agriculture, animal husbandry and Industry (L2). • Discuss limitations and negative aspects of genetic engineering (L1).
Textbooks:	
	1. T.A. Brown, Gene cloning and DNA analysis: an introduction, 6/e, Wiley-Blackwell, 2010. 2. D. S.T. Nicholl, An introduction to genetic engineering, 3/e, Cambridge University press, 2008.

References:	
	1. J.D. Watson, R.M. Meyers, A.A. Caudy and J.A. Witkowski, Recombinant DNA: genes and genomes - A short course, 3/e, W.H. Freeman and Co, 2007. 2. S.B. Primrose, R. Twyman, B. Old, Principles of gene manipulation, 6/e, Wiley-Blackwell, 2001

GENETIC ENGINEERING LABORATORY

Genetic Engineering Laboratory comprises of a series of techniques involved in the transfer genetic material from one organism to another. The primary objective the laboratory is to train the students in recombinant DNA Technology. For efficient learning lab course, students should have a basic knowledge on genetics and molecular biology.

At least 10 of the following experiments:

Expt.1. Isolation of genomic DNA from plants
At the end of his experiment, student will be able to isolate genomic DNA from plants
Expt.2. Determination of plant genomic DNA concentration and purity
At the end of his experiment, student will be able to assess the purity of the isolated DNA
Expt.3. Separation of plant genomic DNA on agarose gel electrophoresis
At the end of his experiment, student will be able to separate the DNA and visualize it
Expt.4. Isolation of plasmid DNA from *E.coli* culture
At the end of his experiment, student will be able to isolate plasmid DNA from bacterial culture
Expt.5. **Separation of plasmid DNA on agarose gel electrophoresis**
At the end of his experiment, student will be able to separate the plasmid DNA and visualize it
Expt.6. **Restriction digestion of λ phage DNA**
At the end of his experiment, student will be able to cut the DNA using enzymes
Expt.7. **Ligation of the DNA digested by restriction endonucleases**
At the end of his experiment, student will be able to join two DNA fragments and clone them into a vector
Expt.8. **Preparation of competent *E.coli* cells**
At the end of his experiment, student will be able to prepare the competent *E.coli* cells for transformation
Expt.9. **Transformation of competent *E.coli* cells with ligated plasmid and selection of positive colonies through Blue-white screening method**
At the end of his experiment, student will be able to perform transformation and screen the positive colonies
Expt.10. Studying the expression of cloned genes (GFP)
At the end of his experiment, student will be able to study the expression of cloned genes
Expt.11. PCR amplification of DNA using gene specific primers
At the end of his experiment, student will be able to amplify the DNA using PCR
Expt.12. Southern blotting of plant genomic DNA
At the end of his experiment, student will be able to transfer the DNA from gel onto a membrane for performing the hybridization
Expt.13. DNA finger printing through RFLP and RAPD
At the end of his experiment, student will be able to study the polymorphisms among organisms
Expt.14. Regulation of gene expression
At the end of his experiment, student will be able to study how a gene can be regulated by using reporter genes

	1. J.F. Sambrook and D.W. Russell, eds. Molecular Cloning: A Laboratory Manual, 3rd ed., Vols 1,2 and 3. Cold Spring Harbor Laboratory Press, 2001. 2. K.V.Chaitanya. Cell and Molecular Biology: A Lab Manual. PHI Learning Pvt. Ltd, India, 2013. **Course Outcomes:** 1. Understand the isolation of nucleic acids, enzymes of rDNA technology and vectors. 2. Apply prokaryotic, eukaryotic expression and molecular techniques in finding gene expression. 3. Explain nucleic acid sequencing methods in understanding sequence and construction and screening of DNA libraries. 4. Apply molecular techniques for nucleic acid amplification and analysis. 5. Discuss RNAi Technology, genome editing and the applications of rDNA technology.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1			1	2	3	1	1
CO2	3	3	3	3	2	1	2	1			1	2	3	2	2
CO3	3	3	3	3	3	2	3	1			1	2	3	3	3
CO4	3	3	3	3	3	3	3	1			1	2	3	3	3
CO5	3	3	3	3	3	3	3	2			1	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT202: INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
2	0	0	2

Instrumental methods of analysis are extensions of the human senses for perceiving the world. Some of these methods enable us to observe the organization of biological systems at a much higher level of resolution than the human eye, whereas others provide information for which there is no human equivalent sense, such as information regarding identity, purity and composition. The objective of this course is to describe the principles of instrumental methods for quantitative and qualitative analysis in biotechnology with examples related to quality control, process monitoring, biomolecular system characterization and diagnostic applications.

Course Objectives:

- summarize methods for quantitative and qualitative analysis of biomolecules and biomolecular systems (L2)
- compare methods for determination of molecular mass and particle size distribution (L4)
- explain the principles of the methods for determination of molecular structure (L2)
- list methods for studies of biomolecular interactions (L1)
- identify methods for high throughput analysis (L3)

Unit- I **6 hrs**

Overview of applications of instrumental methods of Qualitative and Quantitative analysis in biotechnology.

Atomic absorption and flame emission spectroscopy. UV-Visible and vibrational spectroscopy. Polarimetry and Circular Dichroism. Determination of particle number and particle size from light scattering data. Structure determination of biomolecules and biomolecular assemblies from X-ray diffraction data.

Learning Outcomes:

At the end of this unit, the student will be able to

- list methods used for quality control of biotechnology products (L1)
- explain the principles of light scattering and X-ray diffraction (L2)
- summarize principles of methods for determination of particle size (L2)

Unit- II **6 hrs**

Microscopy:

Geometric optics of simple and compound light microscope. Resolution of compound light microscope. Fluorescence microscopy. Confocal light microscope. Transmission electron microscope. Scanning electron microscope and Scanning Tunneling electron microscope. Cryo- electron microscopy. Atomic force microscope

Learning Outcomes:

	At the end of this unit, the student will be able to • relate the principles and resolution limits of microscopes (L2) • compare the principles and applications of electron microscopic techniques (L2) • explain the principles and applications of AFM (L2)

Unit- III	**6 hrs**

Mass spectrometry:

Principles and components of mass spectrometers. Ionization methods. Determination of empirical formula. Determination of structure of small organic molecules. Mass spectral databases for spectral fingerprinting. Oligonucleotide sequencing. Peptide and protein sequencing.

Learning Outcomes:

	After completing this unit, the student will be able to • summarize principles of mass spectrometry (L2) • identify optimum method of ionization for given analyte (L3) • calculate molecular mass and empirical formula from mass spectral data (L3) • utilize mass spectral databases for spectral fingerprinting (L3) • determine peptide sequence from electrospray ionization mass spectrometric data (L5).

Unit- IV	**6 hrs**

NMR spectroscopy:

Principles of Fourier Transform NMR spectroscopy. Chemical shift, coupling constants and peak areas. Structure determination of small organic compounds using NMR spectroscopic data. NMR spectral fingerprinting. Principles of multidimensional NMR spectroscopy. Application of solution NMR spectroscopy for protein structure determination. MRI.

Learning Outcomes:

	After completing this unit, the student will be able to • summarize the principles of FT NMR spectroscopy (L2) • apply NMR spectroscopic data for structure determination of small organic molecules (L3) • list multidimensional NMR spectroscopic methods for biomolecular structure determination (L1)

Unit- V	**6 hrs**

Introduction to high throughput and mini/microscale analytical devices in biotechnology.

Biosensors. Microarray fabrication. Detectors for microarrays. Data analysis tools for microarrays.

Fabrication of Micro Electro Mechanical systems. Principles and components of Microfluidic systems. Lab-on-a-chip devices. Point of care devices for diagnostic applications.

Learning Outcomes:

	After completing this unit, the student will be able to apply • microarray data analysis tools (L3) design protocols for • fabrication of MEMs (L6) • explain the power of high throughput workflow in biotechnology (L2)
Text Books:	
	1. Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce. Spectrometric Identification of Organic Compounds. Wiley. 2014 2. Andreas Manz, Petra S Dittrich, Nicole Pamme, Dimitri Iossifidis. Bioanalytical Chemistry: Second Edition. World Scientific. 2015
References:	
	1. David A. Wells. High Throughput Bioanalytical Sample Preparation: Methods and Automation Strategies. 2nd ed. Elsevier, 2020. 2. Xiujun James Li, Yu Zhou. Microfluidic Devices for Biomedical Applications. Woodhead Publishing. Elsevier, 2013. 3. Jaime Castillo-León, Winnie E. Svendsen. Lab-on-a-Chip Devices and Micro-Total Analysis Systems: A Practical Guide. Springer, 2014.
Course Outcomes:	
	After the completion of the course the student should be able to • compare methods for determination of mass and particle size (L2) • determine the sequence of proteins from mass spectrometry data (L5) • analyze data from NMR spectroscopy (L4) • select optimum instrumental method for monitoring quality of biotechnology products (L3) • list the applications of high-throughput and miniaturized devices in biotechnology (L1)

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	3	1
CO2	3	3	3	3						3	3	2	3	3	1
CO3	3	3	3	3						3	3	2	3	3	1
CO4	3	3	3	3						3	3	3	3	3	1
CO5	3	3	3	3						3	3	3	3	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT204: BIOCHEMICAL THERMODYNAMICS

L	T	P	C
3	0	0	3

Thermodynamics is useful to understand the factors that affect the stability of a system at equilibrium. This course explains the fundamental laws of thermodynamics and introduces the concepts necessary to predict the feasibility of a process. These concepts are applied to explain conformational equilibria of biomolecules and energy storage & utilization in biological systems.

Course Objectives:

- Explain thermodynamic properties and laws
- Estimate free energies of various biochemical reactions
- Derive fundamental property relations using state variables
- Explain phase equilibrium and chemical reaction equilibrium
- Apply laws of thermodynamics to biological systems

Unit- I **8 hrs**

Zeroth law of thermodynamics, The first law of thermodynamics and other basic concepts: Joule's experiments, internal energy, the first law of thermodynamics, energy balance for closed systems, thermodynamic state and state functions, equilibrium, the phase rule, the reversible process, constant volume and constant pressure processes, enthalpy, heat capacity.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the importance of thermodynamics in biotechnology. (L1)
- determine the energy requirement of a process (L3)
- explain thermodynamic properties and thermodynamic laws (L1)

Unit- II **8 hrs**

The second law of thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, entropy, entropy changes of an ideal gas, mathematical statement of the second law. The third law of thermodynamics.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the importance of thermodynamic temperature scales. (L1)
- understand entropy and its changes. (L1)
- estimate the entropy change associated with a process (L3)

Unit- III **8 hrs**

Thermodynamic properties: PVT behavior of pure substances, thermodynamic property relations for homogeneous phases. Solution thermodynamics: fundamental property relation, chemical potential and phase equilibria, fugacity and fugacity coefficient.

Learning Outcomes:	
	After completing this unit, the student will be able to • understand various ways of presenting thermodynamics data. (L1) determine the • thermodynamic properties from available data. (L3) relate thermodynamic • properties from other properties. (L2) understand the concepts of fugacity. (L1) • understand phase equilibria. (L1)
Unit- IV	**8 hrs.**
Chemical reaction equilibria: The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs energy change and the equilibrium constant, effect of temperature on the equilibrium constant, relation of equilibrium constants to composition, equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems.	
Learning Outcomes:	
	After completing this unit, the student will be able to explain Chemical • reaction equilibria. (L1) understand the importance of Gibbs • energy. (L1) • determine the effect of physical parameters on chemical reactions. (L3)
Unit- V	**8 hrs.**
Biochemical applications of thermodynamics: Factors affecting stability of double stranded DNA, statistical thermodynamics of monomer-dimer equilibrium for DNA. The helix-coil transition in polypeptides, ligand-receptor binding equilibria. ATP-ADP energy storage and utilization.	
Learning Outcomes:	
	After completing this unit, the student will be able to • explain importance of thermodynamics in biology. (L1) • understand the reasons for stability of DNA. (L1) interpret ligand • receptor binding equilibrium data. (L2)
Course Outcomes: Text Books:	
	1. JM. Smith, HC Van Ness, MM Abbott, Chemical Engineering Thermodynamics, 6/e, Tata McGra-Hill Edition, 2008. 2. I Tinoco, K Sauer, J C Wang, J D Puglisi, G. Harbison and D Rovnyak, Physical Chemistry: Principles and Applications in Biological Sciences, Pearson, 2013.
References:	
	1. S.I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 5/e, Wiley, 2017. 2. K. Dill and S Bromberg, Molecular driving forces: statistical thermodynamics in biology, chemistry, physics and nanoscience, 2/e Garland science, 2012 3. J.M. Smith, H.C. van Ness, and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6/e, McGraw-Hill, 2003

Course Outcomes:	
	1. Capable of comprehending fundamental thermodynamic concepts and applying the rules of thermodynamics to assess energy exchanges in a variety of systems and processes. 2. Able to apply Second and Third Law of Thermodynamics concepts in analyzing the thermal efficiencies of heat engines and other processes. 3. Able to find the thermodynamic properties data from various thermodynamic charts, diagrams and relations and able to determine changes in thermodynamic properties in ideal and non-ideal solutions used in biochemical applications. 4. Able to determine the feasibility of reactions, heat of reaction, optimum conditions and equilibrium composition for various reactions. Able to apply phase equilibrium concepts in various biochemical engineering contexts. 5. Able to apply thermodynamic concepts in bioprocess applications.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	3	1	1		1	3	3	1	2
CO2	3	3	3	3	3	2	2	1	1	1	1	2	3	3	3
CO3	3	3	2	3		1		1	1		1	1	3	1	1
CO4	3	3	2	3	2	1		2	1			1	3	2	1
CO5	3	3	2	3	2	1	2	1	2	1	1	3	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT292: COMPREHENSIVE SKILL DEVELOPMENT III

L T P A C
0 0 0 6 1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Course Outcomes:

- On completion of the course, student will be able to– Effectively communicate through verbal/oral communication and improve the listening skills
- Write precise briefs or reports and technical documents, actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self motivation and practicing creative thinking.
- Student will be able to understand the problems and develop his competitive coding skills.
- Apply the skills in various domains and will be able to solve complex problems faced by the industry.
- Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality

Part-1 **- 3 Hours per week**

A. Verbal and Soft Skills:

Vocabulary Builder, Reading Comprehension, Fill-in-the-Blanks, General Usage

Unit	Module/ Topics	Hrs
1.	Vocabulary Builder	4
2.	Reading Comprehension	4
3.	Paragraph Jumbles	3
4.	General Usage	4
	Total	**15**

B. Quantitative Aptitude and Reasoning

Puzzles, Arithmetic, Geometry, Mensuration.

Unit	Module/ Topics	Hrs
1.	Numbers	3
2.	Arithmetic	6
3.	Data Interpretation	3

4.	Puzzles	3
	Total	15

Unit	Module/ Topics	Hrs
1.	Numerical Computation and Estimation-2. [i. Time and Work, ii. Pipes and Cisterns, iii. Time and Distance, iv. Problems on trains, Boats and Streams, v. Races and Games of skill, vi. SI & CI]	6
2.	Geometry [i. Lines and Angles ii. Triangles iii. Quadrilaterals & Polygons iv. Circles]	4
3.	Mensuration [i. 2-Dimensional Mensuration (Triangles, Quadrilaterals and Circles), ii. 3-Dimentional Mensuration (Cubes, Cuboids, Cylinder, Cone, Sphere)]	3
4.	Data Sufficiency on Quantitative Reasoning	2
	Total	15

Part-2 **- 3 Hours per week**

Coding: -Medium Level problem solving techniques:
Permutations and Combination, Probability, Hash Tables, Heap, Greedy Method, Backtracking

Scheme of Evaluation

Internal Assessments by Assignments, Quizzes (multiple Choice questions). All the Students are expected to do at least 5 problems in each topic and they should submit the content written by them in each topic for final evaluation.

Type of Assessment	No.of Marks
At least 5 problems in each topic	15
Assignments	15
Content writing	10
Quizzes	10
Total	**50**

Late Work

Each homework is due in the beginning of the class meeting (that is, at 6:00pm) on the due date. If homework is submitted within seven days after this deadline, the grade will be reduced by 50%. Submission more than seven days after the deadline will not be accepted. If you have a serious reason for requesting an extension, such as illness or family emergency, you should discuss it with one of the instructors as soon as the problem arises, and definitely before the submission deadline.

References: -

The course does *not* have a required textbook. You may optionally use the following textbook and URLs to look up standard algorithms:

1. Data Structures and Algorithms made easy by Narasimha Karumanchi
2. Data Structure and Algorithmic Thinking with Python by Narasimha Karumanchi
3. Algorithm Design Techniques: Recursion, Backtracking, Greedy, Divide and Conquer and Dynamic Programming by Narasimha Karumanchi
4. Coding Interview Questions by Narasimha Karumanchi
5. Competitive Programming in Python- 128 Algorithms to develop your Coding Skills by Cristhop Durr & Jill-Jen Vie.
6. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests (Undergraduate Topics in Computer Science) *by* Antti Laaksonen
7. https://www.geeksforgeeks.org/competitive-programming-a-complete-guide/

8. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
9. https://codeforces.com/
10. https://leetcode.com/

Course Outcomes:

1. Effectively communicate through verbal/oral communication and improve the listening skills.

2. Write precise briefs or reports and technical documents, actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self motivation and practicing creative thinking.

3. Understand the problems and develop his competitive coding skills.

4. Apply the skills in various domains and will be able to solve complex problems faced by the industry.

5. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO2	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO3	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO4	2	2	2	1	2	2	2		1	1	1	1	2	2	2
CO5	2	2	1	1	2	2	1		1	1	3	1	1	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT331: BIOPROCESS ENGINEERING

L	T	P	C
3	0	2	4

Industrial scale production of bioproducts involves optimization of media, operational conditions, selection of bioreactor type and method for control of operational parameters at the optimum values. Models of microbial growth are utilized to estimate the time requirements and process efficiency. This course describes the methods for optimization of media, aeration rate, process parameters and bioreactor type.

Course Objectives:

- Identify differences between chemical processes and bioprocesses
- Explain principles of media design and optimization
- Explain principles of microbial growth kinetics
- Describe selection and operation of bioreactors
- Describe fermenter design

Unit- I **8 hrs**

Definition and scope of bioprocess engineering. Bioprocess verses chemical processing: advantages and disadvantages. Substrates for bioconversions. Choice of microbes. Media design and optimization.

Learning Outcomes:

At the end of this unit, the student will be able to

- Define bioprocess engineering (L2)
- Compare chemical processes and bioprocesses (L3)
- Explain principles of media design and optimization (L2)

Unit- II **8 hrs**

Aeration and agitation in bioreactors: Oxygen transfer in microbial systems, oxygen demand mass transfer theories, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth. Measurement of volumetric mass transfer coefficient, power requirement in gassed and unpassed bioreactors, mixing and heat transfer in dispersed systems, biorheology.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain role of aeration and agitation in bioreactors (L2)
- Relate oxygen consumption to heat evolution in aerobic cultures (L3)
- Calculate power requirement of bioreactors (L5)

Unit- III **8 hrs**

Kinetics for batch growth- unstructured non-segregated models, models for transient behavior in batch reactor. Batch and continuous bioreactors, growth in ideal chemostat, chemostat with recycle, multistage chemostat, fed-batch growth. Immobilized cell systems.

Learning Outcomes:		
	After completing this unit, the student will be able to • Explain kinetics of batch growth (L2) • Model bioreactors (L5) • Describe principles and applications of immobilized cell systems (L1)	
Unit- IV		**8 hrs.**
Selection and operation of bioreactors. Bioreactor instrumentation and control, Scale-up of bioreactors: Introduction, criteria of scale-up, similarity criteria, scale-up methods		
Learning Outcomes:		
	After completing this unit, the student will be able to • Select bioreactors (L3) • Describe instrumentation for bioreactor operation and control (L1) • Utilize scale up methods (L3)	
Unit- V		**8 hrs.**
Design of a fermenter: Basic functions of a fermenter for microbial or animal cell culture. Aseptic operation and containment, body construction: construction material, temperature control, aeration and agitation, foam control system, factors affecting antifoam requirements, antifoam addition system. Regulatory constraints		
Learning Outcomes:		
	After completing this unit, the student will be able to • Explain requirements for design of a fermenter (L2) • Explain choice of materials for fermenters (L2) • Explain control of operating conditions in a fermenter (L2) • Describe regulatory constraints (L1)	
Text Books:		
	M. L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, 2/e, Prentice Hall, 2002	
References:		
	1. Pauline M Doran, Bioprocess Engineering Principles, Elsevier, 2005. 2. P.F.A. Stanbury, A. Whitaker, S.J. Hall, Principles of Fermentation Technology,	

BIOPROCESS ENGINEERING LABORATORY

At least 10 of the following experiments are required:

1. Insite sterilization and sterile operation of large reactors

At the end of this experiment the student will be able to: know sterilization types and its operations.

2. Substrate processing- Pretreatment

At the end of this experiment the student will be able to: know different pretreatment methods and pretreat the different lignocellulosic biomass.

3. Media optimization by a) Plackett and Burman method b) Response surface methodology for media design.

At the end of this experiment the student will be able to: understand different design of experiments to optimize the media.

4. Microbial growth and product formation kinetics

At the end of this experiment the student will be able to: know Growth rate data fitting of microorganism using logistic equation

5. Measurement of Volumetric Oxygen transfer coefficient (KLa) by: a) Sodium sulphite method b) Dynamic gassing method

At the end of this experiment the student will be able to: estimate Volumetric Oxygen transfer coefficient (KLa)

6. Batch, Fed batch and continuous bioreactors for Biotech products

At the end of this experiment the student will be able to: understand difference between Batch, Fed batch and continuous bioreactors for Biotech products.

7. Residence time distribution in CSTR

At the end of this experiment the student will be able to: estimate Residence time distribution in CSTR

8. Solid state fermentation

At the end of this experiment the student will be able to: understand specificity of SSF and its process.

9. Production of citric acid by solid state fermentation

At the end of this experiment the student will be able to: estimate amount of citric acid produced by SSF

10. Production and recovery of Penicillin

At the end of this experiment the student will be able to: know production, recovery and estimate amount of Penicillin produced by SmF

11. Production and recovery of Vitamin B_{12}

At the end of this experiment the student will be able to: know production, recovery and estimate amount of Vitamin B_{12} produced by SSF

12. Optimization of parameters for Amylase production

At the end of this experiment the student will be able to: know production, recovery and estimate Amylase activity by SmF

13. Bulk production of tailored organisms

At the end of this experiment the student will be able to: know bulk production of tailored organisms

Text Book(s):

1. N.S. Wang, Biochemical Engineering Lab Manual, 2009.

Course Outcomes:

1. Understand the definition, scope, and differences between bioprocess and chemical processing.
2. Analyze the principles of aeration, agitation, oxygen transfer, and heat evolution in bioreactors, including their impact on microbial system performance.
3. Understand the kinetics of microbial growth in batch and continuous systems, and analyze the operational principles of chemostats, fed-batch systems, and immobilized cell systems.
4. Select and operate bioreactors and understand the methods and criteria for scaling up bioreactor processes.
5. Understand the basic functions, construction, and regulatory constraints of fermenters for microbial or animal cell culture, including aseptic operations and foam control systems.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			1									2		
CO2		2			2	1							1	2	
CO3			3		1	2								1	1
CO4				3		1	2	2							2
CO5		1		2	3				2	1	2	1	3	1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT333: BIOCHEMICAL REACTION ENGINEERING

L	T	P	C
3	0	2	4

All biochemical reactions occur at finite rates. Estimation of the time required for a process to yield the required amount of product is essential for design of any process. Product yield is a function of the reaction conditions as well as the type of reactor. Models of ideal reactors provide quantitative information regarding yield and process efficiency. This course is an introduction to the models of reactors.

Course Objectives:

- Describe kinetics of homogeneous and heterogeneous reactions
- Explore the design of batch reactors and homogeneous flow reactors
- Introduce the techniques used for designing non isothermal reactors**.**
- Introduce different models to interpret non ideal flow in reactors

Unit- I **8 hrs.**

Kinetics: Kinetics of homogeneous reactions, elementary and non- elementary reactions; collision theory and transition state theory, Arrhenius' relation, Monod kinetics. Kinetics of heterogeneous reactions: immobilized enzyme kinetics, effects of mass transfer on immobilized enzyme kinetics.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain kinetics of homogeneous and heterogeneous reactions (L_2)
- Analyze the temperature dependency of the rate equation (L_2)
- Analyze effect of mass transfer on enzyme kinetics. (L_2)

Unit- II **8 hrs.**

Introduction to types of reactors and bioreactors, analysis of batch reactor data, isothermal batch reactor design, batch reactor design for autocatalytic reactions, Design of fermenter, Design of enzyme reactor

Learning Outcomes:

At the end of this unit, the student will be able to

- Demonstrate design of an ideal batch reactor. (L2)
- Interpret batch reactor data (L_2)
- Explain design of a fermenter (L2)

Unit- III **8 hrs.**

Homogeneous flow reactors: Design equation for plug flow reactor (PFR) and continuous stirred tank reactor (CSTR), design of PFR and CSTR for single reactions. Cascade of CSTRs and combination of PFR and CSTR Design for autocatalytic reactions, Stirred tank fermenter, multiple fermenters connected in series

Learning Outcomes:

	After completing this unit, the student will be able to • Demonstrate design of an ideal flow reactor (L2) • Identify best system for a given conversion. (L3) • Selection of best arrangement of a set of ideal reactors (L_3) • Compare single and multiple ideal reactor systems (L_5)

Unit- IV	**8 hrs.**

Non-isothermal design: Energy balance equations for batch, PFR and CSTR under non- isothermal conditions. Equilibrium conversion under adiabatic conditions. Design of the homogeneous reactors under adiabatic conditions. Sterilization kinetics, Batch & Continuous sterilization

Learning Outcomes:

	After completing this unit, the student will be able to • design reactors for non-isothermal conditions (L6) • relate temperature and conversion or reaction rate for reactors (L_2) • design reactors on basis of energy balance (L6) • explain sterilization techniques (L_2)

Unit- V	**8 hrs.**

Non-ideal flow: Residence time distribution curves E, F and C; interpretation of the response data for the dispersion and tanks -in-series models (omit multi parameter models).

Learning Outcomes:

	After completing this unit, the student will be able to • apply the tracer concentration time data (L3) • calculate distribution functions, mean residence time, and variance (L3) • quantify non-ideal flow from experimental data (L_3)

Course Outcomes:

	After the completion of the course the student should be able to • design of batch reactor using rate law and its parameters (L6) • design of flow reactors and fermenters (L_6) • select reactor and conditions to minimize unwanted products (L_3) • design of reactors on the basis of energy balance. (L_6) • identify problems in real reactors (L_3)

Text Books:

	1. Octave Levenspiel, Chemical Reaction Engineering, 3/e, John Wiley, 2010. 2. J.M. Smith, Chemical Engineering Kinetics, 3/e, McGraw Hill, 1981.

References:

	J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Permagon Press, 1999. 2. G.G. Brown, Unit Operations, CBS Publishers, 2005.

BIOCHEMICAL REACTION ENGINEERING LAB

This laboratory course will reinforce the students' understanding of basic concepts pertaining to analyze kinetics for complex reactions using differential and integral methods. Batch reactor will be employed to analyze rate kinetics for isothermal and exothermic reactions. The tracer dynamics in reactors will be studied using Residence Time Distribution. The analysis will include various experiments with the objective of sample preparation, measurement of concentration, prediction of kinetics and modeling of kinetics data.

List of Experiments:

1. Determination of the order of a reaction using a batch reactor and analyzing the data by a) differential method and b) integral method.
[After completing this experiment, the student will be able to analyze data to determine the rate law and rate law parameters using graphical and numerical techniques]
2. Determination of the activation energy of a reaction using a batch reactor.
[After completing this experiment, the student will be able to Analyze the temperature dependency of the rate equation.]
3. To determine the specific reaction rate constant of a reaction of known order using a batch reactor
[After completing this experiment, the student will be able to analyze data to determine the rate law and rate law parameters using graphical and numerical techniques]
4. To determine the order of the reaction and the rate constant using a tubular reactor.
[After completing this experiment, the student will be able to analyze data of plug flow reactor to determine the rate law and rate law parameters using graphical and numerical techniques]
5. To determine the order of the reaction and the rate constant using a CSTR
[After completing this experiment, the student will be able to analyze data of CSTR to determine the rate law and rate law parameters using graphical and numerical techniques]
6. Determination of RTD and dispersion number in a tubular reactor using a tracer.
[After completing this experiment, the student will be able to apply the tracer concentration time data of plug flow reactor to calculate the external age distribution function., the cumulative distribution function, the mean residence time, and the variance]
7. Axial mixing in a packed bed. Determination of RTD and the dispersion number for a packed-bed using tracer.

	[After completing this experiment, the student will be able to apply the tracer concentration time data of packed bed to calculate the external age distribution function., the cumulative distribution function, the mean residence time, and the variance] 8. Determination of RTD and dispersion number in CSTR [After completing this experiment, the student will be able to apply the tracer concentration time data of CSTR to calculate the external age distribution function., the cumulative distribution function, the mean residence time, and the variance] 9. Performance of reactors in series: i. plug-flow reactor followed by a CSTR ii. CSTR followed by Plug flow reactor [After completing this experiment the student will be able to differentiate best arrangement of a set of ideal reactors] 10. Determination of RTD and dispersion number for CSTRs in series [After completing this experiment, the student will be able to apply the tracer concentration time data of CSTRs in series to calculate the external age distribution function., the cumulative distribution function, the mean residence time, and the variance]
Text Books	
	1. . Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 1998 3 rd Edition 2. Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 2006, 4th Edition Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 1981, 3 rd Edition
Course Outcomes	
	1. Able to understand the different types of chemical and biochemical reactions, and their kinetics and influence of various parameters on chemical and biochemical process kinetics. 2. Able to understand principles involved in various reactors and choose suitable reactor for various biochemical reactions. Able to analyze reaction data and use it in the design of ideal batch reactor, fermenter, etc. 3. Able to determine design equations for various ideal flow reactors and analyze their performance in single and combined reactors. 4. Able to understand the kinetics in batch and continuous sterilization processes. 5. Able to identify problems involved during operation of real reactors.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1		1				1	1	3	2
CO2	3	3	3	1	1	2	3	1					2	3	2
CO3	3	3	3	1	1	2	2						2	3	2
CO4	3	3	3	1	2	1		2	1			1	2	3	2
CO5	3	3	3	3	1	1	2		2	1			1	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT335: IMMUNOTECHNOLOGY

L	T	P	C
3	0	2	4

The immune system is designed to prevent foreign organisms from causing harm to the body. Immune technology utilizes the components of the immune system for therapeutic and analytical applications. This course describes the components of the immune system, the mechanisms of immune response and application of this knowledge for selection of transplants and for the production of vaccines.

Course Objectives:

- Introduce the concepts of immunology
- Describe the structure and functions of immunoglobulins and complement proteins
- Introduce various immunological techniques
- Introduce hypersensitivity reactions and transplantation immunology.
- Describe models of immune deficiency

Unit- I **8 hrs**

History of immunology; Types of immunity: Innate and adaptive. Cells of the immune system, T and B lymphocytes Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors. Macrophages phagocytosis, Primary and secondary lymphoid organs: Structure and function. Antigens, immunogen, Hapten, Adjuvant, Epitope. Super antigens. Major Histocompatibility Complex, Human Leukocyte antigens (HLA), Antigen presenting cells, Processing and presentation of antigens. Necrosis & Apoptosis.

Learning Outcomes:

At the end of this unit, the student will be able to

- Recall the history of immunology (L1)
- Summarize the basis of immune cell production. (L2)
- Distinguish structure and function of primary and secondary lymphoid organs. (L4)
- Explain the biological functions of antigens. (L2)
- Describe processing of antigens and mechanism of cell death. (L1)

Unit- II **8 hrs**

Structure of immunoglobulin, Immunoglobulin classes and biological activities. Isotypes, Allotypes, Idiotypes. Immunoglobulin genes and antibody diversity, Class switching, Humoral and cell-mediated immune responses, Cytokines-Interleukins, Interferons, TNF. The Complement, pathways and consequences of complement activation. Tumor immunology: Definition, tumor antigens, immune response to cancer.

Learning Outcomes:

At the end of this unit, the student will be able to

- Outline the importance of immunoglobulins (L2)
- Explain the relationship between the cell and humoral immunity. (L2)
- Interpret the relationship of immunoglobulin genes and antibody diversity. (L2)

	• Summarize the functions of cytokines. (L2) • Explain the biological consequences of complement proteins. (L2)
Unit- III	**8 hrs.**
Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions – Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reactions- Hemagglutination and complement fixation, Immunofluorescence, RIA, ELISA, Immunoblotting, Flow Cytometry and Fluorescence, Hybridoma technology - Production of monoclonal antibodies and their applications. Catalytic antibodies.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Apply immunological techniques to diagnose various diseases. (L3) • Explain the principles of Ag-Ab interactions. (L2) • Describe the production of monoclonal antibodies (L1).
Unit- IV	**8 hrs**
	Hypersensitivity: Immediate (type I, type II, type III) and delayed hypersensitivity reactions, Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases. Transplantation Immunology- auto, allow, iso and xenograft, Bone marrow and Kidney transplants, Graft rejection (Graft versus host rejection and host versus graft rejection mechanisms), Co stimulatory pathways, Immune suppressive agents. Immunodeficiencies - SCID and AIDS.
Learning Outcomes:	
	After completing this unit, the student will be able to • List the hypersensitivity reactions and auto immune diseases and their types. (L1) • understand the basics of transplantation immunology. (L2) • understand the kidney and bone marrow transplantation. (L2) • Describe immunosuppressive drugs and immunodeficiency disorders (L1)
Unit- V	**8 hrs**
	Vaccines: Types of vaccines, Development, Production of peptide and DNA vaccines, Knockout mice, Transgenic mice as models of immune system diseases-Nude mice and SCID mice.
Learning Outcomes:	
	After completing this unit, the student will be able to • outline the principles of vaccine development. (L2) • explain the potential of transgenic mice (L2) • analyses the models for SCID (L4)
Text Books:	
	1. Thomas J. Kindt, Barbara, A. Osborne, Richard A. Goldsby, Kuby Immunology, 8th Edition, W.H Freeman, 2018. 2. P.M. Lydyard, A. Whelan & M.W Fanger, Instant notes in Immunology, 1st Edition, Viva publishers, 2008.

References:	
	1. William E. Paul, Fundamentals of Immunology, 7th Edition, Lippincott and Wilkins, 2012. 2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roit, Roitt's Essential Immunology, 12th edition, Wiley Black well, 2011.

IMMUNOTECHNOLOGY LAB

The establishment of immunology lab will enable the student to gain a broad foundation base and build upon that base for understanding the defense mechanisms of the human body and advanced techniques in diagnosis of diseases. The lab will support the advanced courses for the student of graduate school or post graduates or entering medical school or research scholars or for any student actively involved in the medical healing arts.

