KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI – 2022

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2022 - 2023 and onwards)

BACHELOR OF TECHNOLOGY
IN
FOOD TECHNOLOGY

DEPARTMENT OF FOOD TECHNOLOGY

KONGU
Assuring the Best

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS

2022

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION BACHELOR OF ENGINEERING (BE) / BACHELOR OF TECHNOLOGY (BTech)

DEGREE PROGRAMMES

These regulations are applicable to all candidates admitted into BE/BTech Degree programmes from the academic year 2022 – 2023 onwards.

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

iii. "Programme" means Bachelor of Engineering (BE) / Bachelor of Technology (BTech) Degreeprogramme

iv. "Branch" means specialization or discipline of BE/BTech Degree programme, like CivilEngineering, Information Technology, etc.

v. "Course" means a Theory / Theory cum Practical / Practical course that is normally studied in asemester like Mathematics, Physics etc.

vi. "Credit" means a numerical value allocated to each course to describe the candidate's workloadrequired per week.

vii. "Grade" means the letter grade assigned to each course based on the marks range specified.

viii. "Grade point" means a numerical value (0 to 10) allocated based on the grade assigned

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ix. “Principal” means Chairman, Academic Council of the College.

x. “Controller of Examinations (COE)” means authorized person who is responsible for all examination related activities of the College.

xi. “Head of the Department (HOD)” means Head of the Department concerned.

2. PROGRAMMES AND BRANCHES OF STUDY

The following programmes and branches of study approved by Anna University, Chennai and All IndiaCouncil for Technical Education, New Delhi are offered by the College.

Programme	Branch
BE	Civil Engineering
	Mechanical Engineering
	Electronics and Communication Engineering
	Computer Science and Engineering
	Electrical and Electronics Engineering
	Electronics and Instrumentation Engineering
	Mechatronics Engineering
	Automobile Engineering
	Computer Science and Design
BTech	Chemical Engineering
	Information Technology
	Food Technology
	Artificial Intelligence and Data Science
	Artificial Intelligence and Machine Learning

3. ADMISSION REQUIREMENTS

First Semester Admission

The candidates seeking admission to the first semester of the eight semester BE / BTech Degree Programme:

Should have passed the Higher Secondary Examination (10 + 2) in the academic stream with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III subjects of the study conducted by the Government of Tamil Nadu or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

They should also satisfy other eligibility conditions as prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

Lateral Entry Admission

The candidates who hold a Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamilnadu or its equivalent are eligible to apply for Lateral entry admissionto the third semester of BE / BTech.

(OR)

The candidates who hold a BSc degree in Science(10+2+3 stream) with mathematics as one of

the subjects at the BSc level from a recognised University are eligible to apply for Lateral entry admission to the third semester of BE / BTech. Such candidates shall undergo two additional Engineering course(s) in the third and fourth semesters as prescribed by the College.

They should also satisfy other eligibility conditions prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

The BE / BTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester, professional skills training/industrial training, project work, internship, etc that have been approved by the respective Board of Studies and Academic Council of the College. All the programmes have well defined Programme Outcomes (PO), Programme Specific Outcomes (PSO) and Programme Educational Objectives (PEOs) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses shall be categorized as follows:

i. Humanities and Social Sciences (HS) including Management Courses, English Communication Skills, Universal Human Values and Yoga & Values for Holistic Development.
ii. Basic Science (BS) Courses
iii. Engineering Science (ES) Courses
iv. Professional Core (PC) Courses
v. Professional Elective (PE) Courses
vi. Open Elective (OE) Courses
vii. Employability Enhancement Courses (EC) like Project work, Professional Skills/Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship / In- plant Training in Industry or elsewhere
viii. Audit Courses (AC)
ix. Mandatory Courses (MC) like Student Induction Program and Environmental Science.
x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

Credit Assignment

Each course is assigned certain number of credits as follows:

Contact period per week	Credits
1 Lecture / Tutorial Period	1
2 Practical Periods	1
2 Project Work Periods	1
40 Training / Internship Periods	1

The minimum number of credits to complete the BE/BTech programme is 166.

4.2.2 Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and

appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 8.0 CGPA and no history of arrears to opt for the honours degree and has to maintain the same during the entire programme.

Various specializations for various branches recommended by the respective boards of studies are given below:

Sno	Specializations for Honoursdegree in emerging areas	To be offered as Honours, Only for the following branches mentioned against the specialization
1.	Construction Technology	BE – Civil Engineering
2.	Smart Cities	BE – Civil Engineering
3.	Smart Manufacturing *	BE – Mechanical Engineering
4.	Computational Product Design *	BE – Mechanical Engineering
5.	Intelligent Autonomous Systems *	BE – Mechatronics Engineering
6.	E-Mobility *	BE – Automobile Engineering
7.	Artificial Intelligence and MachineLearning	BE – Electronics and CommunicationEngineering
8.	System on Chip Design *	BE – Electronics and CommunicationEngineering
9.	Electric Vehicles	BE – Electrical and Electronics Engineering
10.	Microgrid Technologies	BE – Electrical and Electronics Engineering
11.	Intelligent Sensors Technology *	BE – Electronics and InstrumentationEngineering
12.	Smart Industrial Automation *	BE – Electronics and InstrumentationEngineering
13.	Data Science	BE – Computer Science and Engineering
14.	Cyber Security	BE – Computer Science and Engineering
15.	Data Science	BTech – Information Technology
16.	Cyber Security	BTech – Information Technology
17.	Petroleum and PetrochemicalEngineering *	BTech – Chemical Engineering
18.	Waste Technology *	BTech – Chemical Engineering
19.	Food Processing and Management *	BTech – Food Technology
20.	Virtual and Augumented Reality	BE- Computer Science and Design
21.	Data Science	BE- Computer Science and Design
22.	Internet of Things (IoT)	BTech – Artificial Intelligence and DataScience
23.	Blockchain	BTech – Artificial Intelligence and DataScience
24.	Internet of Things (IoT)	BTech – Artificial Intelligence and MachineLearning
25.	Blockchain	BTech – Artificial Intelligence and MachineLearning

*Title by KEC

The courses specified under Honours degree in the emerging area may include theory, theory cum practical, practical, project work, etc. under the particular specialization. A candidate can choose and study these specified courses from fourth semester onwards and he/she shall successfully complete the courses within the stipulated time vide

clause 5. Total number of credits earned in each semester may vary from candidate to candidate based on the courses chosen. The registration, assessment & evaluation pattern and classification of grades of these courses shall be the same as that of the courses in the regular curriculum of the programme of the candidate vide clause 6, clause 7 and clause 15 respectively. A candidate can earn Honours degree in only one specialization during the entire duration of the programme.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, internship, professional skills training/industrial training, comprehensive test & viva, and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Indsutrial Training/Entrepreneurships/Start Ups/ Inplant Training

A candidate may be offered with appropriate training courses imparting programming skills, communication skills, problem solving skills, aptitude skills etc. It is offered in two phases as phase I in fourth semester and phase II in fifth semester including vacation periods and each phase can carry two credits.

(OR)

A candidate may be allowed to go for training at research organizations or industries for a required number of hours in fifth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training course II in fifth semester. He/She shall attend Professional Skills Training Phase I in fourth semester and can earn two credits.

(OR)

A candidate may be allowed to set up a start up and working part-time for the start ups by applying his/her innovations and can become a student entrepreneur during BE/BTech programme. Candidates can set up their start up from fifth semester onwards either inside or outside of the college. Such student entrepreneurs may earn 2 credits in place of Professional Skills Training II. The area in which the candidate wants to initiate a start upmay be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test and Viva

The overall knowledge of the candidate in various courses he/she studied shall be evaluated by (i) conducting comprehensive tests with multiple choice questions generally with pattern similar to GATE and/or (ii) viva-voce examination conducted by a panel of experts assigned by the Head of the department. The members can examine the knowledge of the candidate by asking questions from various domains and the marks will be assigned based on their answers. This course shall carry two credits.

4.3.3 Full Time Project through Internships

The curriculum enables a candidate to go for full time project through internship during a part of seventh semester and/or entire final semester and can earn credits vide clause 7.6 and clause 7.11.

A candidate is permitted to go for full time projects through internship in seventh semester with the following condition: The candidate shall complete a part of the seventh semester courses with a total credit of about 50% of the total credits of seventh semester including Project Work-II Phase-I in the first two months from the commencement of the seventh semester under fast track mode. The balance credits required to complete the seventh semester shall be earned by the candidate through either approved One/Two Credit Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

A candidate is permitted to go for full time projects through internship during eighth semester. Such candidate shall earn the minimum number of credits required to complete eighth semester other than project through either approved One / Two Credit Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.3.4 A student shall go for in-plant training for duration of two weeks during the entireprogramme. It is mandatory for all the students.

4.4 One / Two Credit Courses / Online Courses / Self Study Courses

The candidates may optionally undergo One / Two Credit Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 One / Two Credit Courses: One / Two credit courses shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of six credits through one / two credit courses during the entire duration of the programme.

4.4.2 Online Courses: Candidates may be permitted to earn credits for online courses, offered by NPTEL / SWAYAM / a University / Other Agencies, approved by respective Board of Studies.

4.4.3 Self Study Courses: The Department may offer an elective course as a self study course. The syllabus of the course shall be approved by the respective Board of Studies. However, mode of assessment for a self study course will be the same as that used for other courses. The candidates shall study such courses on their own under the guidance of member of the faculty following dueapproval procedure. Self study course is limited to one per semester.

4.4.4 The elective courses in the final year may be exempted if a candidate earns the required credits vide clause 4.4.1, 4.4.2 and 4.4.3 by registering the required number of courses in advance.

4.4.5 A candidate can earn a maximum of 30 credits through all one / two credit courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

4.5.1 A candidate has to earn the total number of credits specified in the curriculum of the respective programme of study in order to be eligible to obtain the degree. However, if the candidate wishes, then the candidate is permitted to earn more than the total number of credits prescribed in the curriculum of the candidate's programme.

4.5.2 From the first to seventh semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates.

4.6 Maximum number of credits the candidate can enroll in a particular semester cannot exceed 30 credits.

4.7 The blend of different courses shall be so designed that the candidate at the end of the programme would have been trained not only in his / her relevant professional field but also would have developed to become a socially conscious human being.

4.8 The medium of instruction, examinations and project report shall be English.

5. DURATION OF THE PROGRAMME

5.1 A candidate is normally expected to complete the BE / BTech Degree programme in 8 consecutive semesters/4 Years (6 semesters/3 Years for lateral entry candidate), butin any case not more than 14 semesters/7 Years (12 semesters/6 Years for lateral entry candidate).

5.2 Each semester shall consist of a minimum of 90 working days including continuous assessment test period. The Head of the Department shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus for the course being taught.

5.3 The total duration for completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum duration specified in clause 5.1 irrespective of the period of break of study (vide clause 11) or prevention (vide clause 9) in order that the candidate may be eligible for the award of the degree (vide clause 16). Extension beyond the prescribed period shall not be permitted.

6. COURSE REGISTRATION FOR THE EXAMINATION

6.1 Registration for the end semester examination is mandatory for courses in the current semester as well as for the arrear courses failing which the candidate will not be permitted to move on to the higher semester. This will not be applicable for the courses which do not have an end semester examination.

6.2 The candidates who need to reappear for the courses which have only continuous assessment shall enroll for the same in the subsequent semester, when offered next, and repeat the course. In this case, the candidate shall attend the classes, satisfy the attendance requirements (vide clause 8) and earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

6.3 If a candidate is prevented from writing end semester examination of a course due to lack of attendance, the candidate has to attend the classes, when offered next, and fulfill the attendance requirements as per clause 8 and earn continuous assessment marks. If the course, in which the candidate has a lack of attendance, is an elective, the candidate may register for the same or any other elective course in the subsequent semesters and that will be considered as an attempt for the purpose of classification.

6.4 A candidate shall register for the chosen courses as well as arrear courses (if any vide clause 6.2 and 6.3) from the list of courses specified under Honours degree.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, Project Work, Industrial Training /Professional Skills Training, Internship/In-plant Training and Entrepreneurships/ Start ups. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE)at the end of the semester except for the courses which are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100

marks as shown below:

Sl. No.	Category of Course	Continuous Assessment Marks	End Semester Examination Marks
1.	Theory	40	60
2.	Theory cum Practical (The distribution of marks shall bedecided based on the credit weightage assigned to theory and	50	50
3.	Practical	60	40
4.	Professional Skills Training / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work I / Mandatory Course/Industrial Training/ Universal Human Values / Yoga and Values for Holistic Development	100	---
5.	Project Work II Phase I / Project WorkII Phase II / Internships	50	50
6.	One / Two credit Course	The distribution of marks shall be decided based on the credit weightage assigned	---
7.	All other Courses		

Examiners for setting end semester examination question papers for theory courses, theory cum practical courses and practical courses and evaluating end semester examination answer scripts, project works, internships and entrepreneurships/start ups shall be appointed by the Controller of Examinations after obtaining approval from the Principal.

Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 40 marks and the end semester examination shall be for 60 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 60. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

The assessment pattern for awarding continuous assessment marks shall beas follows:

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	25	Average of best 2 tests (25 marks)
	Test - II	25	
	Test - III	25	
2.	Tutorial: (Tutorial/Problem Solving (or)Simulation (or) Simulation & Mini Project (or)Mini Project (or) Case Studies (or) Any other relevant to the course)	10	Type of assessment is to be chosen based on the nature of the course and to be approved by Principal
3.	Others: Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	40	Rounded off to the one decimal place

However, the assessment pattern for awarding the continuous assessment marks may be changed based on the nature of the course and is to beapproved by the Principal.

A reassessment test or tutorial covering the respective test or tutorial portions may be conducted for those candidates who were absent with valid reasons (Sports or any other reason approved by the Principal).

The end semester examination for theory courses shall be for a duration of three hours and shall be conducted between November and January during odd semesters and between April and June during even semesters of every year.

Theory cum Practical Courses

For courses involving theory and practical components, the evaluation pattern as per the clause 7.1 shall be followed. Depending on the nature of the course, the end semester examination shall be conducted for theory and the practical components. The apportionment of continuous assessment and end semester examination marks shall be decided based on the credit weightage assigned to theory and practical components approved by Principal.

Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 60 marks and the end semester examination shall be for 40 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidates' records shall be maintained.

The assessment pattern for awarding continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course, and shall be based on rubrics for each experiment.

The end semester examination shall be conducted for a maximum of 100 marks for duration of 3 hours and reduced to 40 marks. The appointment of examiners and the schedule shall be decided by chairman of Board of Study ofthe relevant board.

Project Work II Phase I / Project Work II Phase II

Project work shall be assigned to a single candidate or to a group of candidates not exceeding 4 candidates in a group. The project work is mandatory for all the candidates.

The Head of the Department shall constitute review committee for project work. There shall be two assessments by the review committee during the semester. The candidate shall make presentation on the progress made by him/her before the committee.

The continuous assessment and end semester examination marks for Project Work II Phase I /Project Work II Phase II and the Viva-Voce Examination shall be distributed as below.

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Zeroth Review		Review I (Max.. 20 Marks)		Review II Max. 30 Marks)		Report Evaluation (Max. 20 Marks)	Viva - Voce ax. 30 Marks)		
Rv. Com	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee (excluding supervisor)	Supervisor	Ext. Exr.	Supervisor	Exr. 1	Exr. 2
0	0	10	10	15	15	20	10	10	10

The Project Report prepared according to approved guidelines and duly signed by the Supervisor shall be submitted to Head of the Department. The candidate(s) must submit the project report within the specified date as per the academic schedule of the semester. If the project report is not submitted within the specified date then the candidate is deemed to have failed in the Project Work and redo it in the subsequent semester.

If a candidate fails to secure 50% of the continuous assessment marks in the project work, he / she shall not be permitted to submit the report for that particular semester and shall have to redo it in the subsequent semester and satisfy attendance requirements.

The end semester examination of the project work shall be evaluated based on the project report submitted by the candidate in the respective semester and viva-voce examination by a committee consisting of two examiners and

supervisor of the project work.

If a candidate fails to secure 50 % of the end semester examination marks in the project work, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted as per clause 7.6.6.

A copy of the approved project report after the successful completion ofviva-voce examination shall be kept in the department library.

Project Work I / Industrial Training

The evaluation method shall be same as that of the Project Work II as per clause 7.6 excluding 7.6.3, 7.6.5, 7.6.6 and 7.6.7. The marks distribution is given below.

<table>
<tr><td colspan="9">Continuous Assessment
(Max. 100 Marks)</td></tr>
<tr><td colspan="2" rowspan="2">Zeroth Review</td><td colspan="2" rowspan="2">Review I
(Max.. 20 Marks)</td><td colspan="2" rowspan="2">Review II
ax.. 30 Marks)</td><td colspan="3">Review III(Max. 50 Marks)</td></tr>
<tr><td>Report Evaluation(Max. 20 Marks)</td><td colspan="2">Viva - Voce (Max. 30 Marks)</td></tr>
<tr><td>Review Committee</td><td>Supervisor</td><td>Review Committee (excluding supervisor)</td><td>Supervisor</td><td>Review Committee (excluding supervisor)</td><td>Supervisor</td><td>Review Committee</td><td>Supervisor</td><td>Review Committee</td></tr>
<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>15</td><td>15</td><td>20</td><td>10</td><td>20</td></tr>
</table>

If a candidate fails to secure 50 % of the continuous assessment marks in this course,he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted.

Professional Skills Training

Phase I training shall be conducted for minimum of 80 hours in 3rd semester vacation and during 4th semester. Phase II training shall be conducted for minimum of 80 hours in4th semester vacation and during 5th semester. The evaluation procedure shall beapproved by the board of the offering department and Principal.

Comprehensive Test and Viva

A candidate can earn 2 credits by successfully completing this course. The evaluation procedures shall be approved by the Principal.

Entrepreneurships/ Start ups

A start up/business model may be started by a candidate individually or by a group of maximum of three candidates during the programme vide clause 4.3.1. The head of the department concerned shall assign a faculty member as a mentor for each start up.

A review committee shall be formed by the Principal for reviewing the progress of the Start ups / Business models, innovativeness, etc. The review committee can recommend the appropriate grades for academic performance for the candidate(s) involved in the start ups. This course shall carry a maximum of two credits in fifth semester and shall be evaluated through continuous assessments for a maximum of 100 marks vide clause 7.1.A report about the start ups is to be submitted to the review committee for evaluation for

each start up and the marks will be given to Controller of Examinations after getting approval from Principal.

7.11 In-Plant Training

Each candidate shall go for In-Plant training for a duration of minimum of two weeks during the entire programme of study and submit a brief report about the training undergone and a certificate issued from the organization concerned.

7.12 One / Twe Credit Courses

For all one/ two credit courses out of 100 marks, the continuous assessment shall be 50 marks and the model examination shall be for 50 marks. Minimum of two continuous assessments tests shall be conducted during the one / two credit course duration by the offering department concerned. Model examination shall be conducted at the end of the course.

7.13 Online Course

The Board of Studies will provide methodology for the evaluation of the online courses. The Board can decide whether to evaluate the online courses through continuous assessment and end semester examination or through end semester examination only. In case of credits earned through online mode from NPTEL / SWAYAM / a University / Other Agencies approved by Chairman, Academic Council, the credits may be transferred and grades shall be assigned accordingly.

7.14 Self Study Course

The member of faculty approved by the Head of the Department shall be responsible for periodic monitoring and evaluation of the course. The course shall be evaluated through continuous assessment and end semester examination. The evaluation methodology shall be the same as that of a theory course.

7.15 Audit Course

A candidate may be permitted to register for specific course not listed in his/her programme curriculum and without undergoing the rigors of getting a 'good' grade, as an Audit course, subject to the following conditions.

The candidate can register only one Audit course in a semester starting from second semester subject to a maximum of two courses during the entire programme of study. Such courses shall be indicated as 'Audit' during the time of registration itself.

Only courses currently offered for credit to the candidates of other branches can be audited.

A course appearing in the curriculum of a candidate cannot be considered as an audit course. However, if a candidate has already met the Professional Elective and Open Elective credit requirements as stipulated in the curriculum, then, a Professional Elective or an Open Elective course listed in the curriculum and not taken by the candidate for credit can be considered as an audit course.

Candidates registering for an audit course shall meet all the assessment and examination requirements (vide clause 7.3) applicable for a credit candidate of that course. Only if the candidate obtains a performance grade, the course will be listed in the semester Grade Sheet and in the Consolidated Grade Sheet along with the grade SC (Successfully Completed). Performance grade will not be shown for the audit course.

Since an audit course has no grade points assigned, it will not be counted for the purpose of GPA and CGPA calculations.

7.16 Mandatory Courses

A candidate joined in first semester shall attend and complete a mandatory course namely Student Induction Program of duration three weeks at the beginning of first semester. The candidates studying in second year shall attend and complete another one mandatory course namely Environmental Science. No credits shall be given for mandatory courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Upon the successful completion, these courses will be listed in the semester grade sheet and in the consolidated grade sheet with the grade "SC" (Successfully Completed). Since no grade points are assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

7.17 Universal Human Values (UHV) and Yoga and Values for Holistic Development (YVHD)

Courses YVHD shall be offered to all first year candidates of all BE/ BTech programmes to impart knowledge on yoga and human values. Course UHV shall be offered to all the second year BE/ BTech students. These courses shall carry a maximum of 100 marks each and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits for UHV and 1 credit for YVHD by successfully completing these courses. Two continuous assessment tests will be conducted and the average marks will be taken for the calculation of grades.

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

8.1 A candidate who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester and permitted to appear for the examinations of that semester.

8.1.1 Ideally, every candidate is expected to attend all classes and secure 100 % attendance. However, a candidate shall secure not less than 80 % (afterrounding off to the nearest integer) of the overall attendance taking into account the total number of working days in a semester.

8.1.2 A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to medical reasons (hospitalization / accident / specific illness) but has secured not less than 70 % in the current semester may be permitted to appear for the current semester examinations with the approval of the Principal on payment of a condonation fee as may be fixed by the authorities from timeto time. The medical certificate needs to be submitted along with the leave application. A candidate can avail this provision only twice during the entire duration of the degree programme.

A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to his/her entrepreneurships/ start ups activities, but has secured not less than 60 % in the current semester can be permitted to appear for the current semester examinations with the recommendation of review committee and approval from the Principal.

8.1.3 In addition to clause 8.1.1 or 8.1.2, a candidate shall secure not less than 60 % attendance in each course.

8.1.4 A candidate shall be deemed to have completed the requirements of study of any semester only if he/she has satisfied the attendance requirements (vide clause 8.1.1 to 8.1.3) and has registered for examination by paying the prescribed fee.

8.1.5 Candidate's progress is satisfactory.

8.1.6 Candidate's conduct is satisfactory and he/she was not involved in any undisciplined activities in the current semester.

8.2. The candidates who do not complete the semester as per clauses from 8.1.1 to 8.1.6 except 8.1.3 shall not be permitted to appear for the examinations at the end of the semester and not be permitted to go to the next semester. They have to repeat the incomplete semester in next academic year.

8.3 The candidates who satisfy the clause 8.1.1 or 8.1.2 but do not complete the course as per clause 8.1.3 shall not be permitted to appear for the end semester examination of that course alone. They have to repeat the incomplete course in the subsequent semester when it is offered next.

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

9.1 A candidate shall normally be permitted to appear for end semester examination of the current semester if he/she has satisfied the semester completion requirements as per clause 8, and has registered for examination in all courses of that semester. Registration is mandatory for current semester examinations as well as for arrear examinations failing which the candidate shall not be permitted to move on to the highersemester.

9.2 When a candidate is deputed for a National / International Sports event during End Semester examination period, supplementary examination shall be conducted for sucha candidate on return after participating in the event within a reasonable period of time. Such appearance shall be considered as first appearance.

9.3 A candidate who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

10.1 A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any regular course or all regular courses registered in a particular semester. Application for withdrawal is permitted only once during the entire duration of the degree programme.

10.2 The withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination (vide clause 9) and has applied to the Principal for permission prior to the last examination of that semester after duly recommended by the Head of the Department.

10.3 The withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for First Class with Distinction/First Class.

10.4 If a candidate withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examinations. A final semester candidate who has withdrawn shall be permitted to appear for supplementary examination to be conducted within reasonable time as per clause 14.

10.5 The final semester candidate who has withdrawn from appearing for project viva-voce for genuine reasons shall be permitted to appear for supplementary viva-voce examination within reasonable time with proper application to Controller of Examinations and on payment of prescribed fee.

11. PROVISION FOR BREAK OF STUDY

11.1 A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination. A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.

11.2 The candidates permitted to rejoin the programme after break of study / prevention due to lack of attendance shall be governed by the rules and regulations in force at the time of rejoining.

