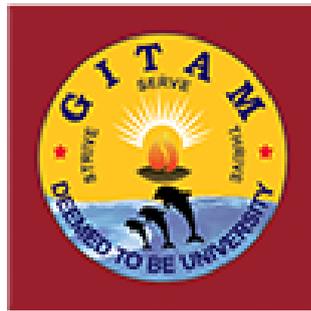


**GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(GITAM)**

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. 2020-21 Admitted Batch)**

A University Committed to Excellence

Institute Vision

To become a global leader in higher education.

Institute 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 Vision

To become a global leader in biotechnology education, research, and innovation

Department Mission

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

B. Tech. in Biotechnology

REGULATIONS

(w.e.f. 2020-21 admitted batches)

1. ADMISSION

- 1.1 Admission into B. Tech. in Biotechnology 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.
- 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) and 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.

Core Courses	Branch specific	Compulsory
Elective courses	Program Electives	<i>Supportive to the discipline courses with expanded scope in a chosen track of specialization or cross track courses</i>
	Interdisciplinary Electives	<i>Interdisciplinary exposure & nurture the student interests in other department courses.</i>
	Open Electives	<i>Common to all disciplines that helps general interest of a student</i>

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

4.4 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.

5. MEDIUM OF INSTRUCTION

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

6. REGISTRATION

Every student has to register himself/herself for the courses in each semester individually at the time as specified in academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his/her 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 65% and 74% on genuine medical grounds and on payment of prescribed fee.

8. EVALUATION

8.1 The assessment of the candidates's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end Examination (60 marks).

8.2 A candidate has to secure an aggregate of 40% in the course in the two components put together to be declared to have passed the course, subject to the condition that the candidate 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 candidate 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 candidate has to acquire 40% in the semester end theory examination. However, candidate 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 candidate 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 candidate secures more than 40 out of 100 marks, he / she will be declared PASS, else FAIL

8.7 Mandatory courses NCC/NSS/NSO/YOGA are assessed for satisfactory or not satisfactory only. No grade will be assigned. A candidate has to undergo two hours training per week in any one of the above in both 1st and 2nd semesters.

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) Twenty (20) marks for mid semester examinations. Three mid examinations shall be conducted; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes iii) Ten (10) marks for Assignments, MOOCs 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.	100	70% of the weightage will be given for theory component. Evaluation for theory component will be same as S. No 1 as above.
		(b) Practical component: continuous evaluation	100	30% weightage for practical components. Evaluation for practical component will be same as S. No 2 as above
		Total	200	
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 for defending the project before 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> (i) Sixty (60) marks for mid semester Examinations. Three mid examinations shall be conducted; performance in best two shall be taken into consideration (ii) Forty (40) marks for Quizzes, Assignments, MOOCs and Presentations

9. RETOTALING & REVALUATION

- 9.1 Retotaling of the theory answer script of the semester-end examination is permitted on request by the candidate 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 the student by paying the prescribed fee within one week after the announcement of the result.
- 9.3 A candidate who has secured 'F' grade in a theory course shall have to reappear at the subsequent examination held in that course. A candidate 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 candidate 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 examination held in that course. A candidate 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 candidate 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 ANSWER BOOK VERIFICATION AND CHALLENGE EVALUATION

- 10.1 If a candidate is not satisfied with his/her grade after revaluation, the candidate can apply for, answer book verification on payment of prescribed fee for each course within one week after announcement of revaluation results.
- 10.2 After verification, if a candidate is not satisfied with revaluation marks/grade awarded, he/she can apply for challenge valuation within one week after announcement of answer book verification result/ two weeks after the announcement of revaluation results, which will be valued by the two examiners i.e., one Internal and one External examiner in the presence of the candidate on payment

of prescribed fee. The challenge valuation fee will be returned, if the candidate is succeeded in the appeal with a change for a better grade.

11. SUPPLEMENTARY EXAMINATIONS AND SPECIAL EXAMINATIONS.

- 11.1 The odd semester supplementary examinations will be conducted on daily basis after conducting regular even semester examinations during April/May.
- 11.2 The even semester supplementary examinations will be conducted on daily basis after conducting regular odd semester examinations during October/November.
- 11.3 A candidate who has completed his/her period of study and still has “F” grade in final semester courses is eligible to appear for Special Examination normally held during summer vacation.

12. PROMOTION TO THE NEXT YEAR OF STUDY

- 12.1 A student shall be promoted to the next academic year only if he/she completes the academic requirements of 50% 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 will be decided by the respective Board of Studies (BoS).

14. BETTERMENT OF GRADES

- 14.1 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 any semester of his/her choice, conducted in summer vacation along with the Special Examinations.
- 14.2 Betterment of Grades is permitted ‘only once’, immediately after completion of the program of study.

15. HONORS

A student who secured 8 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 an average GPA of 5.0 (average of all GPAs in all semesters) at the end of the program to declare pass in the program.

1. GRADE POINT AVERAGE

17.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

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

where, C = number of credits for the course.

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

17.2 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken, 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	≥ 6.5
Second Class	≥ 5.5
Pass Class	≥ 5.0

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

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

- 18.1 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.
- 18.2 However, the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.
- 18.3 A student shall be eligible for award of the B.Tech. Degree if he / she fulfills all the following conditions:
- i) Registered and successfully completed all the courses and projects.
 - 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 against him/ her.

3. 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

- 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 EDUCATIONAL OBJECTIVES

- PEO 1 To impart knowledge of mathematics, science and engineering to design and deliver solutions related to biotechnological issues**
- PEO 2 To inculcate analytical abilities among the students to meet the needs of biotechnology in medicine, agriculture, industry and environment**
- PEO 3 To provide a platform for the graduates to design a plant for commercial production**
- PEO 4 To instill team work, leadership, communication skills as well as professional, ethical and human values to become responsible citizens of the society**

PROGRAM OUTCOMES

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 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
B.Tech. Biotechnology

Semester I									
S. No	Course Code	Course Title	Category	L	T	P	A	C	Remarks
1	19EMA103/ 19EBT101	Mathematics for Biotechnology I / Introduction to Biotechnology	BS	3	0	0		3	
2	GEL131	Communicative English	HS	2	0	2		3	Common to all
3	19ECY135	Chemistry for Biotechnology	BS	3	0	3		4.5	
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	19EMC181A/ 19EMC181B/ 19EMC181C/ 19EMC181D	NSS/NCC/NSO/YOGA	MC	0	0	2		0	Common to all
Total								17.5/ 18.5	

Semester II									
S. No	Course Code	Course Title	Category	L	T	P	A	C	Remarks
1	19EMA106	Mathematics for Biotechnology-II	BS	3	0	0	0	3	
2	19EID132/ 19EID134	Design Thinking / AI Tools	ES	2	0	2		3	Common to all
3	19EPH 135	Physics for Biotechnology	BS	3	0	3		4.5	
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	0/1	0	3		2.5/ 1.5	
6	19EBT122	Biotechnology Workshop	PC	0	0	3		1.5	
7	19EMC181A/ 19EMC181B/ 19EMC181C/ 19EMC181D	NSS/NCC/NSO/YOGA	MC	0	0	2		-	Common to all
8	19EHS122	Comprehensive Skill Development I	HS	0	0	0	6	1	
9	VDC111	Venture Discovery	PW	0	0	4		2	
Total								23/ 22	

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	19EOE3XX	Open Elective I	OE	3	0	0		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	2/3	0	2/0		3	
5	19EBT3XX	Program Elective III	PE	2/3	0	2/0		3	
6	19EID3XX	Open Elective II	OE	3	0	0		3	
7	19EMC382	Engineering Ethics	MC	3	0	0		0	Mandatory Course
8	HSMCH102	Universal Human Values 2**	HS	3	0	0		3	Mandatory Course
9	19EBT392	Comprehensive Skill Development V	PW	0	0	0	6	1	

Total		24	
-------	--	----	--

**Course may be offered in any semester in 2nd, 3rd or 4th Years.

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	17.5/ 18.5	23/22	22	23.5	22	24	20	13	165

Category and Credits

Category	Category Code	Courses	Credits GITAM	Credits suggested by AICTE
Humanities & Social Sciences	HS	Communicative English	17	12
		HS1 and HS2 (elective)		
		Gandhi for the 21 st Century		
		Universal Human Values 2		
		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	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			165	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	19EBT340	AI and ML for Bioengineers	PE	3	0	0	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
5	Medical and Pharmaceutical Biotechnology	19EBT360	Physiology and Clinical Biochemistry	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	19EBT459	Systems Biology	PE	3	0	0	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, Trigonometry 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:	
	<ul style="list-style-type: none">• 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 hrs
Introduction, resolving $g(x)$ 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 <ul style="list-style-type: none">• 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 hrs
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 <ul style="list-style-type: none">• Explain role of aeration and agitation in bioreactors (L2)• 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 hrs
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:	
	After completing this unit, the student will be able to

	<ul style="list-style-type: none"> • 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 hrs
<p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	8 hrs
<p>Limits and Continuity: Definition of right hand limit, left hand limit and limit, limits of $f+g$, $\frac{f}{g}$, $f \circ g$ (without proof), standard limits</p> <p>1) $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a}$ 2) $\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta}$ 3) $\lim_{n \rightarrow 0} \left(\frac{1+1}{n} \right)^n$ 4) $\lim_{x \rightarrow 0} \frac{e^x - 1}{x}$</p> <p>5) $\lim_{x \rightarrow 0} \frac{a^x - 1}{x}$ (without proofs), definition of continuity and simple illustrations.</p> <p>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 function with respect to another function, derivatives of first and second order of a function with respect to another function, derivatives of first and second order</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • find derivative of sum, difference, product and quotient of functions (L3) • apply differentiation techniques in different forms of functions (L3)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • analyze partial fractions of a fractional function (L4) • solve trigonometric ratios (L3) • analyze complex modules and amplitude of a complex number (L4) • illustrate permutations of n dissimilar things (L3) • calculate the derivative of any function (L4)

Text Books:

1. M. L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, 2/e, Prentice Hall, 2002. 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.

19EBT101: INTRODUCTION TO BIOTECHNOLOGY

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:	
	<ul style="list-style-type: none">• 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 hrs
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:	
	At the end of this unit, the student will be able to <ul style="list-style-type: none">• summarize the basis of life. (L2)• distinguish prokaryotes from eukaryotes. (L3)• compare biological organisms and manmade systems. (L2)• classify organisms. (L2)
Unit- II	8 hrs
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:	
	At the end of this unit, the student will be able to <ul style="list-style-type: none">• Calculate power requirement of bioreactors (L5) 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 hrs

Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation, Mechanism of photosynthesis, Human physiology, neurons, synaptic and neuromuscular junctions	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 hrs
Mendel's laws, gene mapping, Mitosis and Meiosis, Epistasis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 hrs
Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • outline the principles of recombinant DNA technology. (L2) • summarize the use of biological materials for diagnostic devices. (L2) • appreciate the potential of recombinant DNA technology. (L2)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • explain catalytic properties of enzymes. (L2) • summarize application of enzymes and fermentation in industry. (L2) • identify DNA as a genetic material in the molecular basis of information transfer. (L2) • apply thermodynamic principles to biological systems. (L2) • analyze biological processes at the reductionistic level. (L4) • appreciate the potential of recombinant DNA technology. (L2)
Text Books:	
	1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology:

	<p>A global approach”, Pearson Education Ltd, 2018.</p> <p>2. Arthur T Johnson, Biology for Engineers, CRC press, 2011</p>
References:	
	<p>3. Alberts Et.Al. The molecular biology of the cell, 6/e, Garland Science, 2014</p> <p>4. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, “Outlines of Biochemistry”, John Wiley and Sons, 2009.</p> <p>5. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012.</p>

GEL 131: COMMUNICATIVE ENGLISH

(Common to all)

L T P C
2 0 2 3

Preamble

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 learners to develop listening skills for better comprehension of academic presentations, lectures and speeches.
- To hone the speaking skills of learners 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 learners with effective strategies of paragraph and essay writing, and formal correspondence such as email, letters and resume.
- To provide learners with the critical impetus necessary to forge a path in an academic environment, in the professional life and in an increasingly complex, interdependent world.

Unit- I

LISTENING: Listening for gist and specific information

SPEAKING: Introducing self and others; Developing fluency through JAM

READING: Skimming for gist and Scanning for specific information

WRITING: Paragraph writing-writing coherent and cohesive paragraph (narrative and descriptive); use of appropriate Punctuation.

GRAMMAR & VOCABULARY: Articles & Prepositions; Word Families (Verbs, Nouns, Adjectives, Adverbs; Prefixes and Suffixes)

Learning Outcomes:

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

- Apply the requisite listening skills and comprehend at local and global level. (L4 and L2) (L5)
- Introduce themselves with accurate structure in diverse social and professional contexts. (L3)
- Apply relevant reading strategies for comprehension of any given text(L3)
- Write a paragraph using cohesive devices maintaining coherence (L3)
- Understand the Use of Articles and Prepositions, and apply appropriately for meaningful communication (L3)
- Understand the relevance of various categories in word family and apply them meaningfully in context (L3)

Unit- II	
<p>LISTENING: Listening for Note taking and Summarizing SPEAKING: Role plays and Oral Presentations. READING: Intensive Reading-Reading for implicit meaning WRITING: Note making and summarizing GRAMMAR & VOCABULARY: Verb forms-Tenses; synonyms to avoid repetition in speech and writing.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Employ note taking and summarizing strategies to comprehend the listening text (L2) • Use strategies for successful and relevant oral presentation (L3, L4) • Demonstrate effective communication skills by applying turn-taking and role distribution techniques for meaningful and contextual Speaking (L3 and L4) • Apply various reading strategies imbuing inferential and extrapolative comprehension of any given text. (L2, L3) • Apply various note-making techniques while comprehending the reading text to present a complete and concise set of structured notes (, L3, L4, L5) • Apply the notes to draft a summary (L3) • Use correct tense forms and appropriate structures in speech and written communication (L3) • Context specific use of Prefixes and Suffixes for meaningful communication (L3)
Unit- III	
<p>LISTENING: Listening for presentation strategies: introducing the topic, organization of ideas, conclusion. SPEAKING: Aided presentations READING: Inferring using textual clues WRITING: Formal Letter and Email writing GRAMMAR & VOCABULARY: Active and Passive Voice; linkers and discourse markers.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Notice and understand effective listening strategies to identify discourse markers in presentations. (L1, L2) • Make formal oral presentations using effective strategies such as audio – visual aids (L3) • Infer meaning and inter – relatedness of ideas (L4) • Understand relevant structures and draft formal letters in suitable format (L3, L4) • Construct relevant sentences in active and passive voice for meaningful communication (L2, L3) • Comprehend and apply available vocabulary items relevant to the context (L1, L2, L3)
Unit- IV	
<p>LISTENING: Listening for labeling-maps, graphs, tables, illustrations SPEAKING: Aided group presentation using charts, graphs etc.</p>	

READING: Reading for identification of facts and opinions
 WRITING: Information transfer (writing a brief report based on information from graph/chart/table)
 GRAMMAR & VOCABULARY: Subject-verb agreement; language for comparison and contrast; Antonyms

Learning Outcomes:

- After completing this unit, the student will be able to
- Match visual and auditory inputs and use the information comprehensively and will adequately demonstrate important relationships or patterns between data points (L2)
 - choose and coordinate resources appropriate to context and speak intelligibly (L3, L4)
 - Develop advanced reading skills for analytical and extrapolative comprehension (L4, L5)
 - Make decisions on arrangement of ideas and transfer them from visual to verbal form using context appropriate structure. (L3, L4)
 - Demonstrate ability to use task specific grammatically correct structures (L3)
- Comprehend and use expressions for negation/contradiction ((L2, L3)

Unit- V

LISTENING: Listening to discussions for opinions
 SPEAKING: Group Discussion
 READING: Reading for inferences
 WRITING: Guided essay writing (argumentative)
 GRAMMAR & VOCABULARY: Editing short texts: correcting common errors in grammar and usage;
 Action verbs for fluency and effective writing.

Learning Outcomes:

- After completing this unit, the student will be able to
1. Apply analytical and problem-solving strategies to identify and interpret facts and opinions from a dialogue. (L3)
 2. Able to administer group dynamics to contribute valid ideas to a discussion with clarity and precision (L3)
 3. Demonstrate techniques to analyze contextual clues(L4)
 4. Compare and correlate ideas and facts to produce an organized essay with adequate supporting evidences (L4, L5)
 5. Organize the available structural/grammatical knowledge and apply them in a real time context (L3)
- Comprehend meaning for new words/phrases used and apply them in a new context. (L2, L3)

Course Outcomes:

- After the completion of the course the student should be able to
6. Able to think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
 7. Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.

	8. Comprehend and analyze different academic texts. 9. Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing. 10. Effectively handle formal correspondence like e-mail drafting and letter writing.
Text Books:	
	1. Avenues I: A Course Book for Enhancing Language Skills by Orient BlackSwan Private Limited, India, 2019.
References:	
	2. C Muralikrishna and Sunita Mishra, Communication Skills for Engineers, Dorling Kindsley 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 Kindsley Pearson Education, India, 2010.

19ECY135 - CHEMISTRY 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 : Chemical Bonding & Coordination Compounds

8 hrs

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, N₂, O₂, NO and CO.

Coordination Compounds: Werner's theory – Sidgwick's theory, valence bond theory,– effective atomic number (EAN).