List Of Experiments:

1. Differential count of White blood cells by hemocytometer
   After completion of this experiment, the student will be able to use hemocytometer and will differentiate different white blood cells based on shape of nucleus
2. Estimation of hemoglobin by Sahli's method
   After completion of this experiment, the student will be able to determine the hemoglobin content and interpret the normal and anemic conditions
3. Widal test for identification of Salmonella Typhi
   After completion of this experiment, the student will be able to understand the antigen and antibody specificity
4. Identification of blood group antigens
   After completion of this experiment, the student will be able to identify blood group antigens
5. Agglutination inhibition test to detect pregnancy
   After completion of this experiment, the student will be able to understand the agglutination inhibition test
6. Antigen/ antibody detection by Enzyme linked immune sorbent assay
   After completion of this experiment, the student will be able to detect Ag/ Ab by Enzyme linked immune assay
7. Detection of antigen / antibody by Immune Diffusion test
   After completion of this experiment, the student will be able to detect Ag/ Ab by immune diffusion method
8. Immunoelectrophoresis After completion of this experiment, the student will be able to learn Ag/ Ab.
9. Differential count of White blood cells by hemocytometer
   After completion of this experiment, the student will be able to use hemocytometer and will differentiate different white blood cells based on shape of nucleus
10. Estimation of hemoglobin by Sahli's method
    After completion of this experiment, the student will be able to determine the hemoglobin content and interpret the normal and anemic conditions
11. Widal test for identification of Salmonella Typhi
    After completion of this experiment, the student will be able to understand the antigen and antibody specificity
12. Identification of blood group antigens
    After completion of this experiment, the student will be able to identify blood group

antigens

13. Agglutination inhibition test to detect pregnancy
    After completion of this experiment, the student will be able to understand the agglutination inhibition test
14. Antigen/ antibody detection by Enzyme linked immune sorbent assay
    After completion of this experiment, the student will be able to detect Ag/ Ab by Enzyme linked immune assay
15. Detection of antigen / antibody by Immune Diffusion test
    After completion of this experiment, the student will be able to detect Ag/ Ab by immune diffusion method
16. Immunoelectrophoresis
17. After completion of this experiment, the student will be able to learn Ag/ Ab.
18. Differential count of White blood cells by hemocytometer
    After completion of this experiment, the student will be able to use hemocytometer and will differentiate different white blood cells based on shape of nucleus
19. Estimation of hemoglobin by Sahli's method
    After completion of this experiment, the student will be able to determine the hemoglobin content and interpret the normal and anemic conditions
20. Widal test for identification of Salmonella Typhi
    After completion of this experiment, the student will be able to understand the antigen and antibody specificity
21. Identification of blood group antigens
    After completion of this experiment, the student will be able to identify blood group antigens
22. Agglutination inhibition test to detect pregnancy
    After completion of this experiment, the student will be able to understand the agglutination inhibition test
23. Antigen/ antibody detection by Enzyme linked immune sorbent assay
    After completion of this experiment, the student will be able to detect Ag/ Ab by Enzyme linked immune assay
24. Detection of antigen / antibody by Immune Diffusion test
    After completion of this experiment, the student will be able to detect Ag/ Ab by immune diffusion method
25. Immuno-electrophoresis After completion of this experiment, the student will be able to learn Ag/ Ab.

References:

1. Practical Immunology A Laboratory Manual, Karthik Kaliaperumal and Senbagam Duraisamy Senthilkumar Balakrishnan, Lambert publishers Academic publishers 2017
2. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
3. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
4. . Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
   Richard C and Geiffrey S. (2009). Immunology.6th edition.Wiley Blackwell Publication.

Course Outcomes:	
	1. Explain the basics of immune system. 2. Understand the antibody structure, types, Complement pathways and cytokines. 3. Apply Ag-Ab specificities in various immunological techniques and monoclonal antibodies production. 4. Explain hypersensitivity, auto immunity, Immune deficiency diseases and Transplantation. 5. Apply principles for Vaccine production, transgenic and knockout mice model systems.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	3	1		3	1			3	2	2	3
CO2	3	1	3	1	3	1		3	1			3	2	2	3
CO3	3	1	3	2	3	1	1	3	1			3	2	2	3
CO4	3	1	3	3	3	2	1	3	1			3	2	2	3
CO5	3	1	3	3	3	2	3	3	1			3	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EID132: DESIGN THINKING
(Common to all)

L	T	P	C
2	0	2	3

Design is a realization of a concept or idea into a configuration, drawing or a product. Design Thinking is cognitive and practical processes by which design concepts are developed by designers. Innovation is a new idea or a new concept. Product development is the creation of a new or different product that offers new benefits to the end user. This course introduces the design thinking in product innovation.

Course Objectives:

- To familiarize product design process
- To introduce the basics of design thinking
- To bring awareness on idea generation
- To familiarize the role of design thinking in services design

UNIT I **8 L**

Introduction to design, characteristics of successful product development, product development process, identification of opportunities, product planning, Innovation in product development.

Learning Outcomes:

After completing this unit, the student will be able to

- identify characteristics of successful product development(L3)
- identify opportunities for new product development(L3)
- plan for new product development(L3)

UNIT II **8 L**

Design Thinking: Introduction, Principles, the process, Innovation in Design Thinking, benefits of Design thinking, design thinking and innovation, case studies.

Learning Outcomes:

After completing this unit, the student will be able to

- explain the principles of Design Thinking(L2)
- identify the benefits of Design Thinking(L3)use
- innovations in Design Thinking(L3)

UNIT III **10 L**

Idea generation: Introduction, techniques, Conventional methods, Intuitive methods, Brainstorming, Gallery method, Delphi method, Synectic's etc Select ideas from ideation methods, case studies.

Learning Outcomes:
After completing this unit, the student will be able to

- explain the techniques in idea generation(L2)
- select ideas from ideation methods(L3)
- identify the methods used in idea generation in some case studies(L3)

UNIT IV **10 L**

Design Thinking in Information Technology, Design Thinking in Business process model, Design Thinking for agile software development, virtual collaboration, multi user and multi account interaction, need for communication, TILES toolkit, Cloud implementation.

Learning Outcomes:

After completing this unit, the student will be able to

- use Design Thinking in business process model(L3)
- apply Design Thinking for Agile software development(L3)
- use TILES toolkit(L3)

UNIT V **8 L**

Design thinking for service design: How to design a service, Principles of service design, Benefits of service design, Service blueprint, Design strategy, organization, principles for information design, principles of technology for service design.

Learning Outcomes:

After completing this unit, the student will be able to

- use principles of service design(L3)
- explain the benefits of service design(L5)
- apply principles of technology for service design(L3)

Text Book(s):

Pahl, Beitz, Feldhusen, Grote – Engineering Design: a systematic approach, Springer, 2007
1. Christoph Meinel and Larry Leifer, Design Thinking, Springer, 2011
2. Aders Riise Maehlum - Extending the TILES Toolkit – from Ideation to Prototyping
3. http://www.algarytm.comA/it-executives-guide-to-design-thinking:e-book.
4. Marc stickdorn and Jacob Schneider, This is Service Design Thinking, Wiely, 2011

Course Outcomes:
At the end of this course, the student will be able to
1. innovate new methods in product development(L6)
2. apply Design Thinking in developing the new designs(L3)
3. select ideas from ideation methods in new product development(L5)

4. use Design Thinking in developing software products(L3)
5. apply principles of Design Thinking in service design(L3)

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1	2	1	1	1	2	2	1	1	1	1	3	1	1
CO2	3	1	3	3	2	2	3	2	2	1	1	1	3	2	1
CO3	3	1	1	2	3	1	3	2	1	1	2	1	3	3	1
CO4	3	2	2	3	3	1	3	2	1	1	1	1	3	3	2
CO5	3	3	3	3	3	2	3	1	2	1	2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EHS302: ENGINEERING ECONOMICS AND MANAGEMENT

L	T	P	C
3	0	0	3

The manager of a biotechnology organization requires an understanding of the principles of business organization, and the ability to assess the profitability of a biotechnology venture. The economic cost for a bioprocess can be estimated for prediction of the profitability of production. This course describes the principles of business organization and the systematic procedures for estimating bioprocess costs.

Unit- I	**8 hrs.**

Economics: Utility, value, wealth, consumption, wants necessaries, comforts and luxuries.
Demand: Law of demand, elasticity of demand, price elasticity of demand, factors affecting elasticity of demand, simple problems.

Unit- II	**8 hrs.**

Costing: Cost concepts, elements of cost, methods of distribution of overhead costs, unit costing, job costing and process costing; Simple problems.
Accounts: Preparation of profit and loss account and balance sheet (outlines only).

Unit- III	**8 hrs.**

Break-Even Analysis: Assumptions, break-even charts, simple problems.
Depreciation: Depreciation methods - Simple problems.

Unit- IV	**8 hrs.**

Forms of Business Organization: Single trader, partnership and public limited company.

Principles of Organization: Types of organization; Span of management; Authority, delegation and decentralization, source of formal authority, difference between authority and power, line and staff authority, simple case studies.

Unit- V	**8 hrs.**

Principles of Management: Importance of management, definition of management, management process, roles of a manager; Management, a science or art - Management, a profession; Functions of management.
Leadership: Difference between a leader and a manager, characteristics of leadership, functions of a leader, simple case studies.

Text Books:

1. Tara Chand, Engineering Economics, Vol - 1, 13/e, Nem Chand & Bros, 2012
2. O.P Khanna, Industrial Engineering and Management, 14/e, Dhanpati Rai Publications, 2011.

References:

1. Maheswari, Engineering and Managerial Economics, 19/e, Sultan Chand & Co, 2009

2. Shukla, Grewal, Cost Accounting, 12/e, S.Chand & Company, 2007

3. L.M.Prasad, Principles and Practice of Management, 8/e, Sultan Chand & Sons, 2012

Course Outcomes:

1. Obtain the basic terminology, laws of demand and supply.
2. Evaluate the economic theories and cost concepts.
3. Analyze various accounting concepts and financial management techniques for preparing effective profit and loss statements.
4. Examine and analyze break-even evaluation concepts for identification of minimum production volume for survival and to gain profits.
5. Adapt and build good manager skills by employing the concepts of various skills like good leadership qualities, utilizing motivation capabilities, and incorporating communications skills.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				1							3	2	1		1
CO2				2							3	2	1		1
CO3				3							3	2	1		1
CO4								2	3	3	3	2	1		1
CO5								2	3	3	3	2	1		1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT391: COMPREHENSIVE SKILL DEVELOPMENT IV

L T P A C
0 0 0 6 1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Part-1 **- 3 Hours per week**

A. Verbal and Soft Skills:

Unit	Module/ Topics	Hrs.
1.	Grammar and Error Detection Exercises	6
2.	Structure and Sentence Correction/ Improvement Exercises	6
3.	Error Detection & Sentence Correction –FAQs with Solutions	2
4.	Fill-in-blanks and Cloze Passages	3
	Total	**15**

Unit	Module/ Topics	Hrs.
1.	Arithmetic	9
2.	Geometry	2
3.	Mensuration	2
4.	Puzzles	2
	Total	15

B. Quantitative Aptitude and Reasoning

Unit	Module/ Topics	Hrs.
1.	Combinatorics [i. Permutations & Combinations, ii. Probability]	3
2.	Cryptarithmetic & Modular Arithmetic [i. Cryptarithmetic, ii. Application of base system (7, 24) Clocks (Base 24) Calendars (Base 7)]	3
3.	Mental Ability [i. Number series ii. Letter series & Alpha numeric series iii. Analogies (Numbers, letters) iv. Classifications]	4
4.	Algebra [i. Exponents, ii. Logarithms, iii. Problems related to Equations, iv. Special Equations, v. Statistics]	5
	Total	15

Part-2 **- 3 Hours per week**

Coding: -Medium Level problem solving techniques: Permutations and Combination, Probability, Hash Tables, Heap, Greedy Method, Backtracking.

Scheme of Evaluation

Internal Assessments by Assignments, Quizzes (multiple Choice questions). All the Students are expected to do at least 5 problems in each topic and they should submit the content written by them in each topic for final evaluation.

Type of Assessment	No..of. Marks
At least 5 problems in each topic	15
Assignments	15
Content writing	10
Quizzes	10
Total	**50**

Late Work

Each homework is due in the beginning of the class meeting (that is, at 6:00pm) on the due date. If homework is submitted within seven days after this deadline, the grade will be reduced by 50%. Submission more than seven days after the deadline will not be accepted. If you have a serious reason for requesting an extension, such as illness or family emergency, you should discuss it with one of the instructors as soon as the problem arises, and definitely before the submission deadline.

References: -

The course does *not* have a required textbook. You may optionally use the following textbook and URLs to look up standard algorithms:

1. Data Structures and Algorithms made easy by Narasimha Karumanchi
2. Data Structure and Algorithmic Thinking with Python by Narasimha Karumanchi
3. Algorithm Design Techniques: Recursion, Backtracking, Greedy, Divide and Conquer and Dynamic Programming by Narasimha Karumanchi
4. Coding Interview Questions by Narasimha Karumanchi
5. Competitive Programming in Python- 128 Algorithms to develop your Coding Skills by Cristhop Durr & Jill-Jen Vie. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests (Undergraduate Topics in Computer Science) *by* Antti Laaksonen
6. https://www.geeksforgeeks.org/competitive-programming-a-complete-guide/
7. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
8. https://codeforces.com/
9. https://leetcode.com/

Course Outcomes:

1. Effectively communicate through verbal/oral communication and improve the listening skills.
2. Write precise briefs or reports and technical documents, actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self-motivation and practicing creative thinking.
3. Understand the problems and develop his competitive coding skills.
4. Apply the skills in various domains and will be able to solve complex problems faced by the industry.
5. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO2	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO3	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO4	2	2	2	1	2	2	2		1	1	1	1	2	2	2
CO5	2	2	1	1	2	2	1		1	1	3	1	1	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT332: BIOINFORMATICS

L	T	P	C
3	0	2	4

Modern high throughput methods generate vast amounts of biological data. Bioinformatics enables us to validate, store, retrieve and analyze these data sets. This course introduces the data structures and algorithms that enable us to compare, classify and predict the function of biological sequences.

Course Objectives:

- describe nature and type of information available in biological databases (L1)
- explain the principles of sequence alignment (L2)
- analyze the algorithms for phylogenetic analysis (L3)
- explain the principles of protein structure prediction (L2)
- explain the principles of structural and functional genomics (L2)

Unit- I **8 hrs.**

Introduction to Biological data types and databases. Brief introduction to information available in the following databases (details to be covered in practical's): NCBI-GenBank, PIR, PFAM, PDB, GOLD. Sequence analysis: introduction. Similarity matrices PAM and BLOSUM.

BLAST Tool for searching sequence databases. Description of the BLAST algorithm

Learning Outcomes:

At the end of this unit, the student will be able to

- summarize the advantages of storing information in databases (L2)
- identify the most appropriate database for each type of biological entity (L5)
- calculate similarity of two aligned sequences (L3)
- summarize the principles of the BLAST algorithm (L2)
- describe the applications of BLAST and its variants (L1)

Unit- II **8 hrs.**

Pairwise sequence alignment using dynamic programming. Needleman & Wunsch algorithm for global alignment. Smith-Waterman algorithm for local alignment. Dynamic programming for sequence alignment with affine gap penalties. Searching for repeats and partial overlaps using dynamic programming.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply dynamic programming for pairwise sequence alignment algorithms (L3)
- evaluate the score for optimal global alignment of a pair of sequences (L5)
- evaluate the score for optimal local alignment of a pair of sequences (L5)
- evaluate the score for optimal end overlap alignment of a pair of sequences (L5)
- predict the optimal alignment to find repeats of one sequence in another (L2)

Unit- III **8 hrs.**

Phylogenetic analysis. Distance based methods: UPGMA and Neighbor joining. Classical parsimony and weighted parsimony methods. Branch and bound.
Multiple sequence alignment. Multidimensional dynamic programming. Progressive alignment and profile alignment. Sankoff and Cedergren method for Simultaneous alignment and phylogeny.

Learning Outcomes:

After completing this unit, the student will be able to

- describe the principles and algorithms used for molecular phylogenetic analysis (L1)
- describe the principles and methods of multiple sequence alignments (L1)
- solve problems in phylogenetic analysis (L3)
- compare the distance based and character-based algorithms for phylogenetic analysis (L5)
- compare the available algorithms for multiple sequence analysis (L5)

Unit- IV **8 hrs.**

Prediction of transmembrane helices. Prediction of secondary structure from protein sequence – Chou-Fasman rules, neural networks. Prediction of protein conformation from protein sequence - Information theoretical methods: Homology and threading. Prediction using Force fields (Basic concepts only, regarding Energy minimization, molecular dynamics and simulated annealing). Forces involved in protein-protein, protein-DNA, protein-ligand and DNA-DNA interactions.

Learning Outcomes:

After completing this unit, the student will be able to

- compare the methods for prediction of transmembrane helices and secondary structure (L5)
- describe the principles of neural networks (L1)
- describe the concepts related to force fields (L1)
- describe the principles of molecular mechanics (L1)
- compare the information theoretical and force field-based methods for protein structure prediction (L5)

Unit- V **8 hrs**

Computational problems in genome sequencing (concepts). Graph theoretical formulation of the fragment assembly problem. Hamiltonian path and Eulerian path-based algorithms. Gene prediction - statistical and similarity-based approaches. Overview (concepts only) of methods for gene annotation. K-means and SOM algorithms for analysis of gene expression data.

Learning Outcomes:

After completing this unit, the student will be able to

- understand the computational problems and concepts of structural and functional genomics (L2)
- compare the algorithms available for structural and functional genomics (L4)
- predict genomic sequence from fragment sequence data by using a Hamiltonian path-based algorithm (L6)
- predict genomic sequence from fragment sequence data by using a Eulerian path-based algorithm (L6)
- predict promoter sites by using genomic sequence data and a position specific score matrix (L6)

Course Outcomes:

After the completion of the course the student should be able to

- list biological databases related to biochemicals, proteins and nucleic acids (L1) assess
- similarity of biological sequences (L5)
- solve problems in phylogenetic analysis (L6)
- predict protein structure based on sequence information and structure of homologs (L6)
- construct genomic sequences from fragments (L6)

Text Books:	
	1. R. Durbin, S. Eddy, A. Krogh, G. Mitchison, Biological sequence analysis: Probabilistic models of proteins and nucleic acids, Cambridge University Press. 1998. 2. P. Pevzner and R. Shamir. Bioinformatics for Biologists. Cambridge University Press. 2011.
References:	
	1. A. Leach, Molecular modeling: principles and applications, 2/e, Pearson, 2009. 2. Teresa K. Attwood, Stephen R. Pettifer, David Thorne. Bioinformatics Challenges at the Interface of Biology and Computer Science: Mind the Gap. John Wiley & Sons, 2016. 047003548X, 9780470035481. 3. D. Mount, Bioinformatics: Sequence and Genome analysis, 2/e. CBS publishers. 2005. 4. T. Schlick, Molecular modeling and simulation, Springer-Verlag, 2002.

BIOINFORMATICS LABORATORY

List of Experiments:

At least 12 of the following experiments are required:

1. Needleman-Wunsch algorithm for Global alignment.
   At the end of this experiment the student will be able to find the optimum global alignment of two protein sequences

2. Smith-Waterman algorithm for Local alignment.
   At the end of this experiment the student will be able to find the optimum local alignment of two protein sequences

3. Multiple sequence alignment.
   At the end of this experiment the student will be able to find the optimum alignment of a set of protein sequences

4. Prediction of coding regions.
   At the end of this experiment the student will be able to predict the coding segments in a nucleotide sequence

5. Phylogeny: Parsimony, Neighbor-Joining, Tree display
   At the end of this experiment the student will be able to construct phylogenetic trees and display them

6. Secondary structure prediction.
   At the end of this experiment the student will be able to predict the secondary structure of a protein using its amino acid sequence

7. Prediction of transmembrane regions.
   At the end of this experiment the student will be able to predict the transmembrane segments of a protein using its amino acid sequence

8. Molecular graphics.
   At the end of this experiment the student will be able to utilize molecular graphics to display the structure of a protein

9. Molecular modeling.
   At the end of this experiment the student will be able to build models of small molecules.

Use of following databases:

10. Pubmed and PMC.

    At the end of this experiment the student will be able to search literature databases to find documents.

11. NCBI-Genbank.

    At the end of this experiment the student will be able to retrieve nucleotide sequences from the Genbank database

12. PDB.

    At the end of this experiment the student will be able to retrieve protein structural information from PDB

13. KEGG.

    At the end of this experiment the student will be able to retrieve metabolic pathway information from KEGG

Text Books:	
	1. Z. Ghosh, B. Mallick, Bioinformatics principles and applications, Oxford University Press, 2009. 2. Andreas D. Baxevanis, Francis Ouellette, B.F. Bioinformatics: A practical guide to the analysis of genes and proteins, 3/e, Wiley-Black Publishers, 2004.

Course Outcomes:

1. List biological databases related to biochemicals, proteins and nucleic acids.
2. Assess similarity of biological sequences.
3. Solve problems in phylogenetic analysis.
4. Predict protein structure based on sequence information and structure of homologs.
5. Construct genomic sequences from fragments.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	2	3
CO2	3	3	3	3						3	3	2	3	2	2
CO3	3	3	3	3						3	3	1	3	1	1
CO4	3	3	3	3						3	3	2	3	2	1
CO5	3	3	3	3						3	3	3	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT334: PROCESS DYNAMICS AND CONTROL

L	T	P	C
3	0	2	4

Bioprocesses are extremely sensitive to variations in temperature, oxygenation level, pH, ionic strength and shear. The response of a system to changes in external variables is time dependent. Hence the current state of the system has to be evaluated and the changes required to restore the system to the desired state have to be calculated. This course describes the dynamic models and control methods used for maintenance of reaction conditions.

Course Objectives:

- operate a process at the desired operating conditions, safely and efficiently, while satisfying environmental and product quality requirements.
- develop models of important physical process systems.
- design various control systems.
- apply the control systems in various chemical and biochemical processes

Unit- I **8 hrs**

Linear Open-loop Systems: Response of First-Order Systems, Physical examples of First-Order systems, Response of First-Order Systems in series, Second-Order Systems, Transportation Lag.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the importance of modeling and dynamics in process control (L2)
- Distinguish first order and higher order systems. (L4)
- Derive modelling equations for various systems. (L5)
- Predict the responses of systems for common forcing functions. (L6)

Unit- II **8 hrs**

Linear Closed-Loop Systems: The control system, Controllers and Final Control elements, Closed-Loop transfer functions, Routh Stability, Root Locus.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concept of control systems. (L2)
- Distinguish various controllers. (L4)
- choose the correct type of controller for a given process. (L3)
- Predict the stability of a system. (L6)

Unit- III **8 hrs**

Frequency Response: Introduction to frequency response. Control system design by frequency response.

Learning Outcomes:

	After completing this unit, the student will be able to Understand the • concept of frequency response. (L2) predict the frequency response • of a system. (L6) • choose the optimum values of controller parameters. (L3)
Unit- IV	**8 hrs**
Process Applications: Cascade control, Feed forward control, Ratio control, Selective Controllers, Split Range Controller, Controller tuning, Control valves.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Understand the concepts of advanced controllers used in the industry. (L2) determine the • stability of the system. (L5) • choose the suitable controller mechanism. (L3) • define the controller parameters for satisfactory response. (L1)
Unit- V	**8 hrs**
Applications of controllers in Bioprocesses: Measurement and control of biochemical process variables pH, dissolved oxygen, viscosity, temperature, NADH, agitation rate and foam. Data logging, analysis and computer control of bioreactors.	
Learning Outcomes:	
	After completing this unit, the student will be able to list the • process variables in fermentation. (L1) control process • parameters in fermentation. (L3) • control operation of bioreactors using computers. (L3
Text Books:	
	1. Process Systems Analysis and Control, 3rd Edn. S. E. Leblanc, Donald R.Coughanowr, McGraw-Hill Inc., 2009. 2. Stanbury, P.F.A., Whitaker & Hall, Principles of Fermentation Technology, 3/e Elsevier, 2017 Reference Books: 3. Seborg, Edgar, Millichamp, Doyle Process dynamics and control, 3/e John Wiley & Sons, 2010 4. Biochemical E ngineering fundamentals, Bailey and Ollis. 2nd Ed. 1986. McGrawHill.

PROCESS DYNAMICS AND CONTROL LABORATORY

List of Experiments:

1. Calibration of thermocouples.

At the end of this experiment the student will be able to: Learn methodology for calibration of thermocouples

2. Calibration of rotameter with compressible fluid.

At the end of this experiment the student will be able to: Learn methodology for calibration of a rotameter

3. Response of resistance thermometer

At the end of this experiment the student will be able to: measure the response of a resistance thermometer

4. Response of bare mercury in glass thermometer.

At the end of this experiment the student will be able to: Measure the response of mercury in a glass thermometer

5. Response of bare mercury in glass thermometer with thermal well.

At the end of this experiment the student will be able to: Measure the response of mercury in glass thermometer with thermal well.

6. Response of U-tube manometer.

At the end of this experiment the student will be able to: Measure the response of a U-tube manometer

7. Response of single-tank liquid-level system

At the end of this experiment the student will be able to: Measure the response of a single-tank liquid-level system

8. Response of two-tank interacting liquid-level system.

At the end of this experiment the student will be able to: Measure the response of a single-tank liquid-level system

9. Response of two-tank non-interacting liquid-level system.

At the end of this experiment the student will be able to:

Measure the response of a two-tank interacting liquid-level system

10. Study of ON-OFF control action.

At the end of this experiment the student will be able to: Demonstrate ON-OFF control action

Text Books:

1. D. Mukund, B. Nitin, Process Dynamics Laboratory, LAP Lambert Academic Publishing, 2011.
2. D.R. Coughnowr, S.E. LeBlanc, Process Systems Analysis and Control, 3/e, McGraw- Hill.

Course Outcomes:

1. Able to develop models to determine the dynamics of first and higher order systems.
2. Able to understand the concepts of different types of controllers, and control systems and able to determine their stability in various processes.
3. Able to use various frequency response methods to determine the stability of control systems.
4. Able to understand the concepts of various advanced controllers and determine their optimum controller settings for operating under stable conditions.
5. Able to know how to measure and control various parameters in a fermenter. Able to understand how data is collected, analyzed and used for controlling bioreactors.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2		1		1		1	1	3	2
CO2	3	3	3	1		3	2	1		1		2	2	3	3
CO3	3	3	3	1		2	1	1				2	2	2	3
CO4	3	3	3	1	2	2		2				1	2	2	2
CO5	3	3	3	1	2	2	2	1				2	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT302: BIOSEPARATION TECHNOLOGY

L	T	P	C
2	0	2	3

Products of interest have to be separated from biomass and remaining constituents of the media at the end of fermentation. The separation of the desired products is a challenging task that often accounts for a major part of the cost of an industrial bioprocess. This course describes the techniques and processes used for separation and purification of bioproducts.

Course Objectives:

- introduce the methods for the separation of bioproducts (L1)
- describe the various methods for the purification of recombinant proteins. (L1)
- explain the mechanism of membrane fouling. (L2)
- create process flow sheet using the unit procedure concept. (L5)
- explain nucleation and growth of crystals (L2)

Unit- I **10 hrs**

Overview of bio separation, classification of bioproducts; Recovery of intracellular products: Cell disruption methods: physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), chemical methods (alkali, detergents), enzymatic methods. Extracellular Products.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the mechanical methods of cell lysis. (L2)
- Understand the chemical methods of cell lysis. (L2)
- Describe Electrokinetic phenomena of cells. (L1)

Unit- II **8 hrs**

Separation of cells and other insoluble from fermented broth: Sedimentation, filtration (pretreatment, filtration theory, continuous rotary filters), microfiltration, ultrafiltration, centrifugation (batch, continuous and basket), Precipitation.

Learning Outcomes:

At the end of this unit, the student will be able to

- calculate filter efficiency using Darcys law. (L2)
- select appropriate filter media and equipment. (L3)
- explain factors that influence protein solubility. (L2)
- explain Sedimentation and precipitation processes. (L2)

Unit- III	**8 hrs**
Extraction: Phase separation and portioning equilibria, liquid-liquid extraction methods, reciprocating-plate column, centrifugal extractor. Adsorption: Theory of adsorption, adsorption isotherms, industrial adsorbents, adsorption types. Chromatography: ion-exchange, column chromatogrphy.	
Learning Outcomes:	
After completing this unit, the student will be able to • explain adsorption isotherms. (L2) • list different unit operations for biochemical product recovery. (L1) • Describe the extraction of biochemical products • understand the principals involved in chromatography techniques (L2)	
Unit- IV	**8 hrs**
Crystallization: Crystallization theory, rate of nucleation and rate of crystal growth, particle size distribution of crystals, batch crystallizer, model for Mixed-Suspension-Mixed-Product -Removal (MSMPR) crystallizer. Drying of bioproducts, methods of drying, equipment for drying, equilibrium moisture content of bioproducts, rate of drying curves, constant rate drying period, falling rate drying period, freeze drying.	
Learning Outcomes:	
After completing this unit, the student will be able to • Understand the principals involved in crystallization and drying operations (L2) • demonstrate the working of MSMPR crystallizer (L2) • design dryers and crystallizers for the separation of biomolecules(L6)	
Unit- V	**8 hrs**
Product recovery: Ethanol, Citric acid, Penicillin, Enzyme, Insulin. Economics of Bioproducts.	
Learning Outcomes:	
After completing this unit, the student will be able to • Understand the recovery of primary metabolites (L4) • Understand the recovery of secondary metabolites (L4) • Understand the recovery of fungal products (L4) • Estimate the cost requirements of downstream processing(L5)	
Text Books:	
1. P.A. Belter, E.L. Cussler & Wei-Shou Hu, Bio separations: Downstream Processing for Biotechnology, Wiley-Intercedence. 2012.	
References:	
1. R.G. Harrison, P. Todd & S.R. Rudge, Bio separation Science and Engineering, Oxford University Press, 2006. 2. McCabe, Smith & Harriot, Unit Operations of Chemical Engineering, 7th edition McGraw Hill book company, 2014. 3. J.A. Asenjo. Separation Processes in Biotechnology, CRC Press, 1990.	

BIO SEPARATION TECHNOLOGY LAB

1. Cell disruption by chemical method.
2. Cell disruption by mechanical method.
3. Product recovery by membrane filtration.
4. Separation of product using rotary vacuum Evaporation
5. Separation of bioproduct using adsorption.
6. Biomass removal by flocculation / Centrifugation method.
7. Purification of ethanol using distillation method.
8. Dehydration and estimation of drying time of a sample using tray dryer.
9. Purification of antibiotic using liquid-liquid extraction.
10. Enzyme Purification using Dialysis method / Salting out method.

Course Outcomes:

1. Introduce the methods for the separation of bioproducts.
2. Describe the various methods for the purification of recombinant proteins.
3. Analyse the principles of major unit operations used in Bio separations.
4. Explain nucleation and growth of crystals.
5. Create process flow sheet using the unit procedure concept.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		2		2	1	1	1	2	3	2	1	
CO2	1	3	3	1			3	2	2	1	2	1	1	2	2
CO3	1	2		3	2	2	3	2	1	1	2	2	3	3	3
CO4	1	1	2	2	1	3	3	2	1	1	2	1	3	3	3
CO5	2	3	2	1	3	3	3	2	2	1	3	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EMC382: ENGINEERING ETHICS (Mandatory Course)

L	T	P	C
3	0	0	0

Unit- I	**8 hrs.**
Basic Concepts: Terminology, morals, ethics, values, integrity and spirituality, edicts-religious, social and constitutional edicts, the question of universality, personal and professional ethics, emotional intelligence, dimensions of ethics	
Unit- II	**8 hrs.**
Rights and Responsibilities: As citizens, as professionals, concepts of justice and fairness, preservation, production, exchange for mutual fulfilment vs. storage for future use, social responsibility and individual rights	
Unit- III	**8 hrs.**
Global Issues in Ethics: Technology and globalization, business ethics, corporate social responsibility, environmental ethics, media ethics, protecting the common good while respecting the values and beliefs of nations/ ethnic groups, issues of compliance and governance, equal opportunities.	
Unit- IV	**8 hrs.**
Ethical Integrity and Attitudes: Integrity as wholeness and consistency of character, beliefs, actions, methods and principles, core group of values, accountability, prioritization, subjectivity and objectivity, attitude, com-ponents (cognitive, behavioral and affective), attitude formation and at-titude change.	
Unit- V	**8 hrs.**
Ethical Living: Needs of life, materialistic and non-materialistic, qualitative and quantitative, harmony in living, self (physical and mental wellbeing), family, building trust, sharing of responsibilities, cultivating sense of security, society, peace, non-violence, diversity, multiculturalism and oneness, nature, environmental sustainability, reorganizing living conditions, reappraising economic sectors and work practices, developing green technologies, ethical consumerism.	
References:	
	1. G. Subba Rao, Roy Chowdhury, P.N. Ethics, Integrity and Aptitude: For Civil Services Main Examination Paper V, Access Publishing, 2013. 2. Singer, Peter. Practical Ethics, Cambridge University Press, 1999. 3. Swami Tathagata Nanda, Healthy Values of Living, Advaita Ashrama, Kolkata, 2010. 4. M. Frost (Ed), Values and Ethics in the 21st Century, BBVA, Available at https://www.bbvaopenmind.com/wp-content/uploads/2013/10/Val-ues-and-Ethics-for-the-21st-Century_BBVA.pdf

19EBT392: COMPREHENSIVE SKILL DEVELOPMENT V

L T P A C
0 0 0 6 1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Part-1 - 3 Hours per week

A. Verbal and Soft Skills:

Unit	Module/ Topics	Hrs.
1.	Resume Writing & Acing Job Interviews	4
2.	Corporate Readiness 1	3
3.	Mock Tests with Solutions 1	5
4.	Company-Specific Tests with Solutions 1	3
	Total	**15**

B. Quantitative Aptitude and Reasoning

Unit	Module/ Topics	Hrs.
1.	Combinatorics	4
2.	Crypt arithmetic & Modular Arithmetic	5
3.	Analogy & Classification of Numbers	3
4.	Puzzles	3
	Total	15

Unit	Module/ Topics	Hrs.
1.	GRE-Oriented Advanced Concepts Discussion	4
2.	CAT-Oriented Advanced Concepts	4
3.	TCS, Infosys-Oriented Advanced Concepts	4
4.	Successful Test Cracking Techniques	3
	Total	15

Part-2 Domain Skills - 3 Hours per week

Design Skills: Bioprocess Design.

Targets for production will be provided – one will be small scale and other, large scale.

A Bioreactor and all downstream processes will have to be modeled to match the required yield per year. Following calculations will be required

a. Equipment required and Plant layout
b. Consumables required
c. Material balance for complete process
d. Bioreactor design: dimensions, rotor type and speed, aeration rate, temperature control
e. Downstream process design, with material balance for each step
f. Economic estimates

Course Outcomes:

1. Ability to formulate bioprocess plant designs for the specified production target.
2. Proficiency in calculating equipment and consumables requirements.
3. Competency in executing complete process material and Energy balance.
4. Competency in designing a functional bioreactor.
5. Skill to develop economic estimates for an entire process.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO2	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO3	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO4	2	2	2	1	2	2	2		1	1	1	1	2	2	2
CO5	2	2	1	1	2	2	1		1	1	3	1	1	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT433: PLANT BIOTECHNOLOGY

L	T	P	C
2	0	2	3

The plant biotechnology course is an essential component of biotechnology program. The course enables students to explore the skills of basic operations such as media preparation, plantlet regeneration and acclimatization. The technique expose student for large scale propagation of plants, their adaptations to climatic changes as well as selection and genetic modifications for disease resistance, herbicide tolerance, abiotic stress tolerance.

Course Objectives:

- Introduce the concepts of screening, isolation and maintenance of industrially important microorganisms.
- Describe the production of organic acids and fermented beverages
- Describe the applications of secondary metabolites, antibiotics and enzymes.
- Introduce the commercial aspects of fermented foods.
- Describe the application of recombinant DNA technology for production of therapeutics

Unit- I : Plant tissue culture and biotechnology — **8 hrs**

Introduction, significance, history, plant tissue culture media, plant growth regulators, Principle and pathways of in vitro plant regeneration- totipotency, cell differentiation, callogenesis, rhizogenesis, organogenesis, somatic embryogenesis, Clonal (Micro) propagation- business and opportunity.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the principles and pathways of plant regeneration (L2)
- Compare organogenesis and somatic embryogenesis for plantlet regeneration (L3)
- Apply micro-propagate techniques for large scale plants production (L3)
- estimate the cost of regenerated plants (L3)

Unit- II : Applications of plant tissue culture technique — **8 hrs**

Haploid plant production, Protoplast technology- isolation, culture, somatic hybrids and cybrids production, Germplasms conservation- cryopreservation, Gene banks, Synthetic seeds technology, Somaclonal variations- origin, cause and in vitro selection, Virus indexing.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain importance and applications of haploids, protoplast, somatic hybrids in plant improvement (L2)
- Select and regenerate variant and disease free plants (L4)
- Describe germplasms conservation, gene bank and synthetic seed technology (L1)

Unit- III: Scale-up propagation — **8 hrs**

Callus and cell culture system- isolation, culture, growth, viability and applications, Secondary metabolite production, biotransformation, Bioreactor- design and models for mass cultivation of plant cells, Hairy root bioreactor for secondary metabolite production, Automation in plant tissue culture.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain growth kinetics and viability in callus and suspension cultures (L2)
- Compare shake flasks and bioreactor system for plant cell cultures (L3)
- Model and design bioreactors for mass production (L5)
- analyze secondary metabolite production from cells and hairy roots in bioreactor (L2)

Unit- IV: Genetic Transformation-basic principles and applications **8 hrs.**

Plant genetic transformation technology: chimeric gene construction, Methods of gene transfer, Vectors of genetic transformation- Ti based vectors, T-DNA, mechanism of *Agrobacterium* gene transfer, , viral vectors, Chloroplast transformation, Gene Silencing-RNA editing, Field techniques for transgenic plants.