11.3 The candidates rejoining in new Regulations shall apply to the Principal in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

11.4 The total period of completion of the programme reckoned from the commencement of the semester to which the candidate was admitted shall not exceed the maximumperiod specified in clause 5 irrespective of the period of break of study in order to qualify for the award of the degree.

11.5 If any candidate is prevented for want of required attendance, the period of prevention shall not be considered as authorized break of study.

11.6 If a candidate has not reported to the college for a period of two consecutive semesters without any intimation, the name of the candidate shall be deleted permanently from the college enrollment. Such candidates are not entitled to seek readmission under any circumstances.

12. PASSING REQUIREMENTS

12.1 A candidate who secures not less than 50 % of total marks (continuous assessment and end semester examination put together) prescribed for the course with a minimum of 45 % of the marks prescribed for the end semester examination in all category of courses vide clause 7.1 except for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course in the examination.

12.2 A candidate who secures not less than 50 % in continuous assessment marks

prescribed for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course. If a candidate secures less than 50% in the continuous assessment marks, he / she shall have to re-enroll for the same in the subsequent semester and satisfy the attendance requirements.

12.3 For a candidate who does not satisfy the clause 12.1, the continuous assessment marks secured by the candidate in the first attempt shall be retained and considered valid for subsequent attempts. However, from the fourth attempt onwards the marks scored in the end semester examinations alone shall be considered, in which case the candidate shall secure minimum 50 % marks in the end semester examinations to satisfy the passing requirements.

13. REVALUATION OF ANSWER SCRIPTS

A candidate shall apply for a photocopy of his / her semester examination answer script within a reasonable time from the declaration of results, on payment of a prescribed fee by submitting the proper application to the Controller of Examinations. The answer script shall be pursued and justified jointly by a faculty member who has handled the course and the course coordinator and recommended for revaluation. Based on the recommendation, the candidate can register for revaluation through proper application to the Controller of Examinations. The Controller of Examinations will arrange for revaluation and the results will be intimated to the candidate concerned. Revaluation is permitted only for Theory courses and Theory cum Practical courses where end semester examination is involved.

14. SUPPLEMENTARY EXAMINATION

If a candidate fails to clear all courses in the final semester after the announcement of final end semester examination results, he/she shall be allowed to take up supplementary examinations to be conducted within a reasonable time for the courses of final semester alone, so that he/she gets a chance to complete the programme.

15. AWARD OF LETTER GRADES:

For all the passed candidates, the relative grading principle is applied to assign the letter grades.

Marks / Examination Status	Letter Grade	Grade Point
Based on the relative grading	O (Outstanding)	10
	A+ (Excellent)	9
	A (Very Good)	8
	B+ (Good)	7
	B (Average)	6
	C (Satisfactory)	5
Less than 50	U (Reappearance)	0
Successfully Completed	SC	0
Withdrawal	W	-

Absent	AB	-

Shortage of Attendance in a course	SA	-

The Grade Point Average (GPA) is calculated using the formula:

$$GPA = \frac{\sum (\text{course credits} \times \text{grade points}) \text{ for all courses in the specific semester}}{\sum \text{course credits for all courses in the specific semester}}$$

The Cumulative Grade Point Average (CGPA) is calculated from first semester (third semesterfor lateral entry candidates) to final semester using the formula

$$CGPA = \frac{\sum (\text{course credits} \times \text{grade points}) \text{ for all courses in all the semesters so far}}{\sum \text{course credits for all courses in all the semesters so far}}$$

The GPA and CGPA are computed only for the candidates with a pass in all the courses.

The GPA and CGPA indicate the academic performance of a candidate at the end of a semester and at the end of successive semesters respectively.

A grade sheet for each semester shall be issued containing Grade obtained in each course,GPA and CGPA.

A duplicate copy, if required can be obtained on payment of a prescribed fee and satisfying other procedure requirements.

Withholding of Grades: The grades of a candidate may be withheld if he/she has not cleared his/her dues or if there is a disciplinary case pending against him/her or for any other reason.

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the BE / BTech Degree provided the candidate has

i. Successfully completed all the courses under the different categories, as specified in the regulations.
ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).
iii. Successfully passed any additional courses prescribed by the respective Board ofStudies whenever readmitted under regulations other than R-2022 (vide clause 11.3)
iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

17.1.1. A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50

(OR)

17.1.2 A candidate who joins from other institutions on transfer or a candidate who gets readmitted and has to move from one regulations to another regulations and who qualifies for the award of the degree (vide clause 16) and satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Submission of equivalent course list approved by the respective Boardof studies.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 9.00

17.2 First Class:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 6.50

17.3 Second Class:

All other candidates (not covered in clauses 17.1 and 17.2) who qualify for the award of the degree (vide clause 16) shall be declared to have passed the examination in Second Class.

17.4 A candidate who is absent for end semester examination in a course / project work after having registered for the same shall be considered to have appeared for that examination for the purpose of classification.

17.5 Honors Degree:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have earned the BE/BTech degree with Honours (vide clause 16 and clause 4.2.2):

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.00

18. MALPRACTICES IN TESTS AND EXAMINATIONS

If a candidate indulges in malpractice in any of the tests or end semester examinations, he/she shall be liable for punitive action as per the examination rules prescribed by the college from time to time.

19. AMENDMENTS

Notwithstanding anything contained in this manual, the Kongu Engineering College through the Academic council of the College, reserves the right to modify/amend without notice, the Regulations, Curricula, Syllabi, Scheme of Examinations, procedures, requirements, and rules pertaining to its BE / BTech programme.

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CURRICULUM BREAKDOWN STRUCTURE – R2022-2023										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS	4	4	3	1			3		15	8.93
BS	7	8		4					20	11.90
ES	8	8	3	4					24	14.29
PC	3	3	15	13	15	9			57	33.93
PE					3	3	9	3	18	10.71
OE					4	4	3	3	14	8.33
EC				2	2	6	6	4	20	11.90
MC	0					0			0	0
Semester wise Total	23	23	21	24	24	22	21	10	168	100.00

Category	**Abbreviation**
Lecture hours per week	L
Tutorial hours per week	T
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	P
Credits	C

CURRICULUM BREAKDOWN STRUCTURE – R2023-2024										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS	4	5	2	1			3		15	8.93
BS	8	8		4					20	11.90
ES	7	10	3	4					24	14.29
PC	3		15	12	16	9	3		57	33.93
PE					3	3	6	3	18	10.71
OE					4	4	3	3	14	8.33
EC				2	2	7	7	4	20	11.90
MC	0					0			0	0
Semester wise Total	22	23	20	23	25	23	22	10	168	100.00

Category	**Abbreviation**
Lecture hours per week	L
Tutorial hours per week	T
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	P
Credits	C

CATEGORISATION OF COURSES							
HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22EGT11	Communication Skills I	3	0	0	3	I
2.	22VEC11	Yoga and Values for Holistic Education	1	0	1	1*	I
3.	22EGT21	Communication Skills II	3	0	0	3	II
4.	22EGL31	Communication Skills Development Laboratory*	0	0	2	1	IV
5.	22GCT31	Universal Human Values	2	0	0	2	III
6.	22GCT71	Engineering Economics and Management	3	0	0	3	VII
Total Credits to be earned						**13**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MAC11	Matrices and Ordinary differential equation	3	1	2	4	I
2.	22PHT23	Physics for Food Technology	3	0	0	3	II
3.	22PHL23	Physics laboratory for Food Technology	0	0	2	1	II
4.	22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	II
5.	22CYT13	Chemistry for Food Technology	3	0	0	3	I
6.	22CYL12	Chemistry laboratory for Food Technology	0	0	2	1	I
7.	22MAT41	Numerical Methods for Engineers	3	1	0	4	IV
Total Credits to be earned						**20**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1	22CSC11	Problem Solving and Programming in C	3	0	2	4	I
2	22MEC11	Engineering Drawing	2	0	2	3	I
3	22MEL11	Engineering Practices Laboratory	0	0	2	1	I
4	22ITC23	Python Programming	3	0	2	4	II
5	22MET22	Basics of Mechanical Engineering	3	0	0	3	II
6	22MEL21	Basics of Mechanical Engineering Laboratory	0	0	2	1	II
7	22ITC31	Java Programming	3	0	2	4	III
8	22FTT41	Heat Transfer Operations	3	1	0	4	IV
Total Credits to be earned						24	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	22FTT11	Fundamentals of Biochemistry	3	0	0	3	I	CA
2.	22FTT21	Engineering Properties of Food Materials	3	0	0	3	II/III	FE
3.	22FTT31	Process Fluid Mechanics	3	0	0	3	III	ES
4.	22FTT32	Food Chemistry	3	0	0	3	III	CA

5.	22FTT33	Food Process Calculations	3	1	0	4	III	PE
6.	22FTT34	Refrigeration and Cold Chain Management	3	1	0	4	III	FE
7.	22FTL31	Fluid Flow Laboratory	0	0	2	1	III	PE
8.	22FTL32	Food Chemistry Laboratory	0	0	2	1	III	CA
9.	22FTT42	Food Microbiology	3	0	0	3	IV	FE
10.	22FTT43	Mass Transfer in Food Processing Operations	3	1	0	4	IV	PE
11.	22FTT44	Food Process Engineering I	3	1	0	4	IV/V	PE
12.	22FTT35	Food Packaging Technology	3	0	0	3	IV	PE
13.	22FTL41	Heat and Mass Transfer Laboratory	0	0	2	1	IV	PE
14.	22FTL42	Food Microbiology Laboratory	0	0	2	1	IV	FE
15.	22FTT51	Food Process Engineering II	3	1	0	4	V	FE
16.	22FTT52	Fruit and Vegetable Processing Technology	3	0	0	3	V	FE
17.	22FTT53	Baking and Confectionery Technology	3	0	0	3	V	FE
18.	22FTL51	Food Process Engineering Laboratory	0	0	2	1	V	FE
19.	22FTL52	Fruit and Vegetable Processing Laboratory	0	0	2	1	V	FE
20.	22FTL53	Baking and Confectionery Technology Laboratory	0	0	2	1	V	FE
21	22FTT54	Food Science and Nutrition	3	0	0	3	V/IV	CA
22.	22FTT61	Dairy Technology	3	0	0	3	VI	FE
23.	22FTT62	Food Quality and Safety	3	0	0	3	VI	CA
24.	22FTL61	Dairy Technology Laboratory	0	0	2	1	VI	FE
25.	22FTL62	Food Analysis Laboratory	0	0	2	1	VI	FE
26.	22FTL63	Food Process Equipment Design and Drawing Laboratory	0	0	2	1	VI	FE
Total Credits to be earned						**57**		

PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester - V							
Elective – I							

1	22FTE01	Technology of Snack and Extruded Foods	3	0	0	3	FE
2	22FTE02	Nanotechnology in Food Processing	3	0	0	3	PE
3	22FTE03	Fermentation Technology	3	0	0	3	CA
4	22FTE04	Food Storage and Infestation Control	3	0	0	3	FE
5	22FTE05	Food Additives and Nutraceuticals	3	0	0	3	CA
Semester - VI							
Elective – II							
6.	22FTE06	Food Allergens and Toxicology	3	0	0	3	CA
7.	22FTE07	Modern Separation Process	3	0	0	3	PE
8.	22FTE08	Bioprocess Engineering	3	0	0	3	PE
9.	22FTE09	Emerging Technologies in Food Processing	3	0	0	3	FE
10.	22FTE10	Plantation and Spices Products Technology	3	0	0	3	FE
Semester - VII							
Elective - III							
11.	22FTE11	Enzymes in Food Processing	3	0	0	3	FE
12.	22FTE12	Dairy Products Technology	3	0	0	3	FE
13.	22FTE13	Technology of Fats and Oils	3	0	0	3	CA
14.	22FTE14	Process Instrumentation and control	3	0	0	3	PE
15.	22FTE15	Fundamentals of Computation Fluid Dynamics	3	0	0	3	PE
Elective – IV							
16.	22FTE16	Energy Management in Process Industries	3	0	0	3	PE
17.	22FTE17	Technology of Cereals, Pulses and Oil Seeds	3	0	0	3	FE
18.	22FTE18	Meat, Fish and Poultry Processing	3	0	0	3	FE
19.	22FTE19	Traditional Foods	3	0	0	3	FE
20.	22FTE20	Reaction Engineering	3	0	0	3	PE
Elective - V							
21.	22FTE21	Modeling, Simulation and Soft tools for Food Technologists	3	0	0	3	FE
22.	22FTE22	Beverage Technology	3	0	0	3	FE
23.	22FTE23	Production of Field and Horticulture Crops	3	0	0	3	FE