Learning Outcomes:

At the end of this unit, 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 N₂ ,CO molecules. (L-2)

Unit- II : Analytical Chemistry & Electrochemistry

8 hrs

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:

At the end of this unit, 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 : Stereochemistry		8 hrs
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 & Diastereomerism		
Learning Outcomes:		
	After completing this unit, the student will be able to <ul style="list-style-type: none"> • 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 : Carbohydrates		9 hrs
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 completing this unit, the student will be able to <ul style="list-style-type: none"> • 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 : Amino acids, Peptides & Proteins		9 hrs
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 completing this unit, the student will be able to <ul style="list-style-type: none"> • 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) 	
Course Outcomes:		
	After the completion of the course the student should be able to <ul style="list-style-type: none"> • define various types of chemical bonding. (L-1) • explain the principles of analytical and electrochemistry.(L2) • classify enantiomers & diastereomers. (L-2) 	

	<ul style="list-style-type: none"> • identify the structures of glucose and fructose. (L-3) • analyze Merrifield synthesis of poly peptides. (L-4)
Text Books:	
	<ol style="list-style-type: none"> 1. M. L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, 2/e, Prentice Hall, 2002. 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:	
	<ol style="list-style-type: none"> 1.L.G. Wade, Organic Chemistry, 6/e, Pearson education, (2005) 2. F.A. Carey, Organic Chemistry, Tata McGraw Hill, (2008).

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

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

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 titrimetry. (L-2)
- demonstrate the surface tension and viscosity. (L-2)

Unit- III 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
- b) Phenols
- c) Aldehydes and Ketones
- d) Esters
- e) Carbohydrates
- f) Hydrocarbons and Ethers
- g) Primary, Secondary and Tertiary amines
- h) Amides and imides
- i) 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) Nitration : 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 completing this unit, 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 the course the student should 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. . I. Vogel, Elementary Practical Organic Chemistry: Qualitative Organic Analysis, Part 2, 2/e, Pearson Education, (2010).

References:

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

19EID131: PROBLEM SOLVING AND PROGRAMMING

(w.e.f 2020-21 admitted batch, Common to all)

L T P C

3 1 3 5.5

This course focuses on problem solving using visual programming and flowchart tools. Python being simple and easy to learn syntax, it is used as an introductory coding platform to translate flow charts into programs. The course introduces fundamental programming concepts. Python language is used to present concepts including control structures, functions, data structures followed by important Python packages that will be useful in data analysis.

Course Objectives:

- To introduce programming through Visual programming tool - Scratch
- To teach problem solving through Flow charting tool - Raptor
- To elucidate problem solving through python programming language
- To introduce function-oriented programming paradigm through python
- To train in development of solutions using modular concepts
- To teach practical Pythonic solution patterns

UNIT I: Computational Thinking and Visual Programming Concepts

10 L+6P

Introduction to computational thinking. Visual programming concepts. Scratch environment: sprites -- appearance and motion, angles and directions, repetition and variation, changing costumes, adding background. Input/Output, variables and operators.

Learning Outcomes

After completion of this unit the student will be able to

- develop a program, controlled by a loop. (L3)
- experiment with “costumes” to change the appearance of sprites. (L3)
- perform Input, Output Operations using scratch. (L3)
- perform computation using common mathematical formulas. (L3)
- develop programs by passing messages between sprites. (L3)

UNIT II: Algorithms and Flowchart design through Raptor

10L+6P

Introduction to the idea of an algorithm. Pseudo code and Flow charts. Flow chart symbols, Input/Output, Assignment, operators, conditional if, repetition, procedure and sub charts.

Example problems – Finding maximum of 3 numbers, Unit converters, Interest calculators, multiplication tables, GCD of 2 numbers

Example problems -- Fibonacci number generation, prime number generation. Minimum, Maximum and average of n numbers, Linear search, Binary Search.

Learning outcomes:

After completion of this unit the student will be able to

- select flowchart symbols for solving problems. (L1)
- develop basic flowcharts for performing Input, Output and Computations (L3)
- solve numerical problems using Raptor (L3)
- analyze problems by modular approach using Raptor (L4)

UNIT III: Introduction to Python

10L+6P

Python – Numbers, Strings, Variables, operators, expressions, statements, String operations, Math function

calls, Input/output statements, Conditional If, while and for loops, User defined Functions, parameters to functions, recursive functions, Turtle Graphics.

Learning outcomes:

After completion of this unit the student will be able to

- interpret numbers, strings, variables, operators, expressions and math functions using Python Interactive Mode. (L2)
- solve simple problems using control structures, input and output statements. (L3)
- develop user defined functions (recursive and non-recursive). (L3)
- build Python programs for section 1 raptor flowcharts. (L3)
- develop Python programs for creating various graphical shapes using turtle graphics. (L3)

UNIT IV: Data Structures and Idiomatic Programming in Python

10L+6P

Lists, Tuples, Dictionaries, Strings, Files and their libraries. Beautiful Idiomatic approach to solve programming problems.

Learning outcomes:

After completion of this unit the student will be able to

- summarize the features of lists, tuples, dictionaries, strings and files. (L2)
- demonstrate best practices of “Beautiful Idiomatic Python”. (L2)
- build Python programs for section 2 raptor flowcharts. (L3).

UNIT V: Packages

10L+6P

Numpy - Create, reshape, slicing, operations such as min, max, sum, search, sort, math functions etc.

Pandas - Read/write from csv, excel, json files, add/ drop columns/rows, aggregations, applying functions

Matplotlib - Visualizing data with different plots, use of subplots.

User defined packages, define test cases and perform unit testing

Learning outcomes:

After completion of this unit the student will be able to

- read data from files of different formats and perform operations like slicing, insert, delete, update (L3)
- visualize the data (L4)
- ability to define packages (L2)
- define test cases (L1)

Problem Solving and Programming Laboratory

Laboratory Experiments

1. Design a script in Scratch to make a sprite to draw geometrical shapes such as Circle, Triangle, Square, Pentagon.
2. Design a script in Scratch to make a sprite to ask the user to enter two different numbers and an arithmetic operator and then calculate and display the result.
3. Design a Memory Game in Scratch which allows the user to identify positions of similar objects in a 3 x 3 matrix.
4. Construct flowcharts to
 - a. calculate the maximum, minimum and average of N numbers
 - b. develop a calculator to convert time, distance, area, volume and temperature from one unit to another.

5. Construct flowcharts with separate procedures to
 - a. calculate simple and compound interest for various parameters specified by the user
 - b. calculate the greatest common divisor using iteration and recursion for two numbers as specified by the user
6. Construct flowcharts with procedures to
 - a. generate first N numbers in the Fibonacci series
 - b. generate N Prime numbers
7. Design a flowchart to perform Linear search on list of N unsorted numbers (Iterative and recursive)
8. Design a flowchart to perform Binary search on list of N sorted numbers (Iterative and recursive)
9. Design a flowchart to determine the number of characters and lines in a text file specified by the user
10. Design a Python script to convert a Binary number to Decimal number and verify if it is a Perfect number.
11. Design a Python script to determine if a given string is a Palindrome using recursion
12. Design a Python script to sort numbers specified in a text file using lists.
13. Design a Python script to determine the difference in date for given two dates in YYYY:MM:DD format ($0 \leq \text{YYYY} \leq 9999$, $1 \leq \text{MM} \leq 12$, $1 \leq \text{DD} \leq 31$) following the leap year rules.
14. Design a Python Script to determine the Square Root of a given number without using inbuilt functions in Python.
15. Design a Python Script to determine the time difference between two given times in HH:MM:SS format. ($0 \leq \text{HH} \leq 23$, $0 \leq \text{MM} \leq 59$, $0 \leq \text{SS} \leq 59$)
16. Design a Python Script to find the value of (Sine, Cosine, Log, PI, e) of a given number using infinite series of the function.
17. Design a Python Script to convert a given number to words.
18. Design a Python Script to convert a given number to roman number.
19. Design a Python Script to generate the frequency count of words in a text file.
20. Design a Python Script to print a spiral pattern for a 2 dimensional matrix.
21. Design a Python Script to implement Gaussian Elimination method.
22. Design a Python script to generate statistical reports (Minimum, Maximum, Count, Average, Sum etc) on public datasets.
23. Design a Python script using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.

Text Book(s):

1. Weingart, Dr. Troy, Brown, Dr. Wayne, An introduction to programming and algorithmic reasoning using raptor.
2. T R Padmanabhan, Programming with python, Springer.
3. Reema Thareja, Python Programming: Using Problem Solving Approach, Oxford University Press.
4. Wes McKinney, Python for Data Analysis, O.Reilly.

Course outcomes:

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

- create interactive visual programs using Scratch. (L6)
- develop flowcharts using raptor to solve the given problems. (L3)
- build Python programs for numerical and text based problems (L3)
- develop graphics and event based programming using Python (L3)
- build Python programs using beautiful Pythonic idiomatic practices (L3)

19EEE131 - BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

(Common to all branches)

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:

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

Unit- I : Basic laws and Theorems

10L+6P

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:

- At the end of this unit, the student will be able to
- state Ohm's law and Kirchoff'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 : DC Machines

10L+6P

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:

- At the end of this 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)

	<ul style="list-style-type: none"> estimate losses and efficiency of electrical machine(L2) 	
Unit- III : Transformers		12L + 9P
<p>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</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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 : Semiconductor Devices		12L + 9P
<p>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.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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 : Operational Amplifiers		10L + 6P
<p>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</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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.

Course Outcomes:

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

- predict and analyze the behavior of an electrical circuit (L3)
- analyze the performance quantities such as losses, efficiency and identify applications of DC machines(L4) explain the use of transformers in transmission and distribution of electric power and other applications (L2)
- demonstrate the operation and applications of various electronic devices (L2)
- construct Inverting and Noninverting configurations of Op-Amp (L3)

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

19EME121: WORKSHOP

(Common to all branches)

L T P C
0 0 3 1.5

The objective of this course is to exposure students 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:

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

- summarize various carpentry operation required to create a product in real time applications. (L2)
- develop different parts with metal sheet in real time applications. (L3)
- demonstrate fitting operations in various applications. (L3)

	<ul style="list-style-type: none">• perform soldering and brazing operations. (L3)• select different types of electric circuits in practical applications (L3)
--	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

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:

7hr

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) Involutives

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.

Projections of solids: Projections of regular solids inclined to one and both the reference planes.

Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone. True shapes of the sections

Development of surfaces: Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts.

Computer Aided Drafting:

6hr

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.

Orthographic Projections: Systems of projections, conventions and application to orthographic projections.

Isometric Projections: Principles of isometric projection- Isometric scale; Isometric views: lines, planes, figures, simple and compound solids.

Course Outcomes:

	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • utilize Engineering Graphics as Language of Engineers. (L3) • prepare drawings as per standards (BIS).(L3) • identify various engineering curves.(L3) • solve geometrical problems in plane geometry involving lines and plane figures (L3) • represent solids and sections graphically. (L3) • develop the surfaces of solids. (L3) • draw isometric and orthographic drawings using CAD packages. (L3)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

19EMC181A: NATIONAL SERVICE SCHEME (NSS)

L T P C
0 0 2 0

National Service scheme is a public service program encouraged by Ministry of Youth Affairs and Sports of the Government of India. NSS is a voluntary association of young people in Colleges, Universities and at +2 level working for a campus-community linkage. The objective of this course is to expose the students to the activities of National Service Scheme, concept of social Service and principles of health, hygiene and sanitation.	
Unit- I : Introduction and Basic concepts of NSS	2hrs
History, Philosophy, aims and Objectives of NSS, Emblem, Flag, Motto, Song, Badge etc..Organizational structure, role and responsibilities of various NSS Functionaries	
Unit- II : Regular activities	2hrs
College campus activities, NS.S, activities in Urban and Rural areas, NSS Annual Activities Calendar, Suggestive List of Activities, Role of Non-Government Organisation (NGO) in social Reforms i) Red Cross ii) Rotary	
Unit- III : Special Camp activities: Nature and its objectives	2hrs
Selection of camp site -Identification of community problems- physical arrangement-Organization of N.S.S.camp through various committees and discipline in the camp- adaption of village-planning for pre -camp during and post campaigning. Activities- Activities to be undertaken during the N.S.S. camp- Use of the mass media in the N.S.S activities.	
Unit- IV: Health, Hygiene and Sanitation	4hrs
Definition, needs and scope of health education, food and Nutrition, Safe drinking water, Sanitation, Swachh Bharat Abhiyan. Disaster Management: Introduction to Disaster Management, Classification of Disasters. Role of Youth in Diasters Management, Home nursing, First Aid. Civil Self Defense: Civil Defense services, aims and objectives of civil defense, Need for self defence training	
Unit- V : Social Project	10hrs
Problems Identification - Data Collection- Preparation of a Questionnaire-Observation- Schedule Interview-Qualitative Research-Quantities Research-Major Findings-Suggestions-Conclusion-Report Writing.	
Text Books:	
	<ol style="list-style-type: none"> 1) National Service Scheme Manual (Revised) 2006, Government of India, Ministry of Youth Affairs and Sports, New Delhi 2) NSS Diaries 3) Sanjay Bhattachaya, Social Work Interventions and Management-Deep and Deep Publications, New Delhi

19EMC181B: NATIONAL Cadet Corps

L T P C
0 0 2 0

Unit- I: Aims and objectives of NCC	5hr
<p>Organization and training, ncc song, incentives for cadets. national integration and awareness: religion, culture, traditions and customs of india, national integration – importance and necessity, freedom struggle and nationalist movement in india, national interests, objectives, threats and opportunities, problems/ challenges of national integration, national integration and awareness, unity and diversity, national integration council, images/ slogans for national integration, contribution of youth in nation building</p>	
Unit- II	5hr
<p>Drill Attention, stand at ease and stand easy, turning and inclining at the at the halt, ceremonial drill-guard mounting, guard of honour, platoon / company drill, instructional practice, weapon training stripping, assembling, care and cleaning and sight setting of .22 rifle, the lying position, holding and aiming, trigger control and firing a shot, short range firing, aiming – alteration of sight</p>	
Unit- III	5hr
<p>Personality development: Introduction to personality development, factors influencing / shaping personality – physical , social, psychological and philosophical self awareness – know yourself / insight, change your mindset, interpersonal relationship and communication communication skills – group discussion / lecturesses, leadership traits, types of leadership, attitude – assertiveness and negotiation, time management, personality development, effects of leadership with historical examples, stress management skills, interview skills, conflict motives – resolution, importance of group – team work, influencing skills, body language, sociability: social skills, values / code of ethics Disaster Management: Civil defence organization and its duties – ndma, types of emergencies / natural disasters, fire service and fire fighting, traffic control during disaster under police supervision, essential services and their maintenance, assistance during natural / other calamities / floods / cyclone / earth quake / accident, setting up of relief camp during disaster management, collection and distribution of aid material</p>	
Unit- IV: Social awareness and community development	
<p>Basics of social service, weaker sections of our society and their needs, social/ rural development projects – menrega , sgsy , nsap etc, ngos : role and contribution, contribution of youth towards social welfare, family planning, drug abuse and trafficking, civil responsibilities, causes and prevention of hiv/ aids role of youth, counter terrorism, corruption, social evils – dowry / female foeticide / child abuse and trafficking, rti and rte, traffic control organization and anti drunken driving, provision of protection of children from sexual harassment act 2012.</p>	
Unit- V: Health and Hygiene	
<p>Structure and functioning of the human body, hygiene and sanitation (personal and food hygiene), physical and mental health, infectious and contagious diseases and its prevention, basic of home nursing and first aid in common medical emergencies, wounds and fractures, introduction to yoga and exercises. Adventure training: Para sailing, slithering, rock climbing, cycling / trekking, environment awareness and conservation natural resources conservation and management, water</p>	

conservation and rain water harvesting, waste management, pollution control, water , air, noise and soil, energy conservation, Wildlife conservation – projects in India. obstacle training, obstacle course, practical training

Text Books:

1. Cadet Hand Book (Common Subjects), published by DG NCC.
2. Cadet Hand Book (Specialized Subjects), published by DG NCC

References:

1. Grooming Tomorrow's Leaders, published by DG, NCC.
2. Youth in Action, published by DG, NCC.
3. The Cadet, Annual Journal of the NCC.

19EMC181C: National Sports Organization
(Common to all)

L T P C
0 0 2 0

National Sports Organization is intended by the Government of India to promote the development of athletics and sporting activities of the nation's youth. This activity enables physical fitness, teamwork and mental health within the students. This course teaches the rules and skills of below sports and games to the students.

Each student shall be made proficient in one of the chosen sport from the below list

1. Cricket
2. Volley Ball
3. Table Tennis
4. Foot Ball
5. Throw Ball (Only for Women)
6. Basket Ball
7. Athletics -100 Meters Run, Long Jump, Shot Put
8. Chess
9. Lawn Tennis
10. Kabaddi
11. Aerobics
12. Badminton

Text Books:

1. Myles Schrag, The Sport Rules Book, 4/e, Human Kinetics, 2018
2. Dhama Prakash Jyoti, Rules. Of. Games. And. Sports, Laxmi Book Publication, 2018

19EMC181D: YOGA

(Common to all)

L T P C
0 0 2 0

The course is designed to enable the student to know about yoga an ancient Indian tradition. It embodies unity of mind and body; thought and action; harmony between human and nature and a holistic approach to health and well-being. It is not only exercise but to discover the sense of oneness with ourselves, the world and nature. The student will be able to learn about Yoga and practice different Yoga asana which influences his lifestyle and creating consciousness, it can help a student to deal with health issues and climate change.

Course Objectives:

- Familiarize the student with YOGA and ancient Indian tradition.
- Enable the student to know the different asana their advantages and disadvantages.
- Explain with the features of different Yoga asana.
- Demonstrate and perform Yoga asana.
- Enable the student to perform pranayama and meditation.