Learning Outcomes:

After completing this unit, the student will be able to

- apply basic principles of genetic engineering for transformation of plant cells (L2)
- Explain the mechanisms of gene silencing and editing (L2)
- Relate field techniques for containments and cultivation of transgenic plants (L3)

Unit- V: Transgenic plants status **8 hrs.**

Delayed ripening, Disease resistance-fungal, bacterial, viral, Herbicide resistance, Stress tolerance, Enhanced nutritional properties- Iron and Vit-A (Golden Rice), Plantibody, Plant cell chemical factory, Current global status and limitations of transgenic crops, Ethical and legal issues related to GM crops, Regulation of GM crops in India.

Learning Outcomes:

After completing this unit, the student will be able to

- analyze the genetic improvements of plants for various traits (L3)
- Explain transformed cells as the chemical factory for metabolite production in plants (L2)
- Describe regulatory constraints, legal and ethical issues of GM crops (L1)

Text Books:

1. H. S. Chawla, Introduction to Plant Biotechnology, 3/e, CRC Press, 2009.
2. A. Slater, N. Scott, M. Fowler, Plant Biotechnology: The Genetic Manipulation of Plants, 2/e, Oxford University Press, India, 2008.
3. Purohit S.D, Introduction to Plant Cell, Tissue and Organ Culture Paperback, 2012.

References:

1. L. Pena, (Editor), Transgenic Plant: Methods and Protocols (Methods in Molecular Biology Series Vol. 286)", Hanumana PressTotowa, New Jersey, USD, 2005.
2. Agnès E Ricrac, Surinder Chopra, Shelby Fleischer. Plant Biotechnology: Experience and Future Prospects. Springer International Publishing, pp.XIII, 291, 2014, 978-3-319-06891-6.
3. Functions and Biotechnology of Plant Secondary Metabolites 2nd ed (2010). Wink, M. Wiley-Blackwell.

PLANT BIOTECHNOLOGY LABORATORY

At least ten of the following:

Safety rules and regulation, Laboratory requirements: Equipment, Glass ware, Chemicals; Laboratory organization and laboratory techniques.

1. Preparation of stock solution for Murashige & Skoog's (1962) (MS) medium.
2. Establishment of seed culture.
3. Induction and establishment of callus culture.
4. Haploids from anther culture.
5. Storage organ culture.
6. Axillary bud culture.
7. Leaf disc culture.
8. Subculture and multiplication of callus.
9. Shoot tip culture.
10. Zygotic embryo culture and somatic embryogenesis.
11. Artificial seeds production and plantlets regeneration.
12. Cell suspension culture.
13. Isolation and culture of protoplasts.
14. Agrobacterium mediated genetic transformation and hairy root culture.
15. In vitro rooting/ germination of somatic embryo and regeneration of complete plant.
16. Soil transfer, hardening and acclimatization of plantlets.

Text Book(s):

1. S.Nagar, M. Adhav, Practical Book of Biotechnology and Plant Tissue Culture. S Chand, 2010.
2. C.C. Giri, A. Giri, Plant Biotechnology: Practical Manual, I K International Publishing House, 2007.

References:

1. C.A. Beyl, R.N. Trigiano (Editors), Plant Propagation Concepts and Laboratory Exercises, 2/e, CRC Press, Tylor and Francis Group LLC, 2015.
2. E.F. George, M.A. Hall, G.J. De Klerk, (Editors) Plant Propagation by Tissue Culture, Volume 1 & 2, 3/e (Volume 1, Available online), 2008.
3. V.M. Loyola-Vargas, F. Vazquez-Flota (Editors), Plant Cell Culture Protocols, 1/e, Springer-Verlag New York, LLC, 2005.
4. J.H. Dodds, L.W. Roberts, J. Heslop-Harrison, Experiments in Plant Tissue Culture, 3/e, Cambridge University Press, 2004.

Course Outcomes:

1. Apply fundamental knowledge of in vitro plant propagation in laboratory and industry.
2. Develop protocols for large scale micropropagation system, germplasm conservation, virus elimination.
3. Explain screening and selection of haploids, somatic hybrids, and other variants for biotic and abiotic resistance.
4. Improvise secondary metabolites through selection and genetic transformation.
5. Calculate the cost of tissue cultured plant and the enterprises.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		3			1	2	2					3	2	2
CO2	3	1	3	2	1	1	3	2	1				3	2	2
CO3	3		2	2	1	1	3	2	1		2		3	3	3
CO4	3	2	2	2	2	1	3	2	1		1	1	3	3	3
CO5	3	3	3	3	3	1	3		1		2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT403: ANIMAL BIOTECHNOLOGY

L	T	P	C
2	0	0	2

The investigations and interpretations in animal biotechnology had contributed to countless impact to the world. This course provides an introduction to basic techniques of cell, tissue and organ culture, isolation and Application of stem cells in medicine, cell culture reactors. This course is prerequisite for organ culture and tissue engineering, production of transgenic Animals.

Course Objectives:

- Introduce the Basic techniques of cell, tissue and organ culture.
- Impart knowledge of stem cells
- Summarize cell culture reactors
- Explain the organ culture and tissue engineering
- Discuss the production of transgenic animals

Unit- I **8 hrs.**

Basic techniques of cell, tissue and organ culture, Primary culture and subculture of cells. kinetics of cell growth, Properties of normal and transformed cells, Role of carbon-dioxide, serum and other supplements in cell culture, Different types of culture media- natural media, BSS, MEM, serum free media, Different methods for the estimation of cell viability and cytotoxicity, Applications of cell culture.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain basic techniques of cell culture (L2).
- explain the role of carbon dioxide and other supplements in cell culture. (L2).
- outline different types of culture media (L1).
- explain different methods for estimation of cell viability (L2).

Unit- II **8 hrs.**

Stem cells – Embryonic and adult stem cells, Isolation and culture of stem cells, induced pluripotency of stem cells, Stem cell markers, Stem cell plasticity and differentiation, Application of stem cells in medicine, Apoptosis- mechanism and significance with reference to degenerative diseases – Parkinson's disease, stroke and diabetes.

Learning Outcomes:

At the end of this unit, the student will be able to

- recall the isolation and culture of stem cells (L1).
- explain the types of stem cells and stem cell markers. (L2).
- explain applications of stem cells (L2).
- Interpret the mechanisms in degenerative diseases (L3).

Unit- III **8 hrs.**

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures.

Learning Outcomes:

After completing this unit, the student will be able to

- recall the cell culture reactors (L1).
- summarize the scale-up and complexity (L2).
- explain the different reactors (L2).

Unit- IV	**8 hrs.**

Organ culture and tissue engineering: Organ cultures, histolytic cultures, three dimensional cultures, organotypic cultures. Production of bio-artificial skin, liver and pancreas, Tissue engineering- cell source and culture, culture of cells, design engineering of tissues, tissue modelling, Embryonic stem cell engineering.

Learning Outcomes:

After completing this unit, the student will be able to

- explain different types of culture (L1)
- relate the tissue engineering with various organs (L1)
- design engineering of tissues (L2)

Unit- V	**8 hrs.**

Production of Transgenic Animals -Mouse, cattle and fish by microinjection, retroviral vector method and embryonic stem cell method. Animal cloning-Somatic cell nuclear transfer and embryonic stem cell nuclear transfer methods. Biopharming and gene knockout technologies

Learning Outcomes:

After completing this unit, the student will be able to

- explain the production various transgenic animals (L2).
- summaries animal cloning (L2).
- explain biopharming and gene knockout technologies (L2).

Text Books:

1. Ranga M.M. Animal Biotechnology. Aerobics India Limited, 2002
   Ramadas P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997

References:

1. Freshney, R.I., "Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications", 6th Edition, John Wiley & Sons, 2010.
2. Portner, R., "Animal Cell Biotechnology: Methods and Protocols", 2nd Edition,

Course Outcomes:

1. Learn basic concepts and techniques of animal cell culture.
2. Understand & apply stem cell technology.
3. Discuss different types of cell culture reactors.
4. Apply organ culture and tissue engineering.
5. Discuss and apply the genetic engineering principles in transgenic animal production

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2		3	1			3	2	2	2
CO2	3	2	3	2	3	2		3	1			3	2	3	3
CO3	3	2	3	2	3	2		3	1			3	2	3	3
CO4	3	2	3	2	3	2		3	1			3	2	3	3
CO5	3	2	3	2	3	2		3	1			3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT495: COMPREHENSIVE SKILL DEVELOPMENT VI

L T P A C
0 0 0 6 1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Part-1 - 3 Hours per week

A. Verbal and Soft Skills:

Unit	Module/ Topics	Hrs
1.	Corporate Readiness 2	4
2.	Topic-Wise Discussion of Question Papers	4
3.	Mock Tests with Solutions 2	4
4.	Company-Specific Tests with Solutions 2	3
	Total	**15**

B. Placement and Career Guidance

Unit	Module/ Topics	Hrs
1.	GRE-Oriented Tests and Discussions	4
2.	CAT-Oriented Tests and Discussions	4
3.	TCS, Infosys-Oriented Tests and Discussions	4
4.	Other Company-Specific Tests & Discussions	3
	Total	15

Part-2 Domain Skills per week 3 Hours

Pedigree Analysis
Computational Skills
Databases: Introduction to SQL
Web Development: Introduction to HTML

1. Software for Bibliography and Scientific paper writing. Essential Biotechnology Journals & Databases
2. Online & Offline Databases for Biochemical engineering & Biotechnology data and tables
3. Student should be able to locate information related to enthalpy, boiling
4. Billy available microbial strains, publicly available cell lines, biosafety guidelines, etc.

Course Outcomes:

1. Effectively communicate through verbal/oral communication and improve the listening skills.

2. Write precise briefs or reports and technical documents, actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self-motivation and practicing creative thinking.

3. Understand the problems and develop his competitive coding skills.

4. Apply the skills in various domains and will be able to solve complex problems faced by the industry.

5. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO2	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO3	3	2	3	1	3	3	2		1	1	1	1	2	2	2
CO4	2	2	2	1	2	2	2		1	1	1	1	2	2	2
CO5	2	2	1	1	2	2	1		1	1	3	1	1	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

GSS115: GANDHI FOR THE 21ST CENTURY

L	T	P	C
0	0	0	1

The course will provide an overall understanding of Gandhi's life, his political contributions, and his basic philosophical thoughts. It also discusses how Gandhi influenced the entire world to think about non-violent resistance as a political strategy to bring and establish world peace.

Course Objectives:

- To provide the basic knowledge of Gandhi's life, thought and works
- To analyse the political contributions of Gandhi towards India's independence
- To examine the significance of Gandhian principles in the contemporary scenario to
- educate the students about the necessity of world peace and sustainable development
- To provide understanding about the life of eminent world leaders who were influenced by Gandhi

Unit- I	**8 hrs.**
Introduction to the course: Gandhi's Early Childhood-Beginning of Satyagraha in South Africa-Entry to Indian Politics-Major Movements	
Unit- II	**8 hrs.**
Gandhi's Political Philosophy: Eleven Vows and their significance, Gandhi's Constructive Programmed and their significance, Sarvodaya and Satyagraha	
Unit- III	**8 hrs.**
Gandhian Way of Management: Management lessons from Gandhi, his views on education and its significance, Gandhian Economics and Sustainability	
Unit- IV	**8 hrs.**
Gandhi and his contemporaries-Gandhi and Tagore, Ambedkar, Subhash Chandra Bose, Muhammed Ali Jinnah, Gandhi Mandela, and Martin Luther King Jr.	
Unit- V	**8 hrs.**
Gandhi and Ecology: Ideas from Hind Swaraj-Environmental movements and Gandhian environmentalism-World Peace and Gandhi-Conflict resolution and Gandhian principles.	

Course Outcomes:

After the completion of the course the student should be able to

- Understand the life and works of Gandhi
- Understand and appreciate the political contributions of Gandhi
- Analyze the contemporary issues and connect it with Gandhian solutions
- Analyze the issues related to world peace and to think about possible alternatives
- Understand and appreciate the role of eminent world leaders towards non-violent social and political transformation.

References:

	1. Allen, Douglas. (2019). Gandhi after 9/11: Creative Non-violence and Sustainability. New Delhi: Oxford University Press. 2. Chandra, B. (2009). History of Modern India. New Delhi: Orient Black swan. 3. Gandhi, M K. (1941). Constructive Programmed. Ahmadabad: Novian Publishing House 4. Gandhi, M. K. (1948). The Story of My Experiments with Truth. Ahmadabad: Novian 5. Publishing House. 6. Gandhi, M K. (1968). Satyagraha in South Africa. Ahmadabad: Novian Publishing House. 7. Hardiman, David. (2004). Gandhi in His Times and Ours: The Global Legacy of His Ideas. New York: Columbia University Press. **Journals** 1. Gandhi Marg, Gandhi Peace Foundation, New Delhi. 2. GITAM Journal of Gandhian Studies, GITAM University, Visakhapatnam.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1	2	3	3	3	3	1	3	3	3	2	3	3
CO2	1	2	1	2	3	3	2	3	2	1	3	3	1	3	2
CO3	3	2	2	1	3	3	3	3	1	2	3	3	1	2	3
CO4	2	3	1	1	3	3	2	3	2	3	3	3	1	3	1
CO5	3	3	2	1	3	3	2	3	2	2	3	3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT242: INDUSTRIAL FERMENTATION TECHNOLOGY

L	T	P	C
2	0	2	3

Fermentation is the process that started the era of industrial biotechnology. This technology can be utilized for the production of biochemicals, fuel and medicines. This course provides an introduction to the procedures involved in fermentation.

Course Objectives:

- Introduce the concepts of screening, isolation and maintenance of industrially important microorganisms.
- Describe the production of organic acids and fermented beverages
- Describe the applications of secondary metabolites, antibiotics and enzymes.
- Introduce the commercial aspects of fermented foods.
- Describe the application of recombinant DNA technology for production of therapeutics

Unit- I **8 hrs.**

Introduction to Industrial Fermentations: Screening, isolation and maintenance of industrially important microorganisms. Types of fermentation processes, carbon and nitrogen sources, conventional and non-conventional raw materials and microbial metabolism.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the significance of Industrially important microorganisms (L2)
- Outline different fermentation processes (L2)
- Explain the composition of raw materials (L2)
- Relate microbial metabolism and raw materials (L2)

Unit- II **8 hrs.**

Production of primary metabolites: Production of organic acids: citric acid, acetic acid and lactic acid.

Production of amino acids: L-glutamic acid and Lysine.

Production industrial solvents and fermented beverages: ethanol, beer and wine.

Learning Outcomes:

At the end of this unit, the student will be able to

- Describe the production of citric acid, acetic acid and lactic acid. (L2)
- Explain the difference in the production of ethanol, beer and wine. (L2)
- Summarize fermentation processes for industrially important products. (L2)

Unit- III **8 hrs.**

Production of secondary metabolites: Production of antibiotics: penicillin and streptomycin. Production of industrial enzymes: amylases, proteases and pectinases.

Learning Outcomes:

After completing this unit, the student will be able to

- List various steps involved in the production of antibiotics. (L1)
- Understand the production of industrial enzymes. (L1)
- Differentiate between antibiotic and enzyme production. (L4)

Unit- IV **8 hrs.**

Food fermentation: Fermented milk foods: cheese. Fermented vegetable foods: Sauerkraut and soya sauce.

Production of food and fodder yeast: Baker's yeast, food and fodder yeast.

Learning Outcomes:

After completing this unit, the student will be able to

explain the production of fermented milk foods.

- (L2)
- Identify the differences in the production of milk and vegetable fermented foods. (L3)
- Analyze the role of microorganisms in production of fermented foods (L4)

Unit- V **8 hrs.**

Production of recombinant products: Production of recombinant biopolymers. Recombinant therapeutics: Production human insulin by bacterial and yeast expression systems. Production of human growth hormone by bacterial expression system.

Learning Outcomes:

After completing this unit, the student will be able to

- Apply recombinant DNA technology for production of therapeutics. (L2)
- Summarize bacterial and yeast expression systems (L2)
- Apply recombinant DNA technology for production of biopolymers. (L2)

Text Books:

1. A. H. Patel, Industrial Microbiology, 2/e, MacMillan Publishers, 2012.
2. N. Okafor, Modern Industrial Microbiology and Biotechnology, Science Publishers, 2007.

References:

1. E. M. T. El Mansi, C. F. A. Bryce, A. L. Demain, A. R. Allaman, Fermentation Microbiology and Biotechnology, 3/e, Taylor and Francis, 2011.
2. W. C. Frazier, D. C. Westhoff and N. M. Vanitha, Food Microbiology, 4/e, McGraw Hill, 2014.

	3. A. N. Glazer and H. Nikaido, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2/e, Cambridge University Press, 2007. 4. G. Reed, Presscott and Dunn's Industrial Microbiology, 4/e, CBS Publishers and Distributors, 2004. 5. W. Cruger and A. Cruger, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2003.

INDUSTRIAL FERMENTATION TECHNOLOGY LABORATORY

Minimum of 8 experiments from the following:

1. Production of yeast
2. Production of bread
3. Production of wine
4. Production of cheese
5. Production of soya sauce
6. Production of alcohol
7. Estimation of alcohol
8. Production of glutamic acid
9. Production of an antibiotic
10. Production of a vitamin
11. Production of citric acid

Course Outcomes:

1. Identify key microorganisms and comprehend their metabolic functions critical to various fermentation processes.
2. Understand and apply the fundamentals of various fermentation processes and optimize media for effective bioconversion.
3. Analyze production methods for both primary and secondary metabolites, focusing on process optimization and compliance with regulatory standards.
4. Gain practical skills in fermenting food and beverages, ensuring product safety, quality, and enhanced nutritional values.
5. Develop competencies in producing recombinant products, particularly therapeutic proteins, with awareness of technological and regulatory challenges.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2	1	2	3		1				3	2	2
CO2	3	3		3	2			2	1				3	3	
CO3	3	3	3		3		2	2					3	3	3
CO4	2			2		3	2		1	3	3		2		2
CO5	3	2		3			3	3	1			3	3	3	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT244: ADVANCED CELL BIOLOGY

L	T	P	C
2	0	2	3

Cells are the basic units of all higher-level living organisms. This course describes the basis of cellular organization, cell-cell communication mechanisms and the molecular basis of cellular response to environmental signals. This course is useful to pursue advanced research in the fields of immunology and cancer biology.

Course Objectives:

- Provide a perspective on recent advances in cell biology
- Familiarize the different approaches of cell biology
- Impart the concept of cell signaling cascades Introduce
- the mechanism of cell-cell communication
- Explore the models and case-studies of signal transduction

Unit- I **8 hrs.**

Introduction to cellular organization and metabolism: Energy trading within the cell: Cellular energy currencies: reduced nicotinamide adenine dinucleotide, nucleoside triphosphates, hydrogen ion gradient across the mitochondrial membrane, sodium gradient across the plasma membrane, inter-convertible mechanisms of energy currencies, feedback and feed-forward control of energy production.

Learning Outcomes:

At the end of this unit, the student will be able to

- Demonstrate the energy trading within the cell (L2)
- Explain about ion gradients in membranes (L2)
- Compare feedback and fee-forward control of energy production (L2)

Unit- II **8 hrs.**

Ions and Voltages: Potassium gradient and the resting voltage, Chloride gradient. Properties of carriers: sodium calcium exchanger, calcium ATPase pump. Action potential: calcium action potential in sea urchin eggs, voltage-gated sodium channel in nerve cells.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain ion channels and voltages in cells (L2)
- List voltage-gated channels in cells (L1)
- Explain the concept of action potential (L2)

Unit- III **8 hrs.**

Intracellular signaling: Calcium, cyclic Adenosine Mono-Phosphate, cyclic Guanosine Mono-Phosphate, Receptor Tyrosine Kinases and the MAP kinase cascade, Protein Kinase B and the glucose transporter: working principle of insulin. Crosstalk between signaling pathways.

Learning Outcomes:

	After completing this unit, the student will be able to • Understand the intra-cellular signaling cascades (L2) • Explain the crosstalk between signaling pathways (L2) • Explain role of transporters in cell signaling (L2)

Unit- IV	**8 hrs.**

Intercellular Communication: Classifying transmitters and receptors, Intercellular communication in action: case study of gastrocnemius muscular action. Nitric oxide signaling. Synapses between neurons: spatial summation, temporal summation, case study of gamma-amino butyric acid (GABA) neuro-transmitter.

Learning Outcomes:

	After completing this unit, the student will be able to • Classify transmitters and receptors (L2) • Explain intercellular communication (L2) • Demonstrate synaptic transmission (L2)

Unit- V	**8 hrs.**

Cytoskeletal molecules: Microtubules, Microfilaments, Intermediate filaments, Cell-Cell junctions, Chemo and durations, Cell locomotion, cell migration and homing.

Learning Outcomes:

	After completing this unit, the student will be able to • Describe cytoskeletal molecules and their interaction (L2) • Explain the cell junctions (L2) • Explain the mechanism of cell locomotion (L2)

Text Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Molecular Biology of the Cell, 6th Edition, 2014
2. Geoffrey M. Cooper, The Cell: A Molecular Approach 7th Edition, Oxford University Press; 2015.

References:

1. Francisco V. Sepulveda and Francisco Bezanilla, Pumps, Transporters, and Ion Channels Studies on Their Structure, Function, and Cell Biology, Kluwer Academic /Plenum Publishers, 2005.
2. P.S. Verma, Cell Biology, Genetics, Molecular Biology: Evolution and Ecology, Chand (S.) & Co Ltd, India 2004.

ADVANCED CELL BIOLOGY LABORATORY

Any 10 of the following experiments:

Session	Description of Experiments	Hrs.
1	Introduction to biological safety cabinets and CO_2 incubators	2
2	Aseptic techniques for cell culture	2
3	Principle and operation of an Inverted Microscope	2

4	Low Speed Centrifugation for separation of Cells from Whole blood	2
5	Isolation of Chloroplasts	2
6	Isolation of Mitochondria	2
7	Harvesting and Counting of cultured mammalian cells	2
8	Cryopreservation of Cells	2
9	Assessment of cell viability	
10	Preparation of whole cell extracts	2
11	Western blot	4
12	Flow cytometry	2
13	Cell separation with magnetic beads	2

Course Outcomes:

1. Understand the energetics of cell metabolism.
2. Understand the concepts of Ion gradients and Voltages in cells.
3. Impart knowledge of inter and intracellular communications.
4. Apply thermodynamic principles to biological systems.
5. Appreciate the potential of recombinant DNA technology.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	2	2	1	1	1	2	3	1	1
CO2	3	1	3	3	2	1	3	2	2	1	1	1	3	2	2
CO3	3	1	1	2	3	1	3	2	1	1	2	2	3	3	3
CO4	3	2	2	3	3	1	3	2	1	1	1	1	3	3	3
CO5	3	3	3	3	3	1	3	1	2	1	2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT246: FOOD SCIENCE AND TECHNOLOGY

L	T	P	C
2	0	2	3

Food science and technology is the application of food science related to chemistry, nutrition, engineering, biotechnology, quality control and safety management. In this course student will learn nutritional importance of raw foods, processing of foods, transform into edible products, preservation processes, quality control and Packaging.

Course Objectives:

- Introduce the Nutritional aspects of foods.
- Describe the importance of thermal and non-thermal methods of food processing
- Provide the knowledge food quality and packaging.
- Introduce role of role of nutraceuticals for human health

Unit- I **8 hrs**

Nutritive aspects of raw food products: cereals, legumes, fruits and vegetables; Introduction and scope of food processing, Post harvest technology: cleaning, grading, milling, hydrothermal treatment and conditioning of plant products; Principles and methods of food processing; preservation method of food products: freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, dielectric heating; Hurdle technology: concept of hurdle technology and its application.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the importance of nutritional values of foods (L1)
- explain the food processing and post-harvest technologies (L2)
- explain the preservation methods (L2)
- describe the hurdle technologies (L1)

Unit- II **8 hrs**

Thermal methods of food processing: Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation and application; Application of following technologies: High intensity light, pulsed electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the thermal methods for food processing (L2)
- explain the mechanism of heat generation (L2)
- differentiate between thermal methods of food processing technologies (L3)

Unit- III **8 hrs**

Non-thermal methods of food processing: Overview of Membrane technology: Micro-filtration, Ultra filtration (UF), Nano filtration (NF) and Reverse Osmosis (RO), industrial applications; High Pressure Concept, equipment for HPP treatment, mechanism of microbial inactivation, its application in food processing; Ultrasonic processing: Properties and application of ultrasonic processing techniques.

Learning Outcomes:	
	After completing this unit, the student will be able to • outline non thermal methods in food processing (L1) • explain various membrane technologies (L2) • explain concepts of high-pressure treatment (L2) • summarize the ultrasonic processing techniques (L3)
Unit- IV	**8 hrs**
Food quality assurance and packaging: Methods of quality assessment of food materials. Concept of codex *Alimentarius* / HACCP/ USFDA/ ISO 9000 series. Principles of food packaging: types of designs for containers, food packaging materials, function and safety of food packaging; Causes of foodstuff deterioration, control methods; Shelf life of packaged foodstuff, methods to extend shelf life. Applications of nanotechnology in food packaging.	
Learning Outcomes:	
	After completing this unit, the student will be able to • understand the methods for quality assessment of foods (L1) • explain the Concepts of Codex Alimentarius (L2) • understand the principles of food packaging (L1) • explain food spoilage and control (L3)
Unit- V	**8 hrs**
Introduction to nutraceuticals. Manufacturing aspects of selected nutraceuticals; lycopene, is flavonoids, prebiotics and probiotics, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals.	
Learning Outcomes:	
	After completing this unit, the student will be able to • describe nutraceuticals for disease control (L1) • describe formulation of nutraceuticals (L1) • understand the manufacturing aspects of nutraceuticals (L1)
Text Books:	
	1. P. Jelen, Introduction to food processing, Prentice Hall, 1985. 2. N. N. Potter, J. H. Hotchkiss, Food Science, 5/e, Springer, 1995.
References:	
	1. P. J. Fellows, Food Processing Technology. Principles and practice, 3/e, Woodhead Publishing, 2009. 2. M. Maracotte, H. Ramaswamy, Food Processing: Principles and Applications, Taylor and Francis, 2006. 3. J. R. Nesser and B. J. German, Bioprocesses and Biotechnology for Nutraceuticals, Chapman and Hall, 2004. 4. G. V. Barbosa-Canovas, M. Tapia and M. P. Cano, (eds.), Novel Food Processing Technologies. CRC Press, 2005. 5. J. Shi, (ed.), Functional Food Ingredients and Nutraceuticals: Processing Technologies, CRC, 2006.

FOOD SCIENCE AND TECHNOLOGY LAB

List of experiments:

1. Cleaning, grading, and milling of rice grain
2. To utilize the hurdle technology (pH and aw) for effective preservation of food.
3. Thermal processing (pasteurization) of milk food
4. Estimation of nutritional values (carbohydrates) in fruit products
5. Microfiltration for removal of solids impurities from fruit juices
6. Determination of chemical constituents (phenol) from Cashew juice
7. Microbial inactivation from liquid milk
8. GMP for good food product quality
9. Microbial analysis in different decaying food products
10. Determination of titration value of citric acid in lemon juice

Course Outcomes:

1. Understand the nutritional aspects of cereal foods and its processing impacts.
2. Apply the importance of thermal methods of food processing for post-harvested food.
3. Implement non-thermal approaches of food processing for post-harvested food.
4. Implement food quality and packaging at national/ international levels.
5. Formulate foods for nutraceuticals development for better human health.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	2	1	1	1	1	1	3	2	1
CO2	3	2	2	2	1	1	2	2	1	1	1	2	3	2	2
CO3	3	1	1	2	3	1	3	2	1	1	2	2	3	2	2
CO4	3	2	2	3	3	1	3	2	1	1	1	2	3	3	2
CO5	3	3	3	3	3	1	3	1	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT248: BIO PHYSICS

L	T	P	C
3	0	0	3

Biological organisms utilize energy from external sources to drive non-equilibrium processes that are utilized for the benefit of the organism and its progeny. Biophysical models can be used to explain the interactions of forces, fields and biological molecules that produce complex behaviour in biological systems. Noninvasive biophysical imaging methods can provide detailed structural information that is useful for diagnosis and quality control. This course introduces the biophysical principles and methods useful for understanding the structure and function of biological organisms.

Course Objectives:

- Explain the physics of energy transfer and molecular interactions in biological systems
- Explain the physical basis of human vision and hearing
- Describe the physiology of biological information processing and response
- Explain the mechanics of locomotion
- Describe the methods for biomedical imaging

Unit- I **8 hrs**

Bioenergetics:
Marcu's theory of electron transfer. Photo physics of chlorophylls and carotenoids: MO model for the electronic states. Huckell approximation. Energy transfer in photosynthetic systems. Proton transfer in bacteriorhodopsin. Molecular basis of human photoreception and Mechano-electrical transduction.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the electronic structure of chlorophyll and carotenoids (L2)
- Apply Huckell's MO theory to explain properties of carotenoids (L3)
- Compare energy transfer mechanisms in photosynthetic systems (L5)
- Describe proton transfer in bacteriorhodopsin (L1)
- Explain the mechanism of vision and auditory sensing (L4)

Unit- II **8 hrs.**

Molecular biophysics: Introduction to molecular mechanics. Role of hydrogen bond in biological systems. Models of allosteric interactions. Thermal stability of double stranded DNA. Transport of oxygen in humans. Self- assembly of micelles and lipid bilayers. Membrane potential. Measurement of transmembrane ionic current. Transmembrane transport mechanisms.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the forces directing the interaction of biological molecules (L1)
- Analyze the physics of self-assembly and stability of multicomponent molecular systems (L1)
- Compare models for ion transport through a membrane (L1)

Unit- III **8 hrs.**

Neuro-biophysics: Conduction of an action potential. Transmission of a nerve impulse across a synapse. Molecular mechanism of memory formation. Experimental measurement of brain activity. Mechanism of activation of muscles by nerve signals. Introduction to cybernetics and coordinated control of movement.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain mechanism of nerve impulse conduction and transmission (L4)
- Describe the mechanism of memory formation (L1)
- List experimental methods for measurement of brain activity (L1)
- Describe mechanism of activation of muscles and coordinate control of movement (L1)

Unit- IV **8 hrs.**

Biomechanics:

Molecular motor models. Measurement of force generated by molecular motors. Propulsion by cilia and flagella. Models of Bacterial chemotaxis. Biofluid mechanics. Scaling laws applicable to biomechanics of locomotion. Energetic cost of locomotion. Terrestrial locomotion gaits. Froude number and dynamic similarity.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain the mechanism of action of molecular motors (L4)
- Describe methods for measurement of force generated by molecular motors (L1)
- Differentiate between ciliary and flagellar motion (L4)
- Apply the scaling laws of biomechanics of locomotion (L3)
- Describe the biomechanics of terrestrial locomotion (L1)

Unit- V **8 hrs.**

Biomedical imaging:

Principles of following non-invasive imaging techniques: CT, PET, ultrasonography and MRI. Application of magnetic resonance for non-invasive imaging. Encoding of spatial information by using magnetic field gradients. MRI for non-invasive pharmacokinetic studies and medical diagnostics. Superparamagnetic iron oxide nanoparticles and their theragnostic applications.

Learning Outcomes:

After completing this unit, the student will be able to

- Understand the principles of common non-invasive imaging techniques Describe
- applications of MRI (L1)
- Explain the principles of MRI (L4)
- Explain relationship between properties of SPIONS and their theranostic applications (L4)

Course Outcomes:

After the completion of the course the student should be able to Describe

- models of energy transfer in photosynthesis (L1)
- Analyze the control systems and mechanics of motion in biological systems (L1)
- Apply scaling laws for biological locomotion (L4)
- Calculate energy requirements for motion in biological systems (L4)
- Compare the advantages and disadvantages of biomedical imaging techniques (L4)

Text Books:

1. W. Hoppe, W. Lohmann, H. Markl, H. Ziegler. Biophysics. Springer. 2012.
2. Andrew W Wood. Physiology, Biophysics, and Biomedical Engineering. CRC Press. 2012.

References:

1. Andrew A. Biewener and Sheila Patek. Animal Locomotion. 2nd Edition. OUP Oxford, 2018.
2. Susan Hall. Basic biomechanics. 8th edition. McGraw Hill. 2019.
3. Robert W. Brown, Y.-C. Norman Cheng, E. Mark Haacke, Norman Cheng, Michael R. Thompson, Ramesh Venkatesan. Magnetic Resonance Imaging: Physical Principles and Sequence Design. John Wiley & Sons, 2014.

19EBT342: ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
2	0	2	3

Measurement of human induced changes to the environment and their remediation are essential for long term sustenance. Biotechnology based methods are useful for monitoring pollution and environmental remediation. This course describes the applications of biotechnology for pollution monitoring, methods for waste treatment and the applications of genetically engineered microbes for bioremediation.

Course Objectives:

- describe the relation between biodiversity and environmental pollution (L1)
- describe sources of pollution (L1)
- describe methods for biomonitoring of pollution (L1)
- describe applications of biotechnology for environmental remediation (L1)
- explain potential of genetically engineering microbes for bioremediation (L2)

Unit- I **8 hrs.**

Issues and Scope of Environmental Biotechnology: Introduction to Biodiversity, environmental pollution, chemical pesticides and their effects, metal pollution, bioaccumulation of toxicants, Biotechnological methods for measurement of pollution. Biomonitoring of air and water pollution, remediation of pollutants.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the relation between biodiversity and environmental pollution (L1)
- describe sources of pollution (L1)
- describe methods for biomonitoring of pollution (L1)

Unit- II **8 hrs.**

Biological Treatment of waste water: Aerobic suspended and attached growth system- activated sludge process, trickling filters, Rotating biological contractors (RBC). Anaerobic suspended and attached growth systems- anaerobic digestion, anaerobic filter process, UASB.
removal of biological nitrogen and phosphorus.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe equipment for biological treatment of waste water (L1)
- describe aerobic and anaerobic processes for treatment of waste water (L1)
- describe removal of biological nitrogen and phosphorus (L1)
- explain the applications of fermentation in industry. (L2)

Unit- III **8 hrs.**

Treatment of waste water of food processing industries: Starch, Dairy, Fruit & Vegetable, Confectionary, Beverages, meat and vegetable oil .