24.	22FTE24	Cane Sugar Technology	3	0	0	3	FE
25	22GEE01	Fundamentals of Research	3	0	0	3	GE
Semester - VIII							
Elective - VI							
26.	22FTE25	Waste Management and By-Product Utilization in Food Industries	3	0	0	3	FE
27.	22FTE26	Food Process Plant Layout and Safety	3	0	0	3	PE
28.	22FTE27	Agri Business Management and Retail marketing	3	0	0	3	FE
29.	22FTE28	Industrial Waste Water Treatment	3	0	0	3	PE
30	22FTE29	Analytical Instruments in Food Industries	3	0	0	3	FE
Total Credits to be earned						**18**	

* Domain/Stream Abbreviations:, PE – PROCESS ENGINEERING, CA – CHEMISTRY AND ANALYIS, FE-– FOOD ENGINEERING, GE – GENERAL ENGINEERING

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22GEL41	Professional Skills Training I	--	--	--	2	IV
2.	22GEL51	Professional Skills Training II	--	--	--	2	V
3.	22FTP61	Project Work I	0	0	4	2	VI
4.	22GEP61	Comprehensive Test and Viva	--	--	--	2	VI
5.	22FTP71	Project Work II Phase I	0	0	8	4	VII
6.	22GEI71	Industrial Training	--	--	--	1	VII
7.	20FTP81	Project Work II Phase II	0	0	14	7	VIII
Total Credits to be earned						20	

MANDATORY COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MNT11	Student Induction Program	--	--	--	0	I

2.	22MNT31	Environmental Science	2	0	0	0	VI
Total Credits to be earned						00	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22FTX01	Baking Technology	3	0	2	4	V
2.	22FTO01	Food Processing Technology	3	1	0	4	V
3.	22FTX02	Processing of milk and milk products	3	0	2	4	VI
4.	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	VI
5.	22FTO02	Principles of Food safety	3	0	0	3	VII
6.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	VII
7.	22FTO04	Food Ingredients	3	0	0	3	VIII
8.	22FTO05	Food and Nutrition	3	0	0	3	VIII

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
1.	22CEX01	Remote Sensing and its Applications	3	0	2	4	CIVIL
2.	22MEX01	Renewable Energy Sources	3	0	2	4	MECH
3.	22MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
4.	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
5.	22MTX02	Factory Automation	3	0	2	4	MTS
6.	22AUX01	Automotive Engineering	3	0	2	4	AUTO
7.	22ECX01	Basics of Electronics in Automation Appliances	3	0	2	4	ECE
8.	22ECX02	Image Processing	3	0	2	4	ECE
9.	22EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE
10.	22EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE
11.	22EEO03	Programmable Logic Controller and	3	1	0	4	EEE

		SCADA					
12.	22EEO04	Analog and Digital Electronics	3	1	0	4	EEE
13.	22EEO05	Power Electronics and Drives	3	1	0	4	EEE
14.	22EEO06	Sensors and Actuators	3	1	0	4	EEE
15.	22EIO01	Measurements and Instrumentation	3	1	0	4	EIE
16.	22EIO02	Biomedical Instrumentation and Applications	3	1	0	4	EIE
17.	22EIO03	Industrial Automation	3	1	0	4	EIE
18.	22CSX01	Fundamentals of Databases	3	0	2	4	CSE
19.	22CSX02	Data science for Engineers	3	0	2	4	CSE
20.	22CSX03	Enterprise Application Development Using Java	3	0	2	4	CSE
21.	22CSO01	Computational science for Engineers	3	1	0	4	CSE
22.	22CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
23.	22ITO01	Artificial Intelligence	3	1	0	4	IT
24.	22ITX01	Next Generation Databases	3	0	2	4	IT
25.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT
26.	22CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD
27.	22ADO01	Data Warehousing and Data Mining	3	1	0	4	AIDS
28.	22ALO01	Business Intelligence	3	1	0	4	AIML
29.	22CHO01	Industrial Enzymology	3	1	0	4	CHEM
30.	22CHO02	Waste to Energy Conversion	3	1	0	4	CHEM
31.	22CHO03	Applied Nanotechnology	3	1	0	4	CHEM
32.	22FTX01	Baking Technology	3	0	2	4	FT
33.	22FTO01	Food Processing Technology	3	1	0	4	FT
34.	22MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
35.	22MAO02	Numerical Computing	3	1	0	4	MATHS
36.	22MAO03	Stochastic Processes and Queuing Theory	3	1	0	4	MATHS
37.	22MAO04	Statistics for Engineers	3	1	0	4	MATHS
38.	22PHO01	Thin Film Technology	3	1	0	4	PHYSICS
39.	22PHO02	High Energy Storage Devices	3	1	0	4	PHYSICS

40.	22PHO03	Structural and Optical Characterization of Materials	3	1	0	4	PHYSICS
41.	22CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
42.	22CYO02	Chemistry Concepts for Competitive Examinations	3	1	0	4	CHEMISTRY
43.	22CYO03	Organic Chemistry for Industry	3	1	0	4	CHEMISTRY
		SEMESTER VI					
44.	22CEO01	Disaster Management	3	1	0	4	CIVIL
45.	22MEX02	Design of Experiments	3	0	2	4	MECH
46.	22MTO02	Robotics	3	1	0	4	MTS
47.	22MTO03	3D Printing and Design	3	1	0	4	MTS
48.	22AUO01	Automotive Electronics	3	1	0	4	ECE
49.	22ECX03	PCB Design and Fabrication	3	0	2	4	ECE
50.	22EEO07	Energy Conservation and Management	3	1	0	4	EEE
51.	22EEO08	Microprocessors and Microcontrollers Interfacing	3	1	0	4	EEE
52.	22EEO09	Electrical Safety	3	1	0	4	EEE
53.	22EEO10	VLSI System Design	3	1	0	4	EEE
54.	22EEO11	Automation for Industrial Applications	3	1	0	4	EEE
55.	22EIO04	PLC Programming with High Level Languages	3	1	0	4	EIE
56.	22EIO05	Virtual Instrumentation	3	1	0	4	EIE
57.	22CSX04	Foundations of Machine Learning	3	0	2	4	CSE
58.	22CSX05	Web Engineering	3	0	2	4	CSE
59.	22ITX02	Advanced Java Programming	3	0	2	4	IT
60.	22ITO02	Internet of Things	3	1	0	4	IT
61.	22ITO03	Fundamentals of Software Development	3	1	0	4	IT
62.	22ITO04	Mobile Application Development	3	1	0	4	IT
63.	22CDX01	Fundamentals of User Interactive Design	3	0	2	4	CSD
64.	22ADX01	Data Visualization	3	0	2	4	AIDS
65.	22ALX01	Data Exploration and Visualization Techniques	3	0	2	4	AIML
66.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	CHEM
67.	22CHO05	Paints and Coatings	3	1	0	4	CHEM

68.	22CHO06	Powder Technology	3	1	0	4	CHEM
69.	22FTX02	Processing of milk and milk products	3	0	2	4	FT
70.	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	FT
71.	22MAO05	Graph Theory and its Applications	3	1	0	4	MATHS
72.	22MAX01	Data Analytics using R Programming	3	0	2	4	MATHS
73.	22MAO06	Operations Research	3	1	0	4	MATHS
74.	22MAO07	Number Theory and Cryptography	3	1	0	4	MATHS
75.	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	3	1	0	4	PHYSICS
76.	22PHO05	Techniques of Crystal Growth	3	1	0	4	PHYSICS
77.	22CYO04	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
78.	22CYO05	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMISTRY
79.	22CYO06	Nanocomposite Materials	3	1	0	4	CHEMISTRY
		SEMESTER VII					
80.	22CEO02	Introduction to Smart Cities	3	0	0	3	CIVIL
81.	22CEO03	Environmental Health and Safety	3	0	0	3	CIVIL
82.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	MECH
83.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	MECH
84.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	MECH
85.	22MTO04	Drone System Technology	3	0	0	3	MTS
86.	22AUO02	Vehicle Maintenance	3	0	0	3	AUTO
87.	22ECO01	Wearable Devices	3	0	0	3	ECE
88.	22ECX04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
89.	22EEO12	Electric Vehicle	3	0	0	3	EEE
90.	22EEO13	E-Waste Management	3	0	0	3	EEE
91.	22EEO14	Embedded System Design	3	0	0	3	EEE
92.	22EEO15	Energy Storage Systems and Controllers	3	0	0	3	EEE
93.	22EEO16	AI Techniques for Engineering Applications	3	0	0	3	EEE
94.	22EIO06	Introduction to Distributed Control Systems	3	0	0	3	EIE

95.	22EIO07	Instrumentation in Aircraft Navigation and Control	3	0	0	3	EIE
96.	22EIO08	Industry 4.0 with Industrial IoT	3	0	0	3	EIE
97.	22EIO09	Industrial Data Communication	3	0	0	3	EIE
98.	22EIO10	Wireless Instrumentation	3	0	0	3	EIE
99.	22EIO11	Instrumentation Techniques in Agriculture	3	0	0	3	EIE
100.	22CSO03	Nature Inspired optimization techniques	3	0	0	3	CSE
101.	22ITO05	Fundamentals of Cloud Computing	3	0	0	3	IT
102.	22CDO02	Introduction to Mobile Game Design	3	0	0	3	CSD
103.	22CDO03	Introduction to Graphics Design	3	0	0	3	CSD
104.	22ADO02	Neural Networks and Deep Learning	3	0	0	3	AIDS
105.	22ALO02	Industrial Machine Learning	3	0	0	3	AIML
106.	22CHO07	Hydrogen Energy	3	0	0	3	CHEM
107.	22CHO08	Rubber Technology	3	0	0	3	CHEM
108.	22FTO02	Principles of Food safety	3	0	0	3	FT
109.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
110.	22MAO08	Non-Linear Optimization	3	0	0	3	MATHS
111.	22MAO09	Optimization for Engineers	3	0	0	3	MATHS
112.	22CYO07	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
113.	22CYO08	Chemistry in Everyday Life	3	0	0	3	CHEMISTRY
		SEMESTER VIII					
114.	22CEO04	Infrastructure Planning and Management	3	0	0	3	CIVIL
115.	22CEO05	Environmental Laws and Policy	3	0	0	3	CIVIL
116.	22MEO04	Safety Measures for Engineers	3	0	0	3	MECH
117.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
118.	22MEO06	Climate Change and New Energy Technology	3	0	0	3	MECH
119.	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	MTS
120.	22AUO03	Public Transport Management	3	0	0	3	ECE
121.	22AUO04	Autonomous Vehicles	3	0	0	3	ECE
122.	22ECO02	Optical Engineering	3	0	0	3	EEE

123.	22EEO17	Smart Grid Technologies	3	0	0	3	EEE
124.	22EEO18	Biomass Energy Systems	3	0	0	3	EEE
125.	22EIO12	Environmental Sensors	3	0	0	3	EIE
126.	22EIO13	Pollution Control and Management	3	0	0	3	EIE
127.	22CSO04	Machine Translation	3	0	0	3	CSE
128.	22CSO05	Fundamentals of Blockchain	3	0	0	3	CSE
129.	22ITO06	Introduction to Ethical Hacking	3	0	0	3	IT
130.	22ITO07	Business Continuity Planning	3	0	0	3	IT
131.	22CDX02	Virtual Reality and Augmented Reality	3	0	0	3	CSD
132.	22ADO03	Business Analytics	3	0	0	3	AIDS
133.	22ALO03	Machine Learning for Smart Cities	3	0	0	3	AIML
134.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	CHEM
135.	22CHO10	Electrochemical Engineering	3	0	0	3	CHEM
136.	22CHO11	Smart and Functional Materials	3	0	0	3	CHEM
137.	22FTO04	Food Ingredients	3	0	0	3	FT
138.	22FTO05	Food and Nutrition	3	0	0	3	FT
139.	22CYO09	Chemistry of Nutrition for Women Health	3	0	0	3	CHEMISTRY

GENERAL OPEN ELECTIVE

(Common to All BE/BTech branches)

S.No	Course Code	Course Title	L	T	P	C	Offering Department	Semester
1.	22GEO01	German Language Level 1	4	0	0	4	ECE	ALL
2.	22GEO02	Japanese Language Level 1	4	0	0	4	ECE	ALL
3.	22GEO03	Design Thinking for Engineers	3	1	0	4	CSE	5
4.	22GEO04	Innovation and Business Model Development	3	1	0	4	MTS	6
5.	22GEO05	German Language Level 2	4	0	0	4	ECE	ALL