- Introduction to Yoga: Evolution of Yoga and Schools of Yoga, Origin of Yoga, History and Development of Yoga; Etymology and Definitions, Misconceptions, Nature and Principles of Yoga.
- Guidelines to yoga practice: Prayer, warmup exercises/ loosening exercises
- Yoga Theory: Therapeutic Benefits of Yoga – primitive, preventive and curative aspects of Yoga
- Application of Yoga to students, Suryanamaskaras, Tadasan, Natarajasan, Vrikshasan, Padahasthasan, ArdhaChakrasan, Trikonasan, Bramari pranayama.
- Yoga for allround fitness, Bhadrasan, Vajrasan, ArdhaUstrasana, Nadishuddhi pranayama, Navasan, Janusirasana, Paschimotthanasana, Shashankasan, Vakrasana, Bhujangasan, Kapalabhati..
- Meditative Postures: Sukhasana, Ardha Padmasana, Padmasana and Siddhasana, Meditation
- Yoga Practice: Makarasana, Sethubandhasana, Pavanmuktasana, Sarvangasana, Matsyasan, Halasana.

Course Outcomes:

- After completion of this course the student will be able to
- understand history and evolution of Yoga (L2).
 - list different schools of yoga (L2).
 - interpret the aim and objectives of yoga to students (L2).
 - perform yoga asana, pranayama, and meditation (L2).

Text Books:

1. Swami MuktibodhandaSaraswathi Shay G.S., Hatha yoga Pradipika, Bihar School of yoga publications, Munger, 2000.
2. Hatha Yoga Pradeepika of Svatmarama, MDNY Publication, 2013
3. Svatmarama, Swami, The Hatha yoga Pradipika/ the original Sanskrit [by] Svatmarama; an English translation [by] Brian Dana Akers. Woodstock, NY:YogaVidya.com, 2002.

References:

1. Bharati, Swami Veda Reddy Venkata: Philosophy of Hatha Yoga (Englis), Himalayan, Pennsylvania, Hatha Ratnavali.
2. Swami Satyananda Saraswathi - Asana, Pranayama, Mudra & Bandha. Bihar School of Yoga, Munger
3. B.KS.Iyenger - The Illustrated Light on Yoga. Harper Collins, New Deli

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:	
	<ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• find determinants of matrices (L3)• apply crammer's rule for solving linear equations (L3)• find inverse of a matrix (L3)
Unit II: Probability	8 hrs
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 <ul style="list-style-type: none">• identify dependent and independent events(L3)• apply multiplication theorem and Baye's theorem (L3)
Unit III: Indefinite Integrals	8 hrs
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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 hrs
<p>Integrals of the following types of functions:</p> $\frac{1}{x^2 \pm a^2}, \frac{1}{a^2 - x^2}, \frac{1}{x^2 \pm a^2}, \frac{1}{a^2 - x^2}, x^2 \pm a^2, a^2 - x^2$ <p>and integration of rational functions using partial fractions.</p> <p>Definite Integrals: Definition of a definite integral and its properties (without proof), formulae</p> $\int_0^{\pi/2} \sin^n \theta d\theta, \int_0^{\pi/2} \cos^n \theta d\theta, \int_0^{\pi/2} \cos^n \theta \sin^m \theta d\theta$ <p>of $\int_0^{\pi/2} \sin^n \theta d\theta$ and $\int_0^{\pi/2} \cos^n \theta d\theta$ (without proofs).</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	10 hrs
<p>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).</p> <p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • identify the equation to straight line in different forms(L3) • find the length of perpendicular from a point to a straight line(L3) • find the equation of a circle passing through three non collinear points(L3)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • identify the properties of matrices (L3) • solve problems on multiplication theorem and Baye's theorem(L3)

	<ul style="list-style-type: none"> • make use of integration techniques (L3) • examine the value of definite integral (L3) • illustrate the straight line and circle properties(L3)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

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, Synectics 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):

1. Pahl, Beitz, Feldhusen, Grote – Engineering Design: a systematic approach, Springer, 2007
2. Christoph Meinel and Larry Leifer, Design Thinking, Springer, 2011
3. Aders Riise Maehlum - Extending the TILES Toolkit – from Ideation to Prototyping
4. <http://www.algarytm.comA/it-executives-guide-to-design-thinking:e-book>.
5. 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

- innovate new methods in product development(L6)
- apply Design Thinking in developing the new designs(L3)
- select ideas from ideation methods in new product development(L5)
- use Design Thinking in developing software products(L3)
- apply principles of Design Thinking in service design(L3)

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:

Course 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 Chatbot (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 Kaggle<https://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> Caffe2:

<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:

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

- able to grasp the concepts of artificial intelligence, machine learning, natural language processing, image processing. (L1)
- recognize various domains in which AI can be applied.(L2)
- implement the methods in processing an image.(L3)
- implement simple of chatbots.(L4) .
 - identify smart applications. (L4)

19EPH135: PHYSICS FOR BIOTECHNOLOGY

L T P C
3 0 3 4.5

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 magnetostatics (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 hrs

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:

At the end of this unit, the student 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 hrs

Interference: Introduction, interference in thin films due to reflected light: interference in parallel-sided film and wedge shaped film, Newton’s rings.

Diffraction: Introduction; Fraunhofer 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 hrs
Transfer of heat energy; Thermal expansion of solids and liquids; Expansion joints - bimetallic strips; Thermal conduction, convection and radiation and their fundamental laws; Heat conduction in solids; Thermal conductivity - Forbes's and Lee's disc method: theory and experiment; Applications (qualitative only): heat exchangers, refrigerators, ovens and solar water heaters.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 hrs
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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 hrs
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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)

	<ul style="list-style-type: none"> • 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)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • estimate forces, fields and waves in electrostatics and magnetostatics (L2). • use principles of interference, diffraction and polarization. (L3) • calculate the thermal properties of materials. (L4) • apply Newtonian laws of motion to macroscopic systems. (L3) • choose from common sensing devices. (L3)
Text Books:	
	<ol style="list-style-type: none"> 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. 3. Ian R Sinclair, Sensor and Transducers 3rd eds, 2001, Elsevier (Newnes).
References:	
	<ol style="list-style-type: none"> 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
 - e. estimate the frequency of a tuning fork (L3, L5).
 - f. examine the relation between frequency and volume of a cavity (L3, L4).
 - g. 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:

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

19EBT122 BIOTECHNOLOGY WORKSHOP

L T P C
0 0 3 1.5

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.

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:

The student will be able to:

- use the scientific calculator and microscope
- measure flow, pH, sugar content
- retrieve data
- observe cell division
- grow yeast cells
- produce and analyse wine
- explain the operation and control of bioreactors.

19EHS122: COMPREHENSIVE SKILL DEVELOPMENT – 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

Self Awareness and Motivation, Goal Setting and Time Management, Interpersonal Skills, Team Work.

Verbal and Soft Skills		
Unit	Module/ Topics	Hrs
1.	Self-Awareness and Self-Regulation	4
2.	Social Awareness & Relationship Management	4
3.	Conflict Management	3
4.	Team Work	4
	Total	15

B. Quantitative Aptitude and Reasoning

Puzzles, Non-Verbal Reasoning, Data Sufficiency, Analytical Reasoning,

Quantitative Aptitude and Reasoning		
Unit	Module/ Topics	Hrs
1.	Verbal Reasoning [Coding decoding, Blood relations, Ranking, Directions, Group Reasoning (Puzzle Test)]	6
2.	Analytical Reasoning [Cubes, Counting of Geometrical Figures)	2
3.	Logical Deductions [Venn diagrams, Syllogisms, Data Sufficiency]	4
4.	Puzzles [Puzzles from books i. Puzzles to puzzle you by Shakunthala devi	3

	ii. More puzzles by Shakunthala devi iii. Puzzles and Teasers by George Summers]	
	Total	15

Part-2

- 3 Hours per week

Coding: GitHub – Accepting assignments pull and push the code or resource, GitHub configuration,

Visual Studio code – Configuring, integrating Git for assignment submission

Online competitive coding platforms – Introduction to online coding platforms to get prepared for competitive coding.

Problem Solving with Python: Collections, Techniques for manipulating Strings, Recursion, Searching, Sorting, Stacks and Queues.

Problem Solving with C: Memory, C Syntax, Conditions and Loops, Functions and Recursion, Arrays, Techniques for manipulating Strings, Searching, Sorting, Stacks and Queues, Structures. sentation 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:

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/>

VDC111: VENTURE DISCOVERY

L T P C
0 0 4 2

India as part of its Make in India initiative has been focusing on creating incubation centers within educational institutions, with an aim to generate successful start-ups. These start-ups will become employment creators than employment seekers, which is the need of the hour for our country.

This common course for all the disciplines is a foundation on venture development. It is an experiential course that lets students venture and find out what is a business, financial and operating models of a business are. How to design and prototype a solution that meets their customers' needs and generate revenue for the business.

COURSE OBJECTIVES

- Discover who you are – Values, Skills, and Contribution to Society.
- Gain experience in actually going through the innovation process.
- Conduct field research to test or validate innovation concepts with target customers.
- Understand innovation outcomes: issues around business models, financing for start-ups, intellectual property, technology licensing, corporate ventures, and product line or service extensions.

UNIT I

(6 sessions)

Personal Values: Defining your personal values, Excite & Excel, build a Team, Define purpose for a venture. Four stages: Personal Discovery, Solution Discovery, Business Model Discovery, Discovery Integration.

UNIT II

(6 sessions)

Solution Discovery: Craft and mission statement, Experience design, Gaining user insight, Concept design and positioning, Product line strategy, Ideation & Impact.

UNIT III

(6 sessions)

Business Model Discovery: Prototyping solutions, Reality Checks, understand your industry, Types of business models, Define Revenue Models, Define Operating Models

UNIT IV

(6 sessions)

Discovery Integration: Illustrate business models, validate business models, Define company impact

UNIT V

(6 sessions)

Tell a Story: Can you make money, Tell your venture story.

Assessment methods

Task	Task type	Task mode	Weightage (%)
A1. Assignments	Individual	Report/Presentation	20
A2. Case / Project/Assignment	Groups* or Individual	Presentations/Report/Assignment	40
A3. Project	Individual/Group	Report/Pitch	40

Transferrable and Employability Skills

	Outcomes	Assessment
1211	Know how to use online learning resources: G-Learn, online journals, etc.	A1 & A2
1		
2	Communicate effectively using a range of media	A1 & A2
3	Apply teamwork and leadership skills	A2
4	Find, evaluate, synthesize & use information	A1 & A2
5	Analyze real world situation critically	A3
6	Reflect on their own professional development	A3
7	Demonstrate professionalism & ethical awareness	A2
8	Apply multidisciplinary approach to the context	A2

Learning and teaching activities

Mixed pedagogy approach is adopted throughout the course. Classroom based face to face teaching, directed study, independent study via G-Learn, case studies, projects and practical activities (individual & group)

Teaching and learning resources

Soft copies of teaching notes/cases etc. will be uploaded onto the G-learn. Wherever necessary, printouts, handouts etc. will be distributed in the class. Prescribed text book will be provided to all. However, you should not limit yourself to this book and should explore other sources on your own. You need to read different books and journal papers to master certain relevant concepts to analyze cases and evaluate projects. Some of these reference books given below will be available in our library.

Prescribed Modules:

Access to NU-IDEA online modules will be provided.

Referential text books and journal papers:

Personal Discovery Through Entrepreneurship, Marc H. Meyer and Chaewon Lee, The Institute of Enterprise Growth, LLC Boston, MA.

Suggested journals:

Vikalpa, Indian Institute of Management, Ahmedabad
 Journal of General Management, Mercury House Business Publications, Limited
 Harvard Business Review, Harvard Business School Publishing Co. USA

On successful completion of this course, students will be able to

	COURSE Outcomes	Assessment
1	Understand conceptual framework of the foundation of a venture	A1, A2
2	Understand the concept of purpose, mission and value-add service offered by a venture	A3
3	Analyze design and positioning of the product	A3
4	Demonstrate prototyping	A3
5	Analyze business, revenue and operating models	A3

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:	
	<ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• analyze complementary function and particular integral (L3)• apply method of variation of parameters technique (L3)

	<ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> formulate partial differential equations apply Lagrange's method for solving partial differential equations (L3) find complementary function and particular integral (L3)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> apply properties of matrices for solving system of equations (L3) develop the solution of first order differential equations (L3) Analyze the complete solution of a linear differential equations (L4) make use of partial differentiation technique for finding Jacobian (L3) solve a partial differential equations (L3)
Text Books:	
	<ol style="list-style-type: none"> B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
References:	
	<ol style="list-style-type: none"> Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley Eastern Pvt. Ltd., New Delhi, 2018. N. P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, 9th edition, Laxmi Publications (P) Ltd., New Delhi, 2014..

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)

	<ul style="list-style-type: none"> predict the physico-chemical properties of air. (L2) 	
Unit- III		8 hrs
<p>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.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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
<p>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.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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
<p>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.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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) 	
Course Outcomes:		
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> explain the composition of solids and liquids, & behaviour of gases. (L2) 	

	<ul style="list-style-type: none"> • interpret the process flow diagrams. (L2) • apply concepts of chemical calculations. (L2) • analyze the bioprocesses for material and energy transfers. (L4) • identify the potential of stoichiometric principles. (L2)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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 Material & 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.

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 phosphorylation.	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> list the types of nucleic acids (L1) relate the structure and conformation of nucleic acids (L1) explain the synthesis and degradation of purines and pyrimidines (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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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).
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> describe the structure and properties of common biomolecules (L1). describe standard metabolic pathways (L1). explain the functional properties of enzymes (L3) explain role of hormones in human body (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.

BIOCHEMISTRY LABORATORY

L T P C
3 0 2 4

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

Course Outcomes:

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

- prepare buffer solutions
- estimate carbohydrates, amino acids, proteins and lipids
- perform absorption spectra for biomolecules
- separate amino acids, sugars and proteins by chromatography
- separate proteins by electrophoresis

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, Psychrophiles, 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.

	<ul style="list-style-type: none"> Differentiate between prokaryotic and eukaryotic organisms 	
Unit- III		8 hrs
<p>Microbial nutrition: Nutrition requirements, nutritional types of bacteria, uptake of nutrients by cell. Microbial metabolism: Respiration, Photosynthesis and Nitrogen fixation.</p>		
<p>Learning Outcomes:</p>		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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
<p>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.</p> <p>Applied Microbiology: Water, Food and Milk borne contamination and remedy. Basic microbial genetics - conjugation, transformation and transduction. Strain improvement of microbes of industrial importance.</p>		
<p>Learning Outcomes:</p>		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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
<p>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.</p>		
<p>Learning Outcomes:</p>		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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). 	
<p>Course Outcomes:</p>		
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> Isolate and identify the microorganisms. Define, describe and utilize microbial growth in fermentation and biological process. Perform sterilization techniques. Assess the quality of milk, water and biological samples. 	

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.

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 cerevisiae*)

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 crossing-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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • explain the concepts of gene structure and its function (L2) • summarize the inheritance of characters by mendelian and non-mendelian genetics (L2) • explain the molecular basis of mutations and DNA repair (L2) • explain the mechanism of gene regulation (L2) • summarize the importance of genetic code and central dogma (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. Albert's, 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's and Wilkins Publishers, 2010.

19EBT235: FLUID MECHANICS AND MECHANICAL OPERATIONS

L T P C
2 0 2 3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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. (L4) • Examine the properties of equations of motion in fluids (L2) • Describe the properties of non-Newtonian flow. (L2)
Unit- II	8 hrs
<p>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).</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Flow of incompressible fluids in pipes: relation between skin friction and wall shear, laminar flow</p>	

in pipes: Hagen-Poiseuille 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 comminution: laws of crushing (Rittinger's, Bond's, Kick's laws); description and working of size reduction equipment: jaw, gyratory crusher, roll crushers, ball mill, hammer mill, and fluid energy mill.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Discuss the mechanical properties of particles (L2) • Select suitable size reduction equipment (L5) • Identify microscopic mechanisms involved in particle processing (L2)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Identify the types of non-Newtonian fluids (L2) • Characterize and describe fluid-particle systems in terms of their basic physical properties. (L2) • Impart the f concepts of fluid statics, pressure distribution and dimensional analysis(L2) • Learn basic principles of particle preparation and their characterization (L2) • Study and understand the principles of various size reduction (L4)

	<ul style="list-style-type: none"> Perform basic design calculations and analyses of typical fluid-particle operations. (L4)
Text Books:	
	<ol style="list-style-type: none"> W.L. McCabe, J.C. Smith, and P. Harriot, Unit Operations of Chemical Engineering, 7/e, McGraw-Hill International Edition, 2005.
References:	
	<ol style="list-style-type: none"> J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Permagon Press, 1999. G.G. Brown, Unit Operations, CBS Publishers, 2005.

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1	2	2	1	2	2	2	2	3	3	1
Avg	3.0	2.0	2.0	2.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0	2.0	3	3	1

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 and powers, 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 and council, 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:	
	<ol style="list-style-type: none">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:	
	<ol style="list-style-type: none">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

<p>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</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).
<p>Unit- III</p>	
<p>8 hrs</p>	
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).
<p>Unit- IV</p>	
<p>9 hrs</p>	
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).