Learning Outcomes:

After completing this unit, the student will be able to

- describe process for treatment of waste water from food processing industries (L1)

Unit- IV	**8 hrs.**
Solid waste management- Sources, preliminary operations, sludge thickening, sludge stabilization, conditioning of sludge, dewatering, heat drying, disposal of sludge, Composting, Vermicomposting, Biofertilizers.	
Learning Outcomes:	
After completing this unit, the student will be able to • describe methods for solid waste management (L1) • compare advantage of disadvantages of biofertilizers (L3)	
Unit- V	**8 hrs.**
Biodegradation and bioremediation- *In situ* and *ex situ* bioremediation, biodegradation of hydrocarbons, pesticides, herbicides and xenobiotics. Bioremediation of contaminated soil, genetically engineered microorganisms in bioremediation. Phytoremediation.	
Learning Outcomes:	
After completing this unit, the student will be able to • describe principles and applications of biodegradation (L1) • describe principles and applications of bioremediation (L1) • explain potential of genetically engineering microbes for bioremediation (L2)	
Text Books:	
1. M.H. Fulekhar, Environmental biotechnology,2017, CRC publishers 2. U. Satyanarayana, Biotechnology, 1st Edition, Books and Allied (P) Ltd, 2005	
References:	
1. Bruce E. Rittmann and Perry L. Mc Carty, Environmental Biotechnology: Principles and applications, Mc Graw Hill Company, 2012. 2. Martin Alexander, Biodegradation & Bioremediation, 2nd Edition, Academic press, 2012	

ENVIRONMENTAL BIOTECHNOLOGY LABORATORY

Any five of the following experiments are required:

1. Assessment of microbes in air
2. Assessment of biological oxygen demand in waste water
3. Demonstration of Activated sludge process for Waste water treatment
4. Demonstration of Anaerobic digestion for Waste water treatment
5. Composting
6. Production of biofertilizer
7. Biodegradation of plastics
8. Estimation of heavy metals in water
9. Environmental impact assessment of Fermentation Unit

Course Outcomes:

After the completion of the course the student should be able to:

1. Describe methods for biomonitoring of pollution.

2. Describe principles and methods for biological treatment of wastewater.
3. Describe methods for solid waste management.
4. Describe principles and applications of biodegradation and bioremediation.
5. Explain potential of genetically engineering microbes for bioremediation.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	2	2	1	1	1	2	3	1	1
CO2	3	1	3	3	2	1	3	2	2	1	1	1	3	2	2
CO3	3	1	1	2	3	1	3	2	1	1	2	2	3	3	3
CO4	3	2	2	3	3	1	3	2	1	1	1	1	3	3	3
CO5	3	3	3	3	3	1	3	1	2	1	2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT344: GENOMICS AND GENOME ENGINEERING

L	T	P	C
2	0	2	3

Genomic studies are used to characterize the nucleotide sequences that encode the genetic information of an organism. Comparative genomic studies are useful for identification of biomarkers for diagnostic applications, for elucidation of the function of genes and to identify targets for drug design. This course introduces the methods for characterization of the genome and the methods and applications of genome engineering.

Course Objectives:

- To learn the concepts related to genome organization, epigenomics and comparative genomics
- To learn the genomic organization and sequencing strategies of model organisms
- To learn techniques for genome editing
- To learn methods for molecular cell imaging and transcriptomics
- To understand the concepts of metabolomics

Unit- I **10 hrs.**

Organization of genomes. Genome maps. Data mining and sequence acquisition. Polymorphism and structural variations. Genome wide association studies (GWAS). Epigenomics and comparative genomics. Genome dynamics and cytogenetics.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the organization of the genome (L1)
- learn the concepts related to genomics and applied genomics (L1)
- learn about the genome wide association studies and their importance (L1)
- Understand the applications of genomic engineering (L2)

Unit- II **10 hrs.**

Genome sequence determination and genome analysis of E. coli, Saccharomyces cerevisiae, C. elegans, Drosophila melanogaster, Arabidopsis thaliana and Homo sapiens. Applications of genomics in predictive medicine and forensics.

Learning Outcomes:

At the end of this unit, the student will be able to Genomes of

- model organisms (L2)
- Genome sequence, assembly and annotation of model organisms (L2)
- Importance of model organisms genome sequence (L2) Genetic diversity of model organisms (L1)

Unit- III	**10 hrs.**
Introduction to Genome Editing, DNA repair mechanisms, Methods used in genome editing technology ZFNs, TALENs, Introduction to CRISPR/ CAS technology and its applications, Transfection optimization for efficient gene editing	
Learning Outcomes:	
After completing this unit, the student will be able to • Learn the concepts of genome editing (L3) • Techniques to perform genome editing (L2) • Concepts related to DNA repair (L3)	
Unit- IV	**10 hrs.**
Fluorescent tagging of fixed and live cells, CRISPR-based DNA tagging, Quantitative and high-throughput single-cell image analysis, Chip-seq, RNA-seq, single-cell transcriptomics, guide RNA.	
Learning Outcomes:	
After completing this unit, the student will be able to • Understand the types of molecular cell imaging • Learn about Single cell transcriptomics (L3) • Learn about DNA tagging (L3) • Understand the importance of guide RNA (L4)	
Unit- V	**10 hrs.**
Applications of genome engineering in therapy, synthetic, developmental biology, human genetics and disease phenotyping, Ethical aspects and safety of genome engineering technology.	
Learning Outcomes:	
After completing this unit, the student will be able to • Learn about applications of genome engineering (L5) • Role of genomic engineering in human genetics (L5) • Ethical issues related to genome engineering (L5)	
Text Books:	
S.B. Primrose and R.M. Twyman, Principles of gene manipulations and genomics,7/e, Blackwell publishing, Oxford, U.K. 2006	
References:	
1. . T.A. Brown, Genomes, 3/e, Garland Science, 2006. . A.M. Campbell and L.J. Heyer, Discovering Genomic, Proteomics and Bioinformatics, 2/e, Benjamin Cummings, 2006	

GENOMICS AND GENOME ENGINEERING LAB

Session	**Description of Experiments**
1	Introduction to micropipette handling, pH measurement, stoichiometry and buffer preparation
2	Isolation of genomic DNA from bacteria or plants or blood
3	Spectrophotometric quantification of genomic DNA

4	Agarose gel electrophoresis of genomic DNA
5	Observation of gel under UV (GDS)
6	PCR
7	RTPCR Application (virtual) and data analysis
8	Sanger Sequencing Application (virtual) and data analysis
9	NGS Application (virtual) and data analysis

Course Outcomes:

1. Comprehend the organization of the genome.
2. Compare the Genomes of model organisms.
3. Explain the various techniques that are available for the genome engineering.
4. Design CRISPR based editing tools for the target gene of interest.
5. Evaluate the ethical issues related to genome engineering.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	2	2	1	1	1	2	3	1	1
CO2	3	1	3	3	2	1	3	2	2	1	1	2	3	2	2
CO3	3	1	1	2	3	1	3	2	1	1	2	2	3	3	3
CO4	3	2	2	3	3	1	3	2	1	1	1	2	3	3	3
CO5	3	3	3	3	3	1	3	1	2	1	2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT346: BIOTECHNOLOGY OF FERMENTED FOODS

L	T	P	C
2	0	2	3

Fermentation is one of the most common and efficient methods for preservation and flavor enhancement of food materials. This course describes mechanisms of food spoilage, methods for production of fermented food and the numerous applications of fermentation of food materials.

Unit- I

Microbial growth in food: Microorganisms in foods: Bacteria, molds, yeast. Sources, Microbial growth in foods, Factors affecting growth of microorganism: Intrinsic, Extrinsic; Physical and chemical methods to control growth of microorganisms, Microbial metabolism of food Methods for the microbiological examination of foods.

Unit- II

Microbial spoilage and its effects on food: Contamination, Preservation and Spoilage of different kind of foods cereal, Pulses, Fruit and Vegetable, Meat, fish egg, poultry and their processed products, Milk and milk Products, Canned foods and Beverages. Indication of food spoilage, food borne diseases, intoxication, infection and microbial toxin; Principle and use of biosensor in fermenter.

Unit- III

Introduction to fermentation: microbes and food fermentations, measurement and control in fermentation, Substrate utilization and product formation. Fermenter design, instruments and operation; Aeration and agitation in fermentation: Types of fermentation: sub-merged and solid state. Batch and continuous fermentation, scale up in fermentation. Fermentation Kinetics, Product recovery. Biological waste treatment and in plant sanitation.

Unit- IV

Fermented food: origin, scope and development, sauerkraut, yoghurt, cheese, miso, tempeh, idli, dosa. Regulatory and social aspects of biotechnology of foods, application of enzymes in food industry, production of food flavor, color, enzymes, Immobilized enzymes.

Unit- V

Microbial cultures for food fermentation, their maintenance, strain development; Production of organic acids (vinegar, lactic acid), vitamins, amino acids, alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka), single cell proteins; glycerol Control of Microbiological quality and safety; Product recovery.

Text Books:

1. Robert W. Hudkins, Microbiology and Technology of Fermented Foods, 2006, Willey online
2. Didier Montet, Ramesh C. Ray, Fermented Foods, Part I, Biochemistry and Biotechnology, 1st Edition, CRC press

BIOTECHNOLOGY OF FERMENTED FOODS LABORATORY

These laboratory experiments aim to impart the concepts of fermentation of foods under laboratory conditions. Also, to perform the techniques for isolation of industrially important cultures, microbial, biochemical tests and sensory evaluation of the fermented products. In total, ten experiments have been designed to train students.

Course Objectives:

- To isolate bacteria from various sources
- To handle to laboratory equipment
- To produce various types of fermented food products
- To carry out sensory, microbial, and biochemical tests for the fermented products
- To understand the textural quality using texture analyzer

List of experiments

1. Isolation and characterization of industrially important microorganisms

After completion of this experiment, students will be able to isolate different microbes from natural sources.

2. Production of Sauerkraut

After completion of this experiment, students will be able to produce sour cabbage through fermentation process.

3. Production of Wine

After completion of this experiment, students will be able to produce wine through fermentation process.

4. Microbial and Chemical Analysis of Sauerkraut

After completion of this experiment, students will be able analyze the fermented product

5. Production of Cheese

After completion of this experiment, students will be able to produce cheese by fermentation

6. Analysis of wine

After completion of this experiment, students will be able to test the quality of wine for its quality.

7. Sensory and Microbiological Evaluation of cheese

After completion of this experiment, students will be able to identify the action of microbes in the fermented product and test the quality of cheese for its suitability for consumption.

8. Production, sensory & microbial analysis of Yoghurt

After completion of this experiment, students will be able to produce and analyze quality of yoghurt

9. Production of Baker's Yeast.

After completion of this experiment, students will be able to understand commercial production of Baker's yeast and the optimum conditions for high yield.

10. Preparation of Bread and Texture Analysis

After completion of this experiment, students will be able to produce bread by fermentation and evaluate its texture.

Text Books:

1. Aneja, K.R. 2013. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition, 607p. New Age International Publishers, New Delhi
2. Cappuccino, J.G. and Sherman, N.2011. Microbiology: A Laboratory Manual, 9th Edition. 544 p. Benjamin Cummings Science Publishing, California
3. E. R. Farnworth, 2017. Handbook of Fermented Functional Foods 2nd Edition, 600p. Taylor & Francis Inc.

References:

James G Cappuccino and Natalie Sherman, Microbiology, A laboratory manual, 10/e, Benjamin Cummings, 2013.

Course Outcomes:

1. Explain the microbial growth in foods, examination and control.
2. Interpret Microbial spoilage and its effects on various foods.
3. Apply principles fermentation in product development.
4. Discuss Fermented foods and applications of enzymes.
5. Develop microbial fermented foods.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	1		2				3	1	3	3
CO2	3	2	2	3	1	1		2				3	1	3	3
CO3	3	2	3	3	2	1		2				3	3	3	3
CO4	3	2	3	3	3	1		2				3	3	3	3
CO5	3	2	3	3	3	1		2				3	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT348: SYSTEMS BIOLOGY

L	T	P	C
2	0	2	3

Descriptions of biological systems generally begin with a description of the components of the system followed by details of interactions of each component with other components of the system. However, this bottom-up view cannot provide a complete perspective of complex systems such as cells and organisms. Systems biology provides a top-down perspective of the control mechanisms that are utilized in living beings for maintenance of homeostasis, development and complex responses to external stimuli.

Course Objectives:

The objectives of the course are to:

- introduce concepts of network motifs observable in biological systems (L1)
- explain feed forward loops and their relevance for optimal gene circuit design (L1)
- explore temporal expression programs by feed forward loops and study of network motifs in sensory transcription networks (L1)
- integrate motifs in signal transduction networks and developmental transcription networks (L3)
- introduce the principles of robustness in biological systems (L1)

Unit- I **8 hrs.**

Overview of control mechanisms at transcriptional, translational and enzyme level. Representation of biological networks. Network modeling tools. Modeling and analysis of metabolic networks. Constraint based modeling of metabolic networks. Flux balance analysis. Metabolic flux analysis.

Learning Outcomes:

At the end of this unit, the student will be able to

- represent biological networks using graphs (L1)
- describe methods for modeling of networks (L1)
- understand the principles of metabolic network modeling and analysis (L1)

Unit- II **8 hrs.**

Basic concepts of transcription networks: input functions - logic input function, multidimensional input functions. Dynamics and response time of simple gene regulation. Optimal gene circuit design: fitness function and optimal expression level under constant conditions, optimal regulation under variable conditions.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the input functions for transcription networks (L1)
- build a model for dynamics of simple gene regulation (L5)
- understand the principles of optimal gene circuit design (L1)

Unit- III **8 hrs.**

Network motifs: negative auto regulation, positive auto regulation. Feed forward loop network motif: structure of the feed forward loop gene circuit. Dynamics of Coherent type-1 feed forward loop and Incoherent type-1 feed forward loop. Biological relevance of feed forward loop types. Selection of the feed forward loop network motif.

Learning Outcomes:	
	After completing this unit, the student will be able to • identify the network motifs in transcriptional regulation (L2) • compare the advantages and disadvantages of positive and negative autoregulation (L2) • describe the principles of the feed forward loop network motif (L1) • model the dynamics of the coherent type-1 feed forward loop (L3) • model the dynamics of the incoherent type-1 feed forward loop (L3)
Unit- IV	**8 hrs.**
Single input Unit network motif. Generation of temporal expression programs by single input Units. FIFO temporal order by multi output feed forward loop. Network motifs in sensory transcription networks. Network motifs in developmental transcription networks: two node positive feedback loops for decision making. Network motifs in signal transduction networks.	
Learning Outcomes:	
	After completing this unit, the student will be able to • describe the principles of the single input unit network motif (L1) • model the dynamics of the single input unit network motif (L3) • model the FIFO temporal order of feed forward loops (L3) • describes the network motifs in sensory transcription networks (L1) • describe the network motifs in signal transduction networks (L1)
Unit- V	**8 hrs.**
The robustness principle. Robust patterning in development. Self-enhanced morphogen degradation. Adaptation in bacterial chemotaxis. Models for exact adaptation. Information processing using multi-layer perceptron's. Network motifs in the neuronal network of *C. elegans*.	
Learning Outcomes:	
	After completing this unit, the student will be able to • describe the biological importance of robustness (L1) • describe models for patterning in development (L1) • describe models for adaptation (L1) • describe the motifs in neuronal networks (L1)
Course Outcomes:	
	After the completion of the course the student should be able to • recall concepts of network-based modeling of biological phenomena (L1) • illustrate the types and properties of motifs in transcription networks (L1) • define the principles of gene circuit design (L1) • identify properties that lead to robust systems (L2) • describe examples of adaptive networks (L1)
Text book	
1. Uri Alon, An introduction to systems biology. Design principles of biological circuits, CRC Press, 2006. 2. Edda Klipp, Wolfram Lieber meister, Christoph Wierling, Axel Kowald. Systems 3. Biology: A Textbook. Edition 2. John Wiley & Sons, 2016. 4. Uri Alon, An introduction to systems biology. Design principles of biological circuits, CRC Press, 2006. 5. Edda Klipp, Wolfram Lieber meister, Christoph Wierling, Axel Kowald. Systems	

References:	
	1. Eberhard Voit. A First Course in Systems Biology. Edition 2. Garland Science, 2017. 2. Markus W. Covert. Fundamentals of systems biology. CRC Press, 2015. 3. C. J. Meyers, Engineering genetic circuits, CRC Press, 2009. 4. M. Ptashne, A genetic switch: phage [lambda] and higher organisms, Cell Press, 1992.

SYSTEMS BIOLOGY LAB

List of experiments for Systems Biology Lab:

Any eight of the following experiments are required:

1. Kegg Pathway: Glycolysis
2. Kegg Pathway: Oxidative phosphorylation
3. Kegg Pathway: Melanoma
4. Cystoscope: Creating Pathways & Networks
5. Cystoscope: Mapping Networks
6. Cystoscope: Data visualization
7. Virtual Cell: Model: reactions
8. Virtual Cell: Model: pathways
9. Virtual Cell: Model: networks
10. Virtual Cell: Simu

19EBT352: MARINE BIOTECHNOLOGY

L	T	P	C
2	0	2	3

Marine ecosystems are a major source of food, oxygen and play a vital role in biogeochemical cycles. This course describes the natural products obtainable from marine resources and the application of biotechnology for diagnosis of diseases prevalent in commercially important marine organisms such as fish.

Course Objectives:

Introduce the marine environment and the processes associated.

- Provide the basis for evaluation and conservation of marine biodiversity.
- Describe the resources from marine environment**.**
- Introduce the different aspects of aquaculture**.**
- Describe the applications of marine biotechnology

Unit- I **8 hrs.**

Overview of the present status of marine biotechnology, Marine ecosystems – intertidal zone, inhabitants and ecology of estuaries, salt marshes, mangrove swamps, coral reefs and the deep sea, Plankton, nekton and benthos.

Learning Outcomes:

At the end of this unit, the student will be able to

- summarize the status of marine biotechnology in India(L2)
- distinguish different zones in the marine environment(L4)
- classify marine organisms. (L2)

Unit- II **8 hrs.**

Introduction to tides and waves. Water currents and winds. Major and minor elements in the sea water and their importance, dissolved oxygen. Biogeochemical cycles (Carbon, Nitrogen, Sulphur and Phosphorus) in the ocean. Global climatic change and potential effects on coral bleaching, eutrophication.

Learning Outcomes:

At the end of this unit, the student will be able to

- the importance of physical and chemical processes in the marine environment(L2) explain
- global climate changes(L2)
- interpret the effects of climate change in the marine environment(L2)

Unit- III **8 hrs.**

Applications from both the biology and policy perspectives (e.g. endangered species, captive breeding, habitat fragmentation, ecosystem restoration, rehabilitation. Marine food web dynamics - primary, secondary and tertiary production.

Learning Outcomes:

After completing this unit, the student will be able to evaluate

- marine biodiversity (L5)
- explain the methods of conservation of marine environment as well as organisms(L2)
- Percieve the potential of marine food web. (L5)

Unit- IV	**8 hrs.**
Marine natural products, aquaculture, valuable chemicals, bioactive compounds from micro-algae, macro-algae and other marine organisms.Important enzymes from marine microorganisms and their applications: Xylanases, proteases, chitinases.	
Learning Outcomes:	
	After completing this unit, the student will be able to • appraise the potential of marine organisms in terms of natural products(L5) • identify chemicals and bioactive compounds useful in medical and research applications(L3) • explain the importance of enzymes for industrial applications(L2)
Unit- V	**8 hrs.**
Marine biotechnology for economic development and environmental problem solving. Aquaculture-fish, shrimp and pearl oyster culture. Transgenic marine organisms. Biofouling and prevention. Bioremediation. Probiotic bacteria and their importance in aquaculture. PCR, molecular and immunological techniques for determination and identification of bacterial and viral pathogens in aquaculture. Vaccines for aquaculture.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Explain the potential of marine biotechnology for economic development & to resolve environmental issues(L5) • outline the principles & processes of different aquaculture techniques(L2) • summarize the use of biotechnological approaches to develop transgenic marine animals and maintenance of health of cultured organisms. (L2)
Course Outcomes:	
	After the completion of the course the student should be able to • explain physicochemical aspects of marine environment(L5) • summarize applications of marine natural products(L2) • apply biotechnological interventions to economic and environmental issues(L3) • appreciate the importance of marine biotechnology. (L5)
Text Books:	
	1. Text book of Marine Ecology. (1989). Nair N.B. & Thampy, D.M. 2. Recent Advances in Marine Biotechnology. Vol.2 (1998) Fingerman, M., Nagabushanam, R., Thompson, M.
References:	
	1. Biological Oceanography. (1999). Lilly, C.M. 2. Ecology of Coastal water. (1988). Mann, K.H. 3. An introduction to Marine Sciences. (1988). Meadows, P.S. & Campbell J.J. 4. General Oceanography –An introduction (1980). Dietrich,G., Kalle,K, Krauss,W&Siedler, G. 5. Biotechnology in the marine sciences: Proceedings of the first annual MIT Sea grant lecture & seminar. (1984). Colwell, R.D.(Ed)

MARINE BIOTECHNOLOGY LABORATORY

Any eight of the following experiments:

1. Identification of marine ecosystems

2. Determination of metal ions in sea water
3. Nitrogen cycle in marine ecosystems
4. Carbon cycle in marine ecosystems
5. Characterization of marine natural products
6. Characterization of marine chitin/chitinase
7. PCR for identification of bacterial pathogens in aquaculture
8. PCR for identification of viral pathogens in aquaculture
9. Immunological techniques for identification of bacterial pathogens in aquaculture.
10. Immunological techniques for identification of viral pathogens in aquaculture.

Course Outcomes:

1. Explain the overview of the present status of marine biotechnology.
2. Discuss tides and waves and Biogeochemical cycles.
3. Apply principles of biology and policy perspectives in marine biology.
4. Discuss various marine natural products.
5. Apply marine biotechnology in economic development and environmental problem solving.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	1						3	2	3	3
CO2	3	2	1	3	1	2	2					3	2	3	3
CO3	3	2	2	3	2	3	2					3	2	3	3
CO4	3	2	2	3	3	3	2	2				3	2	3	3
CO5	3	2	3	3	3	3	3					3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT354: PROTEOMICS AND PROTEIN ENGINEERING

L	T	P	C
2	0	2	3

Proteomic studies are used to characterize the complete set of proteins in a cell, tissue, organ or organism. Comparative proteomic studies are useful for identification of biomarkers for diagnostic applications, for elucidation of the function of proteins and to identify targets for drug design. Stability and enzyme activity can be improved by protein engineering. This course introduces the methods for characterization of the proteome and the methods and applications of protein engineering.

Course Objectives:

- describe potential applications of proteomics
- describe databases related to proteomics
- describe the methods for proteomics studies
- describe the methods of protein engineering
- describe the applications of protein engineering

Unit- I

Expression Proteomics: Proteome characterization by DIGE, Mass spectrometry and High throughput protein sequencing. Protein chips.
Structural Proteomics: Comparative modeling, Molecular Replacement for X-ray diffraction, NMR spectroscopy.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the methods for expression proteome characterization (L1)
- explain the benefits and limitations of proteomics (L2)
- describe the methods used in structural proteomics (L1)

Unit- II

Interaction proteomics: Phage display, yeast two hybrid and mass spectroscopy.
Functional proteomics: Predicting function from sequence, structure and interaction data.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe methods used in interaction proteomics (L1)
- describe methods used in functional proteomics (L1)
- explain the limitations of benefits of interaction proteomics and functional proteomics (L2)

Unit- III

Proteomics databases: protein sequence identification, protein expression data, protein structures, protein-protein interactions, protein function.
Applications of proteomics: Biomarkers for diagnosis. Target identification in drug development.

Learning Outcomes:

After completing this unit, the student will be able to

- summarize information available in proteomics databases (L2)
- identify sources of proteomics information (L3)

	• describe applications of proteomics (L1)
Unit- IV	
Objectives of protein engineering. Reaction environment engineering. Chemical modification of proteins. Principles of directed evolution for protein engineering. Methods for library design and high throughput screening. Semirational and Rational design for protein engineering. Characterization of engineered enzymes.	
Learning Outcomes:	
	After completing this unit, the student will be able to • describe the methods for reaction environment engineering (L1) • describe chemical methods for engineering of proteins (L1) • describe genetic methods for engineering of proteins (L5) • summarize rational design methods for protein engineering (L2)
Unit- V	
Engineering of DNA polymerase for PCR applications. Engineering of lipases and cellulases for biofuel production. Antibody engineering. Enzyme engineering for production of antibiotics. Enzyme engineering for degradation of xenobiotics. Protein engineering for biosensors.	
Learning Outcomes:	
	After completing this unit, the student will be able to • describe applications of protein engineering for bioanalytial applications (L1) • describe applications of protein engineering in environmental biotechnology (L1) • describe applications of protein engineering for biopharmaceutical applications (L1)
Text Books:	
	1. R. Twyman. Principles of proteomics. 2nd edition. Garland Science. 2013. 2. A.Rees M.J.E.Sternberg and R.Wetzel. Protein Engineering. Oxford University Press. 1993.
References:	
	1. S.R.Pennington and M.J.Dunn. Proteomics: From Protein Sequence to Function. Garland Science. 2001. 2. Stefan Lutz, Uwe Theo Bornscheuer. Protein Engineering Handbook. Vol. 3. Wiley. 2013 3. Uwe Theo Bornscheuer and Mathias Hohen. Protein Engineering. Humana Press.2018.

PROTEOMICS AND PROTEIN ENGINEERING LAB

Session	Description of Experiments
1	Isolation of total Protein from bacteria or plants or blood
2	Estimation of total protein concentration using Lowry's method.
3	Estimation of total protein concentration using Bradford's method.
4	Estimation of total protein by using BCA method
5	SDS-PAGE: Application
6	Western blotting: application (Virtual) and data analysis

7	2D-PAGE: application (Virtual) and data analysis
8	MALDI-TOF MS: application (Virtual) and data analysis

Course Outcomes:

1. Explain Expression Proteomics and Structural Proteomics.
2. Discuss Interaction proteomics and functional proteomics.
3. Interpret Proteomics databases and applications of proteomics.
4. Explain protein engineering and high throughput screening.
5. Apply enzyme engineering for production of antibiotics, degradation of xenobiotics, antibody engineering and biosensors.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	1		1				3	2	3	3
CO2	3	2	2	3	2	1		1				3	2	3	3
CO3	3	2	2	3	2	1		1				3	2	3	3
CO4	3	2	2	3	2	1		1				3	2	3	3
CO5	3	2	2	3	2	1		1				3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT356: FOOD PROCESSING TECHNOLOGY

L	T	P	C
2	0	2	3

The shelf life, texture and taste of most food materials can be improved by application of food processing technology. This course describes the methods used for food processing and food quality assessment.

Unit- I

Properties and processing theory of foods, Size reduction theory, Material transfer phenomena of foods, Effects of processing on nutritional properties and sensory characteristics, scope and importance of food processing, Theory and equipment of membrane technology: microfiltration, ultrafiltration, nanofiltration and reverse osmosis processes and their application in food industry.

Learning Outcomes:

At the end of this unit, the student will be able to

- Describe the scope of food processing (L1)
- Describe the benefits of processed food (L1)
- Explain the principles and applications of membrane technology for extending shelf-life of food (L2)

Unit- II

Thermal food processing: Concept and mechanisms of heat transfer, Sources of heat and methods of application to foods, concept of sterilization, blanching, pasteurization on reduction of pathogens, concept and principles of microwave and radio frequency heating, Infra- Red (IR), Ohmic and Inductive heating, and, Effect of heat on nutritional and sensory characteristics, mechanism of microbial inactivation by thermal processing techniques Prolonging shelf life of food

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the mechanism of MW and RF radiation for food preservation and quality improvements (L2)
- explain the principles and application heating in food processing (L2)
- Explain principles and applications of Pulse electric field (PEF) in food processing (L2)
- Explain the principles and applications of X-ray irradiation for food processing (L2)

Unit- III

Non-thermal food processing: Concept and principles: Hurdle technology, Processing Theory, equipment and application of High pressure processing (HP), ultrasonic processing, Irradiation theory and equipment: high intensity light, pulsed electric field, pulsed X-ray heating, application of Irradiation, mechanism of microbial inactivation by non-thermal processing, Concept, principles and application of nanotechnology in food, pharmaceutical or medical sectors

Learning Outcomes:

After completing this unit, the student will be able to

- describe hurdle technology for food (L1)
- describe principles and applications of High Pressure Processing (HPP) (L1)
- describe principles and applications of ultrasonic processing (L1)
- describe principles and applications of nanotechnology in food processing (L1)

Unit- IV

Food safety, good manufacturing practice and quality assurance**,** Contaminants and Food Safety**,** Quality controls and its detection in foods products: Methods of quality assessment, Export Quality Control and Inspection Systems, concept and application of Codex Almentarious, HACCP, USFDA, ISO 9000; Package function and design principles, Controlled- or modified-atmosphere storage and packaging, Deteriorative changes in foodstuff, Packaging methods for protection from deterioration Shelf life of packaged foodstuff

Learning Outcomes:

After completing this unit, the student will be able to

- Describe methods for quality assessment of foods (L1)
- Describe standards for food quality (L1)
- Describe role of packaging (L1)
- Describe the mechanism of food spoilage (L1)
- Describe methods to extend shelf life of food products (L1)

Unit- V

Introduction**,** important and benefits of nutraceuticals, Dietary Supplements and functional food products, manufacturing and application of lycopene, isoflavonoids, Prebiotics and probiotics food, phytosterol and glucosamine, Formulation of functional foods or nutraceuticals.

Learning Outcomes:

After completing this unit, the student will be able to

- Describe the role of nutraceutical compound/ food (L1) Describe the
- mechanism of action of nutraceuticals (L1)
- Describe the manufacturing methods of nutraceutical (L1) distinguish
- probiotics and prebiotics food (L3)

Text Books:

1. Zeki Berk, 2009, Food Process Engineering and Technology, International Series. Series Editor: Steve L. Taylor, First edition,
2. P. Fellows, 2000, Food Processing Technology: Principles and Practice, Woodhead Publishing Limited, Cambridge CB1 6AH, England
3. Carl J Schaschke, 2011, Food Processing, Carl J. Schaschke & Ventus Publishing ApS

References:

1. Fellows, P. & Ellis H.1990 Food Processing Technology. Principles and practice; Newyork
2. Macrae R, Roloson R & Sadlu MJ. 1994. Encyclopedia of Food Science & Technology & Nutrition. VolXVI. Academic Press.
3. Nesser JR & German BJ.2004. Bioprocesses and Biotechnology for Nutraceuticals. Chapman & Hall.
4. Shi J. (Ed) 2006. Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC.
5. Barbosa-Canovas, G.V.,Maria Tapia and M. Pilar Cano, eds. 2005. Novel Food processing Technologies. Boca Raton, FL: CRC Press.
6. Rajesh K. Srivastava, Food processing, quality analysis and quality assurance, 2018, Shree publishers and contributions, Delhi
7. Perkins Muredzi, 2013, Food is Medicine – An Introduction to Nutraceuticals, LAP LAMBERT Academic Publishing, pp.276

FOOD PROCESSING TECHNOLOGY LABORATORY

Minimum of 8 experiments from the following:

Experiment- 1-: Crude Protein- Kjeldahl Method

Experiment- 2-: Moisture Content- Lab Oven Method

Experiment-3-: Crude Fat- Soxhlet Apparatus Method

Experiment- 4-: Detection of adulterants in different food products

Experiment- 5-: Crude Fiber Objective

Experiment- 6-: Cut out test for Canned Fishery Products

Experiment- 7-: Determination of total carbohydrate of a food sample

Experiment- 8-: Microbiological analysis of fruits and vegetables

Experiment- 9-: Microbial analysis of ice cream and soft drink

Experiment- 10: Good Manufacturing Practices for foods

Experiment- 11: Food Preservation Techniques

Experiment- 12: Control drying of fruits and vegetable by microwave heating.

Objective 1: To find out the amount of crude protein in a given food sample

Objective 2: To find out the moisture content from a given food sample by lab oven method

Objective 3: To find out the amount of crude fat in a given food sample.

Objective 4- To test different given food samples for adulteration

Objective 5- To find out the amount of crude fiber in a given food sample

Text Book(s)

1. S. Ranganna, Handbook of analysis and quality control for fruit and vegetable products, 2/e, Tata McGraw Hill, 1986.

2. S. S. Nielsen, Introduction to the chemical analysis of foods. CBS Publishers and Distributors, 2002.

19EBT358: PHARMACEUTICAL BIOTECHNOLOGY

L	T	P	C
2	0	2	3

The science of pharmaceutical biotechnology is a dynamic science aimed at focusing the attention of students on the manufacture and recovery of biopharmaceuticals and other biological products, basic knowledge about biological techniques used in production of some biological drugs and some basic principles and definitions related to pharmaceutical biotechnology. Dosage forms, pharmacokinetics, dynamics and Clinical Trials, case studies on biopharmaceutical product development which would broaden the knowledgebase of the students.

Course Objectives:

- Introduce the drug discovery, development, regulatory aspects of drugs and cosmetics act.
- Impart knowledge of drug dosage forms Pharmacokinetics and dynamics.
- Summarize bulk drug production and a case study.
- Explain pharmacology principles, classification of drugs and mechanisms.
- Discuss case studies on biopharmaceutical product development

Unit- I: Introduction **8 hrs**

History of pharmaceutical industry, drug discovery and development phases; Introduction to pharmacokinetics and pharmacodynamics (factors affecting drug metabolism (ADME)), Dose effect relationship, adverse drug reactions (ADR), the role of patents in the drug industry.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the history of the pharmaceutical industry (L2).
- explain drug discovery and development phases (L2).
- introduction to concepts of pharmacokinetics and pharmacodynamic principles and ADR (L2).
- understand the role of patents in the drug industry and protein-based drugs (L2).

Unit- II: Dosage form **8 hrs**

Drug screening principles; definition of dosage forms, classification of dosage forms (solid unit dosages – Tablets, capsules; liquids – solutions, lotions, suspension etc; semi-solid – ointments; Parenteral)

Learning Outcomes:

At the end of this unit, the student will be able to

- explain drug screening principles (L2)
- define dosage forms (L2).
- explain different classes of dosage forms (L2).
- understand the factors affecting ADME (L2).

Unit- III: Bulk Drug Manufacturing	**8 hrs**
Bulk drug manufacturing: Types of reactions in bulk manufacture and processing. Special requirements for bulk drug manufacture. Case study: Unit process and unit operations of inulin production, purification, formulation, and packaging.	
Learning Outcomes:	
After completing this unit, the student will be able to ● explain types of reactions in bulk drug manufacture(L2) ● explain special requirement for bulk drug production (L2) ● explain unit process, operations, formulations and packaging of insulin (L2)	

Unit- IV	**6 hrs**
Generics and its advantages; bio-generics and biosimilar, protein-based biopharmaceuticals; Marine natural products, bioactive compounds from micro-algae, macro-algae, and other marine organisms.	
Learning Outcomes:	
After completing this unit, the student will be able to ● explain generics, bio-generics and biosimilars (L2) ● appraise protein-based biopharmaceuticals (L2) ● appraise the potential of marine organisms in terms of natural products (L2) ● explain the importance of micro and macro algae and marine microorganisms (L2)	

Unit- V	**6 hrs**
Quality control: GMP, GLP, Purity determination as per ICH guidelines, FSSA guidelines, use of biochemical and molecular techniques in quality evaluation. Drugs and Cosmetics Act and regulatory aspects.	
Learning Outcomes:	
After completing this unit, the student will be able to ● Explain Good Manufacturing Practices (GMP) (L2) outline the ICH ● guidelines for purity determination (L2) ● summarize the biochemical and molecular techniques used in quality evaluation of drugs (L2). ● explain regulatory aspects of drug production.	

Textbooks:

1. D.M. Brahmankar and Sunil B. Jaiswal 2019 Biopharmacuitics and pharmacokinetics - A Treatise 3/e Vallabha prakashan new edition. 9788185731933.
2. Ghangas Jyoti, A. N. Nagappa, A. Kaushik, G. Agarwal 2022 Biopharmaceutics and Pharmacokinetics, 1/e, CBS Publishers & Distributors.
3. Fingerman, M., Nagabushanam, R., Thompson, M. 1998. Recent Advances in Marine Biotechnology. Vol.2

References:	
	1. R.K. Khar, S. P. Vyas, F J Ahmad G.K. Jain 2020. Lachman/Lieberman's, The Theory And Practice Of Industrial Pharmacy, CBS publishers and Distributors 4/e. 2. Biotechnology in the marine sciences: Proceedings of the first annual MIT Sea grant lecture & seminar (1984), Colwell, R.D. (Ed)

19EBT358P: PHARMACEUTICAL BIOTECHNOLOGY LABORATORY

This laboratory course provides knowledge and hands on experience in pharmaceutical agents in pharmaceutical biotechnology to the students. The student will be able to learn weights and measures, preparation of tablets, capsules, semisolid dosage forms and monophasic liquid dosage forms, phytochemical analysis, preparation bioactive compounds from marine microbes and micro algae, probiotics for usage in aquaculture, Isolation of proteases and chitinases from marine microbes and identification of bacterial/ viral pathogens in aqua culture using PCR or immunological techniques.