6.	22GEO06	German Language Level 3	3	0	0	3	ECE	ALL
7.	22GEO07	German Language Level 4	3	0	0	3	ECE	ALL
8.	22GEO08	Japanese Language Level 2	4	0	0	4	ECE	ALL
9.	22GEO09	Japanese Language Level 3	3	0	0	3	ECE	ALL
10.	22GEO10	Japanese Language Level 4	3	0	0	3	ECE	ALL
11.	22GEO11	French Language Level 1	4	0	0	4	ECE	ALL
12.	22GEO12	French Language Level 2	4	0	0	4	ECE	ALL
13.	22GEO13	French Language Level 3	3	0	0	3	ECE	ALL
14.	22GEO14	Spanish Language Level 1	4	0	0	4	ECE	ALL
15.	22GEO15	Spanish Language Level 2	4	0	0	4	ECE	ALL
16.	22GEO16	Spanish Language Level 3	3	0	0	3	ECE	ALL
17.	22GEO17	Entrepreneurship Development	3	0	0	3	MTS	7
18.	22GEX01	NCC Studies (Army Wing) - I	3	0	2	4	EEE	5 / 6
19.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT	5 / 6
20.	22MBO01	Cost Accounting for Engineers	3	1	0	4	MBA	5
21.	22MBO02	Economic Analysis for Decision Making	3	1	0	4	MBA	6
22.	22MBO03	Marketing Analytics	3	1	0	4	MBA	7

KEC R2022: SCHEDULING OF COURSES – B.Tech (Food Technology)(2022-2023) Total Credits: 168

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	22EGT11 Communication Skills I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-1*-2*-4)	22CYT13 Chemistry for Food Technology (3-0-0-3)	22FTT11 Fundamentals of Biochemistry (3-0-0-3)	22CSC11 Problem Solving and Programming in C (3-0-2-4)	22MET11 Engineering Drawing (2-1-0-3)	22CYL13 Chemistry laboratory for Food Technology (0-0-2-1)	22MEL11 Engineering Practices Laboratory (0-0-2-1)	22VEC11 Yoga and Values for Holistic Development (1-0-1-1)	22MNT11 Student Induction Program (0-0-0-0)	23
II	22EGT21 Communication Skills II (3-0-0-3)	22MAC21 Multivariable Calculus and Complex Analysis (3-1*-2*-4)	22PHT23 Physics for Food Technology (3-0-0-3)	22FTT21 Engineering Properties of Food Materials (3-0-0-3)	22ITC23 Python Programming (3-0-2-4)	22MET22 Basics of Mechanical Engineering (3-0-0-3)	22PHL23 Physics Laboratory for Food Technology (0-0-2-1)	22MEL21 Basics of Mechanical Engineering Laboratory (0-0-2-1)	22TAM01 Heritage of Tamil (1-0-0-1)		23
III	22FTT31 Process Fluid Mechanics (3-0-0-3)	22FTT32 Food Chemistry (3-0-0-3)	22FTT33 Food Process Calculations (3-1-0-4)	22FTT34 Refrigeration and Cold Chain Management (3-1-0-3)	22FTT35 Food Packaging Technology (3-0-0-3)	22FTL31 Fluid Flow Laboratory (0-0-2-1)	22FTL32 Food Chemistry Laboratory (0-0-2-1)	22GCT31 Universal Human Values (2-0-0-2)	22TAM02 Tamils and Technology (1-0-0-1)		21
IV	22MAT41 Numerical Methods for Engineers (3-1-0-4)	22FTT41 Heat Transfer Operations (3-1-0-4)	22FTT42 Food Microbiology (3-0-0-3)	22FTT43 Mass Transfer in Food Processing Application (3-1-0-4)	22FTT44 Food Process Engineering I (3-1-0-4)	22FTL41 Heat and Mass Transfer Laboratory (0-0-2-1)	22FTL42 Food Microbiology Laboratory (0-0-2-1)	22GCL41 Professional Skills Training I (0-0-0-2)	22EGL31 Communication Skills Development Laboratory (0-0-2-1)		24
V	22FTT51 Food Process Engineering II (3-0-0-3)	22FTT52 Fruit and Vegetable Processing Technology (3-0-0-3)	22FTT53 Baking and Confectionery Technology (3-0-0-3)	22FTT54 Food Science and Nutrition (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22FTL51 Food Process Engineering Laboratory (0-0-2-1)	22FTL52 Fruit and Vegetable Processing Laboratory (0-0-2-1)	22FTL53 Baking and Confectionery Technology Laboratory (0-0-2-1)	22GCL51 Professional Skills Training II (0-0-0-2)	24
VI	22FTT61 Dairy Technology (3-0-0-3)	22FTT62 Food Quality and Safety (3-0-0-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22FTL61 Dairy Technology Laboratory (0-0-2-1)	22FTL62 Food Analysis Laboratory (0-0-2-1)	22FTL63 Food Process Equipment Design and Drawing Laboratory (0-0-2-1)	22FTP61 Project Work I (0-0-8-4)	22MNT31 Environmental Science (2-0-0-0)	20GEP61 Comprehensive Test and Viva (0-0-0-2)	22
VII	22GCT71 Engineering Economics and Management (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	Open Elective III (3-0-0-3)	22FTP71 Project Work II Phase I (0-0-10-5)	22GEI71 Industrial Training (0-0-0-1)				21
VIII	Professional Elective VI (3-0-0-3)	Open Elective IV (3-0-0-3)	22FTP81 Project Work II Phase II (0-0-8-4)								10

KEC R2022: SCHEDULING OF COURSES – B.Tech (Food Technology)(2023-2024) Total Credits: 168

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	22EGT11 Communication Skills I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-1*-2*-4)	22CYT13 Chemistry for Food Technology (3-0-0-3)	22FTT11 Fundamentals of Biochemistry (3-0-0-3)	22CSC11 Problem Solving and Programming in C (3-0-2-4)	22MEC11 Engineering Drawing (2-0-2-3)	22CYL24 Chemistry laboratory for Food Technology (0-0-2-1)	22MEL11 Engineering Practices Laboratory (0-0-2-1)	22VEC11 Yoga and Values for Holistic Development (1-0-1-1)	22MNT11 Student Induction Program (0-0-0-0)	23
II	22EGT21 Communication Skills II (3-0-0-3)	22MAC21 Multivariable Calculus and Complex Analysis (3-1*-2*-4)	22PHT23 Physics for Food Technology (3-0-0-3)	22FTT21 Engineering Properties of Food Materials (3-0-0-3)	22ITC23 Python Programming (3-0-2-4)	22MET22 Basics of Mechanical Engineering (3-0-0-3)	22PHL23 Physics Laboratory for Food Technology (0-0-2-1)	22MEL21 Basics of Mechanical Engineering Laboratory (0-0-2-1)	22TAM01 Heritage of Tamils (1-0-0-1)		23
III	22MAT31 Numerical Methods for Engineers (3-1-0-4)	22FTT31 Process Fluid Mechanics (3-1-0-4)	22FTT32 Food Chemistry (3-0-0-3)	22FTT33 Food Process Calculations (3-1-0-4)	22FTT34 Refrigeration and Cold Chain Management (3-1-0-4)	22FTL31 Fluid Flow Laboratory (0-0-2-1)	22FTL32 Food Chemistry Laboratory (0-0-2-1)	22GCT31 Universal Human Values (2-0-0-2)	22TAM02 Tamils and Technology (1-0-0-1)		22
IV	22FTT41 Heat Transfer Operations (3-1-0-4)	22FTT42 Food Microbiology (3-0-0-3)	22FTT43 Mass Transfer in Food Processing Application (3-1-0-4)	22FTT44 Food Process Engineering I (3-1-0-4)	22FTT45 Food Packaging Technology (3-0-0-3)	22FTL41 Heat and Mass Transfer Laboratory (0-0-2-1)	22FTL42 Food Microbiology Laboratory (0-0-2-1)	22GCL41 Professional Skills Training I (0-0-0-2)	22EGL31 Communication Skills Development Laboratory (0-0-2-1)		23
V	22FTT51 Food Process Engineering II (3-0-0-3)	22FTT52 Fruit and Vegetable Processing Technology (3-0-0-3)	22FTT53 Baking and Confectionery Technology (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22FTL51 Food Process Engineering Laboratory (0-0-2-1)	22FTL52 Fruit and Vegetable Processing Laboratory (0-0-2-1)	22FTL53 Baking and Confectionery Technology Laboratory (0-0-2-1)	22GCL51 Professional Skills Training II (0-0-0-2)		22
VI	22FTT61 Dairy Technology (3-0-0-3)	22FTT62 Food Quality and Safety (3-0-0-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22FTL61 Dairy Technology Laboratory (0-0-2-1)	22FTL62 Food Analysis Laboratory (0-0-2-1)	22FTL63 Food Process Equipment Design and Drawing Laboratory (0-0-2-1)	22FTP61 Project Work I (0-0-4-2)	22MNT31 Environmental Science (2-0-0-0)	20GEP61 Comprehensive Test and Viva (0-0-0-2)	22
VII	22GCT71 Engineering Economics and Management (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	Open Elective III (3-0-0-3)	22FTP71 Project Work II Phase I (0-0-8-4)	22GEI71 Industrial Training (0-0-0-1)				20
VIII	Professional Elective VI (3-0-0-3)	Open Elective IV (3-0-0-3)	22FTP81 Project Work II Phase II (0-0-14-7)								13