	<ul style="list-style-type: none"> analyze environmental impact assessment and management plan (L4).
Unit- V	6 hrs
<p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> Anubha Kaushik and C.P. Kaushik, Text book of environmental studies New Age International Publisher (2014). Erach Barucha, Text book of environmental studies for undergraduates courses, published by – University Grants Commission, University Press (2005) Anindita Basak, Environmental Studies. Pearson (2009).
References:	
	<ol style="list-style-type: none"> D.K. Asthana and Meera Asthana, A Text book of Environmental Studies, S. Chand (2010). P.M Cherry Solid and Hazardous waste Management, CBS Publisher (2016). Charles H. Eccleston, Environmental Impact Assessment, CRC Press (2011). K.K. Singh, Natural Resources Conservation and Management, MD Publications (2008). 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– 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 week

3 Hours per

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 week

3 Hours per

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:

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/>

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:	
	<ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Vector Differentiation: Scalar and vector fields, gradient, directional derivative, divergence, curl, vector identities, irrotational and solenoidal fields.</p> <p>Vector Integration: Line integral, surface integral, Green's theorem in plane, Stoke's theorem and Gauss divergence theorem (without proofs).</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Calculate the normal to a given surface, directional derivative and divergence, curl to given vector point functions.(L3) • evaluate line and surface integrals.(L3)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • develop analytic function and Cauchy-Riemann equations. (L3) • examine complex integral. (L3) • apply Laplace transform to derivatives and integrals. (L3) • construct half range expansion. (L3) • apply Z transform of discrete function. (L3)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

19EID232: INTERNET OF THINGS

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

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):

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

References

1. ArshdeepBahga, Vijay Madiseti, 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

- choose the sensors and actuators for an IoT application(L1)
- select protocols for a specific IoT application(L2)
- utilize the cloud platform and APIs for IoT application(L3)
- experiment with embedded boards for creating IoT prototypes(L3)
- design a solution for a given IoT application(L6)

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.

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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 equipments for extraction and heat exchange
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Analyze Modes of heat transfer. Basic laws of heat transfer and unsteady state heat transfer • Analyze Heat transfer by forced and free convection • Analyze Mass transfer operations ,molecular diffusion in fluids and interphase mass transfer • Analyze continuous steady state distillation processes • Explain Concept about single and multistage operations and different types of equipments used in extraction
Text Books:	
	<ol style="list-style-type: none"> 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. 4. B.K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall of India, 2007.
References:	
	<ol style="list-style-type: none"> 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.

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]
9. Differential distillation
[After completing the experiment the student is able to verify Rayleighs equation]
- 10 Arnolds cell
[After completing the experiment the student is able to determine the diffusion coefficient of vapor through air film]
11. Liquid-liquid diffusion
[After completing the experiment the student is Able to determine the diffusion

	coefficient of HCL in water] 12. Solid Liquid equilibrium experiment [After completing the experiment the student is able to determine the equilibrium distribution data for the given solid-liquid system]
Course Outcomes:	
	After the completion of the course the student should be able to 1. Utilize and operate measurement techniques and devices respectively to measure concentrations and temperatures. 2. Measure different variables of interest in unit operations involving heat and mass transfer. 3. Estimate heat and mass transfer coefficients for the unit operations involved.
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. 3. Awais Ali, Heat and Mass Transfer Lab Manual, 2014.
References:	

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, lamda phage, cosmids 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Summarize the common methods of isolation of nucleic acids and enzymes used in molecular biology(L2). • Explain the applications of genome sequencing methods(L2). • Select best biological hosts for optimum production of a protein (L3). • Explain the principles of modern gene therapy(L2). • Describe the applications of rDNA technology(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 LAB

L T P C
3 0 3 4.5

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

References:

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.

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)

	<ul style="list-style-type: none"> • compare the principles and applications of electron microscopic techniques (L2) • explain the principles and applications of AFM (L2)
Unit- III	6 hrs
<p>Mass spectrometry:</p> <p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>NMR spectroscopy:</p> <p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Introduction to high throughput and mini/microscale analytical devices in biotechnology.</p> <p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • apply microarray data analysis tools (L3) • design protocols for fabrication of MEMs (L6) • explain the power of high throughput workflow in biotechnology (L2)

Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

19EBT204: BIOCHEMICAL THERMODYNAMICS

L	T	P	C
3	0	0	3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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
<p>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,</p>	

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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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:

- After the completion of the course the student should be able to
- apply the fundamental concepts of thermodynamics to engineering applications (L3)
 - estimate thermodynamic properties of substances in gas and liquid states. (L3)
 - determine thermodynamic efficiency of a process. (L3)
 - Analyze chemical reaction equilibrium data (L3)
 - Comprehend the thermodynamic basis of biological phenomena (L2)

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.

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	2	2	2	2	2	2	3	3	2	2
Avg	3.0	2.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3	2	2

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-Dimensional 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/>

19EBT331: BIOPROCESS ENGINEERING

L T P C
3 0 2 4

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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
<p>Definition and scope of bioprocess engineering. Bioprocess verses chemical processing: advantages and disadvantages. Substrates for bioconversions. Choice of microbes. Media design and optimization.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Define bioprocess engineering (L2) • Compare chemical processes and bioprocesses (L3) • Explain principles of media design and optimization (L2)
Unit- II	8 hrs
<p>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 ungassed bioreactors, mixing and heat transfer in dispersed systems, biorheology.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	

	After completing this unit, the student will be able to <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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)
Course Outcomes:	
	After the completion of the course the student should be able to <ul style="list-style-type: none"> • Explain requirements for design of a bioreactor (L2) • Calculate power requirements of a bioreactor (L3) • Explain kinetics of microbial growth (L2) • Explain control of operating conditions in a fermenter (L2) • Describe regulatory constraints (L1)
Text Books:	
	1. 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, 2/e, Pergamon, 1995.

At least 10 of the following experiments are required:

In situ 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.

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.

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.

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

Measurement of Volumetric Oxygen transfer coefficient (K_La) 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 (K_La)

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.

Residence time distribution in CSTR

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

Solid state fermentation

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

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

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

Production and recovery of Vitamin B₁₂

At the end of this experiment the student will be able to: know production, recovery and estimate amount of Vitamin B₁₂ produced by SSF

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

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.

19EBT333: BIOCHEMICAL REACTION ENGINEERING

L T P C
3 0 2 4

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none">• 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none">• Explain kinetics of homogeneous and heterogeneous reactions (L₂)• Analyze the temperature dependency of the rate equation (L₂)• Analyze effect of mass transfer on enzyme kinetics. (L₂)
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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none">• Demonstrate design of an ideal batch reactor. (L₂)• Interpret batch reactor data (L₂)• 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none">• 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 (L₃)

	<ul style="list-style-type: none"> • Compare single and multiple ideal reactor systems (L₅) 	
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:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • design reactors for non isothermal conditions (L₆) • relate temperature and conversion or reaction rate for reactors (L₂) • design reactors on basis of energy balance (L₆) • explain sterilization techniques (L₂) 	
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:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • apply the tracer concentration time data (L₃) • calculate distribution functions, mean residence time, and variance (L₃) • quantify non-ideal flow from experimental data (L₃) 	
Course Outcomes:		
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • design of batch reactor using rate law and its parameters (L₆) • design of flow reactors and fermentors (L₆) • select reactor and conditions to minimize unwanted products (L₃) • design of reactors on the basis of energy balance. (L₆) • identify problems in real reactors (L₃) 	
Text Books:		
	<ol style="list-style-type: none"> 1. Octave Levenspiel, Chemical Reaction Engineering, 3/e, John Wiley, 2010. 2. J.M. Smith, Chemical Engineering Kinetics, 3/e, McGraw Hill, 1981. 	
References:		
	<ol style="list-style-type: none"> 1. J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Pergamon 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 analysing 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]

	<p>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]</p>
<p>Course Outcomes:</p>	
	<p>After the completion of the course the student should be able to</p> <ol style="list-style-type: none"> 1. Familiarize with suitable measurement techniques and devices to measure concentration and temperature. 2. Able to employ various methods to determine the kinetics of reactions. 3. Able to quantify the effect of non-ideality of flow in chemical reactors.
<p>Text Books:</p>	
	<ol style="list-style-type: none"> 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 3. Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 1981, 3 rd Edition
<p>References:</p>	

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. Immunotechnology 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- Hemeagglutination and complement fixation, Immunofluorescence, RIA, ELISA, Immunoblotting, Flow Cytometry and Fluorescence, Hybridoma technology - Production of monoclonal antibodies and their applications. Catalytic antibodies.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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, allo, iso and xenograft, Bone marrow and Kidney transplants, Graft rejection (Graft versus host rejection and host versus graft rejection mechanisms), Co stimulatory pathways, Immuno suppressive agents. Immunodeficiencies - SCID and AIDS.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • outline the principles of vaccine development. (L2) • explain the potential of transgenic mice (L2) • analyse the models for SCID (L4)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • describe the molecular basis of the immune response (L1) • understand the basics of transplantation immunology. (L2) • Describe immunosuppressive drugs and immunodeficiency disorders (L1) • outline the principles of vaccine development. (L2) • explain the potential of transgenic mice (L2)
Text Books:	
	<ol style="list-style-type: none"> 1. Thomas J. Kindt, Barbara, A. Osbarne, 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.

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 haemocytometer
After completion of this experiment, the student will be able to use haemocytometer 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 Immuno 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 detection by electrophoresis
9. Protein immunoblotting (Western blotting) technique
After completion of this experiment, the student will be able to learn to detect multiple Ag/Ab by blotting technique
10. Flow cytometry
After completion of this experiment, the student will be able to understand the principle of flow cytometry

Course Outcomes:

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

- Use haemocytometer
- explain bacterial agglutination
- Detect the Ag/Ab by immunological techniques
- Understand the principle of immunoelectrophoresis, western blotting
- Explain the principle of flow cytometry

Text Books:	
References:	
	<ol style="list-style-type: none">1. Practical Immunology A Laboratory Manual, <u>Karthik Kaliaperumal and Senbagam Duraisamy Senthilkumar Balakrishnan</u>, Lambert publishers Academic publishers 20172. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited3. 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.5. Richard C and Geiffrey S. (2009). Immunology.6th edition.Wiley Blackwell Publication

19EHS302: ENGINEERING ECONOMICS AND MANAGEMENT

L T P C
3 0 0 3

<p>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.</p>	
Unit- I	8 hrs
<p>Economics: Utility, value, wealth, consumption, wants necessities, comforts and luxuries. Demand: Law of demand, elasticity of demand, price elasticity of demand, factors affecting elasticity of demand, simple problems.</p>	
Unit- II	8 hrs
<p>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).</p>	
Unit- III	8 hrs
<p>Break-Even Analysis: Assumptions, break-even charts, simple problems. Depreciation: Depreciation methods - Simple problems.</p>	
Unit- IV	8 hrs
<p>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.</p>	
Unit- V	8 hrs
<p>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.</p>	
Text Books:	
	<ol style="list-style-type: none"> 1. Tara Chand, Engineering Economics, Vol - 1, 13/e, Nem Chand & Bros, 2012 2. O.P Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2011.
References:	
	<ol style="list-style-type: none"> 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

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

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:

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.	Cryptarithmic & Modular Arithmetic [i. Cryptarithmic, 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.
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/>

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 practicals): 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:

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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.

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)

	<ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> list the process variables in fermentation. (L1) control process parameters in fermentation. (L3) control operation of bioreactors using computers. (L3)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> analyse process controls and their applications (L4) assess the dynamics of first and higher order systems. (L4) evaluate the stability of controllers used in process industry (L5) understand the functioning of different controllers. (L2) Apply control systems for bioreactor operation
Text Books:	
	<ol style="list-style-type: none"> Process Systems Analysis and Control, 3rd Edn. S. E. Leblanc, Donald R.Coughanowr, McGraw-Hill Inc., 2009. Stanbury, P.F.A., Whitaker & Hall, Principles of Fermentation Technology, 3/e Elsevier, 2017 <p>Reference Books:</p> <ol style="list-style-type: none"> Seborg, Edgar, Millichamp, Doyle Process dynamics and control, 3/e John Wiley & Sons, 2010 Biochemical engineering fundamentals, Bailey and Ollis. 2nd Ed. 1986. McGrawHill.

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	3	2	1	2	2	2	2	2	2	3	2	2
Avg	3.0	2.0	2.0	3.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	3	2	2

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:	
	<ol style="list-style-type: none">1. D. <u>Mukund</u>, B. <u>Nitin</u>, Process Dynamics Laboratory, LAP Lambert Academic Publishing, 2011.2. D.R. Coughnowr, S.E. LeBlanc, Process Systems Analysis and Control, 3/e, McGraw- Hill.

19EBT302: BIOSEPARATION TECHNOLOGY

L T P C
2 0 2 3

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • 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
<p>Overview of bioseparation, 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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Separation of cells and other insolubles from fermented broth: Sedimentation, filtration (pretreatment, filtration theory, continuous rotary filters), microfiltration, ultrafiltration, centrifugation (batch, continuous and basket), Precipitation.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Extraction: Phase separation and partitioning equilibria, liquid-liquid extraction methods, reciprocating-plate column, centrifugal extractor. Adsorption: Theory of adsorption, adsorption isotherms, industrial adsorbents, adsorption types. Chromatography: ion-exchange, column chromatography.</p>	

Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • explain adsorption isotherms. (L2) • list different unit operations for biochemical product recovery. (L1) • Describe the extraction of biochemical products • understand the principles involved in chromatography techniques (L2)
Unit- IV	8 hrs
<p>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.</p> <p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand the principles 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
<p>Product recovery: Ethanol, Citric acid, Penicillin, Enzyme, Insulin.</p> <p>Economics of Bioproducts.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • describe the various methods for the purification of recombinant proteins. (L1) • list unit operations for biochemical product recovery. (L1) • design equipment for the separation and purification of bioproducts (L6) • create process flow sheet (L5) • Estimate the cost requirements of downstream processing(L5)
Text Books:	
	<p>1. P.A. Belter, E.L. Cussler & Wei-Shou Hu, Bioseparations: Downstream Processing for Biotechnology, Wiley-Interscience. 2012.</p>
References:	
	<p>1. R.G. Harrison, P. Todd & S.R. Rudge, Bioseparation Science and Engineering, Oxford University Press, 2006.</p> <p>2. McCabe, Smith & Harriot, Unit Operations of Chemical Engineering, 7th edition McGraw Hill book company, 2014.</p> <p>3. J.A. Asenjo. Separation Processes in Biotechnology, CRC Press, 1990.</p>

Bioseparation 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.**

Reference:

- 1. R.G. Harrison, P. Todd & S.R. Rudge, Bioseparation Science and Engineering, Oxford University Press, 2006.**
- 2. S. Sadasivam & A. Manickam. Biochemical Methods, 3rd edition, New age publisher, 2009.**

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, components (cognitive, behavioral and affective), attitude formation and attitude change.	
Unit- V	8 hrs
Ethical Living: Needs of life, materialistic and non-materialistic, qualitative and quantitative, harmony in living, self (physical and mental well being), 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:	
	<ol style="list-style-type: none"> 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 Tathagatananda, 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/Values-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

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:

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**

19EBT433: PLANT BIOTECHNOLOGY

L T P C
2 0 2 3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<p>Callus and cell culture system- isolation, culture, growth, viability and applications, Secondary</p>	

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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 <i>Agrobacterium</i> gene transfer, , viral vectors, Chloroplast transformation, Gene Silencing-RNA editing, Field techniques for transgenic plants.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 constrains, legal and ethical issues of GM crops (L1)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • apply fundamental knowledge of in vitro plant propagation in laboratory and industry (L2) • Develop protocols for large scale micropropagation system, germplasm conservation, virus elimination (L3) • Explain screening and selection of haploids, somatic hybrids, and other variants for biotic and abiotic resistance (L2) • Improvise secondary metabolites through selection and genetic transformation (L3) • calculate the cost of tissue cultured plant and the enterprises (L5) • Undertake higher education and research as career in Plant Biotechnology (L5)

Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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 Ricroch, 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.

19EBT403: ANIMAL BIOTECHNOLOGY

L T P C
2 0 0 2

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • 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
<p>Unit- I</p>	<p>8 hrs</p>
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).
<p>Unit- II</p>	<p>8 hrs</p>
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).
<p>Unit- III</p>	<p>8 hrs</p>
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • recall the cell culture reactors (L1). • summarize the scale-up and complexity (L2).

	<ul style="list-style-type: none"> explain the different reactors (L2). 	
Unit- IV		8 hrs
Organ culture and tissue engineering: Organ cultures, histotypic 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:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> explain the production various transgenic animals (L2). summarise animal cloning (L2). explain biopharming and gene knockout technologies (L2). 	
Course Outcomes:		
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> learn Basic techniques of cell, tissue and organ culture. outline cell culture reactors Explain the organ culture and tissue engineering Discuss the production of transgenic animals explain the production various transgenic animals 	
Text Books:		
	<ol style="list-style-type: none"> Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002 Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997. 	
References:		
	<ol style="list-style-type: none"> Freshney, R.I., "Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications", 6th Edition, John Wiley & Sons, 2010. Portner, R., "Animal Cell Biotechnology: Methods and Protocols", 2nd Edition, Humana Press, 2007. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000. 	

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

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:

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

- 3 Hours per week

Pedigree Analysis

Computational Skills

Databases: Introduction to SQL

Web Development: Introduction to HTML

Software for Bibliography and Scientific paper writing.

Essential Biotechnology Journals & Databases

Online & Offline Databases for Biochemical engineering & Biotechnology data and tables

Student should be able to locate information related to enthalpy, boiling points, Young's modulus, publicly available microbial strains, publicly available cell lines, biosafety guidelines, etc.

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 Programmes 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
 - Analyse the contemporary issues and connect it with Gandhian solutions
 - Analyse 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 Blackswan.
3. Gandhi, M K. (1941). Constructive Programme. Ahmadabad: Navjivan Publishing House
4. Gandhi, M. K. (1948). The Story of My Experiments with Truth. Ahmadabad: Navjivan Publishing House.
5. Gandhi, M K. (1968). Satyagraha in South Africa. Ahmadabad: Navjivan Publishing House.
7. Hardiman, David. (2004). Gandhi in His Times and Ours: The Global Legacy of His Ideas. New York: Columbia University Press.

Journals

8. Gandhimarg, Gandhi Peace Foundation, New Delhi.
9. GITAM Journal of Gandhian Studies, GITAM University, Visakhapatnam.