Course Objectives:

This laboratory aims to

- Provide concepts in weights and measures, preparation of various dosage forms and phytochemical analysis and bioactive compounds isolation from various sources, probiotics used in aqua culture and determination of pathogens in aquaculture either by PCR or immunological methods. Some of the experiments are demonstration experiments.

1. Recombinant insulin production video-based lecture (demonstration)

   After completion of this experiment, the student will be able to prepare protein-based pharmaceuticals.

2. Preparation and evaluation of Aspirin tablets

   After completion of this experiment, the student will be able to prepare tablet dosage forms.

3. Preparation and evaluation of Tetracycline capsules

   After completion of this experiment, the student will be able to prepare capsule dosage forms.

4. Preparation of Creams (cold / vanishing cream).

   After completion of this experiment, the student will be able to prepare ointments.

5. Preparation of Eye drops/ and Eye ointments

   After completion of this experiment, the student will be able to liquid dosage forms.

6. Powder characteristics & extraction & detection of: Cinchona, Cinnamon

   After completion of this experiment, the student will be able to identify the type of phytochemicals present in the given plant extract.

7. Preparation of bioactive compounds from marine microbe/ algae

   After completion of this experiment, the student will be able to identify the type of bioactive compounds present in the given marine microbe / algae.

8. Probiotics for aquaculture

   After completion of this experiment, the student will be able to prepare probiotics.

9. Identification of bacterial/ viral pathogens in aquaculture using PCR
   After completion of this experiment, the student will be able to identify the pathogens of aquaculture.
10. Identification of bacterial/ viral pathogens in aquaculture using immunological techniques After completion of this experiment, the student will be able to identify the pathogens of aquaculture.

Text Books:

1. Pharmaceutical dosage forms - Tablets, volume 1 -3 by H.A. Liberman, Leon Lachman & J.B.Schwartz
2. W.C.Evans, Trease and Evans Pharmacognosy, 16th edition, W.B. Sounders & Co., London, 2009.

References

1. Modern Pharmaceutics by Gilbert S. Banker & C.T. Rhodes, 3rd edition.

Course Outcomes:

1. Explain drug development, pharmacokinetics and pharmacodynamics
2. Apply drug screening principles and dosage forms for drug delivery.
3. Analyse types of reactions in bulk drug manufacture with a case study.
4. Explain of generics and bioactive compounds as drugs.
5. Discuss regulatory aspects and GMP & ICH guidelines in purification of drug.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	1	2			1	2	2	2	2
CO2	3	3	3	3	3	2	1	2			1	2	3	2	2
CO3	3	3	3	3	3	2	1	2			1	2	3	2	2
CO4	3	3	3	3	3	2	1				1	2	3	2	2
CO5	2	2	1	2	3	2	1	3		1	2	2	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT441: BIOPROCESS PLANT DESIGN

L	T	P	C
2	0	2	3

Unit- I	**8 hrs**
General design information; Material and energy balance calculations; Process flow sheeting.	
Unit- II	**8 hrs**
Scale up issues: Effect of oxygenation, mixing, sterilization, pH, temperature, inoculums and nutrient availability; Bioreactor scale-up based on constant power consumption per unit volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution); Filtration (constant resistance); Centrifugation (equivalent times); Extractors (geometry-based rules).	
Unit- III	**8 hrs**
Selection of bioprocess equipment (upstream and downstream); Specifications and Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment.	
Unit- IV	**8 hrs**
Facility design: Utility supply; Equipment cleaning; Cell culture banks; cGMP guidelines; Validation; Safety.	
Unit- V	**8 hrs**
Pilot plant design; Fermenter design calculations (simulations), downstream processing calculations, environmental and economic considerations.	
Text Books:	
	1. M.V. Joshi and V.V. Mahajani, Process Equipment Design, 3/e, Macmillan India, 2008. 2. J.M. Coulson, J.F. Richardson (Eds.) and R.K. Sinnott, Chemical Engineering Volume 6: An introduction to Chemical Engineering Design, 2/e, Butterworth-Heinemann, 1996.
References:	
	1. M. Shuler and F. Kargi, Bioprocess Engineering Basic Concepts, 2 /e, Prentice Hall, 2002. 2. M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 3/e, McGrawHill, 2003. 3. R. H. Perry and D. W. Green (eds.), Perry's Chemical Engineers' Handbook, 8/e, McGraw Hill, 2007.

BIOPROCESS PLANT DESIGN LABORATORY

Minimum of 8 experiments from the following:

1. Selection of equipment for production of alcohol by fermentation
2. Plant layout for production of alcohol by fermentation
3. Process flowsheet for production of alcohol by fermentation
4. Material & Energy balance for production of alcohol by fermentation
5. Material and Energy balance for distillation
6. Design of a unit for distillation of alcohol
7. Material and Energy balance for pasteurization of milk
8. Selection of equipment for pasteurization and packaging of milk
9. Design of a unit for pasteurization of milk
10. Plant layout for pasteurization and packaging of milk

Course Outcomes:

1. Understand and apply essential design parameters and procedures for bioprocess equipment.
2. Grasp scale-up issues and perform preliminary scaling measures for various bioprocess equipment.
3. Select, design, and maintain bioprocess equipment with sterility considerations.
4. Understand facility requirements, utility supply, safety regulations, and implement validation processes.
5. Efficiently design a pilot plant, accounting for fermentation & downstream processing calculations, and environmental/economic considerations.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	2	1	1		1	1	1	1	1	2	2
CO2	2	2	3	2	2	1	1		1	1	1	1	1	2	2
CO3	2	1	1	1	1	2	1		1	1	1	1	1	2	2
CO4	2	1	1	1	1	2	1		1	1	1	1	1	2	2
CO5	1	2	3	2	2	1	1		1	1	1	1	1	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT443: METABOLOMICS AND METABOLIC ENGINEERING

L	T	P	C
2	0	2	3

Metabolomic studies are used to characterize the complete set of metabolites in a cell, tissue, organ or organism. Comparative metabolomic studies are useful for identification of biomarkers for diagnostic applications, for elucidation of metabolic pathways and to identify targets for drug design. Metabolic engineering can be utilized for optimizing the yield of desired metabolites in industrial biotechnology. This course introduces the methods for characterization of the metabolome and the methods and applications of metabolic engineering.

Course Objectives:

- Provide information regarding databases of metabolomic data
- Describe methods useful for obtaining metabolomic data
- Introduce methods for analysis of metabolomic data
- Describe the principles of metabolic engineering
- Describe the applications of metabolic engineering

Unit- I **8 hrs**

Introduction to metabolomics. Metabolite identification and quantification by mass spectrometry and NMR spectroscopy. Mass spectral databases. Metabolic flux determination by time dependent changes in concentration. Metabolic flux determination by isotope labeling: Analysis of mass spectral data. Analysis of NMR spectral data.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe methods for metabolite identification (L1)
- compare methods for metabolite quantification (L3)
- describe methods for metabolic flux determination (L1)
- interpret metabolomic data (L2)

Unit- II **8 hrs**

Stoichiometry of cellular reactions, mathematical formulation of rate laws. Metabolic network reconstruction. Introduction to Metabolic flux analysis. Steady state analysis and sensitivity analysis (Linear systems only).

Learning Outcomes:

At the end of this unit, the student will be able to

- calculate stoichiometric coefficients (L3)
- explain the concepts of metabolic flux analysis (L4)
- analyze metabolic flux analysis data (L4)
- describe the methods for metabolic network reconstruction (L1)

Unit- III **8 hrs**

Metabolic control analysis: Fundamentals of metabolic control analysis, control coefficients and the summation theorems, determination of flux control coefficients. MCA of linear and branched pathways. Case studies.

Learning Outcomes:

After completing this unit, the student will be able to

- understand the concepts of Metabolic control analysis (L2)
- describe methods for determination of flux control coefficients (L1)
- analyze linear and branched pathways (L4)

Unit- IV **8 hrs**

Metabolic engineering and metabolic pathway engineering. Regulation of metabolic pathways. Regulation of metabolic networks. Metabolic engineering by gene amplification, gene disruption, and strain improvement. Synthetic biology for metabolic engineering.	
Learning Outcomes:	
	After completing this unit, the student will be able to • summarize mechanisms of regulation of metabolic pathways and networks (L2) • describe methods of metabolic engineering based on gene manipulation (L1) • describe application of synthetic biology for metabolic engineering (L1)
Unit- V	**8 hrs**
Calculation of theoretical yield. Amino acid production by glutamic acid bacteria, metabolic engineering of lactic acid bacteria, riboflavin production by Bacillus subtilis, metabolic engineering of Saccharomyces cerevisiae.	
Learning Outcomes:	
	After completing this unit, the student will be able to • list metabolomic databases (L1) • calculate theoretical yield of a reaction (L3) • apply metabolic control analysis (L2)
	• describe application of metabolic engineering in bacteria (L1) • describe application of metabolic engineering in eukaryotes (L1)
Course Outcomes:	
	After the completion of the course the student should be able to • describe methods for identification and quantification of metabolites (L1) • summarize methods for control of metabolic pathways (L2) • calculate flux control coefficients and theoretical yeilds (L3) • explain the principles of metabolic engineering (L4) • describe the applications of metabolic engineering (L1)
Text Books:	
	1. Eberhard Voit. A First Course in Systems Biology. Edition 2. Garland Science, 2017. 2. G.N. Stephanopoulos, A.A. Aristidou, J. Neilsen, Metabolic engineering. Principles and Methodologies, Academic Press, Elsevier, 1998.
References:	
	1. C .Wittman, S.Y.Lee (ed.), Systems metabolic engineering, Springer, 2012. 2. B.N. Kholodenko, H.V. Westerhoff (ed.), Metabolic engineering in the post-genomic era, Horizon bioscience, 2004.

METABOLOMICS AND METABOLIC ENGINEERING LABORATORY

Minimum of 5 experiments from the following:

1. Estimation of k_m of an enzyme
2. Estimation of V_{max} of an enzyme
3. Effects of enzyme inhibitors on enzyme kinetics: Competitive inhibition
4. Effects of enzyme inhibitors on enzyme kinetics: Irreversible inhibition
5. Metabolite identification from Mass Spectral data
6. Metabolite identification from NMR spectral data
7. Metabolic pathways models
8. Optimization of flux in a metabolic pathway

19EBT445: SEA AND DAIRY FOOD PROCESSING

L	T	P	C
2	0	2	3

Unit- I	**8 hrs**
Seafood Processing: Principles of preservation and processing; chilling and freezing methods, cold storage, phenomena of rigor mortis, spoilage changes and causative factors. Drying; conventional methods, salt curing, pickling and smoking. Canning and hurdle technology in food preservation. Role of preservatives in processing. Fishery by-products.	
Unit- II	**8 hrs**
Milk processing: Fluid milk processing, packaging and distribution. Common dairy processes: cream separation (standardization), pasteurization, sterilization and homogenization. UHT processing of milk. Process technology for manufacture of evaporated milk, condensed milk, dried milk, malted milk, reconstituted/rehydrated milk, recombined milk, toned milk and fermented milk.	
Unit- III	**8 hrs**
Dairy and food processing operations 1: Overview of thermal operations carried out in dairy processing. Role of water and water activity in foods. Crystallization and freezing. Estimation of freezing time of foods. Concentration of liquid foods in batch, continuous type and multiple effect evaporators with mechanical and thermal vapor compression. Mechanism of moisture removal in solid and liquid foods during drying. Spray, freeze, roller tray and through-flow drying operations.	
Unit- IV	**8 hrs**
Dairy and food processing operations 2: Overview of mechanical operations carried out in dairy processing. Particle size separation in spray dryer and gravity separator. Filtration of food. Slurry filter medium and cake resistances. Size separation through sieving. Particle movement in sediment and centrifugal settling tank. Solid bowl and disc bowl centrifuges. Operation of cyclone separator and self cleaning centrifuge. Agitation and mixing of liquid foods, powders and pastes.	
Unit- V	**8 hrs**
Butter: Composition, flow diagram of production, yield, fat loss in butter making. Continuous butter making, grading of table butter, defects in butter; causes and prevention. Cheese: Flow diagram of production. Cheddar cheese, mozzarella cheese and processed cheese manufacturing. Curing and storage of cheese. Defects cause, prevention and quality control. Ice Cream: Composition and flow diagram of production. Infant, baby foods and indigenous dairy products. Laws and standards in Fishery Industry: Quality control with reference to sea food. Novel product development, nutrition promotion, consumer studies, marketing and sea food export. MPEDA, government policies, export finance, economic importance.	
Text Books:	
	1. A. Tufail, Dairy Plant Engineering and Management, Kitab Mahal Distributors, 2014. 2. P. Sinha, Fish processing and preservation, APH Publishing, 2011.
References:	
	1. A.W. Farrall, Engineering for Dairy and Food Products, John Wiley and Sons, New York, 1963. 2. R. P. Aneja, B. N. Mathur, R. C. Chandan and A. K. Banerjee, Technology of Indian M i l k Products: Handbook on Process Technology, Modernization for Professionals, Entrepreneurs and Scientists. A Dairy Indian publication ,2002

SEA AND DAIRY FOOD PROCESSING LABORATORY

Minimum of 8 experiments from the following:

1. Drying of fish
2. Production of marine algal foods
3. Production of cheese
4. Production of yoghurt
5. Production of buttermilk
6. Production of butter
7. Evaluation of cheese
8. Evaluation of yoghurt
9. Pasteurization of milk
10. Evaluation of milk

Text Book(s)

1. S. S. Nielsen, Introduction to the chemical analysis of foods. CBS Publishers and Distributors, 2002.

Course Outcomes:

1. Understand the scope and importance of sea foods processing with its zero wastes concept.
2. Apply processing and packaging technology for milk products with its manufacturing concept.
3. Implement thermal operation for processing /technology for milk products with its manufacturing concept.
4. Understand mechanical operation concept for milk processing/ technology with its products manufacturing.
5. Implement the regulations pertinent to the sea and dairy food industries including butter and cheese quality.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	2	2	1	1	1	1	3	2	3
CO2	3	3	1	1	2	2	2	2	2	1	1	2	3	2	3
CO3	3	2	2	1	1	1	3	2	1	1	2	2	3	2	3
CO4	3	2	2	2	2	1	2	2	1	1	1	2	3	3	2
CO5	3	3	3	2	3	1	3	2	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT447: MOLECULAR MODELING AND DRUG DESIGN

L	T	P	C
2	0	2	3

Quantum mechanics is the foundation for predistortion of the stability of molecules. Molecular mechanics enables us to evaluate the relative energies of different conformations of a molecule. Molecular mechanics and knowledge-based methods can be used to predict the mode of binding and stability of protein-ligand complexes. This knowledge can be used to design drugs that bind to selected molecular targets. This course is an introduction to the principles and algorithms applicable for design of drugs.

Course Objectives:

- introduce the principles of quantum mechanical methods of molecular modeling
- introduce the principles of classical mechanical methods of molecular modeling
- introduce the principles of knowledge-based methods of molecular modelling
- introduce the principles of conformational analysis of biomolecules
- describe the benefits and limitations in the application of molecular modeling for drug design.

Unit- I

Quantum chemistry for Modeling of small molecules: Postulates of Quantum Mechanics. Variation method and Time independent Perturbation theory. Ab initio methods for molecules: Hartree-Fock SCF method. Common basis sets. Semi-empirical methods. Huckell's molecular orbital theory.

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstrate knowledge of the postulates of quantum mechanics (L1)
- understand the principles of the basic quantum chemical methods (L2)
- understand the principles of the the ab initio and semi-empirical methods (L2)
- select optimum basis set based on requirements of the application (L5)
- calculate energies and wavefunctions of small molecules using Huckels MO theory (L3)

Unit- II

Stability of biomolecular systems: The hydrogen bond. Hydrophobic effect. Solvation energy. Force fields for molecular modeling: Functional form of a type one force field. Parametrization of a force field. Anharmonicity. Potentials of mean force. Common force fields for biomolecules.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the factors affecting the stability of biomolecular systems (L1)
- describe the functional form of a type one force field (L1)
- understand the limitations of type one force fields (L2)
- understand the methodology used for parametrization of a forcefield (L2)
- select optimum force field based on requirements of the application (L5)

Unit- III

Conformational analysis: Geometry optimization using steepest descent and conjugate gradients. Molecular dynamics. Simulated annealing.
Conformational analysis of polypeptides: Ramachandran map and rotamer libraries. Comparative modeling of protein structure. *De novo* Protein structure prediction.

Conformation and stability of polynucleotides.

Learning Outcomes:

After completing this unit, the student will be able to

- describe the methods for target identification (L1)
- demonstrate knowledge of the desirable properties of small molecule drugs (L1)
- understand the concepts related to quantification of similarity of molecules (L2)
- use quantitative structure property relationships to predict properties of small molecules (L3)
- demonstrate knowledge of databases for drug design (L1)

Unit- IV

Target identification for drug design. Desired properties of small molecule drugs. Molecular descriptors. Distance and similarity of molecules. Quantitative structure property relationships. Introduction to databases for drug design and development.

Learning Outcomes:

After completing this unit, the student will be able to

- describe the methods for target identification (L1)
- demonstrate knowledge of the desirable properties of small molecule drugs (L1)
- understand the concepts related to quantification of similarity of molecules (L2)
- apply quantitative structure property relationships to predict properties of small molecules (L3)
- demonstrate knowledge of databases for drug design (L1)

Unit- V

Ligand based drug design: Quantitative Structure Activity Relationships (QSAR). Pharmacophore analysis. Receptor based drug design: Principles of receptor based de novo ligand design. Rigid body molecular Docking. Flexible docking. Scoring functions for predicting ligand-receptor binding. Case study: Structure based design of non-peptide inhibitors specific for HIV1 protease.

Learning Outcomes:

- After completing this unit, the student will be able to distinguish between the strategies for ligand based and receptor-based drug design (L4)
- predict activity of small molecules using QSARs (L2)
- compare advantages and disadvantages of rigid body docking and flexible docking (L4)
- understand the applications and limitations of scoring functions for ligand receptor binding (L2)
- describe the progress in design of inhibitors for HIV1 protease (L1)

Text Books:

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001.
2. Atkins and Friedman. Molecular quantum mechanics. Oxford University Press. 5th ed. 2011.

References:

	1. Tamar Schlick. Molecular modeling and simulation: An interdisciplinary guide. 2nd Edition. Springer. 2010. 2. Jan H. Jensen. Molecular modeling basics. CRC press. 2010.

Molecular Modeling and Drug Design Laboratory

This laboratory course is designed to enhance the conceptual understanding of molecular modeling and provides hands on experience for molecular modeling and an introduction to ligand-based drug design as well as structure based drug design.

Course Objectives:

This laboratory aims to

- Introduce the concepts of forcefields.
- Introduce examples of structure optimization
- Demonstrate utilization of QSAR for predicting properties of molecules
- Demonstrate the application of docking for estimating binding constants
- Demonstrate the applications of molecular graphics

1. Molecular graphics for virtual manipulation of molecules
2. Molecular graphics for visualization of protein-ligand interactions
3. Calculation of potential energy of a molecule
4. Structure optimization of a molecule
5. Generating 3D representations from 2D descriptions of small molecules
6. QSAR calculations
7. Molecular editor for ligand design
8. Comparative modeling of proteins
9. Rigid body docking
10. Flexible docking

Text Books:

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001.

References

1. Rasmo Reference Manual. https://www.umass.edu/microbio/rasmol/distrib/rasman.htm

Course Outcomes:

1. Recall principles of quantum mechanics and molecular mechanics.
2. Utilize computational methods to model molecules.
3. Select optimum computational method for binding site prediction.
4. Apply computational methods for predicting stability of protein-ligand complex.
5. Design drugs.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	1	3	1	1
CO2	3	3	3	3						3	3	3	3	3	1
CO3	3	3	3	3						3	3	2	3	2	2
CO4	3	3	3	3						3	3	3	3	3	2
CO5	3	3	3	3						3	3	3	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT451: APPLIED BIOCATALYSIS AND BIOTRANSFORMATION

L	T	P	C
3	0	0	3

Unit- I	**8 hrs**
General usage of biocatalysts, fermentation and applied biocatalysis. Types of bioconversion reactions, procedures for biotransformation's, use of cells and enzymes for biotransformation, genetic manipulations of organisms for biotransformation, Application of bioconversions.	
Unit- II	**8 hrs**
Reaction types for microbial transformations of steroids, microbial breakdown of sterol side chain. L-Ascorbic acid, Dihydroxy acetone from glycerol, Prostaglandins, Hydantoinases, Carboxylases, catalytic antibodies, Acylases and peptidases, reaction of penicillin and cepharosporin substrates, protection of amino groups, accumulation of pesticides, pesticides as carbon source, conjugate formation.	
Unit- III	**8 hrs**
Nitrile hydratases and nitriles, biotechnology of nitrile transformations, regio and stereo selective biotransformation of nitriles, commercial processes, search for novel nitrile biotransforming activities, redesign of existing enzyme by protein engineering, metabolic engineering by multistep biotransformation, cyanide biotransformation.	
Unit- IV	**8 hrs**
Commercial lipases, properties and application of lipases, lipid or surfactant coated lipases, inter-esterification of fats and oils, enantioselective esterification by lipase, commercial application (food ingredients and enantiomerically pure chemical and pharmaceutical intermediates)	
Unit- V	**8 hrs**
Tropane alkaloid biosynthesis, microbial metabolism of tropane alkaloids, morphine alkaloid biosynthesis, transformation of morphine alkaloid by Pseudomonas putida M10, microbial transformation of heroin.	
Text Books:	
1. A.J.J. Straathof, P Adler Creutz (Eds.), Applied catalysis, 2/e, Hardwood academic publishers, Taylor and Francis, 2005.	

19EBT453: ARTIFICIAL NEURAL NETWORKS

L	T	P	C
2	0	2	3

Neural Networks can assist in the analysis, interpretation and utilization of large amounts of highly complex structured and unstructured data. Neural Network based decision support systems have been deployed in agricultural, biomedical, biometric, economic and legal applications. Neural Networks can be utilized as components of advanced robots and control systems for industrial automation. Neural Networks can also be utilized in engineering design.

Course Objectives:

- introduce a variety of Neural Network architectures
- evaluate merits and demerits of learning models used by Artificial Neural Networks
- describe the algorithms for training of Neural Networks
- explain the effect of choice of parameters on training efficiency
- exemplify the relation between problem type and Neural Network type

Unit- I : **8 hrs**

Introduction to Neural Networks: Architecture based classification of Neural Networks. Classification of Neural Networks based on learning methods. Activation functions and Loss functions. Factors to be considered for choice of type of Neural Network. Introduction to hardware requirements for implementation of Neural Networks.

Learning Outcomes:

At the end of this unit, the student will be able to

- classify Neural Networks based on type of architecture (L2)
- classify Neural Networks based on type of learning (L2)
- identify optimal type of Neural Network based on problem description (L4)

Unit- II: **8 hrs**

Rosenblatt's perceptron model. Rosenblatt's perceptron convergence theorem. Back Propagation Method. Back propagation learning algorithm for multilayer feed forward Neural Network. Factors affecting back propagation based training of a Neural Network.

Learning Outcomes:

At the end of this unit, the student will be able to

- prove convergence for Rosenblatt's perceptron model (L2)
- calculate output of a small feed forward Neural Network with one hidden layer for specified values of architectural parameters and weights using a handheld calculator (L5)
- predict the effect of parameters on training efficiency using the backpropagation learning algorithm (L4)

Unit- III **8 hrs**

Radial basis function networks. Generalized regularization theory. Neural Network models with Hebbian learning. Introduction to Hopfield networks. Recurrent Neural Network models. Universal approximation theorem. Backpropagation through time. Real time recurrent learning. Long short term memory.

Learning Outcomes:

	After completing this unit, the student will be able to • understand concepts of hebbian learning models (L2) • describe recurrent Neural Networks and their applications (L1) • evaluate a problem and identify the optimal training algorithm (L5)

Unit- IV	**8 hrs**

Convolutional Neural Networks. Variants of the basic convolution function. Convolution algorithms. Recursive Neural Networks. Greedy layer-wise pretraining. Transfer learning. Structured probabilistic models for deep learning. Convolutional boltzmann machines.

Learning Outcomes:

	After completing this unit, the student will be able to • identify advantages and disadvantages of deep learning (L2) • describe concepts of convolutional Neural Networks (L1) • compare merits and demerits of deep learning (L4)

Unit- V	**8 hrs**

Model based calculation of reward in Reinforcement learning. Markov decision process. Bellman's optimality criteria. Policy iteration. Value iteration. Q-learning. Model free Reinforcement learning. Deep reinforcement learning. Generative adversarial networks

Learning Outcomes:

	After completing this unit, the student will be able to • understand the concepts of reinforcement learning (L2) • analyze a problem and identify optimal algorithms for its solution (L4) • evaluate reward for specified model and policy function for training a Neural Network by using reinforcement learning (L5)

ARTIFICIAL NEURAL NETWORKS LABORATORY

At least five of the following experiments:

1. Software installation for Artificial Neural Networks
2. Training of an Artificial Neural Network
3. Testing of a trained Artificial Neural Network
4. Application of an Artificial Neural Network for secondary structure prediction
5. Application of an Artificial Neural Network for protein-ligand binding study
6. Application of an Artificial Neural Network for promoter identification
7. Application of an Artificial Neural Network for identification of genes in a genome
8. Application of an Artificial Neural Network for image recognition.

19EBT455: FOOD HANDLING, PACKAGING AND STORAGE

L	T	P	C
3	0	0	3

Course Objectives:		
	• Acquire knowledge of various type of material handling and the type of equipment utilized • Understand to designing food packaging materials depends the variety of food products • Select the packaging materials and types depending upon the properties and sources of food. • ensure the self-life of the packaged food product and adapt appropriate storage condition • Describe the national and international acts and rules about food packaging	
Unit- I :		**8 hrs**
Material Handling: Solids and granular materials handling: elevators, conveyors; Pumps: centrifugal and positive displacement; Liquid filling machines: open vent, closed vent and piston fillers.		
Learning Outcomes:		
	At the end of this unit, the student will be able to • Understanding the physical properties of materials • Basic operational principles of various machinery used to process materials	
Unit- II:		**8 hrs**
Packaging Materials: Polymer films, metal containers, flexible packages, special packing.		
Learning Outcomes:		
	At the end of this unit, the student will be able to • Understanding of different types of packaging material and its properties • Designing different type of modern packaging and concept of packaging system	
Unit- III		**8 hrs**
Food Packaging: Requirements for cereals, meat, poultry, fish, milk, vegetables, fruits, plantation crop based products and carbonated beverages.		
Learning Outcomes:		
	After completing this unit, the student will be able to • Selection of food packaging materials for different types of food product • Source of food product and it properties of processed and unprocessed food product	
Unit- IV		**8 hrs**
Storage Principle and Practice: Storage losses and their estimation: Modified and control atmosphere storage: Bin and silo storage for cereals and pulses.		
Learning Outcomes:		
	After completing this unit, the student will be able to	

	• To understanding the appropriate storage condition for processed and unprocessed food product • To minimize the food wastage • To facilitate the incoming and outgoing food product from warehouse
Unit- V	**8 hrs**
Loss in cereal quality: insect and pest control. Design of storage structures and facilities including cold storage.	
Learning Outcomes:	
	After completing this unit, the student will be able to • To understanding long term stored and seasonal food product storage and enhance the shelf life of product • To understanding pest and rodent control
Text Books:	
	1.M.J. Kirwan, McDowell, R.Coles, Food packaging technology. Wiley- Blackwell, 2010.
References:	
	1. S. Stanley, C.G. Roger, Food Packaging, AVI Publications, 1970. 2. S. Sacharow, R.C. Griffin, Principles of Food Packaging, AVI Publication, 1980. 3. F.A. Painy, A handbook of Food Packaging, App. Sci. Publishers, 1980.

Course Outcomes:
1.Designing various food packaging materials and the equipments used in handling of materials. 2.Select the packaging materials on their prpperties of food materials. 3.Apply principle of food processing for efficient packaging with enhanced self-life with implementation of various acts and rules. 4.Specialised and sustainable (environmental) packaging for end user satisfaction. 5.Structuring storage facilities to control insect and pests.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1			1	1	2		1	1		1	3	1	1
CO2	3	2	1		1	I	2	1	2	1	1	1	3	2	1
CO3	3	1	1	2	2	1	1		1	1		1	3	2	1
CO4	3	2	2	2	2	1	2	1	1	1	1	1	3	2	2
CO5	3	2	2	2	3	1	3	1	2	1	2	1	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT457: MOLECULAR DIAGNOSTICS

L	T	P	C
2	0	2	3

Molecular diagnostics is a dynamic and transformative area of diagnostics, leading to insights in research and treatment in many disease states that are revolutionizing health care. This course describes the methods to detect and measure the presence of genetic material or proteins associated with a specific health condition or disease, helping to uncover the underlying mechanisms of disease. Students aspiring to continue higher education and research in medical biotechnology will have a solid footing in this course

Course Objectives:

- To learn methods for isolation and sequencing of nucleic acids
- To learn molecular techniques useful for molecular diagnosis and prognosis
- To learn methods for molecular diagnosis of common genetic disorders
- To learn methods for molecular diagnosis of cancer and infectious diseases
- To learn quality control and quality assurance for molecular diagnosis

Unit- I: **6 hrs**

Nucleic acid isolation. Nucleic acid amplification -PCR. DNA sequencing: Direct methods, Hybridization based sequencing methods, Commercial systems. MALDI-TOF, NGS methods. Lab-on-a-chip approach to molecular diagnostics.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn the selection of the methodology for isolation of DNA (L1)
- Amplify the DNA (L2)
- Sequencing the DNA employing different technologies (L2)
- Understand importance of lab on a chip (L2)

Unit- II: **6 hrs**

Molecular techniques: Blotting Techniques, Probes, Probe labelling. Variants of PCR technique, Probe Amplification techniques, Transcription-Based Amplification Systems, SSCP, CSGE, DGGE

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn the molecular techniques related to the diagnosis(L1)
- Understand Sensitive PCR amplification methods for DNA(L2)
- Separate DNA by electrophoresis(L2)

Unit- III **6 hrs**

Genetic Disorders and classification of genetic disorders, single gene disorders (Cystic Fibrosis, Marfan's syndrome), multifactorial disorders (Diabetes, Atherosclerosis, Schizophrenia). Tumor profiling. Molecular diagnosis for cervical cancer.

Learning Outcomes:

After completing this unit, the student will be able to

- Categorize genetic disorders(L4)

- Make use of tumor profiling for cancer diagnosis(L3)
- Appraise multifactorial disorders (L5)

Unit- IV	**6 hrs**

Disease identification and genetic tests for following disorders: Thrombophilia, sickle cell anaemia, cystic fibrosis, Alzheimer's disease, Huntington 's disease, fragile-X syndrome, Cytomegalovirus, and tuberculosis. Molecular diagnosis for HLA typing.

Learning Outcomes:

After completing this unit, the student will be able to

- Perceive the genetic basis of different diseases(L5)
- Identify diagnostic methods applicable to infectious diseases(L3)
- Appraise the effectiveness of different diagnostic procedures(L5)

Unit- V	**6 hrs**

Quality control and quality assurance: identification and standards for molecular diagnosis. Regulatory issues in molecular diagnostics. Ethical considerations in molecular diagnostics.

Learning Outcomes:

After completing this unit, the student will be able to

- Summarize standards to be followed in molecular diagnostics(L2)
- Outline the regulatory issues in molecular diagnostics(L2)
- Explain ethical considerations in molecular diagnostics(L5)

Text Books:

1. C.A. Burtis, D.E. Bruns Tietz. Fundamentals of clinical chemistry and molecular diagnostics, 7/e, Saunders, 2015.
2. L. Buckingham, Molecular Diagnostics: fundamentals, methods and clinical applications, F.A. Davis Company, 2011.

References:

1. G.P. Patrinos, W.J. Ansorge, Molecular Diagnostics, 2/e, Elsevier publications, 2010.
2. W.W. Grody, R.M. Nakamura, F.L. Kiechle, C. Storm, Molecular diagnostics: techniques and applications for the clinical laboratory, 1/e, Academic press, 2009.
3. D.E. Bruns, E.R. Ashwood, C.A. Burtis, Fundamentals of molecular diagnostics, Elsevier-Saunders. 2007.

MOLECULAR DIAGNOSTICS LABORATORY

The establishment of a Molecular Diagnostic lab will enable the student to acquire a broad foundation regarding understanding the different diseases and molecular techniques in diagnosis of diseases. The lab will impart knowledge that motivates the students to take up advanced courses/research in the same field of study.

Demonstrate At least five of the following experiments:

1. Demonstration of Polymerase Chain Reaction
   After completion of this experiment, the student will be able to use PCR and as an important tool for disease diagnosis
2. Demonstration reverse transcriptase Polymerase Chain Reaction
   After completion of this experiment, the student will be able to use PCR and its variants as tools for diagnosis

3. HLA typing (Virtual)
   After completion of this experiment, the student will be able to understand the basis for successful transplantation
4. Molecular diagnostics for detection of HPV infection in cervical cancer
   After completion of this experiment, the student will be able to understand the methods for detection of cervical cancer
5. Detection of Mycobacterium tuberculosis infection
   After completion of this experiment, the student will be able to understand methods of detection of tuberculosis
6. Molecular Diagnosis of Cystic fibrosis (Virtual)
   After completion of this experiment, the student will be able to perceive the molecular basis and diagnosis of cystic fibrosis

Course Outcomes:

1. Explain nucleic acid isolation, sequencing of DNA and lab on chip technology.
2. Discuss molecular techniques involved in molecular diagnostics.
3. Explain various genetic disorders and molecular diagnostics of cervical cancer.
4. Identification of genetic disorders and their molecular diagnosis.
5. Apply quality control, quality assurance, regulatory and ethical considerations in molecular diagnostics.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1			2			3	2	3	3
CO2	3	3	3	3	3	2			2			3	2	3	3
CO3	3	3	3	3	3	3		2	1			3	2	3	3
CO4	3	3	3	3	3	3		2	1			3	1	3	3
CO5	3	3	3	3	3	3		3	1			3	1	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT452: MODELLING AND SIMULATION IN BIOPROCESSES

L	T	P	C
2	0	2	3

Unit- I	**8 hrs**
Modeling of biological systems: Modeling principles, significance of modeling and simulation, model development from first principles. Modeling approaches for biological systems - structured and unstructured systems; Compartment models (two and four); Deterministic and stochastic, segregated and unsegregated approaches for modeling structured systems. kinetic models on different approaches; product formation model; genetically structured models, modeling of extra cellular enzyme production.	
Unit- II	**8 hrs**
Modeling of diffusion: Bioprocess modeling: Modeling of continuous sterilization of medium; Models for external mass transfer, internal diffusion and reaction within biocatalysts, model for SCP production from spent sulphite liquor, model for antibiotic formation; modeling of therapeutic protein production with recombinant cells. Modeling of activated sludge process with a control system; model for anaerobic digestion.	
Unit- III	**8 hrs**
Bioreactor modeling: Ideal and non-ideal bioreactors; stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, tower reactor model; flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models, modeling of non-ideal behaviour in bioreactors-tanks-in-series and dispersion models.	
Unit- IV	**8 hrs**
Linear system analysis: Study of linear systems, linearization of non-linear systems; Software based simulation of linear models; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production (Insulin). Simulation techniques (Software): continuous system simulators; dynamic process simulators; steady state material and energy balance programs.	
Unit- V	**8 hrs**
Hybrid and other modeling techniques: Simulation techniques (numerical methods): Programs based on numerical methods like algebraic equations, Newton_ Raphson method for algebraic convergence,interpolationarbitrary function generation. Programs based on solution of differential equations: Euler method for 1st and 2nd order integration; Fourth order Runge -Kuttab method: stability of numerical integration, variable slip size method. Case studies, numerical problems. Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.	
Text Books:	
	1. B.W.Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice-Hall, 1998. 2. Said S.E.H. Elnashaie, P. Garhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, Marcel Dekker, Inc., 2003.
References:	
	1. I.J. Dunn, Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples, Wiley-VCH, 2003

MODELLING AND SIMULATION IN BIOPROCESSES LABORATORY

At least five of the following experiments:

1. Bioreactor model to demonstrate effect of stirring speed
2. Bioreactor model to demonstrate effect of aeration rate
3. Modeling of Bioreactor tanks-in-series
4. Structured model for a tower reactor
5. Simulation of population growth in bacteria
6. Model of pharmacokinetics of a drug.