MAPPING OF COURSES WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	22EGT11	Communication Skills I						✓			✓	✓	✓	✓		
1	22MAC11	Matrices and Ordinary differential equations	✓	✓	✓		✓									
1	22CYT13	Chemistry for Food Technology	✓	✓	✓	✓									✓	✓
1	22FTT11	Fundamentals of Biochemistry	✓	✓	✓	✓		✓				✓	✓	✓	✓	✓
1	22CSC11	Problem Solving and Programming in C	✓	✓	✓	✓	✓					✓		✓		
1	22MET11	Engineering Drawing	✓	✓	✓		✓					✓		✓	✓	✓
1	22CYL13	Chemistry laboratory for Food Technology	✓	✓	✓	✓			✓						✓	✓
1	22MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓
1	22VEC11	Yoga and Values for Holistic Development						✓		✓	✓					
1	22GCL12	Foundation Engineering Laboratory II	✓	✓	✓	✓					✓					
1	22MNT11	Student Induction Program														
2	22EGT21	Communication Skills II						✓			✓	✓	✓	✓		
2	22MAC21	Multivariable Calculus and Complex Analysis	✓	✓	✓		✓									
2	22PHT23	Physics for Food Technology	✓	✓	✓						✓	✓		✓	✓	✓
2/3	22FTT21	Engineering Properties of Food Materials	✓	✓	✓	✓	✓					✓		✓	✓	✓
2	22ITC23	Python Programming	✓	✓	✓	✓										
2	22MET22	Basics of Mechanical Engineering	✓	✓	✓			✓						✓		✓
2	22PHL23	Physics Laboratory for Food Technology	✓	✓	✓	✓					✓	✓		✓	✓	✓
2	22MEL21	Basics of Mechanical Engineering Laboratory	✓			✓					✓			✓		✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	22GCL11	Foundation Engineering Laboratory I	✓	✓	✓		✓				✓	✓		✓		
3	22TAM01	Heritage of Tamils						✓		✓	✓	✓		✓		
3	22FTT31	Process Fluid Mechanics	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓	✓
3	22FTT32	Food Chemistry	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓
3	22FTT33	Food Process Calculations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	22FTT34	Refrigeration and Cold Chain Management	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓
3	22FTT35	Food Packaging Technology	✓	✓	✓	✓	✓			✓				✓	✓	✓
3	22FTL31	Fluid Flow Laboratory	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
3	22FTL32	Food Chemistry Laboratory	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
3	22GCT31	Universal Human Values	✓	✓	✓	✓										
3	22TAM02	Tamils and Technology						✓		✓	✓	✓		✓		
4	22MAT41	Numerical Methods for Engineers	✓	✓	✓											
4	22FTT41	Heat Transfer Operations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22FTT42	Food Microbiology	✓	✓	✓		✓	✓	✓	✓		✓		✓	✓	✓
4	22FTT43	Mass Transfer in Food Processing Operations	✓	✓	✓	✓	✓		✓	✓		✓		✓	✓	✓
4	22FTT44	Food Process Engineering I	✓	✓	✓	✓	✓					✓		✓	✓	✓
4	22FTL41	Heat and Mass Transfer Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	22FTL42	Food Microbiology Laboratory	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
4	22GEL41	Professional Skills Training I														
4	22EGL31	Communication Skills Development Laboratory									✓	✓		✓		
5	22FTT51	Food process Engineering II	✓	✓	✓	✓		✓				✓		✓	✓	✓
5	22FTT52	Fruit And Vegetable Processing Technology	✓	✓	✓	✓		✓				✓			✓	✓
5	22FTT53	Baking And Confectionery Technology	✓	✓	✓	✓		✓				✓		✓	✓	✓
5	22FTL51	Food Process Engineering Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	✓
5	22FTL52	Fruit And Vegetable Processing Technology	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Laboratory														
5	22FTL53	Baking And Confectionery Technology Laboratory	✓	✓	✓	✓		✓		✓	✓	✓		✓	✓	✓
5/4	22FTE54	Food Science And Nutrition	✓	✓	✓	✓		✓				✓		✓	✓	✓
6	22FTT61	Dairy Technology	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓
6	22FTT62	Food Quality And Safety	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓
6	22FTL61	Dairy Technology Laboratory	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓
6	22FTL62	Food Analysis Laboratory	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓
6	22FTL63	Food Process Equipment Design Drawing Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
6	22FTP61	Project work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	22GEP61	Comprehensive Test And Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
6	22MNT31	Environmental Science	✓	✓	✓				✓							
7	22GCT71	Engineering Economics And Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	22FTP71	Project work II Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	22FTP81	Project II Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Professional Elective Courses																
5	22FTE01	Technology of Snack And Extruded Foods	✓	✓	✓	✓						✓		✓	✓	✓
5	22FTE02	Nano Technology In Food Processing	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓
5	22FTE03	Fermentation Technology	✓	✓	✓	✓	✓					✓		✓	✓	✓
5	22FTE04	Food Storage And Infestation Control	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓
5	22FTE05	Food Additives And Nutraceuticals	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓
6	22FTE06	Food Allergens And Toxicology	✓	✓	✓	✓		✓	✓			✓		✓	✓	✓
6	22FTE07	Modern Separation Process	✓	✓	✓		✓	✓	✓			✓		✓	✓	✓
6	22FTE08	Bioprocess Engineering	✓	✓	✓	✓	✓					✓		✓	✓	✓
6	22FTE09	Emerging Technology In Food Processing	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓
6	22FTE10	Plantation and Spices	✓	✓	✓			✓	✓	✓		✓		✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Products Technology														
7	22FTE11	Enzymes in Food Processing	✓	✓	✓	✓		✓				✓		✓	✓	✓
7	22FTE12	Dairy Products Technology	✓	✓	✓	✓	✓					✓		✓	✓	✓
7	22FTE13	Technology of Fats and Oils	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓
7	22FTE14	Process Instrumentation And Control	✓	✓	✓	✓	✓					✓		✓	✓	✓
7	22FTE15	Fundamentals Of Computation Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
7	22FTE16	Energy Management In Process Industries	✓	✓	✓			✓	✓			✓		✓	✓	✓
7	22FTE17	Technology of Cereals and Pulses and Oil Seeds	✓	✓	✓	✓		✓	✓			✓		✓	✓	✓
7	22FTE18	Meat, Fish and Poultry Processing	✓	✓	✓			✓				✓		✓	✓	✓
7	22FTE19	Traditional Foods	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓
7	22FTE20	Reaction Engineering	✓	✓	✓	✓	✓							✓	✓	✓
7	22FTE21	Modeling Simulation And Soft Tools For Food Technologists	✓	✓	✓	✓	✓					✓		✓	✓	✓
7	22FTE22	Beverage Technology	✓	✓	✓			✓				✓		✓	✓	✓
7	22FTE23	Production Of Field And Horticulture Crops	✓	✓	✓			✓				✓		✓	✓	✓
7	22FTE24	Cane Sugar Technology	✓	✓	✓				✓			✓		✓	✓	✓
7	22GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	22FTE25	Waste Management and By-Product Utilization In Food Industries	✓	✓	✓	✓		✓	✓			✓		✓	✓	✓
8	22FTE26	Food Process Plant Layout And Safety	✓	✓	✓			✓	✓			✓		✓	✓	✓
8	22FTE27	Agri Business Management And Retail Marketing	✓	✓	✓							✓	✓	✓		✓
8	22FTE28	Industrial Waste Water Treatment	✓	✓	✓	✓		✓	✓			✓		✓	✓	✓
8	22FTE29	Analytical Instruments In Food Industries	✓	✓		✓	✓					✓		✓	✓	✓
5	22FTX01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
5	22FTO01	Food Processing Technology	✓	✓	✓	✓		✓				✓		✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22FTX02	Processing Of Milk And Milk Products	✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓
6	22FTX03	Processing Of Fruits And Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓
7	22FTO02	Principles Of Food Safety	✓	✓	✓			✓	✓	✓		✓		✓		
7	22FTO03	Fundamentals Of Food Packaging Storage	✓	✓	✓	✓	✓	✓		✓		✓		✓		
8	22FTO04	Food Ingredients	✓	✓	✓			✓		✓		✓		✓		
8	22FTO05	Food And Nutrition	✓	✓	✓			✓				✓		✓		

Open elective

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22CEX01	Remote Sensing and its Applications	✓	✓	✓	✓		✓			✓			✓		
5	22MEX01	Renewable Energy Sources	✓		✓	✓	✓	✓	✓	✓	✓					
5	22MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	22MTX01	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓							✓		
5	22MTX02	Factory Automation	✓	✓	✓	✓	✓				✓	✓		✓		
5	22AUX01	Automotive Engineering	✓	✓	✓			✓	✓		✓	✓		✓		
5	22ECX01	Basics of Electronics in Automation Appliances	✓	✓	✓	✓		✓	✓	✓			✓	✓		
5	22ECX02	Image Processing	✓	✓	✓	✓	✓				✓	✓		✓		
5	22EEO01	Solar and Wind Energy Systems	✓	✓	✓			✓	✓					✓		
5	22EEO02	Electrical Wiring and Lighting	✓	✓	✓	✓	✓							✓		
5	22EEO03	Programmable Logic Controller and SCADA	✓	✓	✓	✓		✓			✓			✓		
5	22EEO04	Analog and Digital Electronics	✓	✓	✓	✓	✓							✓		
5	22EEO05	Power Electronics and Drives	✓	✓	✓	✓	✓	✓			✓					
Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22EEO06	Sensors and Actuators	✓	✓	✓			✓						✓		

5	22EIO01	Measurements and Instrumentation	✓	✓	✓	✓	✓									
5	22EIO02	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓	✓		✓						
5	22EIO03	Industrial Automation	✓	✓	✓	✓	✓									
5	22CSX01	Fundamentals of Databases	✓	✓	✓											
5	22CSX02	Data science for Engineers	✓	✓	✓	✓	✓									
5	22CSX03	Enterprise Application Development Using Java	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5	22CSO01	Computational science for Engineers	✓	✓	✓											
5	22CSO02	Formal Languages and Automata Theory	✓	✓	✓											
5	22ITO01	Artificial Intelligence	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
5	22ITX01	Next Generation Databases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
5	22CDO01	Fundamentals of User Experience Design	✓	✓	✓	✓	✓				✓	✓	✓			
5	22ADO01	Data Warehousing and Data Mining	✓	✓	✓											
5	22ALO01	Business Intelligence	✓	✓	✓											
5	22CHO01	Industrial Enzymology	✓	✓	✓							✓	✓	✓		
5	22CHO02	Waste to Energy Conversion	✓	✓												
5	22CHO03	Applied Nanotechnology	✓	✓	✓	✓	✓	✓	✓	✓				✓		
5	22FTX01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
5	22FTO01	Food Processing Technology	✓	✓	✓	✓		✓				✓		✓		
5	22MAO01	Mathematical Foundations for Machine Learning	✓	✓	✓	✓	✓									
5	22MAO02	Numerical Computing	✓	✓	✓											
5	22MAO03	Stochastic Processes and Queuing Theory	✓	✓	✓											
5	22MAO04	Statistics for Engineers	✓	✓	✓											
5	22PHO01	Thin Film Technology	✓	✓	✓						✓	✓		✓		
5	22PHO02	High Energy Storage Devices	✓	✓	✓						✓	✓		✓		
		Structural and Optical														

5	22PHO03	Characterization of Materials	✓	✓	✓						✓	✓		✓		
5	22CYO01	Instrumental Methods of Analysis	✓	✓	✓	✓										
Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22CYO02	Chemistry Concepts for Competitive Examinations	✓	✓	✓											
5	22CYO03	Organic Chemistry for Industry	✓	✓	✓	✓										
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22CEO01	Disaster Management	✓	✓	✓			✓	✓					✓		
6	22MEX02	Design of Experiments	✓	✓	✓	✓	✓				✓					
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
6	22MTO02	Robotics	✓	✓	✓	✓	✓							✓		
6	22MTO03	3D Printing and Design	✓	✓			✓							✓		
6	22AUO01	Automotive Electronics	✓	✓	✓	✓								✓		
6	22ECX03	PCB Design and Fabrication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
6	22EEO07	Energy Conservation and Management	✓	✓	✓		✓		✓	✓	✓			✓		
6	22EEO08	Microprocessors and Microcontrollers Interfacing	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
6	22EEO09	Electrical Safety	✓	✓	✓				✓	✓			✓	✓		
6	22EEO10	VLSI System Design	✓	✓	✓	✓	✓				✓		✓	✓		
6	22EEO11	Automation for Industrial Applications	✓	✓	✓	✓			✓		✓			✓		
6	22EIO04	PLC Programming with High Level Languages	✓	✓	✓	✓	✓									
6	22EIO05	Virtual Instrumentation	✓	✓	✓	✓	✓									
6	22CSX04	Foundations of Machine Learning	✓	✓	✓											
6	22CSX05	Web Engineering	✓	✓	✓											
6	22ITX02	Advanced Java Programming	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22ITO02	Internet of Things	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO03	Fundamentals of Software Development	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			

6	22ITO04	Mobile Application Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22CDX01	Fundamentals of User Interactive Design	✓	✓	✓	✓										
6	22ADX01	Data Visualization	✓	✓	✓											
6	22ALX01	Data Exploration and Visualization Techniques	✓	✓	✓											
6	22CHO04	Air Pollution Monitoring and Control	✓	✓	✓			✓	✓							
6	22CHO05	Paints and Coatings	✓	✓	✓				✓							
6	22CHO06	Powder Technology	✓	✓	✓			✓	✓					✓		
6	22FTX02	Processing of milk and milk products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22FTX03	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22MAO05	Graph Theory and its Applications	✓	✓	✓											
6	22MAX01	Data Analytics using R Programming	✓	✓	✓	✓	✓									
6	22MAO06	Operations Research	✓	✓	✓											
6	22MAO07	Number Theory and Cryptography	✓	✓	✓		✓									
6	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	✓	✓	✓						✓	✓		✓		
6	22PHO05	Techniques of Crystal Growth	✓	✓	✓						✓	✓		✓		
6	22CYO04	Corrosion Science and Engineering	✓	✓	✓	✓										
6	22CYO05	Chemistry of Cosmetics in Daily Life	✓	✓	✓											
6	22CYO06	Nanocomposite Materials	✓	✓	✓	✓										
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22CEO02	Introduction to Smart Cities	✓	✓	✓	✓	✓									
7	22CEO03	Environmental Health and Safety	✓	✓	✓			✓	✓							
7	22MEO01	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		

7	22MEO02	Principles of Management and Industrial Psychology	✓					✓				✓	✓			
7	22MEO03	Waste Heat Recovery System and Storage	✓	✓	✓	✓			✓							
7	22GEO05	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7	22MTO04	Drone System Technology	✓	✓	✓	✓	✓							✓		
7	22AUO02	Vehicle Maintenance	✓	✓			✓		✓					✓		
7	22ECO01	Wearable Devices	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
7	22ECX04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
7	22EEO12	Electric Vehicle	✓	✓	✓	✓		✓	✓		✓			✓		
7	22EEO13	E-Waste Management	✓	✓	✓	✓		✓	✓					✓		
7	22EEO14	Embedded System Design	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
7	22EEO15	Energy Storage Systems and Controllers	✓	✓	✓			✓			✓		✓	✓		
7	22EEO16	AI Techniques for Engineering Applications	✓	✓	✓	✓										
7	22EIO06	Introduction to Distributed Control Systems	✓	✓	✓	✓	✓			✓		✓				
7	22EIO07	Instrumentation in Aircraft Navigation and Control	✓	✓	✓	✓	✓									
7	22EIO08	Industry 4.0 with Industrial IoT	✓	✓	✓	✓	✓			✓						
7	22EIO09	Industrial Data Communication	✓	✓	✓	✓	✓	✓								
7	22EIO10	Wireless Instrumentation	✓	✓	✓	✓	✓		✓							
7	22EIO11	Instrumentation Techniques in Agriculture	✓	✓	✓	✓	✓									
7	22CSO03	Nature Inspired optimization techniques	✓	✓	✓											
7	22ITO05	Fundamentals of Cloud Computing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			