19EBT242: INDUSTRIAL FERMENTATION TECHNOLOGY

L T P C
2 0 2 3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>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..</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<p>Production of primary metabolites: Production of organic acids: citric acid, acetic acid and lactic acid.</p> <p>Production of amino acids: L-glutamic acid and Lysine.</p> <p>Production industrial solvents and fermented beverages: ethanol, beer and wine.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> explain the production of fermented milk foods.(L2) Identify the differences in the production of milk and vegetable fermented foods. (L3) Analyse 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 <ul style="list-style-type: none"> 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)
Course Outcomes:	
	After the completion of the course the student should be able to <ul style="list-style-type: none"> understand the scope and importance of fermentation technology (L1) distinguish between methods for production of primary and secondary metabolites (L2) describe applications of recombinant DNA technology for pharmaceutical production (L1)
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, Prescott 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
12. Production of amylase

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 signalling 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Understand the intra-cellular signalling cascades (L2) • Explain the crosstalk between signaling pathways (L2) • Explain role of transporters in cell signalling (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 <ul style="list-style-type: none"> • 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 durataxis, Cell locomotion, cell migration and homing.	
Learning Outcomes:	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Describe cytoskeletal molecules and their interaction (L2) • Explain the cell junctions (L2) • Explain the mechanism of cell locomotion (L2)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Understand the energetics of cell metabolism • Understand the concepts of Ion gradients and Voltages in cells • Impart knowledge of inter and intracellular communications • Describe cellular locomotion (L2) • apply thermodynamic principles to biological systems. (L2) • analyze biological processes at the reductionistic level. (L4) • appreciate the potential of recombinant DNA technology. (L2)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 1. Francisco V. Sepiilveda 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:

19EBT244P	Advanced Cell Biology Lab	
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

19EBT246: FOOD SCIENCE AND TECHNOLOGY

L T P C
2 0 2 3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none">• 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
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none">• 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
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none">• 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
<p>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</p>	

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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 <i>Alimentarius</i> / 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • describe nutraceuticals for disease control (L1) • describe formulation of nutraceuticals (L1) • understand the manufacturing aspects of nutraceuticals (L1)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • understand the scope and importance of food processing (L1) • design modules for filtration processes in food industry (L5) • formulate food products based on customer demand (L4)
Text Books:	
	<ol style="list-style-type: none"> 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. G. V. Barbosa-Canovas, M. Tapia and M. P. Cano, (eds.), Novel Food Processing Technologies. CRC Press, 2005.
4. J. Shi, (ed.), Functional Food Ingredients and Nutraceuticals: Processing Technologies, CRC, 2006.
5. J. R. Nesser and B. J. German, Bioprocesses and Biotechnology for Nutraceuticals, Chapman and Hall, 2004.

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

19EBT248: BIOPHYSICS

L T P C
3 0 0 3

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • 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
<p>Unit- I</p>	<p>8 hrs</p>
<p>Bioenergetics: Marcus theory of electron transfer. Photophysics of chlorophylls and carotenoids: MO model for the electronic states. Huckel approximation. Energy transfer in photosynthetic systems. Proton transfer in bacteriorhodopsin. Molecular basis of human photoreception and Mechano-electrical transduction.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand the electronic structure of chlorophyll and carotenoids (L2) • Apply Huckels MO theory to explain properties of carotenoids (L3)

	<ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Neurobiophysics: 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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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</p>	

diagnostics. Superparamagnetic iron oxide nanoparticles and their theranostic applications.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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

19EBT340: AI and ML for BioEngineers

L T P C
3 0 0 3

The progress of modern biology and medicine is closely linked to acquisition and analysis of massive amounts of data. Machine learning and Artificial Intelligence have proven their ability to utilize available biological data to facilitate inferential studies. In addition, the tools of Machine Learning and Artificial Intelligence have the potential to assist in the design and synthesis of complex biomolecules, pathways, gene circuits and even entire organisms. This course starts with a review of the fundamentals of AI and ML and provides an insightful overview of the diverse applications of AI and ML in Bioengineering.

Course Objectives:

- Explain the concepts of automated reasoning and planning (L2)
- Compare methods for machine learning (L4)
- Describe applications of AI & ML in biomedicine (L1)
- Explain the utility of AI & ML for protein structure prediction & drug design (L1)
- Describe potential applications of AI & ML for the synthesis of drugs and the design of living organisms (L1)

Unit- I: Artificial Intelligence

10 hrs

Intelligent agents and Expert systems. Knowledge representation. Automated Reasoning. Perception and Action. Planning. Propositional logic. First order logic. Fuzzy sets, Fuzzy logic and Fuzzy inference. Fuzzy relations. Fuzzy relations between symptoms and diseases.

Learning Outcomes:

- | | |
|-----------------------------------------------------------------|----|
| After completing this unit, the student will be able to | L1 |
| • Understand the concept of Intelligent agents | L1 |
| • Understand the principles of automated reasoning and planning | L1 |
| • Predict diseases using fuzzy relations | L3 |

Unit- II: Machine Learning

10 hrs

Learning association, classification and regression. Nonparametric models. Principal component analysis. Support vector machines. Unsupervised clustering. Self organizing maps. Artificial Neural Networks. Rosenblatt's perceptron convergence theorem. Back propagation learning algorithm for multilayer feed forward Neural Network.

Learning Outcomes:

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--|
| After completing 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 (L5) | |
| • select optimal machine learning method (L3) | |

Unit- III: Biomedical Applications

8 hrs

Diagnostics, Biometrics and Forensics. AI & ML for biomedical image recognition and classification. Clinical Decision Support systems based on Biomedical Images, Molecular markers and Genome sequence data. Computer assisted surgery. Smart prosthetics. Brain-Machine interface.

Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand utility of machine learning for Biomedical Image classification L1 • Understand the utility of machine learning for Biomedical marker analysis L1 • Describe the role of AI in clinical decision support systems L1
Unit- IV : Bioinformatics & Pharmacoinformatics	9 hrs
Applications of AI & ML in Structural Genomics and Functional Genomics. Machine learning for metagenomics. AI & ML for Protein function prediction, Protein structure prediction and Drug Design.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand the role of AI & ML in Genomics L1 • Understand the role of AI & ML in protein structure and function prediction L1 • Understand the role of AI & ML in Drug Design L1
Unit- V : Synthetic Biology	8 hrs
AI & ML for retrosynthesis of drugs. Metabolic pathway engineering. Design & inference of signaling networks. Potential applications of AI & ML for gene circuits, Genomic engineering and Organism design	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand the utility of AI & ML in retrosynthesis of drugs L1 • Describe utility of AI & ML in studies of cellular pathways, networks and gene-circuits L1 • Understand the potential of AI & ML for Genomic engineering and Organism Design L1
Course Outcomes:	
	<p>After completing this unit, the student will be able to:</p> <ul style="list-style-type: none"> • Understand and apply the concepts of planning, logic and inference (L1) • Understand and apply the basic concepts of classification and decision theory (L2) • Describe applications of AI & ML in clinical decision support systems (L1) • Describe applications of AI & ML in Bioinformatics & Pharmacoinformatics (L1) • Describe applications of AI & ML in the design of biochemical synthetic pathways, metabolic pathways and gene circuits (L1)

AI & ML FOR BIOENGINEERS 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

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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • describe methods for solid waste management (L1) • compare advantage of disadvantages of biofertilizers (L3)
Unit- V	8 hrs
Biodegradation and bioremediation- <i>In situ</i> and <i>ex situ</i> 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 <ul style="list-style-type: none"> • describe principles and applications of biodegradation (L1)

	<ul style="list-style-type: none"> • describe principles and applications of bioremediation (L1) • explain potential of genetically engineering microbes for bioremediation (L2)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • describe methods for biomonitoring of pollution (L1) • describe principles and methods for biological treatment of waste water (L1) • describe methods for solid waste management (L1) • describe principles and applications of biodegradation and bioremediation (L1) • explain potential of genetically engineering microbes for bioremediation (L2)
Text Books:	
	<ol style="list-style-type: none"> 1. M.H. Fulekhar, Environmental biotechnology, 2017, CRC publishers 2. U. Satyanarayana, Biotechnology, 1st Edition, Books and Allied (P) Ltd, 2005
References:	
	<ol style="list-style-type: none"> 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

List of experiments for Environmental Biotechnology Lab

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

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 cytogenomics.

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:

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Learn about applications of genome engineering (L5) • Role of genomic engineering in human genetics (L5) • Ethical issues related to genome engineering (L5)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Be familiar with concepts of genomics and genomic engineering • Be familiar with the techniques that are available for the genome engineering • Design CRISPR based editing tools for the target gene of interest
Text Books:	
	S.B. Primrose and R.M. Twyman, Principles of gene manipulations and genomics, 7/e, Blackwell publishing, Oxford, U.K. 2006.
References:	
	<ol style="list-style-type: none"> 1. T.A. Brown, Genomes, 3/e, Garland Science, 2006. 2. A.M. Campbell and L.J. Heyer, Discovering Genomic, Proteomics and Bioinformatics, 2/e, Benjamin Cummings, 2006.

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

19EBT346: BIOTECHNOLOGY OF FERMENTED FOODS

L T P C
2 0 2 3

<p>Fermentation is one of the most common and efficient methods for preservation and flavour 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.</p>	
<p>Course objectives:</p>	
	<ul style="list-style-type: none"> • Describe the microbes important for fermentation, their growth and metabolism • Explain food spoilage, food borne diseases and preservation methods • Explain the role of microbes in food fermentations, types of fermentations, controls and kinetics, and waste treatment. • Describe production of different fermented foods. • Describe production of acids, alcoholic beverages etc.,
Unit- I	8hrs
<p>Microbial growth in food: Microorganisms in foods: Bacteria, moulds, 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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Identify, group the microorganism associated with foods (L2). • Understand the factors responsible for growth of microorganisms (L2) • Explain metabolic activities of microorganisms(L2)
Unit- II	8hrs
<p>Microbial spoilage and its effects on food: Contamination, Preservation and Spoilage of different kind of foods, cereals, 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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand the factors responsible for microbial spoilage of different foods (L2) • Apply principles of preservation to different foods(L3) • Make use of biosensors for monitoring food fermentations(L3)
Unit- III	8hrs
<p>Introduction to fermentation: microbes and food fermentations, measurement and control in fermentation, Substrate utilization and product formation. Fermenter design, Aeration and agitation in fermentation: Types of fermentation: sub-merged and solid state. Batch and continuous fermentation, scale up in fermentation. Product recovery. Biological waste treatment and plant sanitation.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Describe different fermenters used for fermented food production(L2)

	<ul style="list-style-type: none"> • Understand fermenter design, operation, controls, kinetics and scaling up(L2) • Make use of biological methods of waste treatment(L3)
Unit- IV	8hrs
Fermented food: origin, scope and development, saurkraut, youghurt, cheese, miso, tempeh, idli, dosa. Regulatory and social aspects of biotechnology of foods, application of enzymes in food industry, production of food flavour, colour, enzymes, Immobilised enzymes.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Apply technologies to produce fermented foods and enzymes(L3). • Apply regulatory and social aspects of production of fermented foods(L3)
Unit- V	8hrs
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.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Illustrate the production of alcohol and other products of importance (L2) • Apply quality and safety protocols for fermentation processes and for product recovery(L3).
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Identify the microorganisms associated with foods, their growth and metabolism • Understand food spoilage and preservation techniques • Describe the fermenters used for production of fermented foods- design, types and kinetics. • Understand and develop fermented foods • Understand production processes of alcoholic beverages and other important products
Textbooks:	
	<ol style="list-style-type: none"> 1. Hutkins, R.W., Microbiology and Technology of Fermented Foods, 2006, 500pp. Blackwell Publishing. 2. Montet, D., Ray, R. C., Fermented Foods, Part I, Biochemistry and Biotechnology, 2015 1st Edition, CRC press 3. Stanbury, P.F., Whitaker, A. and Hall, S.J., Principles of Fermentation Technology, 1995. 350pp. Butterworth-Heinemann Ltd.
References:	
	<ol style="list-style-type: none"> 4. Prescott, L., Klein M. D. A. and Harley, J. P., Microbiology, 7/e, 2008, McGraw Hill.

EBT346P: 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 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 to 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.

Course Outcomes:

	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> ▪ handle to laboratory equipment ▪ differentiate various types of bacterial groups important commercially ▪ produce different fermented products ▪ analyze the products for their quality and suitability for consumption ▪ plan and execute production of fermented food products
Text Books:	
	<ol style="list-style-type: none"> 1. <u>Aneja</u>, 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:	
	<ol style="list-style-type: none"> 1. James G Cappuccino and Natalie Sherman, Microbiology, A laboratory manual, 10/e, Benjamin Cummings, 2013.

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)

	<ul style="list-style-type: none"> • Percieve the potential of marine food web.(L5) 	
Unit- IV		8 hrs
<p>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.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:		
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:		
	<ol style="list-style-type: none"> 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:		
	<ol style="list-style-type: none"> 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

19EBT354: PROTEOMICS AND PROTEIN ENGINEERING

L	T	P	C
2	0	2	3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> describe applications of protein engineering for bioanalytical applications (L1) describe applications of protein engineering in environmental biotechnology (L1) describe applications of protein engineering for biopharmaceutical applications (L1)
Course Outcomes:	
	After the completion of the course the student should be able to <ul style="list-style-type: none"> describe methods for obtaining proteomic data (L1) list applications of proteomics (L1) summarize the methods used for engineering of proteins (L2)

	<ul style="list-style-type: none"> describe applications of protein engineering (L1)
Text Books:	
	<ol style="list-style-type: none"> R. Twyman. Principles of proteomics. 2nd edition. Garland Science. 2013. A.Rees M.J.E.Sternberg and R.Wetzel. Protein Engineering. Oxford University Press. 1993.
References:	
	<ol style="list-style-type: none"> S.R.Pennington and M.J.Dunn. Proteomics: From Protein Sequence to Function. Garland Science. 2001. Stefan Lutz, Uwe Theo Bornscheuer. Protein Engineering Handbook. Vol. 3. Wiley. 2013 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

19EBT356: FOOD PROCESSING TECHNOLOGY

L T P C
2 0 2 3

<p>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.</p>	
<p>Course Objectives:</p>	
<ul style="list-style-type: none"> • describe the scope and importance of food processing (L2) • describe the application of membrane technology (L2) • demonstrate design of filter module (L5) • describe principles of formulation of food products (L3) • describe the benefits of nutraceuticals (L2) 	
Unit- I	6 hrs
<p>Properties and processing theory of foods, Size reduction theory, Material transfer phenomena of foods, Effects of processing on nutritional properties and sensory characteristics, Food additives and its impacts on food safety, Principles of food processing, Processing of Food Commodities for high, medium and low moistures food, Theory and equipment of membrane technology for food, Microfiltration for food components separation and clarification, Ultrafiltration for protein concentration, Reverse osmosis processes for water quality.</p>	
<p>Learning Outcomes:</p>	
<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	6 hrs
<p>Thermal food processing: Concepts 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. Effect of heat on nutritional and sensory characteristics, mechanism of microbial inactivation by thermal processing techniques.</p>	
<p>Learning Outcomes:</p>	
<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	6 hrs
<p>Non-thermal food processing: Concept and principles of non-thermal food processing, Hurdle technology for food preservation and processing Theory, equipment and application of High pressure processing (HP) and ultrasonic processing.</p> <p>Preservation of foods by pulsed light technology. Food Irradiation, technology of food irradiation, and effect of irradiation on food borne microbial pathogens. Ionizing Radiation sources. Mechanism of microbial inactivation.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	6 hrs
<p>Food safety and good manufacturing practice, , 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 Alimentarius, HACCP, and ISO 9000; Package principles, Controlled-or-modified-atmosphere storage and packaging, Deteriorative changes in foodstuff in packed food, Packaging methods for protection from deterioration, Approaches for enhancing. Shelf life of packaged foodstuff.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	6 hrs
<p>Nutraceuticals and functional foods: Definition, Classification of nutraceuticals, health benefits of nutraceuticals, Spirulina, Ginseng , Lycopene, Microbes as nutraceuticals, Probiotics, Prebiotics. Functional foods, Different cereal products.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • understand the scope and importance of food processing. (L2) • understand the application of membrane technology (L2)

	<ul style="list-style-type: none"> • design the filter module for long stability of filtration process (L5) • formulate food products based on modern customer demand. (L3) • understand the benefits of nutraceuticals (L2)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none">● 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
<p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none">● 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
<p>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)</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none">● 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> ● 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> ● 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> ● 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.

Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> ● explain drug development, pharmacokinetics and pharmacodynamics (L2) ● summarize dosage forms in drug delivery (L2) ● explain the various process involved in bulk production with a case study(L2) ● summarize drug screening method and applications of marine natural products(L2) ● apply GMP and ICH guidelines in purification of drug (L3) ● appreciate the importance of regulatory aspects of drug production (L5)
Textbooks:	

	<ol style="list-style-type: none"> 1. D.M. Brahmkar and Sunil B. Jaiswal 2019 Biopharmacutics 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:	
	<ol style="list-style-type: none"> 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.

Course Outcomes:

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

- prepare recombinant protein product
- preparation of tablets, capsules, ointments, and liquids
- extraction of bioactive compounds from plants
- separate amino acids, sugars and proteins by chromatography separate proteins by electrophoresis

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. Saunders & Co., London, 2009.

References

1. Modern Pharmaceutics by Gilbert S. Banker & C.T. Rhodes, 3rd edition.

19EBT360: PHYSIOLOGY AND CLINICAL BIOCHEMISTRY

L T P C
2 0 2 3

The physiology is the study of life. It asks questions about the internal workings of organisms and how they interact with the external world. It generates information on how organs and systems within the body work, how they communicate, and how they combine their efforts to make conditions favourable for survival of the human. It includes various systems such as nervous, circulatory, respiratory etc. This paper also includes Clinical Biochemistry is the division of laboratory medicine that deals with the measurement of chemicals (both natural and unnatural) in blood, urine and other body fluids. These test results are useful for detecting health problems, determining prognosis and guiding the therapy of a patient.