19EBT454: STEM CELLS AND TISSUE ENGINEERING

L	T	P	C
3	0	0	3

Unit- I	**8 hrs**
Basic biology of stem cells: Types and sources of stem cells with characteristics: embryonic, adult, cancer stem cells, induced pluripotent stem cells; signaling mechanisms of stem cell self renewal and differentiation.	
Unit- II	**8 hrs**
History and scope of tissue engineering. Organization of cells into higher ordered structures. Composition and diversity of extracellular matrix, receptors for ECM molecules. Matrix molecules and their ligands. Preparation of ECM, biologic activities of ECM, scaffolds. Commercially available scaffolds composed of extracellular matrix, cell differentiation and migration.	
Unit- III	**8 hrs**
Biomaterials in cell culture: harvest, selection, expansion, and differentiation, cell nutrition, natural polymers in tissue engineering applications, biomaterial scaffold properties. Models as precursors for prosthetic devices, quantitative aspects, cell tissue mechanics. Mechano- chemical control of cell fate switching.	
Unit- IV	**8 hrs**
Scaffold design and fabrication: degradable polymers and bioceramics for tissue engineering. Principles of scaffold design. Scaffold fabrication technologies: foaming, sintered microspheres, solvent casting, phase separation, electro-spinning. Textile technologies for fibre and fabrics. Solid free form fabrication.	
Unit- V	**8 hrs**
Bioreactors for tissue engineering: 2D and 3D cell culture. Key functions of bioreactors in tissue engineering. Bioreactor design and development. Bioreactors as 3D in vitro model systems, bioreactors in clinical applications, tissue engineering of skin, bone, cartilage, nervous system, lung, liver and pancreas.	
Text Books:	
1. C.A. van Blitterswijk and P. Thomsen, Tissue engineering, Academic Press series in biomedical engineering, 2008. 2. R.P. Lanza, R. Langer, W.L. Chick, Principles of tissue engineering, 3/e, Elsevier Publishers, 2007.	
References:	
1. Donglu Shi, Biomaterials and Tissue Engineering, Springer publishers, 2003. 2. Peter C. Johnson and Antonios G. Mikos, Advances in Tissue Engineering, Mary Ann Liebert publishers, 2012.	

Course Outcomes:

1. Understand the concepts of self-renewal and differentiation of cells.
2. Describe the role of the extra cellular matrix in a tissue.
3. Assess the use of various biomaterials for cell culture and scaffold
4. Understand the concepts of scaffold design and fabrication
5. Design bioreactors for tissue engineering

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	1	1		3	1		3	1	
CO2	3	3	3	2	1	1	1	1		3	1		3	1	
CO3	3	3	3	1	2	1	1	1		3	1		3	1	
CO4	3	3	3	2	3	1	1	1		3	1		3	3	1
CO5	3	3	3	3	3	3	2	1		3	1		3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT456: FOOD SAFETY AND QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

In our healthy life, selection of types of foods or its products play important role with awareness of types of foods. And modern era, our customers are more sincere about selection of foods which could be safe, nutritious and least processed in nature. Most of our food processing industries are developing the more variety of foods for our people. But they are sensitive about processing conditions with maintenance of food standards as well ensuring of food safety for their products. A lot of international or national food safety guideline has been provided to maintain our products in safety nature.

Course Objectives:

- To understand the values of hygienic conditions for our food products
- To understand the guidelines for food safety issues to be maintained
- To understand the food borne disease from food safety failure
- To understand the food processing condition changes during transformation of foods
- To optimize processing conditions for more safe food products

Unit- I **8 hrs**

Characterization of food safety: Food Safety definition and principles, characterization of food hazards, risk analysis for chemical and microbial hazards, exposure assessment of microbial food hazards, chemical risk assessment in foods

Learning Outcomes:

At the end of this unit, the student will be able to

- Students will learn the food safety guideline during food processing
- Students will learn the different types of hazarding agents, occurred during food handling or processing
- Students will learn the different risk assessment for food safety maintenance during food processing
- Student will understand the different hazard agents effecting the food safety

Unit- II **8 hrs**

Food hazards from biological agents, prevalence of food-borne pathogens, physiology and survival of food-borne pathogens in various food systems, characteristics of biological hazards in foods

Learning Outcomes:

At the end of this unit, the student will be able to

- Students will learn biological agents (microbial or macro-organism), causes food hazards during food handling, transporting or processing
- Students will learn the different factors for inducing the biological mediated food hazards occurred during food handling or processing
- Students will learn for characterization methods of biological risk assessment for food safety
- Student will understand impact of biological food hazard with their food quality

Unit- III **8 hrs**

Chemical and physical nature of food hazards, hazards from natural origins, chemical and physical hazards produced during food processing, storage, and preparation, hazards associated with nutrient fortification, monitoring chemical hazards: regulatory information

Learning Outcomes:

	After completing this unit, the student will be able to • Students will learn physical or chemical nature agents, causes food hazards during food handling, transporting or processing • Students will learn about hazards impact from natural origins food safety issues occurred during food handling or processing • Students will learn for fortification of food with food safety and also learn for monitoring strategy for assessment of hazards nature • Student will understand food hazard nature with their neutralization mechanisms

Unit- IV	**8 hrs**

Food quality and food standard, Codex Alimentarius as FAO/WHO food standards program Implementation of FSLS regulatory programs for pathogen reduction, advances in food sanitation: use of intervention strategies, use of surveillance networks, hazard analysis critical control point (HACCP)

Learning Outcomes:

	After completing this unit, the student will be able to • Students will learn food standard to ensure the food quality with safe food products • Students will know about different guideline for maintaining the food safety at national or international levels • Students will learn food safety assessment via utilization of regulatory guideline during food processing • Student will understand the different mechanism to control the food hazards during post harvesting periods

Unit- V	**8 hrs**

Food plant sanitation, food safety control systems in food processing, food safety and innovative food packaging, safe handling of fresh-cut produce and salads, good manufacturing practices, prerequisites for food safety, the principles of modern food hygiene

Learning Outcomes:

	After completing this unit, the student will be able to • Students will learn food sanitation guideline to ensure food safety • Students will know innovative and safe handling of food products • Students will learn good manufacturing practicing for food safety • Student will understand mechanism good and modern food hygiene principles

Text Books:

	1.Ronald H. Schmidt and Gary E. Rodrick, 2003, Food Safety Handbook. A John Wiley & Sons Publication

References:

1.A. K. Singh P. N. Raju & A. Jana. Food Technology-I, www.agrimoon.com

2.R. Paul Singh and Dennis R. Heldman. 2009. Introduction to Food Engineering Fourth Edition, Academic Press is an imprint of Elsevier

Course Outcomes:

1. Explain nucleic acid isolation, sequencing of DNA and lab on chip technology.
2. Discuss molecular techniques involved in molecular diagnostics.
3. Explain various genetic disorders and molecular diagnostics of cervical cancer.
4. Identification of genetic disorders and their molecular diagnosis.
5. Apply quality control, quality assurance, regulatory and ethical considerations in molecular diagnostics

CO-PO Mapping:

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	3	1		1		1	2	2	1	2		2	3	1	1
CO 2	3	2	1	2	2	1	2	2	2	2	1	1	3	2	1
CO 3	3	2	1	1	2	1	2	1	1	1	2	2	3	2	2
CO 4	3	2	2	2	3	2	3	2	1	1	1	1	3	3	2
CO 5	3	3	3	3	3	1	3	1	2	1	2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EBT458: NANOBIOTECHNOLOGY

L	T	P	C
3	0	0	3

Nanomaterials are materials that are restricted to nanoscale size in at least one dimension.
Nanoscience is the study of nanomaterials that have unique physical, chemical or biological properties due to their size.Nanobiotechnology utilizes the unique properties of nanomaterials for applications in medicine, agriculture and industry. This course is an introduction to the fabrication, characterization and biological applications of nanomaterials.

Course Objectives:

- describe the unique properties of nanomaterials
- describe the methods for synthesis and fabrication of nanomaterials
- describe the methods for characterization of nanomaterials
- create awareness of applications of nanotechnology
- describe the application of nanomaterials in novel biomedical devices and components

Unit- I **8 hrs**

Structure and properties of C60, carbon nanotubes and graphene.
Size dependent properties: Size dependence of sedimentation rate, adsorption effects, scattering of light, absorption of electromagnetic radiation, magnetic and electrical properties. Cooperative transitions in biological systems: Zimm-Bragg theory for helix-coil transition in polypeptides

Learning Outcomes:

At the end of this unit, the student will be able to

- list novel allotropes of carbon (L1)
- understand the relationship between size and properties of nano systems (L1)
- calculate the fraction of residues in helical conformation using a simple model (L1)
- predict potential applications of nanomaterials based on their unique properties (L4)

Unit- II **8 hrs**

Production of nanomaterials: Top down & bottom up strategies.
Green synthesis of nanoparticles.
Self-assembly: Langmuir-Blodgett films. DNA origami.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the methods for production of nanomaterials (L2)
- compare the strategies for production of nanomaterials (L2)
- understand the principles of self-assembly (L1)

Unit- III **8 hrs**

Bionanomaterial characterization: Electron microscopy. Scanning probe microscopy. Light Scattering. Optical tweezers. Surface plasmon resonance. Light scattering. X-ray diffraction.

Learning Outcomes:

After completing this unit, the student will be able to

- describe the methods for characterization of bionanomaterials (L3)
- compare the methods for characterization of bionanomaterials (L3)

Unit- IV **8 hrs**

Vectors for drug delivery: Liposomes, Micelles and viral capsids. Targeted drug delivery – Nano bioconjugates for receptor targeting and magnetic guidance. Controlled drug release. Nanomaterials for Biomedical imaging: Quantum dots, SPIONs Theragnostic.	
Learning Outcomes:	
	After completing this unit, the student will be able to • describe the properties nanoscale drug delivery vehicles (L4) • compare the advantages and disadvantages of different type of drug delivery vehicles (L4) • describe nanomaterials used for biomedical imaging (L4) • describe the principles and applications of nanomaterials in theragnostic (L4)
Unit- V	**8 hrs**
Diagnostics and Prognostics: Principles and applications of Nanoarrays and Nanofluidic. Nanopore sequencing of DNA. BioNanomechanics: NanoBiomotors. Mechanics of cilia and flagella. Nanobioelectronics: Nanowires based on DNA. Molecular transistors. Voltage gated ion channels.	
Learning Outcomes:	
	After completing this unit, the student will be able to • list the unique properties of nanobiomaterials (L1) • describe the applications of nanodevices (L5) • describe the principles and applications of nanopore sequencing of DNA (L5) • describe the structure and function of nanobiomotors (L1) • describe nanobioelectronic components (L1)
Text Books:	
	1. C. M. Niemeyer and C. A. Mirkin. Nanobiotechnology: Concepts, applications and perspectives. Wiley, 2006. 2. C. A. Mirkin and C. M. Niemeyer, Nanobiotechnology II: More concepts and applications, Wiley-VCH, 2007
References:	
	1. T.Vo-Dinh, Nanobiotechnology in biology and medicine: methods, devices and applications, CRC, 2007. 2. Y Xie, The nanobiotechnology handbook, CRC, 2012 3. https://nptel.ac.in/courses/118107015

Course Outcomes:

1. Understand and explain the unique properties of nanomaterials.
2. Compare the methods for fabrication of nanomaterials
3. Select optimum methods for nanomaterial characterization
4. Compare drug delivery vectors.
5. Describe the applications of nanobioelectronics.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	2	3
CO2	3	3	3	3						3	3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3	3
CO4	3	3	3	3						3	3	3	3	3	3
CO5	3	3	3	3						3	3	3	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19ECY371: CHEMICAL ASPECTS OF BIOMOLECULES

L	T	P	C
2	1	0	3

The course enables the students to gain knowledge on various methods of isolation of natural products of medicinal importance, their purification and characterization techniques. Exposes the students to significance of metals in biological systems, latest spectroscopic techniques, isolation of bioactive compounds from natural source and important pesticides.

Course Objectives:

- To impart knowledge on the significance of metals in biological systems.
- To demonstrate the biological importance of heterocyclic compounds.
- To study about drugs and pesticides.
- To create awareness on separation techniques such as GC and HPLC.
- To acquaint with the basic principles involved in various spectroscopic techniques such as IR, UV, NMR and Mass.

Unit- I **8 hrs**

Metals in Biological Systems

Introduction- Essential elements and their importance-Bulk elements- Macrominerals Macro-elements Important –metals in biological systems Haemoglobin: Structure and physiological importance Vitamin B12 : Structure and medical uses Chlorophyll: –Structure and importance-
Metals and their toxicity: Toxicity of Arsenic, Lead and Mercury.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the importance of elements in biological systems (L-2)
- illustrate different metal containing (L-2)
- list the toxic metals in biological systems. (L-4)

Unit- II **8 hrs**

Bioactive heterocyclic compounds

Introduction-Structure-preparation-properties and reactions of Furan, Pyrrole, Thiophene, Pyridine, Indole – significance of heterocyclic compounds in biological systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- classify heterocyclic compounds (L-2)
- distinguish between various heterocyclic compounds (L-4)
- explain the preparation of heterocyclic compounds (L-2)
- compare the properties and uses of heterocylic compounds (L-2)
- explain the importance of the heterocyclic compounds (L-2)

Unit- III **9 hrs**

Drugs and Pesticides

Introduction

Antibacterial agents-sulfadrugs-sulfanilamide-sulfadiazine-structure and synthesis.
Analgesics: Aspirin-Phenacetin- structure and synthesis.
Anti-malarial drugs: Chloroquine-4,7 dichloroquinoline, Novaldiamine structure and synthesis
Insecticides: Organochlorine and Organophosphorus compounds-DDT, Malathion- structure and synthesis.
Fungicides: Thiram- structure, their synthesis

Learning Outcomes:

	After completing this unit, the student will be able to • explain the structure of sulfa drugs. (L-2) • illustrate the importance of antibacterial agents, Anti-malarial drugs. (L-2) • identify the importance of Insecticides and Fungicides. (L-3) • classify the different class of drugs (L-2) • apply the basic principles of organic synthesis (L-4)

Unit- IV	**8 hrs**

Isolation of bioactive natural products

Terpenoids and alkaloids from natural sources: Extraction-Solvent Extraction-Purification methods, isolation of taxol, Azaderichtin, Geraniol, citral, Eugenol; applications of Terpenoids and alkaloids.

Learning Outcomes:

	After completing this unit, the student will be able to • explain the importance of isolation of the natural products (L-2) • identify a suitable chromatographic technique for the desired purification (L-3) • compare different purification techniques (L-2) • apply the concepts of extraction and chromatographic techniques (L-3)

Unit- V	**9 hrs**

Spectroscopy- Applications of UV-Visible, IR, NMR and Mass in the determination of structures of bioactive Organic Molecules. Problem solving -Examples-ethyl alcohol, benzoic acid, Taxol, Penicillin etc.

Learning Outcomes:

	After completing this unit, the student will be able to • list the principles of various instruments. (L-1) • compare different spectroscopic techniques. (L-2) • explain the structural elucidation of a given compound. (L-2) • identify the structure of organic compounds. (L-3) • distinguish different organic compounds based on the spectral data. (L-4)

Text Books:

1. B.Mehta and M. Mehta, Organic Chemistry, 2/e, PHI, (2015).
2. K. Sesha Maheswaramma and Mridula Chugh, Engineering Chemistry, Pearson (2016)

References:

1. Singh and Mukharjee, Text Book of Organic Chemistry, New Age International Limited Publishers, (2015)
2. I L Finar, Organic Chemistry, vol.1, 6/e, Pearson (2002)
3. J. March, March's Advanced Organic Chemistry, 6/e. Wiley (2007)
4. William Kemp, Organic Spectroscopy, 3/e, Palgrave USA (2008)
5. S. Warren and P. Wyatt, Organic Synthesis: The Disconnection Approach, 2/e, Wiley, (2008)

Course Outcomes:

1. To impart knowledge on the significance of metals in biological systems.
2. To demonstrate the biological importance of heterocyclic compounds.
3. To study about drugs and pesticides.
4. To create awarness on separation techniques like GC and HPLC.
5. To acquaint with the basic principles involved in various spectroscopic techniques such as IR, UV, NMR and Mass.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	3	1	1			1		1		1	1		1	1	
CO 2	3	1	1	1		1		1		1	1		1	1	
CO 3	3	1	1					1					1		
CO 4	3	1	1					1		1			1		
CO 5	3	1	1			1		1		1			1	1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EEI477: INDUSTRIAL AUTOMATION

L	T	P	C
2	1	0	3

Unit- I	**8 hrs**
Control Systems and Automation Principles: Evolution of instrumentation and control, Role of automation in industries, Benefits of automation, Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC, Automation strategy evolution, Control system audit, performance criteria, Safety Systems.	
Unit- II	**9 hrs**
Programmable logic controllers (PLC): Introduction, architecture, definition of discrete state process control, PLC Vs PC, PLC Vs DCS, relay diagram, ladder diagram, PLC design, Advance Applications of PLC and SCADA**:** PLC programming methods , PLC applications for batch process using SFC, Analog Control using PLC, PLC interface to SCADA/DCS using communication links (RS232, RS485) and protocols (Mod bus ASCII/RTU).	
Unit- III	**8 hrs**
Instrumentation Protocols: HART Protocol introduction, frame structure, programming, implementation examples, Benefits, Advantages and Limitations. Foundation Field bus H1 introduction, structure, programming, FDS configuration, implementation examples, Benefits, Advantages and Limitations, Comparison with other field bus standards including Device net, Profibus, Control net, CAN, Industrial Ethernet etc.	
Unit- IV	**9 hrs**
Distributed Digital Control Systems: DCS introduction, functions, advantages and limitations, DCS as an automation tool to support Enterprise Resources Planning, DCS Architecture of different makes, specifications, configuration and programming, functions including database management, reporting, alarm management, communication, third party interface, control, display etc. Enhanced functions viz. Advance Process Control, Batch application, Historical Data Management, OPC support, Security and Access Control etc.	
Unit- V	**8 hrs**
Industrial Applications for Automation: – Power, Water Treatment, Food and Beverages, Dairy, Cement, Steel, Pharmaceuticals, Automobile and Building Automation.	
Text Books:	
	1. Distributed Computer Control for Industrial Automation, Poppovik Bhatkar, Dekkar Publications. 2. Programmable Logic Controllers: Principles and Applications, Webb and Reis, PHI. 3. Computer Aided Process Control, S.K.Singh, PHI.
References:	
	1. Introduction to Programmable Logic Controllers, Garry Dunning, Thomson Learning. 2. The Management of Control System: Justification and Technical Auditing,N.E.Battikha,ISA. 3. Computer Based Process Control, Krishna Kant, PHI.

Course outcomes:

1. Interpret the knowledge on fundamentals of Automation, DCS, PLC,SCADA.
2. To gain complete details of PLC's.
3. Explain full details of Instrumentation protocols.
4. Analyze the performance of Distributed digital control systems
5. Implementation of Industrial Automation Applications.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3									2	2	
CO2	3	2	3	2	2								2		
CO3	2	3	2	3	2							2	2	2	
CO4	2	2	2	2	2							2	2	2	
CO5	3	2	3	2	2							2			2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EMA371: NUMERICAL METHODS, PROBABILITY AND STATISTICS

L	T	P	C
2	1	0	3

Course Objectives:

- Familiarize the students with numerical methods of solving the non-linear equations,
- Learn about interpolation, differentiation, integration, and ordinary differential equations.
- Impart knowledge in basic concepts and few techniques in probability and statistics in relation to the engineering applications.

Unit- I: Solution to Algebraic Equations **9 hrs**

Solution of polynomial and transcendental equations: bisection method and Newton-Raphson method, finite differences, relation between operators, interpolation using Newton's forward and backward difference formulae, interpolation with unequal interv als: Lagrange's formula.

Learning Outcomes:

At the end of this unit, the student will be able to

- find approximate roots of the an equation by using different numerical methods (L3)
- explain various discrete operators and find the relation among operators(L3)
- apply Newton's forward and backward formulae for equal and unequal intervals (L3)

Unit- II: Numerical Differentiation and Integration **10 hrs**

Numerical Differentiation- Newton's forward and backward difference formulae, numerical integration- trapezoidal rule and Simpson's 1/3rd and 3/8 rules, Ordinary differential equations- Euler, modified Euler's, Runge -Kutta method of fourth order for solving first and second order equations.

Learning Outcomes:

At the end of this unit, the student will be able to

- find differentiation of a function by using different numerical methods (L3)
- find integration of a function by using different numerical methods (L3)
- solve ordinary differential equations by using different numerical schemes (L3)

Unit- III: Probability **8 hrs**

Random variables (discrete and continuous)**,** probability distribution: Binomial - Poisson approximation to the binomial distribution, normal distribution and exponential distribution-their properties (mathematical expectation and variance).

Learning Outcomes:

After completing this unit, the student will be able to

- apply Binomial and Poisson distributions for real data to compute probabilities, theoretical frequencies (L3)
- interpret the properties of normal distribution, exponential distribution and their applications (L3)

Unit- IV: Testing of Hypothesis	**8 hrs**
Formulation of null hypothesis, critical regions, level of significance. Large sample tests: test for single proportion, difference of proportions, test for single mean and difference of means.	
Learning Outcomes:	
After completing this unit, the student will be able to • explain the concept of estimation, interval estimation and confidence intervals (L3) • apply the concept of hypothesis testing for large samples (L3)	
Unit- V: Small Sample Tests	**7 hrs**
Student t-distribution (single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit.	
Learning Outcomes:	
After completing this unit, the student will be able to • apply the concept of testing hypothesis for small samples to draw the inferences (L3) • test for the goodness of fit (L4)	
Text Books:	
1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017. 2. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2/e, Reprint 2012.	
References:	
1. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008. 2. Erwin kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2006. 3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.	

19ECS371: INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS

L	T	P	C
2	1	0	3

Unit- I	**8 hrs**
Introduction to DBMS: Overview, file system vs. DBMS, advantages of DBMS, storage data, queries, transaction management, DBMS Structure.	
Unit- II	**8 hrs**
Entity Relationship Model: E-R model entities, attributes and entity sets, relationship and relationship sets, features of E-R model, conceptual database design with E-R model	
Unit- III	**8 hrs**
Relational Model: Integrity constraints over relations and enforcement, querying relational data, logical database design, views, destroying/altering tables and views, relational algebra and calculus**.** Relational algebra and calculus	
Unit- IV	**8 hrs**
Structure Query Language: Basic SQL, query, union, interest, except, nested queries, aggregated operation, null values, embedded SQL, cursors, ODBC and JDBC, triggers and active database.	
Unit- V	**8 hrs**
Transaction Management, Concurrency Control and Crash Recovery: Transaction concept, transactions and schedules, concurrent execution of transactions, lock based concurrency control, crash recovery.	
Text Books:	
1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 2003. 2. H.F.Korth and A.Silberschatz, Data System Concepts, McGraw-Hill, 2011.	
References:	
1. Ramez Elmasri and S.B.Navathe, Fundamentals of Database System, Benjamin Cummings, 1989.	

19ECS373: OBJECT ORIENTED PROGRAMMING WITH C++

L	T	P	C
2	1	0	3

C++ is one of the most popular languages, contains object-orientation, a new programming concept, is used to create an object, in code, that has certain properties and methods or Units, the implementation of the Units helps to see the whole world in the form of objects. This course also helps in developing high quality software like system application software, drivers, client-server applications and embedded firmware.

Course Objectives:

- To understand the difference between procedure oriented programming and object oriented programming.
- To learn the basic concept , applications of OOPS and practice of object oriented analysis and design in the construction of robust, maintainable programs which satisfy their requirements;
- To identify and practice the object-oriented programming concepts and techniques, practice the use of C++ classes and class libraries, modify existing C++ classes, develop C++ classes for simple applications
- Ability to implement features of object oriented programming to solve real world problems using Inheritance, data abstraction, encapsulation and Polymorphism.
- To understand the concept of file and handling function to perform file operations like accessing the data from file and store the data into file.

Unit- I **10 hrs**

Introduction to OOP: Procedure oriented programming, object oriented programming, basic concepts of OOP, simple C++ program, namespace scope, structure of C++ Program, creating, compiling and linking a file.

Tokens : Keywords, identifiers, constants, basic data types, user defined data types, derived data types, dynamic initialization of variables, reference variables, operators in C++, scope resolution operator, member dereferencing operators, memory management operators.

Learning Outcomes:

At the end of this unit, the student will be able to

- List the difference between procedure and object oriented programming, appilications of OOP.
- Tell the basic concepts of object oriented programming.
- Create, compile and run the C++ programs.
- Choose appropriate datatype and operators in programs.
- Extend the concepts of C++ in developing efficient programs.

Unit- II **9 hrs**

Control Structures.

Classes and Objects: Specifying a class, defining member functions, C++program with class, private member functions, arrays within class, memory allocation for objects, static data members, static member functions, arrays of objects.

Functions in C++: Main function, function prototyping, inline functions, default arguments.

Learning Outcomes:

At the end of this unit, the student will be able to

- . Compare and contrast parameter passing techniques of C and C++.
- Illustrate the concept of classes and objects
- Develop real world applications by using appropriate concepts.
- Make use of static members in programming.

	• Compare and contrast inline functions with macros.
Unit- III	**9 hrs**
More about Functions: Function overloading, friendly functions: friendfunction, objects as function arguments. **Constructors & Destructors:** Constructors, parameterized constructors,multiple constructors in a class, copy constructors, dynamic constructors, destructors.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Apply function overloading concept whenever required. • Explain the need of friend function • Extend the concept of parameter passing techniques with objects. • Outline the different types of Constructors. • Make use of constructor and destructor in programming
Unit- IV	**10 hrs**
Inheritance: Introduction to inheritance, single inheritance, making aprivate member inheritable (protected member), multi-level inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance. **Operator Overloading:** Rules for overloading operators, overloading unaryoperators, overloading binary operators. **Pointers:** Introduction to pointers, declaring and initializing pointers,pointers with arrays, arrays of pointers, 'this' pointer.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Explain the need of reusability concept with inheritance. • Summarize different types of inheritance. • Extend the overloading concept on operators. • Recall the basics of pointers from C language and extend to objects. • Tell the need of this pointer.
Unit- V	**9 hrs**
Polymorphism and Virtual Functions: Compile-time polymorphism, run-time polymorphism, virtual functions. **Templates:** Introduction, function templates, class templates. **Exception Handling:** Introduction, exception handling mechanism,throwing mechanism, catching mechanism.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Compare and contrast compile time and run time polymorphism. • Make use of virtual functions. • Classify the various input and output operators into formatted and unformatted. • Apply the concept of templates for generic programming. • Demonstrate the handling of run time errors.
Course Outcomes:	
	After the completion of the course the student should be able to • Able to differentiate between procedure-oriented programming and object-oriented programming with emphasis on special features of C++ language* • Differentiate the fundamental concepts of C and C++* • Identify the differences in C and C++ operators and their usage in C++ applications*

	• Examine the working of Control structures in C++ programs* • Able to define, declare and implement classes and objects • Able to develop applications with the help of functions, constructors and destructors • Understand various Inheritance mechanisms, operator overloading ,polymorphism and apply in applications • Learn the concepts of Polymorphism, Virtual functions and Exception handling and be able to develop applications with them • Construct applications using generic programming concepts (templates)*
Text Books:	
	1. E. Balagurusamy, Object Oriented Programming with C++, 6/e, McGraw Hill, 2013.
References:	
	1. SouravSahay, Object Oriented Programming with C++, 2/e, Oxford University Press, 2012. 2. Behrouz A. Forouzan and Richard F. Gilberg, Computer Science : A Structured Approach Using C++, 2/e, Cengage Learning, 2003. 3. Ashok N. Kamthane, Object Oriented Programming with ANSI and Turbo C++, 1/e, Pearson Education, 2006.

19ECS375: INTRODUCTION TO PROGRAMMING WITH JAVA

L	T	P	C
2	1	0	3

Java's unique architecture enables programmers to develop a single application that can run across multiple platforms seamlessly and reliably. In this hands-on course, students gain extensive experience with Java and its object-oriented features. Students learn to create robust console and GUI applications and store and retrieve data from relational databases.

Course Objectives:

- To make it understand the difference between programming languages C, C++ and Java.
- Learn various types of Inheritance mechanisms.
- Give exposure over various software packagesapplicability and usage of multithreading concepts.
- Applet creation and its graphical effects.
- Learn different components required for forms designing in AWT.

Unit- I **10 hrs**

Java Evolution and Overview of java Language: Fundamentals of OOP, Java evolution, overview of java language, java history, features of java, how java differs from C and C++, java and World Wide Web, web browser.Java Environment: Java Development kit (JDK), Application Programming Interface (API), java programming structure, java tokens, constants, variables, expressions, decision making statements and looping, java statements, overview of arrays and strings, machine neutral, Java Virtual Machine (JVM), Command Line Arguments.Arrays and Strings :One-dimensional arrays, creating an array, declaration of arrays, initialization of arrays, two-dimensional arrays, string arrays, string methods, string buffer class, vectors, wrapper classes.Basic I/O Streams: Scanner, buffered reader.

Learning Outcomes:

At the end of this unit, the student will be able to

1. Identify the difference between c++ and Java
2. Identify the Environment that allows to write platform independent programs
3. Apply the methods of Strings to solve the string oriented problems.
4. Analyze the uses of wrapper classes in the design of solutios.
5. Contrast the difference between the usage of I/O Streams

Unit- II **11 hrs**

Classes, Objects and Methods: Introduction, defining a class, creating objects, accessing class members, constructors, methods overloading, static members.Inheritance: Defining a sub class, sub class constructor, multilevel variables, final classes, and finalize methods, abstract methods and classes, visibility control.Managing Errors and Exceptions: Introduction, types of errors: compile time and run time errors, exceptions, types of exceptions, syntax of exception handling code, multiple catch statements, using finally statement, throwing our own exceptions.

Learning Outcomes:

At the end of this unit, the student will be able to

1. Define the user defined classes of the given problem to be solved.
2. Explain the behavior of each object in its scope.
3. Apply the concepts finalize, abstract and final over the methods and classes.
4. Analyze the exception handling mechanisms.
5. Develop a code with try and catch blocks.

Unit- III **9 hrs**

Interfaces, Package & Multithreaded Programming: Introduction, defining interfaces, extending

interfaces, implementing interfaces.Package: Creation, importing a package and user defined package.Threads: Introduction to threads, creating threads, extending the thread class, implementing the 'runnable' interface, life cycle of a thread, priority of a thread, synchronization, and deadlock.

Learning Outcomes:

After completing this unit, the student will be able to

1. Recall the concepts of Inheritance for implementing new classes.
2. Extends the new classes from one or more classes.
3. Define the interfaces and packages.
4. Develop new packages for solving complex problems.
5. Survey the flow of execution by decomposing into two or more

Unit- IV	**9 hrs**

Applet Programming: Introduction, how applets differ from applications, building applet code, applet life cycle, about HTML, designing a web page, passing parameters to applets, getting input from the user.

Learning Outcomes:

After completing this unit, the student will be able to

1. Defining the new concept applet on internet programming.
2. Compare applet with application programs
3. Apply applet life cycle to the real problem to solve.
4. Examine the behavior of applet using HTML code
5. Test the parameterized applet.

Unit- V	**8 hrs**

Graphics Programming: Introduction, abstract window toolkit class hierarchy, frames, event-driven programming, layout managers, panels, canvases, drawing geometric figures.Introduction to Swings: Introduction to swings, overview of swingcomponents-Jbutton, JCheckBox, JRadioButton, JLabel, JTextField, JTextArea, JList.Introduction to Networking: InetAddress class, socket class, URL class.

Learning Outcomes:

After completing this unit, the student will be able to

1. Choose awt to create GUI
2. Classify the various layouts
3. Develop the very user friendly GUIs
4. Contrast the between applet and Swings
5. Build an Internet based application using networking concepts in java

Course Outcomes:

After the completion of the course the student should be able to

- Ability to differentiate Java and C,C++ and basic environment required for implementing Java program.
- Introduce the concept of class and object and Ability to apply inheritance concepts
- Illustrate concept of user defined exceptions
- Demonstrate usage of a package and thread implementation in application development
- Develop applets with various graphical aspects and Develop GUI forms using different AWT Components

Text Books:

1. Herbert Scheldt, The Java complete References, 9/e, TMH Publications,2014

References:	
	1. Balagurusamy, Programming with JAVA, 2/e, TMH Publications,2014. 2. Y.DanielLiang, An Introduction to JAVA Programming, TMH Publications, 2009. 3. Kathy Sierra, Head First Java, 2/e, Shroff Publishers, 2012.

19EME456 OPTIMIZATION TECHNIQUES

L	T	P	C
2	1	0	3

Course Objectives:

- Introduction to optimization theory and methods, with applications in systems, control, and communication
- This is a course on nonlinear optimization problems, both unconstrained and constrained. We will study optimality conditions and the basic numerical optimization methods with their convergence analysis.
- The numerical methods include: basic descent methods, conjugate direction methods, quasi Newton algorithms, reduced gradient method, gradient projection method, penalty and barrier methods, duality, and Lagrange methods
- Introduction to Integer programming, with emphasis on Integer linear Programming (ILP), its relation with linear programming and the various types of integer programming,. Among the various techniques for solving ILP, a well knownmethodGomory's cutting plane method is explained
- Principles of search heuristics and branch and bound and outer linearization methods for mixed integer problems.

Unit- I **8 hrs**

Introduction to optimization: Introduction, engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function, classification of optimization problems, optimization techniques.

Optimization techniques: Introduction, single variable optimization, multi variable optimization with no constraints, multi variable optimization with equality and inequality constraints-Kuhn-tucker conditions, constraint qualification

Learning Outcomes:

At the end of this unit, the student will be able to

- Describe the need and origin of the optimization methods (L1)
- Classify design constraints, constraint surface, objective functions, optimization problems and techniques (L2)
- Familiarize optimization problems to suitably choose the method needed to solve the particular type of problem (L2)
- Solve the Optimization of multivariable function with and without equality Constraints using analytical methods (L3)

Unit- II **10 hrs**

Non-linear programming I: One Dimensional Minimization Methods: Introduction, unimodal function, elimination methods- unrestricted search, exhaustive search, interval halving method, Fibonacci method, golden section method, interpolation method, cubic interpolation method, direct root method-Newton method, secant method.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand Optimization techniques with elimination process for solving 1-dimensional objectives (L1)
- Solve 1-dimensional numerical methods like basic descent methods, conjugate direction methods, quasi Newton algorithms, reduced gradient method, gradient projection method, penalty and barrier methods, duality, and Lagrange methods particular type of problems (L2)

- Expose students to utilize gradient of problems for solving problems. (L3)
- Apply numerical methods to solve multi variable unconstrained Non-Linear programming problems (L3)

Unit- III **8 hrs**

Non-linear programming II: Introduction, classification of unconstrained minimization methods, random search methods, univariate method, Hooke and Jeeves method, Powell's method, indirect search methods- steepest descent method (Cauchy's method)

Learning Outcomes:

After completing this unit, the student will be able to

- Acquaint with classification of unconstrained minimization methods (L2)
- Introduce optimization techniques like Hooke and Jeeves method, Powell's method as random search methods. (L2)
- Solve NLP with indirect search methods like Cauchy's method. (L3)
- Solve un-constrained Non-Linear programming problems (L3)

Unit- IV **8 hrs**

Dynamic Programming: Multistage decision processes, Concepts of sub optimization, computational procedure in dynamic programming calculus method and tabular methods, Linear programming as a case of D.P and Continuous D.P.