Sem.	Course Code	Course Title	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22ITO06	Introduction to Ethical Hacking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22CDO02	Introduction to Mobile Game Design	✓	✓	✓	✓										
7	22CDO03	Introduction to Graphics Design	✓	✓	✓	✓										
7	22ADO02	Neural Networks and Deep Learning	✓	✓	✓	✓										
7	22ALO02	Industrial Machine Learning	✓	✓	✓											
7	22CHO07	Hydrogen Energy	✓	✓										✓		
7	22CHO08	Rubber Technology	✓	✓				✓	✓					✓		
7	22FTO02	Principles of Food safety	✓	✓	✓			✓	✓	✓		✓		✓		
7	22FTO03	Fundamentals of Food Packaging and Storage	✓	✓	✓	✓	✓	✓		✓		✓		✓		
7	22MAO08	Non-Linear Optimization	✓	✓	✓											
7	22MAO09	Optimization for Engineers	✓	✓	✓											
7	22CYO07	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	22CYO08	Chemistry in Every day Life	✓	✓	✓	✓										
7	22MBO03	Marketing Analytics										✓	✓	✓		
8	22CEO04	Infrastructure Planning and Management	✓	✓	✓		✓									
8	22CEO05	Environmental Laws and Policy	✓	✓			✓									
8	22MEO04	Safety Measures for Engineers	✓					✓	✓	✓						
8	22MEO05	Energy Conservation in Thermal Equipments	✓		✓		✓	✓	✓					✓		
8	22MEO06	Climate Change and New Energy Technology	✓		✓			✓	✓	✓						
8	22MTO05	Micro and Nano Electromechanical Systems	✓	✓	✓	✓								✓		
8	22AUO03	Public Transport Management	✓	✓				✓	✓	✓				✓		
8	22AUO04	Autonomous Vehicles	✓	✓	✓	✓	✓	✓	✓					✓		
8	22ECO02	Optical Engineering	✓	✓	✓	✓		✓	✓	✓	✓			✓		

8	22EEO17	Smart Grid Technologies	✓	✓	✓	✓	✓			✓				✓		
8	22EEO18	Biomass Energy Systems	✓	✓	✓			✓	✓				✓	✓		
8	22EIO12	Environmental Sensors	✓	✓	✓	✓	✓		✓							
8	22EIO13	Pollution Control and Management	✓	✓	✓	✓	✓	✓		✓						
8	22CSO04	Machine Translation	✓	✓	✓											
8	22CSO05	Fundamentals of Blockchain	✓	✓	✓											
8	22ITO07	Business Continuity Planning	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
8	22CDX02	Virtual Reality and Augmented Reality	✓	✓	✓	✓										
8	22ADO03	Business Analytics	✓	✓	✓	✓										
8	22ALO03	Machine Learning for Smart Cities	✓	✓	✓	✓										
8	22CHO09	Industrial Accident Prevention and Management	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		
8	22CHO10	Electrochemical Engineering	✓	✓	✓											
8	22CHO11	Smart and Functional Materials	✓	✓					✓	✓	✓			✓		
8	22FTO04	Food Ingredients	✓	✓	✓			✓		✓		✓		✓		
8	22FTO05	Food and Nutrition	✓	✓	✓			✓				✓		✓		
8	22CYO09	Chemistry of Nutrition for Women Health	✓	✓	✓											
General Open ElectiveCourses																
ALL	22GEO01	German Language Level1								✓	✓	✓		✓		
ALL	22GEO02	Japanese Language Level 1								✓	✓	✓		✓		
5	22GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
ALL	22GEO05	German Language Level2								✓	✓	✓		✓		
ALL	22GEO06	German Language Level3								✓	✓	✓		✓		
ALL	22GEO07	German Language Level4								✓	✓	✓		✓		
ALL	22GEO08	Japanese Language Level 2								✓	✓	✓		✓		
ALL	22GEO09	Japanese Language Level 3								✓	✓	✓		✓		

ALL	22GEO10	Japanese Language Level 4								✓	✓	✓		✓		
ALL	22GEO11	French Language Level1								✓	✓	✓		✓		
ALL	22GEO12	French Language Level2								✓	✓	✓		✓		
ALL	22GEO13	French Language Level3								✓	✓	✓		✓		
ALL	22GEO14	Spanish Language Level1								✓	✓	✓		✓		
ALL	22GEO15	Spanish Language Level2								✓	✓	✓		✓		
ALL	22GEO16	Spanish Language Level3								✓	✓	✓		✓		
7	22GEO17	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5 / 6	22GEX01	NCC Studies (Army Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5 / 6	22GEX02	NCC Studies (Air Wing) -1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22MBO03	Marketing Analytics										✓	✓	✓		

B.Tech . FOOD TECHNOLOGY CURRICULUM – R2022
(For the students admitted in the academic year 2022-23)

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT11	Communication Skills I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22CYT13	Chemistry for Food Technology	3	0	0	3	40	60	100	BS
22FTT11	Fundamentals of Biochemistry	3	0	0	3	40	60	100	PC
22CSC11	Problem Solving and Programming in C	3	0	2	4	50	50	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
Practical / Employability Enhancement									
22CYL13	Chemistry Laboratory for Food Technology	0	0	2	1	60	40	100	BS
22MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	ES
22VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					**23**				

*Alternate weeks

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT21	Communication Skills - II	3	0	0	3	40	60	100	HS
22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
22PHT23	Physics for Food Technology	3	0	0	3	40	60	100	BS
22FTT21	Engineering Properties of Food Materials	3	0	0	3	40	60	100	PC
22ITC23	Python Programming	3	0	2	4	50	50	100	ES
22MET22	Basics of Mechanical Engineering	3	0	0	3	40	60	100	ES
Practical / Employability Enhancement									
22PHL23	Physics Laboratory for Food Technology	0	0	2	1	60	40	100	BS
22MEL21	Basics of Mechanical Engineering Laboratory	0	0	2	1	60	40	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
	Total Credits to be earned				**23**				

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SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22FTT31	Process Fluid Mechanics	3	0	0	3	40	60	100	ES
22FTT32	Food Chemistry	3	0	0	3	40	60	100	PC
22FTT33	Food Process Calculations	3	1	0	4	40	60	100	PC
22FTT34	Refrigeration and Cold Chain Management	3	1	0	3	40	60	100	PC
22FTT35	Food Packaging Technology	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22FTL31	Fluid Flow Laboratory	0	0	2	1	60	40	100	PC
22FTL32	Food Chemistry Laboratory	0	0	2	1	60	40	100	PC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Total Credits to be earned					21				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22FTT41	Heat Transfer Operations	3	1	0	4	40	60	100	ES
22FTT42	Food Microbiology	3	0	0	3	40	60	100	PC
22FTT43	Mass Transfer in Food Processing Operations	3	1	0	4	40	60	100	PC
22FTT44	Food Process Engineering - I	3	1	0	4	40	60	100	PC
Practical / Employability Enhancement									
22FTL41	Heat and Mass Transfer Laboratory	0	0	2	1	60	40	100	PC
22FTL42	Food Microbiology Laboratory	0	0	2	1	60	40	100	PC
22GCL41	Professional Skills Training I	--	--	--	2	100	0	100	EC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
Total Credits to be earned					24				

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SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22FTT51	Food Process Engineering - II	3	0	0	3	40	60	100	PC
22FTT52	Fruit and Vegetable Processing Technology	3	0	0	3	40	60	100	PC
22FTT53	Baking and Confectionery Technology	3	0	0	3	40	60	100	PC
22FTT54	Food Science and Nutrition	3	0	0	3	40	60	100	PC
	Professional Elective – I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22FTL51	Food Process Engineering Laboratory	0	0	2	1	60	40	100	PC
22FTL52	Fruit and Vegetable Processing Technology Laboratory	0	0	2	1	60	40	100	PC
22FTL53	Baking and Confectionery Technology Laboratory	0	0	2	1	60	40	100	PC
22GCL51	Professional Skills Training II	--	--	--	2	100	0	100	EC
Total Credits to be earned					24				

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22FTT61	Dairy Technology	3	0	0	3	40	60	100	PC
22FTT62	Food Quality and Safety	3	0	0	3	40	60	100	PC
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Open Elective – II	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22FTL61	Dairy Technology Laboratory	0	0	2	1	60	40	100	PC
22FTL62	Food Analysis Laboratory	0	0	2	1	60	40	100	PC
22FTL63	Food Process Equipment Design and Drawing Laboratory	0	0	2	1	60	40	100	PC
22FTP61	Project Work I	0	0	8	4	50	50	100	EC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					22				

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SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Professional Elective – V	3	0	0	3	40	60	100	PE
	Open Elective – III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22FTP71	Project Work II Phase I	0	0	10	5	50	50	100	EC
22GEI71	Industrial Training	0	0	0	1	100	0	100	EC
Total Credits to be earned					**21**				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective – VI	3	0	0	3	40	60	100	PE
	Open Elective – IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22FTP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					**10**				

Total Credits: 168

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LIST OF PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22FTE01	Technology of Snack and Extruded Foods	3	0	0	3	FE
2.	22FTE02	Nanotechnology in Food Processing	3	0	0	3	PE
3.	22FTE03	Fermentation Technology	3	0	0	3	CA
4.	22FTE04	Food Storage and Infestation Control	3	0	0	3	FE
5.	22FTE05	Food Additives and Nutraceuticals	3	0	0	3	CA
Semester - VI							
Elective – II							
6.	22FTE06	Food Allergens and Toxicology	3	0	0	3	CA
7	22FTE07	Modern Separation Process	3	0	0	3	PE
8.	22FTE08	Bioprocess Engineering	3	0	0	3	PE
9.	22FTE09	Emerging Technologies in Food Processing	3	0	0	3	FE
10.	22FTE10	Plantation and Spices Products Technology	3	0	0	3	FE
Semester - VII							
Elective - III							
11.	22FTE11	Enzymes in Food Processing	3	0	0	3	FE
12.	22FTE12	Dairy Products Technology	3	0	0	3	FE
13.	22FTE13	Technology of Fats and Oils	3	0	0	3	CA
14.	22FTE14	Process Instrumentation and control	3	0	0	3	PE
15.	22FTE15	Fundamentals of Computation Fluid Dynamics	3	0	0	3	PE
Elective – IV							
16.	22FTE16	Energy Management in Process Industries	3	0	0	3	PE
17.	22FTE17	Technology of Cereals, Pulses and Oil Seeds	3	0	0	3	FE
18.	22FTE18	Meat, Fish and Poultry Processing	3	0	0	3	FE
19.	22FTE19	Traditional Foods	3	0	0	3	FE
20.	22FTE20	Reaction Engineering	3	0	0	3	PE

Elective - V							
21.	22FTE21	Modeling, Simulation and Soft tools for Food Technologists	3	0	0	3	FE
22.	22FTE22	Beverage Technology	3	0	0	3	FE
23.	22FTE23	Production of Field and Horticulture Crops	3	0	0	3	FE
24.	22FTE24	Cane Sugar Technology	3	0	0	3	FE
25.	22GEE01	Fundamentals of Research	3	0	0	3	GE
Semester - VIII							
Elective - VI							
26.	22FTE25	Waste Management and By-Product Utilization in Food Industries	3	0	0	3	FE
27.	22FTE26	Food Process Plant Layout and Safety	3	0	0	3	PE
28.	22FTE27	Agri Business Management and Retail marketing	3	0	0	3	FE
29.	22FTE28	Industrial Waste Water Treatment	3	0	0	3	PE
30.	22FTE29	Analytical Instruments in Food Industries	3	0	0	3	FE
Total Credits to be earned						**18**	