Course Objectives:

- Introduce the Physiology of human internal organs and systems
- Impart knowledge of nervous, muscular, circulatory and respiratory systems
- Summarize maintenance of clinical laboratory.
- Composition of blood, plasma associated disorders and digestive system disorders.
- CSF, kidney, liver functions tests and endocrine disorders

Unit- I :

8 hrs

Physiology of the Central Nervous System: General design, major levels of CNS function, synapses and synaptic transmission. Physiology of the musculoskeletal system: General and molecular basis of muscle contraction, excitation - contraction coupling, muscle action potential, neuromuscular junction.

Learning Outcomes:

- At the end of this unit, the student will be able to
- explain general design and major levels of CNS (L2).
 - explain Synapse and synaptic transmission (L2).
 - explain General and molecular basis of muscle contraction (L2).
 - understand the excitation-contraction coupling and muscle action potential (L2).

Unit- II:

8 hrs

Physiology of the Cardiovascular system: Specialized excitatory and conduction system of heart, cardiac cycle, heart valves, heart sounds and heart pumping. Characteristics of normal ECG, vectorial analysis of normal ECG, Cardiac arrhythmias, and ECG interpretation. Physiology of respiratory system: mechanics of pulmonary ventilation, transport of oxygen and carbondioxide in blood and tissue fluids.

Learning Outcomes:

	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • explain specialized excitatory and conduction system of heart (L2). • explain events of cardiac cycle (L2). • introduction ECG and variations in ECG(L2). • explain mechanics of pulmonary ventilation, transport of oxygen and carbon dioxide (L2). 	
Unit- III		8 hrs
<p>Maintenance of Clinical laboratory, Collection and preservation of samples and sampling methods. Composition of Blood, Serum, and Plasma. Digestive system disorders: functions and methods of evaluation, Pancreatic exocrine functions, and methods of evaluation. Plasma proteins: properties, functions, variations during disease. Plasma lipid and lipoproteins, variations during disease.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • explain various requirements for establishing and maintenance of clinical laboratory (L2) • explain collection and preservation samples in clinical laboratory (L2) • explain digestive system and pancreatic system functions and their disorders (L2) • explain plasma proteins, plasma lipoproteins functions and their variation during disease. (L2). 	
Unit- IV		8 hrs
<p>Cerebrospinal fluid: Functions and their variation in diseases. Kidney: Function and composition of urine, investigation of renal disorders. Liver: Liver functions and function tests, Liver diseases: Jaundice, Hepatitis, Gallstones, Cirrhosis, and fatty liver. Clinical enzymology: Isoenzymes in health and disease.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • appraise the functions and variations of CSF in disease (L2) • explain kidney, liver functions and their disorders (L2) • explain the importance of isoenzymes in health and disease (L2) 	
Unit- V		8 hrs
<p>Endocrine disorders of pancreas: Diabetes mellitus, Hypoglycaemia and Glucose tolerance tests, Thyroid: Hypo and Hyperthyroidism, BMR and tests for thyroid functions.</p>		
Learning Outcomes:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • explain clinical characters of diabetes mellitus (L2) • outline the principles & processes of Hypoglycemia and GTT (L2) • explain hypo and hyperthyroidism, tests of thyroid functions (L2). 	
Course Outcomes:		

	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • explain important physiological systems of human (L2) • summarize various disorders associated with physiological systems (L2) • apply clinical evaluation tests to identify the various disorders (L3) • explain the importance of clinical biochemistry lab (L2).
Text Books:	
	<ol style="list-style-type: none"> 1. J. E. Hall and A. C. Guyton, Guyton and Hall, Textbook Of Medical Physiology, 12/e, Saunders Elsevier, 2011. 1. R. Chaterjee, Text book of Medical Biochemistry, 8/e, JP Medical Limited, 2012. <p>References 1. C. A. Burtis, E. R. Ashwood, Teitz, Fundamentals of Clinical Chemistry, 6/e, Elsevier, 2008.</p>
References:	
	<ol style="list-style-type: none"> 1. Dee Unglaub Silverthorn Human Physiology: An Integrated Approach, 7/e Pearson, 2014, 978-0321981226, USA. 2. Barrett, 2016 Ganong's review of medical physiology 25/e, McGraw Hill Education, 2016, 978-9339223281

PHYSIOLOGY AND CLINICAL BIOCHEMISTRY LAB

This laboratory course provides knowledge and hands on experience in physiology and clinical biochemistry to the students. The student will be able to learn how to collect the samples from patients and how to store the sample and how to analyze the samples for various clinical disorders like blood glucose associated disorders, general disorders of blood, plasma proteins etc.

Course Objectives:

This laboratory aims to

- Provide concepts in clinical biochemistry lab and collection and preservation samples, estimation of blood glucose, hemoglobin, ESR, clotting time, lipid profile, SGOT, SGPT bilirubin, heart rate, blood pressure etc.

Perform any 8 Experiments

1. Collection and preservation of clinical samples.
After completion of this experiment, the student will be able to collect the samples and their preservation.
2. Estimation of blood glucose by enzymatic method
After completion of this experiment, the student will be able to estimate the blood glucose levels in the given samples.
3. Estimation of hemoglobin
After completion of this experiment, the student will be able to estimate the hemoglobin levels.
4. Erythrocyte sedimentation rate (ESR)
After completion of this experiment, the student will be able to estimate the ESR.
5. Estimation of Fibrinogen in plasma
After completion of this experiment, the student will be able to estimate the fibrinogen levels in plasma.
6. Prothrombin time/ clotting time.
After completion of this experiment, the student will be able to estimate the blood clotting time.
7. Total proteins, albumins and globulins
After completion of this experiment, the student will be able to estimate the total proteins, albumins and globulins in the given blood sample.
8. Lipid profile
After completion of this experiment, the student will be able to estimate TG, LDL and VLD present in the blood.
9. Determination of Uric acid in serum
After completion of this experiment, the student will be able to estimate the uric acid levels in the given serum.
10. Measurement of Blood pressure
After completion of this experiment, the student will be able to measure the blood pressure.
11. Measurement of heart rate.
After completion of this experiment, the student will be able to measure the heart rate.
12. Determination of serum bilirubin
After completion of this experiment, the student will be able to estimate the serum bilirubin levels.
13. Determination of SGOT
After completion of this experiment, the student will be able to estimate the SGOT levels.
14. Determination of SGPT
After completion of this experiment, the student will be able to estimate the SGPT levels.
15. Qualitative tests and microscopic examination of urine

After completion of this experiment, the student will be able to qualitative test on urine to identify various components.

Course Outcomes:

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

- collection and preservation of blood samples
- estimate blood glucose, hemoglobin, ESR and fibrinogen and clotting time etc.
- measure heart rate and blood pressure
- measure serum bilirubin, SGOT, SGPT

Text Books:

3. Practical Clinical Biochemistry by Harold Varley.
4. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, IKI Pvt. Ltd
5. Cell Death techniques; A Laboratory Manual by Rickey John Stone and John Silke, Cold spring Harbor Press
6. R P Jayaswal, Clinical Biochemistry-Student's Laboratory Manual 1/e, 2019, Notion Press; 1st edition

19EBT441: BIOPROCESS PLANT DESIGN

L T P C
2 0 2 3

Preamble: The chemical engineering principles are utilised in life sciences for the industrial production of biotechnology products. These mass production demands the design of bioprocesses. This course was designed to apply the knowledge of Biochemical engineering, Bioprocess engineering and downstream processing learnt in previous semesters to design a complete bioprocess plant for the large scale production of biotech products.

Course Objectives:

The objective of the course is to

1. Acquire basic understanding of design parameters, procedures for commonly used process equipment.
2. Perform preliminary design of bioprocess plant.
3. Demonstrate downstream process equipment and facility design aspects.
4. Implement simulation software in designing process flow sheet and equipment .

Unit- I	6 hrs
General design information; Material and energy balance calculations; Process flowsheeting.	
Unit- II	6 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	6 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	6 hrs
Facility design: Utility supply; Equipment cleaning; Cell culture banks; cGMP guidelines; Validation; Safety.	
Unit- V	6 hrs
Pilot plant design; Fermenter design calculations (simulations), downstream processing calculations, environmental and economic considerations.	
Course Outcomes:	
At the end of the course, students are able to	
<ul style="list-style-type: none">• apply engineering principles to design unit operations in bioprocess plant.• design and evaluate a suitable unit operation and equipment in a bioprocess plant.• apply modern simulation software to solve unit operations.• design process flow diagram (PFD) for bioprocess plant.	

Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

Learning Outcomes

Unit- I

At the end of the unit, students are able to

- Understand the design concepts
- Perform the material balance calculations
- Perform energy balance calculations
- Draw process flow sheet
- Incorporate material and energy balances into the process flow sheet

Unit- II

At the end of the unit, students are able to

- Understand the requirements for bioprocess design
- Know the factors required for scaleup
- Perform the scaleup of bioreactors from lab to commercial scale
- Perform the scaleup of absorption equipment
- scaleup the downstream equipment from lab to commercial scale

Unit- III

At the end of the unit, students are able to

- Understand the specifications required for bioprocess equipment
- Select the equipment for bioprocess design
- Design the mechanical aspects of bioreactors
- Incorporate the sterility requirements into the equipment
- Follow SIP practices in bioprocess plant design

Unit- IV

At the end of the unit, students are able to

- Understand the various utilities required for the design of bioprocess Plant
- Select the method of cleaning for bioprocess equipment
- Operate and maintain the cell culture banks
- validate the bioprocess equipment
- Follow CIP practices in bioprocess plant design

Unit- V

At the end of the unit, students are able to

- Understand the design of pilot plant
- Calculate the fermenter design calculations

Calculate the downstream equipment design calculations
Consider environmental aspects into bioprocess plant design
Consider economic aspects into bioprocess plant design

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

19EBT443: METABOLOMICS AND METABOLIC ENGINEERING

L T P C
2 0 2 3

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • 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
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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).</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
<p>Learning Outcomes:</p>	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Calculation of theoretical yield. Amino acid production by glutamic acid bacteria, metabolic engineering of lactic acid bacteria, riboflavin production by <i>Bacillus subtilis</i>, metabolic engineering of <i>Saccharomyces cerevisiae</i>.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • describe methods for identification and quantification of metabolites (L1) • summarize methods for control of metabolic pathways (L2) • calculate flux control coefficients and theoretical yields (L3) • explain the principles of metabolic engineering (L4) • describe the applications of metabolic engineering (L1)
Text Books:	
	<ol style="list-style-type: none"> 1. Eberhard Voit. A First Course in Systems Biology. Edition 2. Garland Science, 2017. 2. G.N. Stephanopoulos, A.A. Aristidou, J. Nielsen, Metabolic engineering. Principles and Methodologies, Academic Press, Elsevier, 1998.
References:	
	<ol style="list-style-type: none"> 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

The sea and dairy food are major components of the food processing industry with specialized requirements. This course describes the methods used for food processing and food quality assessment applicable to sea and dairy foods.

Course Objectives:

- Describe the scope and importance of sea and dairy food processing. (L2)
- describe milk processing technology (L1)
- introduce unit operations in sea and dairy food processing (L3)
- describe the processing technology for production of butter and cheese (L1)
- describe the regulations pertinent to the sea and dairy food industries

Unit- I

6 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.

Learning Outcomes:

After completing this unit, the student will be able to

- Apply the principles of preservation (L3)
- Select a method for preservation based on scientific principles (L3)
- Describe the methods of preservation (L1)

Unit- II

6 hrs

Milk processing: Fluid milk processing, packaging and distribution. Common dairy processes: cream separation (standardization), pasteurization, sterilization and homogenisation. 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.

Learning Outcomes:

After completing this unit, the student will be able to

- List milk products (L1)
- Select the optimum method for preservation of milk (L3)
- Describe the methods of milk processing (L1)

Unit- III

6 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 vapour compression.

Mechanism of moisture removal in solid and liquid foods during drying. Spray, freeze, roller tray and through-flow drying operations.

Learning Outcomes:

After completing this unit, the student will be able to

- Estimate freezing time of food materials (L3)
- Describe the methods of moisture removal (L1)
- Select the optimum method for removal of moisture (L3)

Unit- IV

6 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.

Learning Outcomes:

After completing this unit, the student will be able to

- Describe the principles of particle size separation (L1)
- Describe the mechanical methods used food processing (L1)
- Select the optimum method for size separation (L3)

Unit- V

6 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 causes, 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.

Learning Outcomes:

After completing this unit, the student will be able to

- Describe the production of butter (L1)
- Describe the production of cheese (L1)
- Select the optimum method for novel product development (L3)

Course Outcomes:

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

- understand the scope and importance of sea and dairy food processing. (L2)
- understand the application of milk processing technology (L2)
- optimize unit operations in sea and dairy food processing (L3)
- describe the processing technology for production of butter and cheese (L1)
- describe the regulations pertinent to the sea and dairy food industries (L1)

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 Milk Products: Handbook on Process Technology, Modernization for Professionals, Entrepreneurs and Scientists. A Dairy India 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.

19EBT447: MOLECULAR MODELING AND DRUG DESIGN

L T P C
2 0 2 3

Quantum mechanics is the foundation for prediction 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. Huckel'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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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. <i>De novo</i> Protein structure prediction. Conformation and stability of polynucleotides.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> 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)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> recall principles of quantum mechanics and molecular mechanics (L1) utilize computational methods to model molecules (L3) select optimum computational method for binding site prediction (L5) apply computational methods for predicting stability of protein-ligand complex (L2) design drugs (L6)
Text Books:	
	<ol style="list-style-type: none"> Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001. Atkins and Friedman. Molecular quantum mechanics. Oxford University Press. 5th ed. 2011.
References:	
	<ol style="list-style-type: none"> Tamar Schlick. Molecular modeling and simulation: An interdisciplinary guide. 2nd Edition. Springer. 2010. 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

- Molecular graphics for virtual manipulation of molecules
- Molecular graphics for visualization of protein-ligand interactions
- Calculation of potential energy of a molecule
- 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

Course Outcomes:

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

- Utilize molecular graphics for visualization of biomolecules
- Utilize molecular graphics for visualization of biomolecular interactions
- Apply QSAR for predicting molecular properties
- Implement structure optimization for small molecules
- Utilize docking for prediction of binding modes and binding scores

Text Books:

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001.

References

1. Rasmol Reference Manual. <https://www.umass.edu/microbio/rasmol/distrib/rasman.htm>

19EBT451: APPLIED BIOCATALYSIS AND BIOTRANSFORMATION

L T P C
3 0 0 3

Biocatalysts have the potential to catalyze a wide variety of reactions of industrial, pharmaceutical, agricultural and medical significance. They have the potential to enhance reaction rates in mild conditions at low cost using sources that are environmentally friendly. This course provides an overview of the different types of biotransformations, the sources the the biocatalysts as well as their current and potential applications.

Course objectives:

- To describe different types of biocatalysts and their applications
- To classify reaction types of microbial transformations
- To describe redesign of biocatalysts
- To describe commercial lipases and their applications
- To describe the biosynthesis and transformation of alkaloids

Unit- I

8 hrs

General usage of biocatalysts, fermentation and applied biocatalysis. Types of bioconversion reactions, procedures for biotransformations, 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, Carbamoylases, 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 nitrilases, 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 Adlercreutz (Eds.), Applied catalysis, 2/e, Hardwood academic publishers, Taylor and Francis, 2005

Course Outcomes:

At the end of this course the student should be able to:

- Understand the significance of biocatalysts
- classify reaction types of microbial transformations
- discuss the engineering of biocatalysts
- list commercial lipases and their applications
- describe the biosynthesis and transformation of alkaloids

19EBT455: FOOD HANDLING, PACKAGING AND STORAGE

L T P C
3 0 0 3

Course Objectives:	
	<ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p>

	<ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • To understanding long term stored and seasonal food product storage and enhance the shelf life of product • To understanding pest and rodent control
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Designing various food packaging materials and the equipment's used in processing of materials • Select the packaging materials based on their properties and usage. • Apply principles of food processing for efficient packaging with enhanced self-life with implementation of various acts and rules • Specialised and sustainable (environmentally) packaging for end user satisfaction.
Text Books:	
	1.M.J. Kirwan, McDowell, R.Coles, Food packaging technology. Wiley- Blackwell, 2010.
References:	
	<ol style="list-style-type: none"> 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.