Learning Outcomes:

After completing this unit, the student will be able to

- Introduce calculus method like dynamic programming for optimization solving. (L1)
- Comprehend multistage decision processes.(L2)
- Apply dynamic programming method towards optimization of linear programming problems. (L3)
- Apply different approaches in dynamic programming problems(L3)

Unit- V **8 hrs**

Integer Programming: Introduction, Graphical Representation, Gomory's cutting plane method, Balas algorithm for zero-one programming, Branch-and- bound method, Penalty Function method; Basic approaches of Interior and Exterior penalty function methods

Learning Outcomes:

After completing this unit, the student will be able to

- Introduce Integer programming concepts (L1)
- Formulate Integer linear Programming (ILP) with its relation with linear programming and the various types of integer programming. (L2)
- Familiarize with the need of a well known method *Gomory's cutting plane method*.(L3)
- Apply optimization concepts like Balas algorithm for zero-one programming, Branch-and- bound method, Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. (L3)

Course Outcomes:

After the completion of the course the student should be able to

- Understand the need and origin of the optimization methods
- Classify optimization problems to suitably choose the method needed to solve the particular type of problem
- Optimization of multivariable function with and without equality Constraints
- Formulate Integer Linear Programming (ILP) models.

	• Use computer software efficiently for modelling and solving the ILP problems. • describe the logic underlining the idea in the Branch and Bound method and use that method to solve ILPs • Describe the logic underlining the idea in the Cutting Plane algorithm and use that method to solve ILPs • Use computer software efficiently for modelling and solving the Non-Linear programming problems. • solve single variable constrained Non-Linear programming problems.
Text Books:	
	1. S.S.Rao, Engineering optimization theory and practice,3rd Edition, New age international,2007.
References:	
	1. H.A.Taha, Operations Research, 9th Edition, Prentice Hall of India, 2010. 2. F.S.Hillier, and G.J.Lieberman, Introduction to Operations Research, 7th Edition, TMH, 2009.

19EHS405 OPERATIONS RESEARCH

L	T	P	C
2	1	0	3

Course Objectives:

- Introduce the basics of Operations research, formulation and solution of Linear Programming Problems using different methods
- Explain formulation and solve problems of optimization problems in transportation and assignment of jobs.
- Explore different queuing models and sequencing techniques for optimal schedule of jobs on machines
- Impart Knowledge on replacement policies for estimation of economic life of equipment and the concept of game theory to arrive at the optimal business strategy for a given situation.
- Demonstrate basic inventory models to optimize inventory costs and Project scheduling techniques – CPM & PERT for optimum time and costs.

Unit- I

Basics of Operations Research: History, definition, operations research models, phases of implementing operations research in practice.
Linear Programming: Introduction, formulation, graphical solution, simplex method, artificial variable techniques – Big M and two phase methods, duality principle.

Learning Outcomes:

At the end of this unit, the student will be able to

- Recognizethe significance of Operations Research and mathematical modelling while analysing the practical problems in industry(L1)
- Formulate the various linear Programming Models(L5)
- Evaluatethe optimal solution to simple linear programming problems(L6)

Unit- II

Transportation Model: Formulation, initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems.
Assignment Model: Formulation, optimal solution, Hungarian method, travelling salesman problem.

Learning Outcomes:

At the end of this unit, the student will be able to

- Formulate the linear programming problem as a Transportation model(L5)
- Formulate the linear programming problem as an Assignment model(L5)
- Evaluate the optimal solution to Transportation Problems(L6)
- Evaluate the optimal solution to Assignment Problems(L6)

Unit- III

Queuing Models: Introduction, Kendall's notation, classification of queuing models, single server and multi-server models, Poisson arrival, exponential service, infinite population
Sequencing Models: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, n-jobs through m-machines, and graphic solution for processing 2 jobs through n machines with different order of sequence.

Learning Outcomes:

After completing this unit, the student will be able to

- Definethevarious queuing models(L1)

	• Calculate Queue length & waiting time of a given queue system(L6) • Evaluatetheoptimal sequence of the jobs on machines for minimum cycle time(L6)
Unit- IV	
Replacement Models: Introduction, replacement of items that deteriorate with time - value of money unchanging and changing, simple probabilistic model for replacement of items that fail completely. **Game Theory**: Introduction, game with pure strategies, game with mixed strategies, dominance principle, graphical method for 2xn and mx2 games, linear programming approach for game theory.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Analyze the replacement and maintenance costs of items under various replacement policies(L4) • Evaluatethe optimal replacement policy of items(L6) • Analyze the players' strategies and thereby Evaluate optimal business strategies for the players (L4 & L6)
Unit- V	
Inventory Models: Introduction, inventory costs, Economic Order Quantity (EOQ) and Economic Batch Quantity (EBQ) models with and without shortages, inventory models with quantity discounts **Project Management**: Introduction, phases of project management, network construction, numbering the events-Fulkerson's rule, Critical Path Method (CPM), ProgrammeEvaluation and Review Technique (PERT)	
Learning Outcomes:	
	After completing this unit, the student will be able to • Recognize the significance of Inventory models & Project Management in real world industrial scenarios(L1) • Differentiate between the critical and non-critical activities of a given project(L4) • Propose the optimal schedule of the activities involved in a project(L5) • Evaluate the optimal order/batch quantity for minimum inventory cost(L6)
Course Outcomes:	
	After the completion of the course the student should be able to • Recognize the scope of operations Research (L1) • Develop the mathematical models for practical problems in industry(L3) • Analyze the various resource allocation problems (L4) • Formulate and solve transportation models for optimum shipment cost (L) • Formulate and solveassignment Models for optimum time (L5) • Analyze the Queue system and Predict the Queue length & waiting time (L4) • Propose the sequence of performing jobs on machines for minimum cycle time(L5) • Evaluate the best policy to be adopted with respect to replacement of the equipment(L5) • Analyze the strategic interaction between rational decision-makers(L4) • Design the inventory systems to minimize the costs(L6) • Plan and schedule the activities involved in a project(L5&L3)
Text Books:	
	1. Gupta P K. & Hira D.S., Operation Research, 6/e, *S Chand* Publishers, 2006.

	2. Paneerselvam R., Operations Research, 2/e Prentice Hall of India, 2010.
References:	
	1. Taha H.A., Operations Research, 9/e, Prentice Hall of India, 2010. 2. Harvey M. Wagner, Principles of Operations Research: With Applications to Managerial Decisions, 2/e, Prentice Hall of India, 1975. 3. KantiSwarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research, 7/e, Sultan Chand & Sons, 2005. 4. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2009.

19EME361 3D PRINTING

L	T	P	C
2	1	0	3

Fundamental understanding of manufacturing processes and manufacturing technology.	
Course Objectives:	
	• Understand the fundamentals ofvarious Additive ManufacturingTechnologies for application to variousindustrial needs. • Able to convert part file into STLformat. • Able to understand the method ofmanufacturing of liquid based, powderbased and solid based techniques. • Understand the manufacturingprocedure of a prototype using FDMtechnique.
Unit- I : Introduction	**8 hrs**
Introduction of 3D Printing, Evolution of 3D Printing, General procedure of 3D Printing, Prototyping fundamentals, Historical development, Advantages of AMT, Commonly usedterms, process chain, 3D modeling, Data Conversion, and transmission, Checking and preparing,Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields.	
Learning Outcomes:	
	At the end of this unit, the student will be able to • Understand history, concepts and terminology of additive manufacturing (L1). • Differentiate between additive and subtractive manufacturing techniques (L4).
Unit- II: Liquid based systems	**8 hrs**
Stereo lithography apparatus (SLA): Models and specifications, process,workingprinciple, photopolymers, photo polymerization, layering technology, laser and laser scanning,applications,advantages and disadvantages, case studies. **Solid ground curing (SGC):** Models andspecifications, process, working,principle, applications, advantages and disadvantages, case studies	
Learning Outcomes:	
	At the end of this unit, the student will be able to • Able to prepare CAD model, understand the various software tools, processes and techniques that enable manufacturing and personal fabrication (L3). • Articulate the various tradeoffs that must be made in selecting additive manufacturing processes, devices and materials to suit particular product requirements (L4).
Unit- III	**8 hrs**
Solid based systems: Laminated object manufacturing (LOM): Models and specifications, Process,Working principle, Applications, Advantages and disadvantages, Case studies.Fused Deposition Modeling(FDM): Models and specifications, Process, Working principle, Applications, Advantages anddisadvantages, Case studies, practical demonstration.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Identify the need for liquid and solid based additive manufacturing systems (L3). • Demonstrate the application of different AM techniques (L2).

Unit- IV	**8 hrs**
Powder Based Systems: Selective laser sintering (SLS): Models and specifications, process, workingprinciple, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, casestudies.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Design and develop newer tooling models (L3). • Analyze the best powder based AM method for present day market requirements (L4).
Unit- V	**8 hrs**
Medical And Bio-Additive Manufacturing:Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- ComputerAided Tissue Engineering (CATE) Case studies.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Evaluate the Additive Manufacturing systems, scope for new product development for medical and bio implants (L5). • Analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools (L4).
Text Books:	
	1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010. 2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
References:	
	1. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer,2/e,2014. 2. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007. 3. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 4. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

Course outcomes

1. Understand the fundamentals of Additive Manufacturing Technologies for engineering applications.
2. Understand the methodology to manufacturing the products using SLA and SGC technologies and study their applications, advantages and case studies.
3. Understand the methodology to manufacturing the products using LOM and FDM technologies and study their applications, advantages and case studies.
4. Understand the methodology to manufacturing the products using SLS and 3D Printing technologies and study their applications, advantages and case studies.
5. Develop the new additive manufacturing methods for the biomedical and tissue engineering fields.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2		3		2	1		1	3	2	2			
CO2		1		1		1	3		1	1	2	1			
CO3		2		2		1	3		2	1	1	1			
CO4		1		3		1	2		1	1	1	1			
CO5		2		3		2	1		1	3	2	2			

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EEI371: SENSORS AND SIGNAL CONDITIONING

L	T	P	C
2	1	0	3

Unit- I : Sensors Fundamentals and Applications	**8 hrs**
Basic Sensor Technology, Sensor Systems, Sensor classification,Sensor Characteristics, System Characteristics, Instrument Selection, Data Acquisition and Readout.	
Unit- II: Mechanical & Electromechanical Sensors	**8 hrs**
Potentiometer, Strain gauges, Inductive sensors —Ferromagnetic type, Transformer type, Electromagnetic, Capacitive sensors— parallel plate, variable permittivity, electrostatic, piezoelectric	
Unit- III	**8 hrs**
Thermal sensors: Thermal Sensors-resistance change type thermometric sensors, Thermo emf sensors and semiconductor sensors. Magnetic Sensors-Basic working principles, Magnetostrictive, Hall effect, Eddy current type, SQUID sensors.	
Unit- IV	**8 hrs**
Photo sensors – photo emissive cell, photomultiplier, photoconductive cell, photovoltaic and photo junction cells Fiber optic sensors – temperature, liquid level, fluid flow and micro bend sensors	
Unit- V	**8 hrs**
Advancement in Sensor technology: Introduction to smart sensors, Film sensors, Introduction to semiconductor IC technology and Micro Electro Mechanical System (MEMS), Nano-sensors. Bio-Sensors.	

Text Books:

1. Sensor Technology Handbookby Jon S. Wilson, Elsevier, 2005
2. Measurement Systems, Application and design, E.O. Doeblin, Tata McGraw Hill, 2004.

References:

1. A course in mechanical measurements and instrumentation, A. K. Sawhney&PuneetSawhney, Dhanpat Rai & Co., 2001.
2. Transducer Engineering, Ranganathan, Allied Publishers, Chennai.
3. Transducers and Instrumentation, D.V.S.Murthy, PHI, 1995.
4. Sensors and Transducers, D.Patranabis, PHI, 2004.
5. Principles of Industrial Instrumentation,Tata McGraw –Hill Education.

19ECS471: INTRODUCTION TO OPERATING SYSTEMS

L	T	P	C
2	1	0	3

Operating systems are essential part of in any computer system and equally important for computer science education. This course provides a clear description of the concepts that underlie operating systems.

Course Objectives:

- To introduce students with basic concepts of operating system, its functions and ser
- To provide the basic concepts of process management and synchronization
- To familiarize the dead lock issues
- To understand the various memory management schemes.
- To give exposure over I/O systems and mass storage structures and Linux system.

Unit- I : Introduction **8 hrs**

What Operating Systems Do, Computer System Organization, Computer-System Architecture, Operating System Structure, Operating system operations, Process Management, Memory Management, Storage management, Protection and security, Kernel data structures

Learning Outcomes:

At the end of this unit, the student will be able to

- To describe the basic organization of the computer systems(L1)
- To provide a grand tour of the major components of operating systems: (L1)
- To give an overview of the many types of computing environments: (L1)

Unit- II **8 hrs**

Operating system Structures: operating system services, User and operating system Interface, system calls, Types of System calls, system programs, operating system structure, system boot.
Process Management: Process concepts, process scheduling, Operations on processes, inter-process communication.

Learning Outcomes:

At the end of this unit, the student will be able to

- To describe the services an operating system provides to user's, processes, and other systems: (L1)
- To discuss the various ways of structuring an operating system: (L2)
- To introduce the notion of a process- a program in execution and describe the various features of processes, including scheduling, creation and termination: (L3)
- To explore interprocess communication using shared memory and message passing: (L4)

Unit- III **8 hrs**

CPU Scheduling: Scheduling-criteria, scheduling algorithms, Thread scheduling, Multiple processor scheduling, algorithm evaluation.
Process Synchronization: Critical section problem, Peterson's solution, synchronization hardware, Mutex locks, semaphores, classic problems of synchronization, monitors.

Learning Outcomes:

After completing this unit, the student will be able to

- To introduce CPU-scheduling and describe various CPU-scheduling algorithms: (L3)
- To discuss evaluation criteria for selecting a CPU-scheduling algorithm for a particular system: (L3)
- To introduce critical section problem: (L3)
- Both hardware and software solutions to the critical section problem(L4)

	• To examine several classical process synchronization problems(L4)
Unit- IV	**8 hrs**
Deadlock: System model, deadlock characterization, deadlock prevention, detection and avoidance, recovery from deadlock. **Memory Management:** Swapping, contiguous memory allocation, paging, segmentation, structure of page the table.	
Learning Outcomes:	
	After completing this unit, the student will be able to • To develop description of deadlocks(L5) • To present a number of different methods for preventing or avoiding deadlocks(L5) • To provide detailed description of various ways of organizing memory hardware(L5) • To explore various techniques of allocating memory to processes(L5)
Unit- V	**8 hrs**
Virtual memory: Demand paging, Copy-on-Write, page-replacement, allocation of frames, thrashing. **File Concepts:** File concept, access Methods, directory and disk structure, protection.	
Learning Outcomes:	
	After completing this unit, the student will be able to • Discuss in detailed how paging works in contemporary computer systems(L6) • Explain the concept of demand paging, page replacement algorithms, allocation of page frames(L6) • Discuss briefly about file concepts(L6)
Course Outcomes:	
	After the completion of the course the student should be able to • Illustrate the basic and overall view of operating system: (L2) • Demonstrate the structure of operating systems, applications, and services provided by operating systems: (L3) • Analyze the concept of a process, process life cycle, process states and state transitions: (L2) • The student will be able to implement various CPU scheduling strategies and process synchronization techniques: (L3) • Simplify & Resolve Deadlock handling situation: (L5) • Explain the importance of file structures in the Data Storage and Manipulation: (L4) • Ability to implement and practice various memory-management schemes: (L4)
Text Books:	
	1. Abraham Silberchatz, Peter B. Galvin, Greg Gagne, Operating System Concepts with Java, 9/e, John Wiley, 2016.
References:	
	1. Andrew S Tanenbaum, Modern Operating Systems, 2/e, Pearson/PHI, 2014. 2. Crowley, Operating System, A Design Approach, McGraw-Hill, 2012. 3. Stallings, Operating Systems - Internal and Design Principles, 5/e, 2013. 4. Pal Chaudhary, Operating system principles & Design, PHI Learning,1/e, 2013. 5. Deitel and Deitel, Operating System, Pearson Education, 2003. 6. D.M. Dhamdhere, Operating systems- A Concept baed Approach-2/e, McGraw Hill, 2010.

19ECS473: INTRODUCTION TO SOFTWARE ENGINEERING

L	T	P	C
2	1	0	3

This course provides the fundamentals of software engineering, including understanding system requirements, effective methods of design, coding and testing, team software development, and the application of engineering tools. By applying the above scientific knowledge we can create practical, cost effective solutions to computing and information processing problems

Course Objectives:

- Having a good understanding of the Software Development Life Cycle [SDLC].
- Good Knowledge about how to the design based on the project requirements and planning.
- Knowing what kind of process model has to be implemented based on the Communication and Planning.
- All the students will have the understanding of the Project, Quality and Risk Managements in the Project.
- All will have good expose to the S/W testing strategies, Tactics and Software Metrics.
- They will have the good understanding of the Good software development practices.

Unit- I : Introduction — **10 hrs**

Introduction: Evolution, Software Development Projects, Exploratory Style of Software Development, Emergence of Software Engineering, Notable Changes in Software Development Practices, Computer Systems Engineering

Software Life Cycle Models: A Few Basic Concepts, Waterfall Model and its Extensions, Rapid Application Development (RAD), Agile Development Models, Spiral Model, A Comparison of Different Life Cycle Models

Learning Outcomes:

At the end of this unit, the student will be able to

- illustrate the importance of software engineering.(L2)
- identify the changes in software development practices.(L3)
- outline different software life cycle models(L2).
- select which model fits for different types of problems(L3)

Unit- II: — **10 hrs**

Requirements Analysis And Specification: Requirements Gathering and Analysis,
Software Requirements Specification (SRS), Formal System Specification, Axiomatic Specification, Algebraic Specification, Executable Specification and 4GL

Software Design: Overview of the Design Process, How to Characterise a Good Software Design?, Cohesion and Coupling, Layered Arrangement of Units, Approaches to Software Design.

Learning Outcomes:

At the end of this unit, the student will be able to

- find the requirements for different types of problems(L1)
- list different specification methods for a given problem(L1)
- identify project constraints and solutions, problem decomposition, requirements elicitation(L3)
- develop a model for a given problem using different levels of design methodologies(L3)

Unit- III — **8 hrs**

Function-Oriented Software Design : Structured Analysis, Developing the DFD, Model of a

System, Structured Design, Detailed Design, Design Review

Basic Object-Orientation Concepts : Unified Modelling Language (UML), UML Diagrams, Use Case Model, Class Diagrams, Interaction Diagrams, Activity Diagram, State Chart Diagram

User Interface Design : Characteristics of a Good User Interface, Basic Concepts, Types of User Interfaces, Fundamentals of Component-based GUI Development, A User Interface Design Methodology

Learning Outcomes:

After completing this unit, the student will be able to

- develop a design for software problem using UML diagrams(L3)
- show the solution of software problem in various UML diagrams(L2)
- understand the multiple levels of detail and abstraction of a solution(L2)
- identify design patterns that best suits for a problem solution(L3)

Unit- IV **10 hrs**

Coding and Testing: Coding, Software Documentation, Testing, Unit Testing, Black-box Testing, White-Box Testing, Debugging, Program Analysis Tools, Integration Testing, Testing Object- Oriented Programs, System Testing

Software Reliability and Quality Management : Software Reliability, Statistical Testing, Software Quality, Software Quality Management

Learning Outcomes:

After completing this unit, the student will be able to

- distinguish various types of testing methods and their importance(L4)
- Apply these methods for testing the solution of a problem(L3)
- Develops a reliable software solution for a problem(L3)
- Understand the importance of software quality(L2)

Unit- V **10 hrs**

Computer Aided Software Engineering, Case and its Scope, Case Environment, CASE Support in Software Life Cycle, Other Characteristics of Case Tools, Towards Second Generation CASE Tool, Architecture of a Case Environment.

Software Maintenance: Characteristics of Software Maintenance, Software Reverse Engineering, Software Maintenance Process Models, Estimation of Maintenance Cost.

Learning Outcomes:

After completing this unit, the student will be able to

- explain three different perspectives for CASE tools classification(L2)
- compare and contrast the fitness of existing CASE Tools to the needs of specific software development context(L2).
- construct documentation and presentations for effective software reuse(L3)

Course Outcomes:

After the completion of the course the student should be able to

- make use of different process models in the SDLC.(L3)
- construct system design by using different types of modeling i.e., object oriented, scenario based, flow oriented, class based(L3)
- understand Pattern based design, Architectural Design; Component based Design, user Interface Design(L2)
- develop different test strategies, understand different test tactics.(L3)

	• understand project estimation and quality, of Risk and Quality Management and apply in applications(L2)
Text Books:	
	1. Rajib Mall, Fundamentals of Software Engineering, 4/e, PHI, 2009.
References:	
	2. Roger S. Pressman, Software Engineering: A Practitioner's Approach, 7/e, McGraw Hill, International Edition, 2009 3. K.K. Agarwal &Yogesh Singh, Software Engineering, New Age International Publishers, 2007. 4. Waman S Jawadekar, Software Engineering Principles and Practice, McGraw Hill, 2004.

19ECS475 Introduction to Web Technologies

L	T	P	C
2	1	0	3

Course objectives:

- Design static web page using Markup languages.
- Design and implement webpages using style sheets.
- Implement with java script web applications with dynamic webpages.
- Understand working of Webservers and Design Methodologies.
- Develop web applications using XML.

Module I **8 hours**

Introduction to HTML Version 5 and Cascading Style Sheets (CSS)Version 3: Basic syntax, elements, attributes and tags, paragraph, heading, forms, frames, CSS: levels of style sheets, style specification formats, selector forms, span and div tags.

Learning Outcomes:

After completion of this unit, the student will be able to:

- outline various steps to design static websites. (L2)
- demonstrate the importance of HTML tags for designing web pages. (L2)
- distinguish the design from content using various levels of Style Sheets. (L4)

Module II **8 hours**

Introduction to Java Script and Document Object Model (DOM): Variables, literals, operator and control structures, arrays, functions, the window object, the location object, the history object and event handlers: Key Press, Mouse handlers.

Learning Outcomes:

After completion of this unit, the student will be able to:

- Illustrate dynamic, interactive web pages by embedding Javascript code in HTML (L3)
- Demonstrate validations of user input and perform dynamic documents. (L2)

Module III **8 hours**

Introduction to XML: Syntax of XML, document structure, and document type definition, namespaces, XML schemas, document object model.

Learning Outcomes:

After completion of this unit, the student will be able to:

- Understand XML document structure (L1)
- Create XML documents (L3)

Module IV **9 hours**

Introduction to Servlets and Tomcat Web Server: Lifecycle of a servlet, the servlet API, the javax.servlet package, Tomcat Server and testing Tomcat, structure of web application, deploying web application.

Learning Outcomes:

After completion of this unit, the student will be able to:

- demonstrate running of application on Tomcat server instance(L2)
- Illustrate structure of web application and its deployment. (L3)

Module V **9 hours**

Introduction to JSP: JSP and servlet, the anatomy of a JSP page, JSP syntax, comments, expressions, scriptlets, scope of objects and synchronization.

Learning Outcomes:

After completion of this unit, the student will be able to:

- Understand the anatomy of JSP page. (L1)
- Illustrate application development framework using JSP objects. (L3)

Text Book(s)

1. Uttam K.Roy, Web Technologies, 2/e, Oxford Higher Education Publication,2010.

References

1. Dietel and Nieto, Internet and World Wide Web – How to Program, Pearson Education, Asia, 2009.

2. Chris Bates, Web Programming Building Internet Applications, 3/e, Wiley India,2009.

Course Outcomes:

- Demonstrate the importance of HTML & DHTML tags for designing webpages and separate design from content using Cascading Style Sheet(L2)
- Interprets the design process of interactive web pages with client and server-side
- scripting(L4) Apply validations on user input using JavaScript (L3)
- Understand XML document structure. (L2)
- Understand how to create and deploy Web Applications over webserver. (L2)

19ECS477: FUNDAMENTALS OF DATA STRUCTURES

L	T	P	C
2	1	0	3

Unit- I	**10 hrs**
Data Representation: Introduction, array based representation and operations, indirect addressing and operations, linked representation, comparisons. **Searching**: Linear search, binary search. **Arrays**: Arrays, matrices, sparse matrices.	
Unit- II	**8 hrs**
Linked Lists: Creation of single linked list, double linked list, circular linked list, and operations on it.	
Unit- III	**8 hrs**
Stacks: Definitions, operations and applications, array and linked representation of stacks. **Queues:** Definitions and operations, array and linked representation of queues.	
Unit- IV	**8 hrs**
Graphs: Introduction, representation of graphs, graph traversals, spanning trees. **Introduction to Sorting:** Insertion sort, selection sort, bubble sort, quick sort.	
Unit- V	**8 hrs**
Trees: Definitions and properties, representation of binary trees, operations, binary tree traversals, binary search tree, heap sort.	
Text Books:	
	1. Reema Thareja, Data Structures using C, 2/e, Oxford University Press, 2011.
References:	
	1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, 2/e, Universities Press, 2008. 2. Seymour Lipschutz, Data Structures with C, Tata McGraw Hill, 2011.

Course outcomes

1. To introduce the fundamental concept of data structures and to emphasize the importance of data structures in developing and implementing efficient algorithms**.**
2. To develop effective software engineering practice, emphasizing such principles as decomposition, procedural abstraction, and software reuse.
3. To obtain technical knowhow, how data can be stored in static and dynamic data structures.
4. To understand the complex data structures such as trees and graphs.
5. To understand the various techniques of sorting and searching.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1										2		1		
CO2	1												1		
CO3	1		3									1			3
CO4	1	2	3									1			
CO5	1	2							1	2		3	1	1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EME349: Total Quality Management

L	T	P	C
2	1	0	3

This Course is to introduce the applications to formulate new plans/procedures to be implemented to achieve the desired quality status by knowing about the various principles of quality management. The total quality management tools will help the student to understand the procedures in measuring the quality of the organization/process and will also enable them to identify the parameters that are improving/depriving the quality. By knowing about the quality ISO systems, the student will maintain processes/documentation properly so that the quality maintained by the organization gets recognized.

Course objectives:

1. The overall purpose of the course is to provide an understanding of the process of managing quality and managing services.
2. The principles of Quality, Quality Assurance, and Total Quality Management will provide an insight into the concepts of Excellence and Best Value and the contribution of quality to strategic management
3. Understand the usage of several techniques and quality management tools.
4. Identify the elements that are part of the quality measuring process in the industry.
5. Learn various Customer satisfaction measurement techniques

Module I: **Quality, Strategic Planning and Competitive Advantage** Number of hours(LTP) 9 0 0

Brief history, definitions of quality. Quality in manufacturing and service systems. Quality and price, quality and market share, quality and cost, quality & competitive advantages. ISO 9000, 14000.

Module II: **Managing and Organization for Quality** Number of hours(LTP) 9 0 0

Quality policy, quality objectives, leadership for quality, quality and organization culture, cross-functional teams, supplier/customers partnerships.

Module III: **Quality Control and Improvement Tools** Number of hours(LTP) 9 0 0

Cheek sheet, histogram, pareto chart, cause and effect diagram, scatter diagram, control chart, graph, affinity diagram, tree diagram, matrix diagram, process decision program chart, arrow diagram, acceptance sampling, process capability studies, zero defect program (POKA-YOKE)

Module IV: **Quality Circles** Number of hours(LTP) 9 0 0

Concept and total quality through bench marking, Japanese 5-S, quality management systems QS 9000, ISO 14000. Statistical process control: Control chart - X bar R, P, np and C Charts, benefits of control charts and applications (10 %)

Module V: **Customer Focus and Six sigma principles** Number of hours(LTP) 9 0 0

Customer satisfaction measurement techniques, customer relationship management techniques, Concept of Six Sigma, Six Sigma for manufacturing, Six Sigma for service, Understanding Six Sigma organization.

Text Books(s)

1. J.M. Juran, & F.M. Gryna, Quality Planning and Analysis, McGraw-Hill, 1993
2. Dale H.Besterfiled, et al., "Total Quality Management", Pearson Education, Inc.2003. (Indian reprint 2004).

3. Evans. J. R. & Lindsay. W, M "The Management and Control of Quality", (5thEdition),SouthWestern (Thomson Learning), 2002
4. Geoff Tennant, Six Sigma: SPC and TQM in Manufacturing and Services, 1/e, Gower Publishing Ltd., 2001.

Reference Book(s)

1. J.Bank, Essences of Total Quality Management, Prentice Hall, 2007
2. Joel E. Ross - Text & Cases, Total Quality Management, St. Lucie Press, 1995
3. D.L. Goetsch & S. Davis, Introduction to Total Quality, Prentice- Hall, 2002.
4. R. Cavanagh, R. Neuman, P. Pande, what is Design for Six Sigma, 1/e, Tata McGraw- Hill, 2005.

Course Outcomes:

1. Understand the fundamental principles of Total Quality Management
2. Choose appropriate statistical techniques for managing and improving processes in Organisations
3. Develop skills on Quality control and improvement tools
4. Understand benefits of control charts and their applications
5. Analyse Customer relationship management techniques

19EME356: ENTERPRISE RESOURCE PLANNING

L	T	P	C
2	1	0	3

Course Objectives:

1. To provide awareness about the ERP concepts and the technologies.
2. To Understand ERP Implementation Procedure.
3. To know the process of Post Implementation of ERP.
4. To provide knowledge of ERP for various Units.
5. To help in understanding how companies have implemented ERP successfully.

Unit- I : Introduction — **8 hrs**

Concept of Enterprise, ERP Overview, Integrated information system, The role of Enterprise, Business Modeling, Myths about ERP, Basic ERP Concepts, Intangible benefits of ERP, Justifying ERP investment, Risks of ERP, Benefits of ERP.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the concept of enterprise resource planning(L1)
- apply and interpret basic summary and modelling techniques of business modelling in ERP(L4)
- Get equipped with the myths, risks and benefits of ERP(L3)
- Enhance wide knowledge in the areas where ERP has significance. (L2)

Unit- II: Implementation — **9 hrs**

Life Cycle, Methodologies, Strategy, Business Case and Return on Investment Analysis for ERP,Selecting Consulting Partner, ERP Package Selection, ERP Project Team and Project Organization Structure,ERP Project Management, Managing Requirements, Business Process Re-engineering, Business Process Modeling and Business Modeling.

Learning Outcomes:

At the end of this unit, the student will be able to

- understand the concept of life cycle and strategies involved in ERP(L1)
- apply the ideas of any project team and develop modelling techniques in the structure of ERP(L4)
- get equipped with the process of selecting consulting partner and package selection.(L3)
- Enhance wide knowledge in business process re engineering. (L2)

Unit- III : Post ERP Implementation — **8 hrs**

Post-Implementation Review of ERP Systems, Post-Implementation Support, Maintenance and Security of ERP, Gaps Identification and Strategies to Bridge the Gap, Configuring and Testing of the Solution, Data Migration, Cutover Planning and Go Live Preparation,Training, Change Management, Success or Failure of ERP Implementation.

Learning Outcomes:

After completing this unit, the student will be able to

- Identify the gaps in the maintenance and security of ERP systems.(L1)
- configure and test the solutions in data migration (L2)
- get equipped with the process of cutover planning, preparation and training (L3)
- enhance wide knowledge in the success and failure of ERP(L2)

Unit- IV: ERP Functional Units — **9 hrs**

Human Capital Management, Financial Management Procurement, Inventory Management through

ERP, Supplier Relationship Management, Production Planning, Execution, Supply Chain Planning, Sales and Service, Logistics Execution, Warehouse and Transport Management, Customer Relationship Management, Quality Management, Maintenance Management, Enterprise Asset Management, Product Lifecycle Management.

Learning Outcomes:

After completing this unit, the student will be able to

- Understand the concept and distinguish the features between capital management, financial management and inventory management.(L1)
- Recognise the execution of logistics, ware house and transport management.(L1)
- Get equipped with the basic knowledge of customer relationship management, quality management and enterprise management.(L3)
- Identify the features of product life cycle management.(L1)

Unit- V: ERP Applications **8 hrs**

Portal, Content Management, Knowledge Management, Data Warehousing, Data Mining, Business Intelligence and Analytics, ERP and Enterprise Applications, Emerging Trends, ERP for Industries- ERPs for Different Manufacturing Industries, ERPs for Different Service Industries, Case Studies.

Learning Outcomes:

After completing this unit, the student will be able to

- Identify the gaps in the maintenance and security of ERP systems.(L1)
- configure and test the solutions in data migration (L2)
- get equipped with the process of cutover planning, preparation and training (L3)
- enhance wide knowledge in the success and failure of ERP(L2)

Course Outcomes:

After the completion of the course the student should be able to

- The student will be able to understand the concept of ERP.
- The student will be able to know ERP Implementation Procedure.
- The student will be able to learn Various ERP Units.
- The student will be able to know various software's using for ERP
- The student will be able to compare ERP Units for Industries and Service org.

Text Books:

1. Rajesh Ray, Enterprise Resource Planning, 1st Edition, McGraw Hill Education, 2010.
2. Robert D.Hisrich, Michael P.Peters, Mathew J. Manimala and Dean A. Shepherd, Entrepreneurship, 9th Edition, McGraw Hill Education, 2010.

References:

1. D. P. Goyal, Enterprise Resource Planning A Managerial Perspective, 1st Edition, McGraw Hill Education, 2011.
2. L.Wagner, Concepts in Enterprise Resource Planning, 4th Edition, engage Learning India Pvt. Ltd, 2014.
3. A. leon, Enterprise Resource Planning, 3rd Edition, McGraw Hill Education, 2014.
4. P. C. Reddy,Enterprise Resource Planning, 1st Edition, S. K. Katarina& Sons, 201

19EEI475: MEDICAL INSTRUMENTATION

L	T	P	C
2	1	0	3

This course is designed to make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance. The fundamental principles of equipment that are actually in use at the present day are introduced.

Course Objectives:

- To explain the human physiological systems and bio-signals.
- To study various electrodes and transducers used in medical field.
- To introduce the student, various sensing and measurement of physiological parameters.
- To familiarize with the functions of patient monitoring systems.
- To understand various medical imaging techniques and their applications.

Unit- I : Physiological systems and Bio-signals — **8 hrs**

Physiological systems of the human body, functional structure of the cell, electrical activity of cells: resting and action potentials, functioning of the heart, physiological signal amplifiers.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe the physiological systems of the human body (L2).
- explain the functional structure of cell (L2).
- distinguish between resting and action potentials (L2).
- summarize the function of heart (L2).
- design physiological signal amplifiers (L5).

Unit- II: Electrodes, Sensors, and Transducers — **9 hrs**

Introduction to electrodes, half-cell potential, electrode paste, electrode material, various types of electrodes: surface electrodes, micro electrodes, needle electrodes depth electrodes, inductive, capacitive, resistive and temperature transducers.

Learning Outcomes:

At the end of this unit, the student will be able to

- state the role of an electrode (L1).
- estimate the half cell potential (L2).
- categorize various electrode materials used in electrodes (L4).
- analyze various types, functions of electrodes and transducers (L4).

Unit- III : Measurement of Physiological parameters — **8 hrs**

Measurement of blood pressure, blood flow and cardiac output – Plethysmography, respiration rate, temperature, ECG, EEG, EMG, safety measures medical instrumentation.

Learning Outcomes:

After completing this unit, the student will be able to

- explain the process involved in BP, cardiac output and respiration rate measurements (L2).
- analyze ECG, EEG, EMG signals (L4).
- interpret safety measures taken in medical instrumentation (L2).

Unit- IV : Patient Monitoring Systems and Medical assist devices — **8 hrs**

Intensive cardiac care units and central monitoring systems, patient monitoring through biotelemetry, pacemakers, defibrillators.