19EBT457: MOLECULAR DIAGNOSTICS

	L	T	P	C
	2	0	2	3
<p>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</p>				
Course Objectives:				
<ul style="list-style-type: none"> • 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
<p>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.</p>				
Learning Outcomes:				
<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Molecular techniques: Blotting Techniques, Probes, Probe labelling. Variants of PCR technique, Probe Amplification techniques, Transcription-Based Amplification Systems, SSCP, CSGE, DGGE</p>				
Learning Outcomes:				
<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>				
Learning Outcomes:				
<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<ul style="list-style-type: none"> • 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	
<ul style="list-style-type: none"> • Summarize standards to be followed in molecular diagnostics(L2) • Outline the regulatory issues in molecular diagnostics(L2) • Explain ethical considerations in molecular diagnostics(L5) 	
Course Outcomes:	
<ul style="list-style-type: none"> • Explain the basic techniques useful for molecular diagnostics (L2) • Understand the molecular basis for genetic disorders (L3) • Identify molecular methods of testing genetic diseases (L3) • Describe molecular methods for diagnosis of infectious diseases (L1) • Perceive QC, QA, ethics and regulatory issues pertaining to diagnostics (L4). 	
Text Books:	
<ol style="list-style-type: none"> 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:	
<ol style="list-style-type: none"> 1. G.P. Patrinos, W.J. Ansoerge, 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:

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

- Understand the role of PCR and its variants in disease diagnosis
- Interpret the result of HLA typing in transplantations
- Appraise infectious disease diagnosis
- Discover genetic basis of certain diseases

19EBT459: SYSTEMS BIOLOGY

L T P C
3 0 0 3

<p>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.</p>	
<p>Course Objectives:</p>	
	<p>The objectives of the course are to:</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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</p>	

feed forward loop types. Selection of the feed forward loop network motif.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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) • describe 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 perceptrons. Network motifs in the neuronal network of <i>C. elegans</i> .	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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 Books:	
	<ol style="list-style-type: none"> 1. Uri Alon, An introduction to systems biology. Design principles of biological circuits, CRC Press, 2006. 2. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald. Systems Biology: A Textbook. Edition 2. John Wiley & Sons, 2016.
References:	

	<ol style="list-style-type: none">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 [λ] 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. Cytoscape: Creating Pathways & Networks
5. Cytoscape: Mapping Networks
6. Cytoscape: Data visualization
7. Virtual Cell : Model : reactions
8. Virtual Cell : Model : pathways
9. Virtual Cell : Model : networks
10. Virtual Cell : Simulation

19EBT452: MODELLING AND SIMULATION IN BIOPROCESSES

L T P C
2 0 2 3

Bioprocess mathematical modeling involves the modeling of the dynamic changes of the metabolic rates and their distribution inside the cells with the changes of time and cultivation conditions, as well as the modeling of the dynamic changes of the reaction rates and mass transfer rates as well as the cultivation conditions inside the cell. This course focuses on the principles of process design and analysis of biochemical reactors. These designed reactors are applicable in the production lines of pharmaceutical, biotech and chemical industries.

Course Objectives:

- To study the modeling & simulation techniques of biochemical processes and to gain skills in using process simulators.
- analysis and interpretation of data
- Use research-based knowledge and research methods including design of experiments
- to know the requirements for real time process analytics at the bioreactor
- Parameters involved in the bioprocess
- Simulation of bioprocess

Unit- I

6 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.

Learning Outcomes:

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

- Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines (L3)
- strong foundation about bioreactor design and scale-up. (L4)
- identify problems and seek practical solutions for large scale implementation of Biotechnology (L3)

<ul style="list-style-type: none"> Understand modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems. (L5) 	
Unit- II	6 hrs
<p>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.</p>	
<p>Learning Outcomes:</p> <ul style="list-style-type: none"> Create, select and apply appropriate techniques, resources for modeling (L3) prediction and modeling to complex engineering activities with understanding of the limitations of process (L4) Apply the knowledge of mathematics, science, engineering fundamentals to solve complex engineering problems. (L3) 	
Unit- III	6 hrs
<p>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.</p>	
<p>Learning Outcomes:</p> <ul style="list-style-type: none"> analyze physical and chemical phenomena involved in various process. (L3) develop mathematical models for various chemical processes. (L3) use various simulation approaches. (L4) Simulate a process using process simulators(L5) 	
Unit- IV	6 hrs
<p>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.</p>	
<p>Learning Outcomes:</p> <ul style="list-style-type: none"> 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- V	6 hrs
<p>Hybrid and other modeling techniques: Simulation techniques (numerical methods): Programs based on numerical methods like algebraic equations, Newton_ Raphson method for algebraic convergence, interpolation arbitrary function generation. Programs based on solution of differential equations: Euler method for 1st and 2nd order integration; Fourth order Runge -Kutta 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.</p>	
<p>Learning Outcomes:</p>	

<ul style="list-style-type: none"> • Familiarize the students with numerical methods of solving the non-linear equations (L3) • find approximate roots of the an equation by using different numerical methods (L3) • apply Newton’s forward and backward formulae for equal and unequal intervals (L3) • find integration of a function by using different numerical methods (L3) • inference based on small and large sampling tests using statistical methods (L4) 	
<p>Course Outcomes</p> <p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Understand the kinetics of enzymatic reactions • Assess / Evaluate the tools and techniques for design of bioprocesses • Apply basic programming tools for the modeling of enzymatic/microbial phenomena • Analyze biochemical processes • Visualize results obtained through modeling • Model a bioreactor 	
<p>Text Books:</p>	
	<ol style="list-style-type: none"> 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.
<p>References:</p>	
	<ol style="list-style-type: none"> 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

Stem cells play crucial roles in tissue regeneration and understanding their properties is necessary for tissue engineering applications.	
Course Objectives:	
	<ul style="list-style-type: none"> • Introduce the concepts of self renewal and differentiation of cells • Describe the role of the extra cellular matrix • Describe the biomaterials for cell culture • Introduce the concepts of scaffold design and fabrication • Describe the bioreactors for tissue engineering
Unit- I	
	9 hrs
<p>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.</p> <p>Learning outcomes: After completion of the unit, the student will be able to:</p> <ul style="list-style-type: none"> • Describe the characteristics of stem cells (L1) • Describe the types and sources of stem cells (L1) • Describe the signaling mechanisms that are unique to stem cells (L1) 	
Unit- II	
	9 hrs
<p>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.</p> <p>Learning outcomes: After completion of the unit, the student will be able to:</p> <ul style="list-style-type: none"> • Understand the organization of cells (L1) • Describe the molecular constituents of the ECM (L1) • List the commercially available scaffolds composed of ECM (L1) 	
Unit- III	
	9 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.

Learning outcomes:

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

- Describe natural polymer in tissue engineering applications (L1)
- Describe the models for prosthetic devices (L1)
- Understand the principles of cell tissue mechanics (L1)

Unit- IV

9 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.

Learning outcomes:

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

- Describe bioceramics and degradable polymers for tissue engineering applications (L1)
- Describe the principles of scaffold design (L1)
- Describe methods for scaffold fabrication (L1)

Unit- V

9 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.

Learning outcomes:

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

- Describe principles of 2D and 3D cell culture (L1)
- Understand the functions of bioreactors in tissue engineering (L1)
- Describe bioreactors for tissue engineering applications (L1)

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:

	<ol style="list-style-type: none">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:

	<p>After completion of the course the student should be able to:</p> <ul style="list-style-type: none">• Describe the concepts of self renewal and differentiation of cells• Describe the role of the extra cellular matrix• Describe the biomaterials for cell culture• Understand the concepts of scaffold design and fabrication• Design bioreactors for tissue engineering
--	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

19EBT456: FOOD SAFETY AND QUALITY MANAGEMENT

L T P C
3 0 0 3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>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</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<p>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</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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

	<ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • People can purchase of more variety of food via ensuring the food safety issues • Processed foods can create more marketing opportunity for different food once consumer will secure about food safety issue and quality or food standards • Safe food can enhance the shelf-life of many foods • Processed foods can help to gain more opportunity for investment with foreign currency gain with proving of food safety and hygienic processing conditions • Processed foods can maintain the sensory quality and nutrient contents for customers for long periods
Text Books:	
	<p>1.Ronald H. Schmidt and Gary E. Rodrick, 2003, Food Safety Handbook. A John Wiley & Sons Publication</p>
References:	
	<p>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</p>

19EBT458: NANOBIO TECHNOLOGY

L T P C
3 0 0 3

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>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</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • list novel allotropes of carbon (L1) • understand the relationship between size and properties of nanosystems (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	
<p>Production of nanomaterials: Top down & bottom up strategies. Green synthesis of nanoparticles.</p>	

Self-assembly: Langmuir-Blodgett films. DNA origami.	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • describe the methods for chracterization of bionanomaterials (L3) • compare the methods for chracterization of bionanomaterials (L3)
Unit- IV	8 hrs
<p>Vectors for drug delivery: Liposomes, Micelles and viral capsids. Targeted drug delivery – Nanobioconjugates for receptor targeting and magnetic guidance. Controlled drug release. Nanomaterials for Biomedical imaging: Quantum dots, SPIONs Theranostics.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 theranostics (L4)
Unit- V	8 hrs
<p>Diagnostics and Prognostics: Principles and applications of Nanoarrays and Nanofluidics. Nanopore sequencing of DNA. BioNanomechanics: NanoBiomotors. Mechanics of cilia and flagella. Nanobioelectronics: Nanowires based on DNA. Molecular transistors. Voltage gated ion channels.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • list the unique properties of nanobiomaterials (L1) • describe the applications of nanodevices (L5) • describe the principles and applications of nanopore sequencing of DNA (L5)

	<ul style="list-style-type: none"> • describe the structure and function of nanobiomotors (L1) • describe nanobioelectronic components (L1)
<p>Course Outcomes:</p> <p>After completing this unit, the student will be able to:</p> <ul style="list-style-type: none"> • understand and explain the unique properties of nanomaterials (L1) • compare the methods for fabrication of nanomaterials (L2) • select optimum methods for nanomaterial characterization (L2) • compare drug delivery vectors (L2) • describe the applications of nanobioelectronics (L1) 	
<p>Text Books:</p>	
	<ol style="list-style-type: none"> 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
<p>References:</p>	
	<ol style="list-style-type: none"> 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

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:	
	<ul style="list-style-type: none">• 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 heterocyclic compounds (L-2) • explain the importance of the heterocyclic compounds (L-2)
Unit- III	9 hrs
Drugs and Pesticides	
Introduction	
Antibacterial agents-sulfadugs -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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)

	<ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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)
Course Outcomes:	
	After the completion of the course the student should be able to <ul style="list-style-type: none"> • list the extraction techniques used in the isolation of bioactive natural products (L-1)

	<ul style="list-style-type: none"> • explain identification and purification techniques such as Thin Layer Chromatography, Column chromatography etc. (L-2) • identify basic heterocyclic compounds (L-3) • apply knowledge of presence of metals in biological systems (L-3) • distinguish spectroscopic techniques such as IR, UV, NMR and Mass (L-4)
Text Books:	
	<ol style="list-style-type: none"> 1. B.Mehta and M. Mehta, Organic Chemistry, 2/e, PHI, (2015). 2. K. Sessa Maheswaramma and Mridula Chugh, Engineering Chemistry, Pearson (2016)
References:	
	<ol style="list-style-type: none"> 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)

19EEI 477: 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:	
	<ol style="list-style-type: none"> 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:	

	<ol style="list-style-type: none">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.
--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

19EMA371: NUMERICAL METHODS, PROBABILITY AND STATISTICS

L T P C
2 1 0 3

Course Objectives:	
	<ul style="list-style-type: none">• 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 intervals: Lagrange's formula.	
Learning Outcomes:	
	At the end of this unit, the student will be able to <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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), χ^2 - test for goodness of fit.		
Learning Outcomes:		
	After completing this unit, the student will be able to <ul style="list-style-type: none"> • apply the concept of testing hypothesis for small samples to draw the inferences (L3) • test for the goodness of fit (L4) 	
Course Outcomes:		
	After the completion of the course the student should be able to <ul style="list-style-type: none"> • solve approximating the roots of polynomial and transcendental equations by different algorithms (L3) • apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations (L3) 	

	<ul style="list-style-type: none"> • apply discrete and continuous probability distributions (L3) • identify the components of a classical hypothesis test (L3) • inference based on small and large sampling tests using statistical methods (L4)
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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

<p>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.</p>	
Course Objectives:	
	<ul style="list-style-type: none"> 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
<p>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.</p> <p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> List the difference between procedure and object oriented programming, applications 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.	

<p>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.</p> <p>Functions in C++: Main function, function prototyping, inline functions, default arguments.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • . 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
<p>More about Functions: Function overloading, friendly functions: friendfunction, objects as function arguments.</p> <p>Constructors & Destructors: Constructors, parameterized constructors,multiple constructors in a class, copy constructors, dynamic constructors, destructors.</p>	
<p>Learning Outcomes:</p>	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Inheritance: Introduction to inheritance, single inheritance, making aprivate member inheritable (protected member), multi-level inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance.</p> <p>Operator Overloading: Rules for overloading operators, overloading unaryoperators, overloading binary operators.</p> <p>Pointers: Introduction to pointers, declaring and initializing pointers,pointers with arrays, arrays of pointers, 'this' pointer.</p>	
<p>Learning Outcomes:</p>	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Polymorphism and Virtual Functions: Compile-time polymorphism, run-time polymorphism,</p>	

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

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • To make it understand the difference between programming languages C, C++ and Java. • Learn various types of Inheritance mechanisms. • Give exposure over various software packages applicability and usage of multithreading concepts. • Applet creation and its graphical effects. • Learn different components required for forms designing in AWT.
Unit- I	10 hrs
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ol style="list-style-type: none"> 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 solutiios. 5. Contrast the difference between the usage of I/O Streams
Unit- II	11 hrs
<p>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.</p>	

Learning Outcomes:	
	At the end of this unit, the student will be able to <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> 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 swing components- 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

	<ol style="list-style-type: none"> 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 1. Herbert Scheldt, The Java complete References, 9/e, TMH Publications,2014
References:	
	<ol style="list-style-type: none"> 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:	
	<ul style="list-style-type: none"> • 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 known method Gomory’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
<p>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.</p> <p>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</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	

Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 <i>Gomory's cutting plane method</i>.(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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 1. S.S.Rao, Engineering optimization theory and practice,3rd Edition, New age international,2007.
References:	
	<ol style="list-style-type: none"> 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.

19EHS403 OPERATIONS RESEARCH

L T P C
2 1 0 3

Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>Basics of Operations Research: History, definition, operations research models, phases of implementing operations research in practice.</p> <p>Linear Programming: Introduction, formulation, graphical solution, simplex method, artificial variable techniques – Big M and two phase methods, duality principle.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • Recognize the significance of Operations Research and mathematical modelling while analysing the practical problems in industry(L1) • Formulate the various linear Programming Models(L5) • Evaluate the optimal solution to simple linear programming problems(L6)
Unit- II	
<p>Transportation Model: Formulation, initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems.</p> <p>Assignment Model: Formulation, optimal solution, Hungarian method, travelling salesman problem.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<p>Queuing Models: Introduction, Kendall’s notation, classification of queuing models, single server and multi-server models, Poisson arrival, exponential service, infinite population</p> <p>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.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Define the various queuing models(L1) • Calculate Queue length & waiting time of a given queue system(L6) • Evaluate the optimal sequence of the jobs on machines for minimum cycle time(L6)
Unit- IV	
<p>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.</p> <p>Game Theory: Introduction, game with pure strategies, game with mixed strategies, dominance principle, graphical method for $2 \times n$ and $m \times 2$ games, linear programming approach for game theory.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Analyze the replacement and maintenance costs of items under various replacement policies(L4) • Evaluate the optimal replacement policy of items(L6) • Analyze the players’ strategies and thereby Evaluate optimal business strategies for the players (L4 & L6)
Unit- V	
<p>Inventory Models: Introduction, inventory costs, Economic Order Quantity (EOQ) and Economic Batch Quantity (EBQ) models with and without shortages, inventory models with quantity discounts</p> <p>Project Management: Introduction, phases of project management, network construction, numbering the events-Fulkerson’s rule, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT)</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Recognize the significance of Inventory models & Project Management in real world industrial scenarios(L1)

	<ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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 solve assignment 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:	
	<ol style="list-style-type: none"> 1. Gupta P K. & Hira D.S., Operation Research, 6/e, <i>S Chand</i> Publishers, 2006. 2. Paneerselvam R., Operations Research, 2/e Prentice Hall of India, 2010.
References:	
	<ol style="list-style-type: none"> 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:	
	<ul style="list-style-type: none"> • Understand the fundamentals of various Additive Manufacturing Technologies for application to various industrial needs. • Able to convert part file into STL format. • Able to understand the method of manufacturing of liquid based, powder based and solid based techniques. • Understand the manufacturing procedure of a prototype using FDM technique.
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 used terms, 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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 and disadvantages, Case studies, practical demonstration.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Identify the need for liquid and solid based additive manufacturing systems (L3). • Demonstrate the application of different AM techniques (L2).
Unit- IV	8 hrs
<p>Powder Based Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Design and develop newer tooling models (L3). • Analyze the best powder based AM method for present day market requirements (L4).
Unit- V	8 hrs
<p>Medical And Bio-Additive Manufacturing: Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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).
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Understand the fundamentals of Additive Manufacturing Technologies for engineering applications (L3).

	<ul style="list-style-type: none"> • Understand the methodology to manufacture the products using SLA and SGC technologies and study their applications, advantages and case studies (L1). • Understand the methodology to manufacture the products using LOM and FDM technologies and study their applications, advantages and case studies (L2). • Understand the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages and case studies (L3).
Text Books:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

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:	
	<ol style="list-style-type: none"> 1. Sensor Technology Handbook by Jon S. Wilson, Elsevier, 2005 2. Measurement Systems, Application and design, E.O. Doebelin, Tata McGraw Hill, 2004.
References:	
	<ol style="list-style-type: none"> 1. A course in mechanical measurements and instrumentation, A. K. Sawhney & Puneet Sawhney, Dhanpat Rai & Co., 2001.

<ol style="list-style-type: none"> 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

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • To introduce students with basic concepts of operating system, its functions and • 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
<p>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</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • To describe the services an operating system provides to user's, processes, and

	<p>other systems: (L1)</p> <ul style="list-style-type: none"> • 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
<p>CPU Scheduling: Scheduling-criteria, scheduling algorithms, Thread scheduling, Multiple processor scheduling, algorithm evaluation.</p> <p>Process Synchronization: Critical section problem, Peterson's solution, synchronization hardware, Mutex locks, semaphores, classic problems of synchronization, monitors.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Deadlock: System model, deadlock characterization, deadlock prevention, detection and avoidance, recovery from deadlock.</p> <p>Memory Management: Swapping, contiguous memory allocation, paging, segmentation, structure of page table.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Virtual memory: Demand paging, Copy-on-Write, page-replacement, allocation of frames, thrashing.</p> <p>File Concepts: File concept, access Methods, directory and disk structure, protection.</p>	
Learning Outcomes:	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>1. Abraham Silberchatz, Peter B. Galvin, Greg Gagne, Operating System Concepts with Java, 9/e, John Wiley, 2016.</p>
References:	
	<ol style="list-style-type: none"> 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. Dhamdhare, Operating systems- A Concept baed Approach-2/e, McGraw Hill, 2010.