Learning Outcomes:	
	After completing this unit, the student will be able to • explain the functioning of ICCU and central monitoring systems (L1). • integrate patient monitoring through biotelemetry (L5). • describe the function of pacemakers and defibrillators (L2).
Unit- V: Medical Imaging Systems	**9 hrs**
X-ray machines, principles of computer tomography (CT), CT number scale scanning systems, detector arrays, principles of nuclear magnetic resonance (NMR) and MR imaging, T1 and T2 based imaging, basic MRI system.	
Learning Outcomes:	
	After completing this unit, the student will be able to • explain the principles of X-RAY machines and CT (L2). • interpret the CT number scale scanning systems (L2). • describe the principles of NMR and MRI systems (L2).
Course Outcomes:	
	After the completion of the course the student should be able to • understand the functioning of various physiological systems of human body (L1). • identify various electrodes and transducers used in different physiological measurements (L4). • summarize the process involved in the measurement of various physiological parameters (L2). • explain various units in patient monitoring systems and their importance (L2). • distinguish different medical imaging techniques (L4).
Text Books:	
	1. Leslie Cromwell, Fred J Weibell, and Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI/Pearson Education, 2003. 2. RS Khandpur, Hand Book of Biomedical Instrumentation, TMH, 2003.
References:	
	1. K.KirkShung, Benjamin Tsui and Michael. B. Smith, Principles of Medical Imaging, Academic Press Inc., New York. 2. Joseph J Carr, John M.Brown, Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education, Singapore, 2001. 3. M.Arumugam, Bio-Medical Instrumentation, Anuradha Agencies, 2003.

19EEC475: MICROCONTROLLERS AND INTERFACING

L	T	P	C
2	1	0	3

The knowledge on Microcontroller based embedded system design is much essential in the field of automation. This course begins with the detailed discussion of the architecture and on-chip resources of 8051 followed by complete instruction set and assembly language programming. Further, this course covers C programming for 8051 which is the common platform that any designer would use to program a microcontroller. Concepts of interfacing peripherals like LCD, keypad DAC, ADC and sensors to 8051 are also discussed in the course.

Course Objectives:

- To explain the detailed architecture of 8051 microcontrollers and on chip resources.
- To familiarize with 8051 Instruction set and addressing modes.
- To get acquainted with the C programming model of 8051 microcontroller.
- To explain the functionality of serial communication, timers and other peripherals
- To design an embedded system using 8051 microcontroller.

Unit- I : The 8051 Microcontroller — **8 hrs**

Microcontrollers and embedded processors, overview of the 8051 family, 8051 architecture-on chip resources, internal and external memory configuration,8051 register banks,PSW, clock generator, other special function registers and their purpose,8051 pin description.

Learning Outcomes:

At the end of this unit, the student will be able to

- state architectural differences between microprocessors and microcontrollers(L1).
- describe the features of 8051 and compare features of family of 8051(L2).
- understand the purpose of on chip resources and register banks(L2).
- illustrate the structure and purpose of different SFRs.(L3)
- interpret the functionalities of different pins of 8051(L4)

Unit- II: 8051 assembly language programming — **9 hrs**

Addressing modes, Instruction set: arithmeticinstructions and programs,signed number concepts,logic and compare instructions,rotate instructions and data serialization, BCD,ASCII and other application programs,branch instructions-JUMP,LOOP,CALL instructions and programs.

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstratethepurpose of differenttypes of instructions supported by 8051 (L2).
- interpret the operations of arithmetic, logical, branch and other instructions (L2).
- construct assembly language programs to access SFRs & other on-chip resources (L3).
- estimate the execution time of an assembly language program (L6).

Unit- III: 8051 programming in C — **8 hrs**

Data types and time delay in 8051 C, I/O programming in 8051 C, logic operations in 8051 C, accessing code ROM space in 8051 C,data serialization using C.

Learning Outcomes:

After completing this unit, the student will be able to

- evaluate marine biodiversity (L5)
- explain the methods of conservation of marine environment as well as organisms(L2)

	• Percieve the potential of marine food web.(L5)

Unit- IV: Timers, serial port, Interrupts programming in C	**8 hrs**

Programming 8051 timers,counter programming,basics of serial communication,8051 connections to RS232, serial port programming in assembly and C, 8051 interrupts, interrupt priority and interrupt programming in C.

Learning Outcomes:

	After completing this unit, the student will be able to • explain the functionsoftimers, serial communication and interrupts of 8051 (L1). • develop C programs for serial communication and delay generation (L3). • state different sources of interrupts supported by 8051 and their importance in embedded applications (L1).

Unit- V: Interfacing	**9 hrs**

LCD interfacing, keyboard interfacing, ADC, DAC and sensor interfacing, 8051 interfacing to external memory.

Learning Outcomes:

	After completing this unit, the student will be able to • explain the functions of different pins, control signalsof LCD (L2). • discuss the basic operation of keyboard and describe the key press and detection mechanisms with key de bouncing (L2). • illustrate thefeatures andbasic operations of DAC, ADC, and temperature sensor (L3). • demonstrate the interfacing and LCD, 4X4 keypad, ADC, DAC and sensors with the 8051(L5).

Course Outcomes:

	After the completion of the course the student should be able to • explain the detailed architecture of 8051 micro controllers and on chip resources (L1). • write 8051 Instruction sets and addressing modes (L1) • illustrate the C programming model of 8051 microcontroller (L3). • explain the functionality of serial communication, timers and other peripherals (L1). • develop the on chip hard ware for the embedded system using 8051 microcontroller (L3).

Text Books:

	1. Mazidi and Mazidi, The 8051 Microcontroller and Embedded Systems – Using Assembly and C, 2nd Edition, Pearson Education, 2002.

References:

	1. Kenneth J Ayala, "The 8051 Micro Controller Architecture, Programming and applications. 2. Raj kamal, Microcontrollers - Architecture, Programming, Interfacing and System Design-2e-Pearson education.

19ECY471: CHEMICAL ANALYSIS OF AGRICULTURAL MATERIALS

L	T	P	C
2	1	0	3

Unit- I : Basic instrumental techniques	**9 hrs**
Electromagnetic spectrum-absorption of radiation-Lambert- Beer's law-Principle and applications of P^Hmetry, potentiometry, Conductometry- Principle and instrumentation of UV-spectroscopy	
Unit- II: Water Analysis	**9hrs**
Sources of water, classification of water for different uses, types of water pollutants and their effects, standards for drinking water. Analytical methods for the determination of the following ions in water: Anions: CO_3^{2-}, HCO_3^-, F^-, Cl^-, SO_4^{2-} Cations: Fe^{2+}, Fe^{3+}, Ca^{2+}, Mg^{2+} Determination of Dissolved oxygen (D.O), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).	
Unit- III: Soil Analysis	**9 hrs**
Introduction-types of soils-Analysis of equilibrium soil for PH Electrical conductivity- -Soil sampling-soil microorganisms. Analysis of soil - total nitrogen, phosphorous, silica, lime, magnesia and manganese.	
Unit- IV: Fertilizer and Pesticide Analysis	**9 hrs**
Fertilizers-types-Estimation of moisture, PH, Total nitrogen, Phosphorous, Potassium. Types of pesticides-Estimation of Malathion, parathion. Organomercurials and related pesticides residues in food samples.	
Unit- V: Microbiological Analysis	**9 hrs**
Classification of Microorganisms, chemical methods for the detection, identification or enumeration of microorganisms in a material. Steps in microbiological analysis Nutritional requirements -, Staining techniques.	

Text Books:

1. S.M. Khopkar, Environmental Pollution Analysis, John Wiley & Sons (1993).
2. S. L. Chopra, J. S. Kanwar and A. Rakshit, Analytical Agriculture Chemistry, Kalyani Publishers (2014).
3. N. N. Melnikov, Chemistry of pesticides, Springer (1971).

References:

1. A. K. De, Environmental Chemistry, 7/e, New age international publication (2010).
2. F. J. Welcher, Standard methods of Chemical Analysis, Krieger Pub Co; 6 /e (1962).
3. F. D. Snell and F. M. Griffin, Commercial Methods of Analysis, Mc Graw Hill (1982)
4. D. J. Holme, Analytical Biochemistry, Longman (1983).

19ECS480: Introduction To Machine Learning

L	T	P	C
2	1	0	3

Machine Learning is a flourishing subject in Computer Science which devises models that can automatically learn from data and detect patterns from data. The applications of machine learning are diverse ranging from self-driven cars to disaster management systems. With easy availability of data from different devices and measurements, machine learning techniques become imperative in analysing trends hidden in the data. This course focuses on the major tasks of machine learning viz., supervised and unsupervised learning approaches that can robustly address data that is non-linear, noisy as well as high-dimensional in nature.

Course objectives:

1. Introduce the concepts of machine learning and the complete process model for working with real data
2. Impart the various approaches to supervised learning.
3. Demonstrate unsupervised learning approaches.
4. Illustrate the performance of ensemble models and familiarize with dimensionality reduction techniques
5. Differentiate between shallow and deep neural networks.

Module I: **Machine Learning Fundamentals** Number of hours(LTP) 6 3 0

Machine Learning Fundamentals: Use of Machine Learning, Types of machine learning systems, machine learning challenges, testing and validating, working with real data, obtaining the data, visualizing the data, data preparation.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Identify different machine learning approaches and applications (L1)
2. Demonstrate basic machine learning approach using real world data (L2)
3. Use machine learning approach to train and fine tune a learner (L3)

Module II: **Supervised Learning** Number of hours(LTP) 6 3 0

Supervised Learning: Classification, training a binary classifier, performance measures, multiclass classification, error analysis, multi label classification, multi output classification.
Linear Regression, Polynomial Regression, Logistic Regression.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Demonstrate various supervised learning approaches (L2)
2. Describe classification techniques for real-time data. (L2)
3. Apply regression to make good predictions (L3)

Module III: **Unsupervised Learning** Number of hours(LTP) 6 3 0

Unsupervised Learning: Clustering, K-Means, Using clustering for image segmentation, Semi-supervised learning, DBSCAN, other clustering algorithms.
Gaussian Mixtures, anomaly detection, selecting number of clusters.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Illustrate various clustering techniques (L2)
2. Construct Gaussian Mixture Models to implement anomaly detection (L3)
3. Analyze suitability of different clustering techniques for real-time data (L4)

Module IV: **Dimensionality Reduction & Ensemble Learning** Number of hours(LTP) 6 3 0

Dimensionality Reduction: The curse of dimensionality, main approaches for dimensionality reduction, PCA, Kernel PCA, LLE.

Learning Outcomes:	

After completion of this unit, the student will be able to:

1. Choose best features defining a dataset through dimensionality reduction (L3)
2. Apply PCA and its variants to find the significant feature subset (L3)
3. Compare the performance of ensemble learners to weak learners (L4)

Module V:	**Neural Networks&Deep Neural Networks**	Number of hours(LTP)	6	3	0

Neural Networks: From biological to artificial neurons, implementing MLPs with Keras, fine tuning neural network hyperparameters.

Learning Outcomes:	

After completion of this unit, the student will be able to:

1. Show the working of neural networks (L3)
2. Differentiate between shallow and deep neural networks (L4)
3. Evaluate the performance of deep neural networks on real time data (L5)

Text Books(s)

1. AurelionGeron, Hands-on Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools and Techniques to build Intelligent Systems, 2/e, O'Reilly Media, 2019.

Reference Book(s)

1. Tom M. Mitchell, Machine Learning, McGraw Hill, 2017.
2. EthemAlpaydin, Introduction to Machine Learning, 3/e, PHI, 2015.

Recommended Coursera Courses: 1.

Course Outcomes:

1. Describe different machine learning categories and apply supervised learning approaches on real-time problems.
2. Utilize unsupervised learning approaches for applications such as anomaly detection.
3. Analyze ensemble models for performance improvement.
4. Estimate significant feature subset to handle high dimensionality issue.
5. Construct deep neural networks for computer vision applications.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO
CO 1	2	2	2	2										1	1
CO 2	2	3	2	2										1	2
CO 3	2	3	2	2										1	3
CO 4	2	3	3	2										1	2
CO 5	2	2	3	2										1	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19ECS474: INTRODUCTION TO CLOUD COMPUTING

L	T	P	C
2	1	0	3

This course will help the students to get familiar with Cloud Computing Fundamental concepts, technologies, architecture and state-of-the-art in Cloud Computing fundamental issues, technologies, applications and implementations.

Course Objectives:

- To impart fundamental concepts in the area of cloud computing.
- To impart knowledge in applications of cloud computing.
- To provide sound foundation of the cloud computing.
- To explore some important cloud computing driven commercial systems and other businesses cloud applications.
- Solution for the various issues in cloud computing.

Unit- I : Introduction — **10 hrs**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud

Learning Outcomes:

At the end of this unit, the student will be able to

- apply the concept of Cloud Computing(L3)
- identify parallel computing(L1)
- describe cloud characteristics(L2)
- construct cloud(L6)
- evaluate distributed computing(L4)

Unit- II: Cloud Enabling Technologies — **10 hrs**

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish-Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices

Learning Outcomes:

At the end of this unit, the student will be able to

- examine SOA(L1)
- state REST. (L!)
- identify Virtualization(L1)
- formulate Types of virtualization(L6)

Unit- III — **8 hrs**

Cloud Architecture, Services And Storage Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

Learning Outcomes:

After completing this unit, the student will be able to

- describe Cloud architecture.(L2)
- apply Iaas, Paas(L3)
- compare Cloud Services((L2)
- choose Cloud storage(L3)
- evaluate Cloud Storage providers(L4)

Unit- IV: Resource Management And Security In Cloud **8 hrs**

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – es – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security Security Standards.

Learning Outcomes:

After completing this unit, the student will be able to

- apply Resource Management(L3)
- interpret Resource Provisioning(L2)
- evaluate Security Overview(L4)
- determine VMS(L3)
- determine Security Standards(L3)
- explain Security Governance(L2)

Unit- V **8 hrs**

Hadoop – Map Reduce – Virtual Box –– Google App Engine – Programming Environment for Google App Engine –– Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications.

Learning Outcomes:

After completing this unit, the student will be able to

- understand Hadoop(L2)
- describeGoogleApp Engine(L2)
- describe OpenStack(L2)
- explain Federation in cloud(L2)

Course Outcomes:

After the completion of the course the student should be able to

- Explain the main concepts, key technologies, strengths and limitations of cloud computing.(L2)
- Apply the key and enabling technologies that help in the development of cloud.(L3)
- Explain use the architecture of compute and storage cloud, service and delivery models.(L2)
- Explain the core issues of cloud computing such as resource management and security.(L2)
- Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.(L4)

Text Books:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, ––Cloud Computing: Implementation, Management and Security, CRC Press, 2017.

References:

1. RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, ––Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009

19ECS478: INTRODUCTION TO DATA SCIENCE

L	T	P	C
2	1	0	3

Data Analytics is the science of analyzing data to convert information to useful knowledge. This knowledge could help us understand our world better, and in many contexts enable us to make better decisions. While this is the broad and grand objective, the last 20 years has seen steeply decreasing costs to gather, store, and process data, creating an even stronger motivation for the use of empirical approaches to problem solving.

Course Objectives:

- An understanding of how the nature of the data collection, the data itself, and the analysis processes relate to the kinds of inferences that can be drawn
- Understand the limitations of data sets based on their contents and provenance
- Knowledge of data organization, management, preservation, and reuse
- Knowledge of general linear models and cluster analysis methods for statistical analysis
- Describe the Data Science Process and how its components interact.
- Reason around ethical and privacy issues in data science conduct and apply ethical practices.

Unit- I **8 hrs**

Understanding Big Data: Concepts and Terminology, Datasets, Data Analysis, Data Analytics Business Intelligence, Key Performance Indicators, Big Data Characteristics, Different Types of Data, Metadata, Case Study

Business Motivations and Drivers for Big Data Adoption: Marketplace Dynamics, Business Architecture, Business Process Management, Information and Communications Technology, Data Analytics and Data Science, Digitization, Affordable Technology and Commodity Hardware, Social Media, Hyper-Connected Communities and Devices, Cloud Computing, Internet of Everything

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the terminology of Big data(L2)
- List Big Data characteristics(L1)
- Identify different types of data(L2)
- Analyze Big data with business perspective(L4)

Unit- II **8 hrs**

Big Data Adoption and Planning Considerations :Organization Prerequisites , Data Procurement, Privacy, Security, Provenance , Organization Prerequisites , Data Identification , Data Acquisition and Filtering, Data Extraction, Data Validation and Cleansing, Data Aggregation and Representation, Data Analysis , Data Visualization, Utilization of Analysis Results.

Enterprise Technologies and Big Data Business Intelligence: Online Transaction Processing (OLTP), Online Analytical Processing (OLAP), Extract Transform Load (ETL), Data Warehouses, Data Marts, Traditional BI, Ad-hoc Reports, Dashboards, Big Data BI, Traditional Data Visualization, Data Visualization for Big Data, Enterprise Technology, Big Data Business Intelligence.

Learning Outcomes:

At the end of this unit, the student will be able to

- Illustrate how to handle data and its preprocessing(L3)
- Appraise the usage of OLTP Vs. OLAP and ETL(L4)
- Identify what is a datawarehouse(L2)
- Analyze how Big Data plays a role in BI(L4)

Unit- III **8 hrs**

Big Data Storage Concepts: Clusters, File Systems and Distributed File Systems, NoSQL, Sharding, Replication, Master-Slave, Peer-to-Peer, Sharding and Replication, Combining Sharding and Master-Slave Replication, Combining Sharding and Peer-to-Peer Replication, CAP Theorem, ACID.
Big Data Processing Concepts: Parallel Data Processing, Distributed Data Processing , Hadoop, Processing Workloads , Batch Processing with MapReduce , Map and Reduce Tasks , A Simple MapReduce Example, Understanding MapReduce Algorithms , Processing in Realtime Mode , Speed Consistency Volume (SCV), Event Stream Processing , Complex Event Processing , Realtime Big Data Processing and SCV, Realtime Big Data Processing and MapReduce

Learning Outcomes:

After completing this unit, the student will be able to

- Analyze file system and distributed file system(L4)
- Explain Sharding and replication(L2)
- Understand Big data processing concepts(L2)
- explainMapReduce Algorithms(L2)
- Appraise complex event processing(L4)

Unit- IV **8 hrs**

Big Data Storage Technology: On-Disk Storage Devices, Distributed File Systems, RDBMS, Databases, NoSQL Databases, NewSQL Databases, In-Memory Storage Devices, In-Memory Data Grids, In-Memory Databases.
Big Data Analysis Techniques: Quantitative Analysis, Qualitative Analysis, Data Mining, Statistical Analysis, A/B Testing, Correlation, Regression, Machine Learning, Classification (Supervised Machine Learning), Clustering (Unsupervised Machine Learning), Outlier Detection,
Filtering, Semantic Analysis, Natural Language Processing, Text Analytics , Sentiment Analysis, Visual Analysis, Heat Maps, Time Series Plots, Network Graphs, Spatial Data Mapping.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain Big data storage technology(L2)
- Analyze various Big data analysis techniques(L4)
- Illustrate Natural Language Processing(L3)
- Appraise Text Analytics and sentiment analysis(L4)

Unit- V **8 hrs**

Information Management: The Big data foundation, Big data Computing Platforms, Big data computation, More on Big Data Storage, Big data computational limitations, Big data emerging technologies
Data Privacy and Ethics: The Privacy Landscape, The Great Data Grab isn't new, Preferences, Personalization, and Relationships, rights and responsibility, playing in a global sandbox, conscientitious and Conscious responsibility, privacy may be the wrong focus, can data be anonymized? Balancing for Counterintelligence and Now What?

Learning Outcomes:

After completing this unit, the student will be able to

- Understand the overview of Big data(L2)
- Cite Big Data computational limitations(L2)
- Explain Big Data emerging technologies(L2)
- Appraise Data privacy and ethics(L4)

Course Outcomes:

After the completion of the course the student should be able to

	• Understand the terminology of Big data, its characteristics and various types of data: (L2) • Analyze a data warehouse, OLTP Vs. OLAP Vs. ETL: (L4) • Appraise Big Data Storage and Processing Concepts: (L4) • Examine Big Data Storage Technology and analysis techniques: (L3) • Explain Big Data Computational Limitations, emerging technologies, Privacy and ethics: (L3)
Text Books:	
	1. Thomas Erl, WajidKhattak and Paul Buhler, Big Data Fundamentals, Prentice Hall 2015. 2. Michael Minelli, Michele Chambers, AmbigaDhiraj, Big Data Big Analytics, Wiley Publishing company, 2014
References:	
	1. Davy Cielen, Arno D.B>Meysman, Mohamed Ali, Introducing Data Science, Dreamtech Publishers,2018

19EME357: Supply Chain Management

L	T	P	C
2	1	0	3

The course under Operations and supply chain management has been designed to cover the basic concepts of operations management and supply chain management. The students will understand the role of logistics, drivers and metrics in supply chain and how to design the network. The students will understand the globalization and its risks and forecasting in supply chan. The students will understand collaborative planning and replenishment strategies and how to manage uncertainties in inventory. The students shall also be able to understand the role of information technology in inventory management and transportation in supply chain.

Course objectives:

1. To introduce operations management, role and responsibilities of operations manager.
2. To explain the importance of logistics and supply chain management and the relevant drivers and metrics.
3. To demonstrate the technique of forecasting to reduce uncertainty by identifying the risks in a global supply chain setting
4. To impart knowledge of collaborative planning, forecasting and replenishment methodologies to achieve better coordination in a supply chain.
5. To summarize the importance of technology in operations, logistics and supply chain management.

Module I: **Introduction to Operations Management** Number of hours(LTP) 9 0 0

History of operations management, types of manufacturing systems, roles and responsibilities of operations manager, Product operations and service operations, Current Trends in Operations Management

Module II: **Understanding the Logistics and Supply Chain** Number of hours(LTP) 9 0 0

Introduction to supply chain, supply chain links, role of logistics in supply chain, drivers and metrics in supply chain, designing the supply chain network, online sales and distribution network, factors influencing the network design.

Module III: **Impact of Uncertainty in Network** Number of hours(LTP) 9 0 0

Globalization and supply chain, risk management in global supply chain, demand forecasting in supply chain role of information technology in forecasting.

Module IV: **Coordination in Supply Chain** Number of hours(LTP) 9 0 0

Collaborative planning and replenishment strategies, CPFR, managing uncertainties in inventory.

Module V: **Impact of Replenishment Policies in Safety Inventory** Number of hours(LTP) 9 0 0

Role of information technology in inventory management, transportation in supply chain.

Text Books(s)

1. Sunil Chopra, Supply Chain Management, Pearson Publications, 2012.

Reference Book(s)

1. Sridhara Bhatt, Logistics and Supply Chain Management, Himalaya Publishers, 2011
2. D.K Agarwal, Logistics and Supply Chain Management, Macmillan Publishers, 2013.

Course Outcomes:

1. Identify specific ways in which supply chain management creates value for customers and investors (customer value and financial value).
2. Analyze the existing inventory models to propose the optimal order sizes.
3. Identify sources for the variability in demand and understand the impact of globalization on supply chains.
4. Explore the different supply chain integration options to optimize the costs and time.
5. Evaluate the procurement strategies for a given business model.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1									1			3		
CO2											1		2		
CO3		2	2										2		
CO4					3		2		1	1		1	1	3	
CO5										3	3				

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19EME371: QUANTITATIVE TECHNIQUES FOR MANAGEMENT

L	T	P	C
2	1	0	3

Course Objectives:

- To study the fundamentals of linear programming and its application to special cases like transportation and assignment models.
- To understand the complex nature of operations research, problem, define the problem, formulate and solve the model and to perform the follow-up procedures.
- Demonstrate how analytical techniques and statistical models can help enhance decision making by converting data to information and insights for decision-making.
- Categorize and construct multistage decision analysis problems using decision trees.
- Categorize and construct multifactor problems with multiple objectives and uncertainty.
- Critically evaluate decisions of others and develop ways they could have improved their decision making

Unit- I : Introduction — **10 hrs**

Introduction, Measures of Central Tendency Mean, Median, Mode, Concept of Testing of Hypothesis, Types of Errors, Confidence intervals, Z- test for Means, Standard deviations and Proportions; T-test; F-test for two variances.

Learning Outcomes:

At the end of this unit, the student will be able to

- To memorize how statistical data can be read for analysis and give valid inferences. (L1)
- To describe and discuss the key terminology, concepts tools and techniques used in business statistical analysis.(L2)
- Analyze the data and give valid inferences. (L4)
- Able to design, conduct and analyze the experiments more efficiently and effectively. (L6)

Unit- II: — **8 hrs**

Chi- Square test for goodness of fit and independent of Attributes and their Applications, Correlation and Types, Scatter Diagram Method, Karl Pearson's Coefficient of Correlation and its properties, Spearman's Rank Correlation Coefficient, Regression & Multivariate Analysis.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain and critically discuss the issues surrounding sampling and significance. (L2)
- Apply Regression analysis based on the experimental data and give valid inference. (L3)
- Determine the influential factors and also the interaction effects on the response function. (L5)

Unit- III — **8 hrs**

Decision analysis, Decisions under risk, Decision trees- Decision analysis with experimentation, Decisions under uncertainty.

Learning Outcomes:	
	After completing this unit, the student will be able to • To understand the need of decision analysis. (L2) • To develop the decision making table and tree.(L3) • To correlate the applications of decision making principles to different environments like uncertain and risky.(L4)
Unit- IV	**10 hrs**
Introduction to multi-objective decision making, Concept of Pareto optimality, Goal programming formulation, the weighting method of solution, Utility theory, Analytic hierarchy process	
Learning Outcomes:	
	After completing this unit, the student will be able to • To describe the phenomena of Pareto-optimality.(L2) • To apply the multi-objective solving concepts like utility and analytic hierarchy process(L3) • To choose the appropriate multi-objective making concept for solving. (L5)
Unit- V	**12 hrs**
Linear Programming: Introduction, Formulation, Graphical solution, Simplex method Transportation problem-Formulation, Initial Feasible solution. Assignment Models-Formulation, Optimal solution-Hungarian method	
Learning Outcomes:	
	After completing this unit, the student will be able to • To define, contrast between the different terminologies of real time field. (L1) • To outline the wide applicability of operations research technology from agriculture to defense, covering almost all domains of science, arts, commerce and technology.(L2) • To develop optimum solution for numerous problems of operations research by systematic defining, formulating, analyzing, developing an optimum solution and further refining the solution.(L3) • To anticipate a high level of mathematical, analytical and problem solving skills for problems that are of spontaneous nature, whose solution will be individualistic in application. (L6)
Text Books:	
	1. Anderson, Sweeney, Williams, 2005, An introduction to management science Thomson South Western 2. Barry Render, RalphMStairJr, Michael E Hanna, 2005, Quantitative analysis for management, Pearson Education 1.
References:	
	1. Charles A. Gallagher Hugh. J.Watson , 1985, Quantitative Methods for Business Decisions, McGraw Hill international Book Company 2. Frederic S.Hillier, Gerald J.Liberman,2005 Introduction to Operations Research, A Tata McGraw-Hill 3. Gupta M.P. and R.B. Khanna, 2004, Quantitative Techniques for Decision Making, Prentice Hall of India 4. Sharma J.K, 2006, Operations Research Theory and Practice, Macmillan India Ltd.

19EHS407 Project Management and Entrepreneurship

L	T	P	C
3	0	0	3

This course guides students through fundamental project management concepts and entrepreneurial abilities needed to successfully launch, lead, and realize benefits from projects in profit and nonprofit organizations. Successful project managers skillfully manage their resources, schedules, risks, and scope to produce a desired outcome. This course includes a description of various concepts like process of entrepreneurship, opportunity identification, business plan preparation, registration process of business enterprise, funds requirement for business and evaluation of business enterprise. A key and often overlooked challenge for project managers is the ability to manage without influence to gain the support of stakeholders and access to resources under their control.

Course objectives:

- Understand project management design, development, and deployment
- Use project management tools, techniques, and skills
- Understand the implications, challenges, and opportunities of organizational dynamics in project management
- To identify the concept and process of Entrepreneurship and its role in the society.
- To recognize opportunity identification, different business model and business plan preparation.

Module 1 8L

Basics of Project Management: Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Identification and Selection, Project Planning.

Learning Outcomes.

At the end of this unit, the student will be able to

- Defining "project management" (L2)
- Exploring opportunities in the project management field(L3)
- Developing project management skills (L4)
- Categorizing different types of projects(L1)

Module 2 8L

Project-feasibility report, financial aspects of project preparation, technical aspects, finalization of project implementation schedule, Types of risk, techniques of risk evaluation and its mitigation. evaluation of project profitability. Project Contract Management, Types of Contracts, Fixing the Zero Data.

Learning Outcomes.

At the end of this unit, the student will be able to

- Prepare a project feasibility report (L4)
- Understand financial aspects of project preparation (L3)
- Understand the technical aspects of project implementation (L1)

- Analyze risks. (L4)
- Understand types of contracts. (L1)

Module 3 8L

PERT and CPM: Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System

Learning Outcomes.

At the end of this unit, the student will be able to

- List project tasks and details (L1)
- Identify task dependencies for the project (L2)
- create network diagram of tasks (L2)
- Find critical path based on longest sequence(L3)

Module 4 8L

Introduction: Entrepreneur and Entrepreneurship; Description of an Entrepreneur; Traits of an Entrepreneur; evolution of Entrepreneurship; functions of an entrepreneur; Entrepreneurial mindset; Entrepreneurial Motivation; entrepreneurial process; entrepreneurial competencies; types of entrepreneurships; role of entrepreneurship in the economic development.

Learning Outcomes.

- At the end of this unit, the student will be able to
- Identify the traits and functions of entrepreneur(L2).
- Recognize entrepreneurial process and entrepreneurial competencies(L3).
- Demonstrate the role of entrepreneurship in the economic development(L4).

Module 5 8L

Funding for startups. Business Idea Generation and Business Opportunity Identification: Scanning the environment; finding the gaps for new business and new ways of business, Startup Culture and Incubation; Boot Camps; Mentoring the ideation process, importance of Business Plan preparation- process of Business Plan.

Learning Outcomes

At the end of this unit, the student will be able to ·

- list the gaps for new business and new ways of business(L1).
- Identify startup culture and incubation and boot Camps(L2).
- Recognize mentoring the ideation process, validation of different ideas(L2).
- Apply prototype development and business model development(L3).
- Demonstrate the need for and importance of business plan preparation- process of Business Plan(L3).

Teaching and learning resources:

Recommended Textbooks:

1. Larson, E.W. and Gray, C.F. (2018), Project management the managerial process, Seventh Edition, McGraw-Hill.

2. Robert Hisrich, M.J.Manimala, M.P.Peters and D. A.Shepherd "Entrepreneurship" MC Graw Hill Education, Latest Edition 2014/Latest.

References:

1. Bennett, F. Lawrence. 1996. *The management of engineering*. New York: Wiley.
2. Eisner, H. 1997. *Essentials of project management and systems engineering management*. New York: Wiley
3. Dynamics of entrepreneurial development and management by Vasant desai, Himalaya Publishing, House. (2006)
4. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice, Cengage Learning, New Delhi, Latest Edition.
5. Bruce R Barringer, Preparing effective Business Plan-an Entrepreneurial Approach, New Delhi: Pearson Publication, Latest Edition

Journals

1. International Journal of Project Management
2. The Academy of Management Journal
3. The Journal of Modern Project Management
4. Harvard Business Review
5. International Journal of Entrepreneurial Behaviour and Research
6. International Journal of Small Business Management

Course Outcomes:

1. Understand characteristics and scope of management.
2. Learn the principles and goals of management.
3. Apply characteristics of entrepreneurship.
4. Evaluate project plan and report.
5. Apply business opportunity methods.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		2		2		2		1			1		2	
CO2	1		2		2	1	2		2			1		2	
CO3	1		2	1	2	1	2		2	1		1		2	
CO4	1		2		2	1	2		2	2	2	1		2	
CO5	1	1	2		2	1	2	2	1	2		1		2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

19ECS472: Introduction to Augmented Reality and Virtual Reality

L	T	P	C
2	1	0	3

The objective of this course is to mainly establish and cultivate a broad and comprehensive understanding of this rapidly evolving and commercially viable growing field of Computer Science. Augmented Reality and Virtual Reality technologies are really hitting the ground right now and are the buzz words among the technical communities. With these methods, the businesses are trying to get their brands to a whole new level of success and popularity. Integrating AR/VR in Education can increase the experience of learning, in medicine, increases of experience of understanding, in engineering, increases the experience of visualization, in business, increases the In-User Engagement, Boost In Brand Loyalty, Mobility, Better Advertising
of products and many more.

Course objectives:

1. To provide an understanding of Mixed reality and the cause for its origins
2. To give a practical understanding of Virtual Reality with an immersive Experience
3. To provide a practical understanding of Augmented Reality with the available devices
4. To make aware of necessary hardware and software to develop AR/VR applications and to enable in attaining skills for using hardware and software.
5. To pave a way to analyse the existing AR/VR applications as case studies and create some new applications.

Module I: Introduction to Mixed Reality (MR) Number of hours(LTP) 4

Introduction, A history of Mixed Reality Technologies, The Origin of MR Concept

(Chapter – 1) of Text book 1

Learning Outcomes:

After completion of this unit, the student will be able to:

4. describe the origins of MR concept L1
5. understand the concept of Mixed Reality L2
6. describe real time applications of MR technologies L1
7. analyse the usage of MR Technologies in various fields L4

Module II: Introduction to Virtual Reality (VR) Number of hours(LTP) 10

Fundamental of VR, Types of VR, Current VR Technologies, Benefits, Disadvantages, Case study which cover the applications in various fields, like in Education, Military, Engineering, Architecture, Medical etc.,

(Chapter – 2) of Text book 1

Learning Outcomes:

After completion of this unit, the student will be able to:

4. describe the types of VR with a practical understanding L1
5. understand the concept of Virtual Reality L2
6. analyse the current VR Technologies L3
7. understand the benefits and disadvantages of VR Technologies L2
8. analyse the VR Applications in various fields for creating new applications L3

Module III: Introduction to Augmented Reailty Number of hours(LTP) 10

Definitions and Terminology, Types of AR- Marker and Marker-less based AR tracking, Current AR Technologies like Hardware, Tracking devices and Headmounted displays along with softwares, Benefits of AR, Disadvantages and Case study AR Applications in Education, Medicine, Military etc.,

(Chapter –3) of Text book 1

Learning Outcomes:

After completion of this unit, the student will be able to:

1. understand the concept of Augmented Reality L2 –
2. describe the types of AR with a practical understanding L1 –
3. analyse the current AR Technologies and Tracking Techniques L3 –
4. understand the benefits and disadvantages of AR Technologies L2 –
5. analyse the AR Applications in various fields for creating new applications L3 –

Module IV:	Development Tools and Frame Works	Number of hours(LTP)	8		

Human factors: Introduction, the eye, the ear, the somatic senses.

Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems.
Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to Blender, Meshroom and UNITY

(Chapter or Part 3) for Text Book 2

Learning Outcomes:

After completion of this unit, the student will be able to:

4. understand the different sensors available for AR/VR L2 –
5. describe the existing Hardware like head mounted displays and haptics L1 –
6. hands-on experience with available software L3 –
7. analyse and Convert a 2D image to 3D using Meshroom and Blender L4 –

Module V:	Mixed Reality in Education - Applications	Number of hours(LTP)	10		

Virtual Reality in Education-VR Applications for Primary schools high schools, in-service professional training, Augmented Reality in Education-AR Applications for Primary schools high schools, in-service professional training.

(Chapter 4) of Text Book 1

Learning Outcomes:

After completion of this unit, the student will be able to:

4. understand the application of AR/VR in education L2 –
5. analyse various case studies for education L4 –
6. analyse an AR/VR application for primary school education L4 –

Text Books(s)

1. Zeynep Tacgin, Virtual and Augmented Reality: An Educational Handbook, Cambridge Scholars, 2020, ISBN (10): 1-5275-4813-99
2. Pangilinan, Erin, Steve Lukas, and Vasanth Mohan. Creating augmented and virtual realities: theory and practice for next-generation spatial computing. " O'Reilly Media, Inc.", 2019.

Reference Book(s)

1. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley 2016
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

Course Outcomes:

1. know how AR/VR systems work and the applications of VR L1
2. understand the design and implementation of the hardware that enables AR/VR systems to be built L2
3. understand the system of human vision and its implication on perception and rendering L2
4. Understand the concepts of motion and tracking in AR/VR systems L3