19ECS473: INTRODUCTION TO SOFTWARE ENGINEERING

L T P C
2 1 0 3

<p>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</p>	
Course Objectives:	
	<ul style="list-style-type: none"> • 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	
<p>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</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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	
<p>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.</p>	

Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>Function-Oriented Software Design : Structured Analysis, Developing the DFD, Model of a System, Structured Design, Detailed Design, Design Review</p> <p>Basic Object-Orientation Concepts : Unified Modelling Language (UML), UML Diagrams, Use Case Model, Class Diagrams, Interaction Diagrams, Activity Diagram, State Chart Diagram</p> <p>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</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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</p> <p>Software Reliability and Quality Management : Software Reliability, Statistical Testing, Software Quality, Software Quality Management</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 Jawadkar, 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.

19EME349: TOTAL QUALITY MANAGEMENT

L T P C
2 1 0 3

Course Objectives:	
	<ul style="list-style-type: none"> Develop an understanding on the necessary information and skills needed to manage, control and improve quality practices in the organizations through TQM philosophy. To educate students to know how one can delight customers through continuous improvement of the quality of products and services. To educate to understand the importance of total participation of employees in an organization for improving quality. To educate students to recognize the importance of networking of companies with Govt, Semi-Govt. organizations, Research Institutes, Universities, etc
Unit- I :	
8 hrs	
<p>Quality Pioneers: Deming’s approach, Juran’s quality trilogy, Crosby and quality treatment, Imia’s Kaizen, Ishikawa’s company-wide quality control, and Feigenbaum’s theory of TQC.</p> <p>Evolution of Quality Concepts and Methods: Quality concepts, Development of four fitness’s, evolution of methodology, evolution of company integration, quality of conformance versus quality of design, from deviations to weaknesses to opportunities. Future fitness’s, four revolutions in management thinking, and four levels of practice</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> To educate students the core concepts of Total Quality Management (TQM).(L1) Explain the four revolutions in management thought processes.(L2) Explain the TQM principles and concepts for organizations(L2)
Unit- II:	
8 hrs	
<p>Continuous Improvement: Improvement as problem solving process, Management by process, WV model of continuous improvement, process control and process improvement, process versus creativity.</p> <p>Reactive Improvement: Identifying the problem, standard steps and tools, seven steps, seven QC tools.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p>

	<ul style="list-style-type: none"> To educate students to know how one can delight customers through continuous improvement of the quality of products and services.(L1) Evaluate and select the appropriate framework for continuous improvement.(L2) Apply the reactive methodologies for problem solving in organizations(L4)
Unit- III	8 hrs
Proactive Improvement: Introduction to proactive improvement, standard steps for proactive improvement, semantics, example-customer visitation, Applying proactive improvement to develop new products- three stages and nine steps.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> Apply the reactive and proactive improvement methodologies for problem solving in organizations. (L4)
Unit- IV	8 hrs
Total Participation; Teamwork skill, Dual function of work, teams and teamwork, principles for activating teamwork, creativity in team processes, Initiation strategies, CEO involvement, Strategies for TQM introduction, Infrastructure for mobilization., Phase-in.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> Demonstrate the importance of team work in problem solving processes.(L3)
Unit- V	8 hrs
Hoshin Management: Definition, Concepts, Phases in Hoshin Management – overview. Societal Networking: Networking and societal diffusion, infrastructure for networking. TQM as learning system, a TQM model for skill development	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> Define the business excellence models implemented in various organizations(L2) Design & implement TQM projects in organizational situations(L1)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> Understand the various quality concepts. Apply continuous improvement models to satisfy customers. Apply proactive improvement techniques to improve quality of products. Develop total participation methods among employees to satisfy internal and external customers. Implementation of societal networking and Hoshin management.

Text Books:

1. Shoji Shiba, Alan Graham and David Walden -A New American TQM Four Practical Revolutions in Management, Productivity Press, Portlans (USA) -2001.
2. N Logothetis-Management for Total Quality, Prentice Hall of India, New Delhi - 2002.

References:

1. Roger C Swanson - The Quality Improvement Hand Book, Publisher Vanity Books, International, New Delhi, 9th Edition, 1995
2. William C Johnson and Richard J Chavla, -Encyclopedia of Total Quality Management, New Delhi, 1995
3. N.V.R Naidu, K.M.Babu, G. Rajendra - Total Quality Management, New Age International Publishers-2008 edition,
4. Kesavan R -Total Quality Management, I K International Publishing house Pvt. Ltd, 2ndedition, 2008.

19EME356: ENTERPRISE RESOURCE PLANNING

L T P C
2 1 0 3

Course Objectives:	
	<ol style="list-style-type: none"> 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)

	<ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Identify the gaps in the maintenance and security of ERP systems.(L1) • configure and test the solutions in data migration (L2)

	<ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 1. Rajesh Ray, Enterprise Resource Planning, 1stEdition, McGraw Hill Education, 2010. 2. Robert D.Hisrich, Michael P.Peters, Mathew J. Manimala and Dean A. Shepherd, Entrepreneurship, 9thEdition, McGraw Hill Education, 2010.
References:	
	<ol style="list-style-type: none"> 1. D. P. Goyal, Enterprise Resource Planning A Managerial Perspective, 1stEdition, 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, 3rdEdition, McGraw Hill Education, 2014. 4. P. C. Reddy,Enterprise Resource Planning, 1stEdition, 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:	
	<ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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

	<ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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.

19EEEC475: 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:

	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> 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: arithmetic instructions 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:		
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> demonstrate the purpose of different types 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:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> evaluate marine biodiversity (L5) explain the methods of conservation of marine environment as well as organisms(L2) Perceive 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:		
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> explain the functions of timers, serial communication and interrupts of 8051 (L1). develop C programs for serial communication and delay generation (L3). 	

	<ul style="list-style-type: none"> 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> explain the functions of different pins, control signals of LCD (L2). discuss the basic operation of keyboard and describe the key press and detection mechanisms with key de bouncing (L2). illustrate the features and basic 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> 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 hardware 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:	
	<ol style="list-style-type: none"> Kenneth J Ayala, “The 8051 Micro Controller Architecture, Programming and applications. 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 ^H metry, 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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
<i>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.</i>				
Course objectives:				
<ol style="list-style-type: none">1. Introduce the concepts of machine learning and the complete process model for working with real data2. Impart the various approaches to supervised learning.				

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:					
<ol style="list-style-type: none"> 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)					
<ol style="list-style-type: none"> 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)					
<ol style="list-style-type: none"> 1. Tom M. Mitchell, Machine Learning, McGraw Hill, 2017. 2. EthemAlpaydin, Introduction to Machine Learning, 3/e, PHI, 2015. 					
Recommended Coursera Courses:					
<ol style="list-style-type: none"> 1. 					
Course Outcomes:					
<ol style="list-style-type: none"> 1. Describe different machine learning categories (L2) 2. Apply supervised learning approaches on real-time problems (L3) 3. Utilize unsupervised learning approaches for applications such as anomaly detection (L3) 4. Analyze ensemble models for performance improvement (L4) 5. Estimate significant feature subset to handle high dimensionality issue (L5) 6. Construct deep neural networks for computer vision applications (L6) 					

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:	
	<ul style="list-style-type: none"> 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> examine SOA(L1) state REST. (L1) 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 – IaaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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 Standards.	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • understand Hadoop(L2) • describe Google App Engine(L2) • describe OpenStack(L2) • explain Federation in cloud(L2)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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)

	<ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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

<p>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.</p>	
<p>Course Objectives:</p>	
	<ul style="list-style-type: none"> • 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.
<p>Unit- I</p>	
	<p>8 hrs</p>
<p>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</p> <p>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</p>	
<p>Learning Outcomes:</p>	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)
<p>Unit- II</p>	
	<p>8 hrs</p>
<p>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</p>	

<p>Aggregation and Representation, Data Analysis , Data Visualization, Utilization of Analysis Results.</p> <p>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.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p> <p>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</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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.</p> <p>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.</p>	
Learning Outcomes:	

	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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
<p>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</p> <p>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, conscientious and Conscious responsibility, privacy may be the wrong focus, can data be anonymized? Balancing for Counterintelligence and Now What?</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 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:	
	<ol style="list-style-type: none"> 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

Course Objectives:	
	<ul style="list-style-type: none"> To introduce the major building blocks, functions, business processes, performance metrics and decisions (Strategic, tactical and operational) in Supply chain. Analyse the inventory management methodologies to improve the performance of supply chain. Explore three fundamental design concepts: component commonality, modularity vs. integral design, and universality, and a cost/benefit framework. Compare various procurement strategies and Impact of technology on supply chain optimization in procurement strategy. Acquire knowledge on Risks and issues in Local and Global supply chains.
Unit- I : Introduction to Supply Chain Management (SCM)	
	8 hrs
<p>Concept of supply management and SCM, importance of supply chain flows, core competency, value chain, elements of supply chain efficiency, key issues in SCM, decision phases, supply chain integration, process view of a supply chain, competitive strategy and supply chain strategies, uncertainties in supply chain, supply chain drivers.</p>	
Learning Outcomes:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> Understand and analyze operations and supply chain management issues in a firm. (L2) Use critical thinking skills in business situations. (L2) Analyze the manufacturing operations of a firm(L2) Apply logistics and purchasing concepts to improve supply chain operations(L2) Analyze the global business environment. (L2)
Unit- II: Inventory Management	
	8 hrs
<p>Introduction, selective control techniques, cost involved in inventory system, single stage inventory control, economic lot size models, application to economic production quantity, effect of demand uncertainty, single period models, initial inventory, multiple order opportunities,</p>	

deterministic models, quantity discounts. periodic and quantity review policies, mathematical modelling under known stock out costs and service levels, joint replenishment for multiple items, inventory system constraints, working capital restrictions, and storage space restrictions.

Learning Outcomes:

- At the end of this unit, the student will be able to
- understand a system to keep track of inventory(L2)
 - understand the classification systems of Effective Inventory Management(L2)
 - analyze the satisfactory levels of customer service while keeping inventory costs within reasonable bounds. (L2)
 - analyze the Annual Demand. (L2)
 - understand the factors affecting ADME (L2).

Unit- III

8 hrs

Designing Supply Chain Network: Introduction, network design, factors influencing network design, data collection, data aggregation, transportation rates, warehouse costs, capacities and locations, models and data validation, key features of a network configuration, impact of uncertainty on network design, network design in uncertain environment, value of information: Bullwhip effect, information sharing, information and supply chain trade

Learning Outcomes:

- After completing this unit, the student will be able to
- understand the supply chain management in all its diverse aspects and its applicability (L2)
 - Develop comprehensive strategic and tactical plans for an organization(L2)
 - Understand how supply chain design facilitates network integration(L2)
 - Apply the main network design and implementation steps. (L2)
 - Identify the factors that are to be taken into account during during network design and in locating facilities. (L2)

Unit- IV: Supply Chain Integration

8 hrs

Introduction, push, pull and push-pull supply chains, identifying appropriate supply chain strategy, Sourcing and procurement, outsourcing benefits, importance of suppliers, evaluating a potential supplier, supply contracts, competitive bidding and negotiation. Purchasing, objectives of purchasing, relations with other departments, centralized and decentralized purchasing, purchasing procedure, types of orders, e-procurement, tender buying, role of business in supply chains.

Learning Outcomes:

- After completing this unit, the student will be able to
- Identify the components of an integrated logistics management system. (L2)
 - Identify the decisions involved in transportation management. (L2)

	<ul style="list-style-type: none"> • Ability to develop different alternatives and get a solution to be implemented. (L2) • Analyze suitable methodologies to design a solution for an LSM problem. (L2)
Unit- V	10 hrs
<p>Issues in Supply Chain Management: Introduction, risk management, managing global risk, issues in international supply chain, regional differences in logistics. Local issues in supply chain, issues in natural disaster and other calamities, issues for SMEs, organized retail in India, reverse logistics.</p>	
Learning Outcomes:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • Understand fundamental issues in supply chain management. (L2) • Apply knowledge to evaluate and manage an effective supply chain by minimizing the risk factors. (L2) • Ability to align the management of a supply chain with corporate goals and strategies. (L2) • Analyze the issues and search for methodologies improve supply chain processes. (L2)
Course Outcomes:	
	<p>After the completion of the course the student should be able to</p> <ul style="list-style-type: none"> • Identify specific ways in which supply chain management creates value for customers and investors (customer value and financial value) • Analyze the existing inventory models to propose the optimal order sizes. • Identify sources for the variability in demand and understand the impact of globalization on supply chains. • Explore the different supply chain integration options to optimize the costs and /time. • Evaluate the procurement strategies for a given business model. • Compare the different types of analytical tools used in planning and decision making, including models and simulations.
Text Books:	
	<ol style="list-style-type: none"> 1. Simchi-Levi, D. Kaminsky, P.Simchi-Levi, E. and Ravi Shankar, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, 3/e, Tata McGraw-Hill, 2008. 2. Chopra, S. and Meindl, Supply Chain Management: Strategy, Planning and Operations, 2/e, Pearson Education, 2004
References:	
	<ol style="list-style-type: none"> 1. Doebler, D.W. and Burt, D.N, Purchasing and Supply Management-Text and Cases, 6/e, McGraw-Hill, 1996.

	2. Tersine, R.J, Principles of Inventory and Materials Management, 4/e, Prentice Hall, 1994.
--	----------------------------------------------------------------------------------------------

19EME371: QUANTITATIVE TECHNIQUES FOR MANAGEMENT

L T P C
2 1 0 3

Course Objectives:	
	<ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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)

	<ul style="list-style-type: none"> • 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:	
	<p>At the end of this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<p>After completing this unit, the student will be able to</p> <ul style="list-style-type: none"> • 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:	
	<ol style="list-style-type: none"> 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
References:	
	<ol style="list-style-type: none"> 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.

HSMCH102 UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

L	T	P	C
2	1	0	3

Students would get an initial exposure to human values through this course. Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions. While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than "extraordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting. Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

Course Objectives:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection.
- Development of commitment and courage to act.

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education (8L)

- Purpose and motivation for the course, recapitulation from Universal Human Values-I.
- Self-Exploration—what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself! (8L)

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
- Understanding the characteristics and activities of 'I' and harmony in 'I'.
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship (8L)

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence (8L)

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
- Holistic perception of harmony at all levels of existence.
- Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on

Professional Ethics

(8L)

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order:
- At the level of individual: as socially and ecologically responsible engineers, technologists and managers
- At the level of society: as mutually enriching institutions and organizations
- Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

Textbooks

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

- They would have better critical ability.
- They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
- It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

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).

Course Outcomes:

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

- Understand how to build a strong project foundation(L1)
- Conduct problem solving and stakeholder management (L2)
- Discuss strategies for monitoring the project implementation plan (L3)
- Interpret the concept and process of Entrepreneurship and its role in the society (L4).
- Differentiate different business model and analyze business plan preparation (L5).

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

19ECS472 INTRODUCTION TO AUGMENTED REALITY AND VIRTUAL REALITY

		L	T	P	C
		2	1	0	3
<p>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.</p>					
<p>Course objectives:</p> <ol style="list-style-type: none"> 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	
<p>Introduction, A history of Mixed Reality Technologies, The Origin of MR Concept</p> <p>(Chapter – 1) of Text book 1</p>					
<p>Learning Outcomes:</p> <p>After completion of this unit, the student will be able to:</p> <ol style="list-style-type: none"> 1. describe the origins of MR concept – L1 2. understand the concept of Mixed Reality – L2 3. describe real time applications of MR technologies – L1 4. analyse the usage of MR Technologies in various fields – L4 					
Module II:	Introduction to Virtual Reality (VR)	Number of hours(LTP)		10	
<p>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.,</p> <p>(Chapter – 2) of Text book 1</p>					
<p>Learning Outcomes:</p> <p>After completion of this unit, the student will be able to:</p> <ol style="list-style-type: none"> 1. describe the types of VR with a practical understanding – L1 2. understand the concept of Virtual Reality – L2 3. analyse the current VR Technologies – L3 4. understand the benefits and disadvantages of VR Technologies – L2 5. analyse the VR Applications in various fields for creating new applications – L3 					

Module III:	Introduction to Augmented Reality	Number of hours(LTP)	10		
<p>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.,</p> <p>(Chapter – 3) of Text book 1</p>					
Learning Outcomes:					
<p>After completion of this unit, the student will be able to:</p> <ol style="list-style-type: none"> 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		
<p>Human factors: Introduction, the eye, the ear, the somatic senses.</p> <p>Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems.</p> <p>Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to Blender, Meshroom and UNITY</p> <p>(Chapter or Part 3) for Text Book 2</p>					
Learning Outcomes:					
<p>After completion of this unit, the student will be able to:</p> <ol style="list-style-type: none"> 1. understand the different sensors available for AR/VR – L2 2. describe the existing Hardware like head mounted displays and haptics – L1 3. hands-on experience with available software – L3 4. 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		
<p>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.</p> <p>(Chapter 4) of Text Book 1</p>					
Learning Outcomes:					

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

1. understand the application of AR/VR in education – L2
2. analyse various case studies for education – L4
3. analyse an AR/VR application for primary school education – L4

Text Books(s)

2. Zeynep Tacgin, *Virtual and Augmented Reality: An Educational Handbook*, Cambridge Scholars, 2020, ISBN (10): 1-5275-4813-9
3. 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