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SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT11	Communication Skills I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary differential equation	3	1*	2*	4	50	50	100	BS
22CYT13	Chemistry for Food Technology	3	0	0	3	40	60	100	BS
22CSC11	Problem Solving and Programming in C	3	0	2	4	50	50	100	ES
22FTT11	Fundamentals of Biochemistry	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22CYL12	Chemistry laboratory for Food Technology	0	0	2	1	60	40	100	BS
22GCL12	Foundation Engineering Laboratory – II	0	0	6	3	100	0	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					22				

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT21	Communication Skills II	3	0	0	3	40	60	100	HS
22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
22PHT23	Physics for Food Technology	3	0	0	3	40	60	100	BS
22ITC23	Python Programming	3	0	2	4	50	50	100	ES
22MEC11	Engineering Drawing	2	0	2	3	40	60	100	ES
Practical / Employability Enhancement									
22PHL23	Physics Laboratory for Food Technology	0	0	2	1	60	40	100	BS
22GCL11	Foundation Engineering Laboratory – I	0	0	6	3	100	0	100	ES
22VEC11	Yoga and Values for Holistic Development	--	--	--	1*	100	0	100	HS
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Total Credits to be earned					23				

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SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22FTT21	Engineering Properties of Food Materials	3	0	0	3	40	60	100	PC
22FTT31	Process Fluid Mechanics	3	0	0	3	40	60	100	ES
22FTT32	Food Chemistry	3	0	0	3	40	60	100	PC
22FTT33	Food Process Calculations	3	1	0	4	40	60	100	PC
22FTT34	Refrigeration and Cold Chain Management	3	1	0	3	40	60	100	PC
Practical / Employability Enhancement									
22FTL31	Fluid Flow Laboratory	0	0	2	1	60	40	100	PC
22FTL32	Food Chemistry Laboratory	0	0	2	1	60	40	100	PC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					20				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22FTT41	Heat Transfer Operations	3	1	0	4	40	60	100	ES
22FTT42	Food Microbiology	3	0	0	3	40	60	100	PC
22FTT43	Mass Transfer in Food Processing Operations	3	1	0	4	40	60	100	PC
22FTT54	Food Science and Nutrition	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22FTL41	Heat and Mass Transfer Laboratory	0	0	2	1	60	40	100	PC
22FTL42	Food Microbiology Laboratory	0	0	2	1	60	40	100	PC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
22GCL41	Professional Skills Training - I	--	--	--	2	100	0	100	EC
Total Credits to be earned					23				

$ Professional Skills Training I / Industrial Training I for a total period of about 80 hr during the period of 3rd Sem end summer holidays and 4th sem.

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SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22FTT44	Food Process Engineering - I	3	1	0	4	40	60	100	PC
22FTT51	Food Process Engineering - II	3	1	0	3	40	60	100	PC
22FTT52	Fruit and Vegetable Processing Technology	3	0	0	3	40	60	100	PC
22FTT53	Baking and Confectionery Technology	3	0	0	3	40	60	100	PC
	Professional Elective - I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22FTL51	Food Process Engineering Laboratory	0	0	2	1	60	40	100	PC
22FTL52	Fruit and Vegetable Processing Laboratory	0	0	2	1	60	40	100	PC
22FTL53	Baking and Confectionery Technology Laboratory	0	0	2	1	60	40	100	PC
22GCL51	Professional Skills Training - II	--	--	--	2	100	0	100	EC
Total Credits to be earned					25				

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22FTT61	Dairy Technology	3	0	0	3	40	60	100	PC
22FTT62	Food Quality and Safety	3	0	0	3	40	60	100	PC
	Professional Elective - II	3	0	0	3	40	60	100	PE
	Open Elective - II	3	1/0	0/2	4	40	60	100	OE
Practical / Employability Enhancement									
22FTL61	Dairy Technology Laboratory	0	0	2	1	60	40	100	PC
22FTL62	Food Analysis Laboratory	0	0	2	1	60	40	100	PC
22FTL63	Food Process Equipment Design and Drawing Laboratory	0	0	2	1	60	40	100	PC
22FTP62	Project Work I	0	0	10	5	100	0	100	EC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					23				

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SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
22FTT35	Food Packaging Technology	3	0	0	3	40	60	100	PC
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Open Elective - III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22FTP72	Project Work II Phase I	0	0	12	6	50	50	100	EC
22GEI71	Industrial Training	0	0	0	1	100	0	100	EC
Total Credits to be earned					**22**				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective - V	3	0	0	3	40	60	100	PE
	Open Elective - IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22FTP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 168

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PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22FTE01	Technology of Snack and Extruded Foods	3	0	0	3	FE
2.	22FTE02	Nanotechnology in Food Processing	3	0	0	3	PE
3.	22FTE03	Fermentation Technology	3	0	0	3	CA
4.	22FTE04	Food Storage and Infestation Control	3	0	0	3	FE
5.	22FTE05	Food Additives and Nutraceuticals	3	0	0	3	CA
Semester – VI							
Elective – II							
6.	22FTE06	Food Allergens and Toxicology	3	0	0	3	CA
7.	22FTE07	Modern Separation Process	3	0	0	3	PE
8.	22FTE08	Bioprocess Engineering	3	0	0	3	PE
9.	22FTE09	Emerging Technologies in Food Processing	3	0	0	3	FE
10.	22FTE10	Plantation and Spices Products Technology	3	0	0	3	FE
Semester – VII							
Elective – III							
11.	22FTE11	Enzymes in Food Processing	3	0	0	3	FE
12.	22FTE12	Dairy Products Technology	3	0	0	3	FE
13.	22FTE13	Technology of Fats and Oils	3	0	0	3	CA
14.	22FTE14	Process Instrumentation and control	3	0	0	3	PE
15.	22FTE15	Fundamentals of Computation Fluid Dynamics	3	0	0	3	PE
Elective – IV							
16.	22FTE16	Energy Management in Process Industries	3	0	0	3	PE
17.	22FTE17	Technology of Cereals, Pulses and Oil Seeds	3	0	0	3	FE
18.	22FTE18	Meat, Fish and Poultry Processing	3	0	0	3	FE
19.	22FTE19	Traditional Foods	3	0	0	3	FE
20.	22FTE20	Reaction Engineering	3	0	0	3	PE
21.	22FTE21	Modeling, Simulation and Soft tools for Food Technologists	3	0	0	3	FE

22.	22FTE22	Beverage Technology	3	0	0	3	FE
23.	22FTE23	Production of Field and Horticulture Crops	3	0	0	3	FE
24.	22FTE24	Cane Sugar Technology	3	0	0	3	FE
25.	22GEE01	Fundamentals of Research	3	0	0	3	GE
Semester – VIII							
Elective – V							
26.	22FTE25	Waste Management and By-Product Utilization in Food Industries	3	0	0	3	FE
27.	22FTE26	Food Process Plant Layout and Safety	3	0	0	3	PE
28.	22FTE27	Agri Business Management and Retail marketing	3	0	0	3	FE
29.	22FTE28	Industrial Waste Water Treatment	3	0	0	3	PE
30.	22FTE29	Analytical Instruments in Food Industries	3	0	0	3	FE
Total Credits to be earned						**15**	

Domain/Stream Abbreviations : PE – PROCESS ENGINEERING, CA – CHEMISTRY AND ANALYIS, FE-– FOOD ENGINEERING , GE – GENERAL ENGINEERING

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OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22FTX01	Baking Technology	3	0	2	4	V
2.	22FTO01	Food Processing Technology	3	1	0	4	V
3.	22FTX02	Processing of milk and milk products	3	0	2	4	VI
4.	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	VI
5.	22FTO02	Principles of Food safety	3	0	0	3	VII
6.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	VII
7.	22FTO04	Food Ingredients	3	0	0	3	VIII
8.	22FTO05	Food and Nutrition	3	0	0	3	VIII

22EGT11 - COMMUNICATION SKILLS I							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**I**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to impart required levels of Communication Skills and Proficiency in English language necessary for different professional contexts.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Parts of speech **-** Tenses **-** Types of sentences**:** Assertive, Imperative, Interrogative & Exclamatory **–** Affirmative & Negative **-** Gerunds & Infinitives **- Vocabulary:** Affixes **-** Synonyms & Antonyms **- Listening:** Types of listening **-** Barriers to listening **-** Listening to short talks **-** TV shows **- Speaking:** Verbal & Non-verbal communication **-** Pair conversation **-** Role play **- Reading:** Types of Reading **–** Intensive: scanning, word by word, survey **- Writing:** Dialogue writing, Informal Letters **-** Paragraph writing		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Voices **-** Impersonal passives **- Vocabulary:** Homonyms, Homophones & Homographs **- Listening:** Importance of listening **-** Listening to announcements & radio broadcasts **- Speaking:** Persuasive & Impromptu talks **-** Narrating a story **- Reading:** Reading comprehension **-** Articles from Newspapers/Magazines **-** Cloze exercises **- Writing:** Essay writing, Jumbled sentences		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Prepositions **- Vocabulary:** Compound Nouns **- Listening:** Listening to TED Talks, Commentaries **- Speaking:** Self Introduction **- Reading:** Extensive: speed, skimming **-** Identifying lexical & contextual meanings **- Writing:** Instructions & Warnings **-** Formal letters: Seeking permission for Industrial visits & Inviting guests		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Articles & Determiners **- Vocabulary:** Technical Vocabulary **-** Analogy **-** Unscrambling words **-** Logical reasoning **- Listening:** Listening to conversations - **Speaking:** Tongue twisters **-** Skill Sharing **-** Note-taking **- Reading:** Note making **-** Paraphrasing & Summarizing **- Writing:** Recommendations & Suggestions **-** Business letters: Enquiry, Calling for quotations & placing orders		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Cause and effect expressions **- Vocabulary:** Abbreviations & acronyms, Definitions **Listening:** Listening to eminent personalities **- Speaking:** Commonly mispronounced words **-** Welcome address, Chief guest address & Vote of thanks **- Reading -** IELTS type passages **- Writing:** Preparing transcript for a speech **-** Interpreting news articles & advertisements		
		Total:45

TEXT BOOK:

1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw-Hill India, 2017.
2.	S. P. Dhanavel, "English and Communication Skills for Students of Science and Engineering", Orient BlackSwan Publishers, Hyderabad, 2009.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 1, 3rd Edition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use language effectively by acquiring vocabulary and syntax in context	Applying (K3)
CO2	listen and comprehend different spoken discourses from a variety of situations	Applying (K3)
CO3	speak confidently in different professional contexts and with peers	Creating (K6)
CO4	comprehend different genres of texts by adopting various reading strategies	Understanding (K2)
CO5	write legibly and flawlessly at varied professional contexts proficiently with appropriate choice of words and structures	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2			1	3	1	1
CO2									2	3		1
CO3									2	3		2
CO4						1				3	1	1
CO5										3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		37	30			33	100
CAT2		30	30			40	100
CAT3		33	34			33	
ESE		17	63			20	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MAC11 - MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS							
(Common to all Engineering and Technology branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**1***	**2***	**4**

Preamble	To provide the skills to the students for solving different real time problems by applying matrices and ordinary differential equations.	
Unit – I	**Matrices:**	**9+3**
Introduction **–** Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley – Hamilton theorem (Statement and applications only) - Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation – Applications of Eigen values and Eigen vectors: Stretching of an elastic membrane.		
Unit – II	**Ordinary Differential Equations:**	**9**
Introduction – Solutions of First order differential equations: Exact differential equations – Leibnitz's Linear Equation – Bernoulli's equation –Clairaut's equation - Applications: Law of natural growth and decay.		
Unit – III	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax / sinax – x^n – $e^{ax}x^n$, e^{ax} sinbx and e^{ax} cosbx – x^n sinax and x^n cosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.		
Unit – IV	**Applications of Ordinary Differential Equations:**	**9**
Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).		
Unit – V	**Laplace Transform:**	**9**
Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms –Transforms of derivatives and integrals – Transform of unit step function – Transform of periodic functions. Inverse Laplace transform: Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Applications: Solution of linear ODE of second order with constant coefficients.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Introduction to MATLAB
2.	Computation of eigen values and eigen vectors
3.	Plotting and visualizing single variable functions
4.	Solving first and second order ordinary differential equations
5.	Solution of Simultaneous first order ODEs
6.	Solving second order ODE by variation of parameters
7.	Determining Laplace and inverse Laplace transform of basic functions
8.	Solution of Second order ODE by employing Laplace transforms

Lecture:45, Tutorials and Practical:15, Total:60

TEXT BOOK:

1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.

4.	Grewal B.S., “Higher Engineering Mathematics" 44thEdition, Khanna Publishers, New Delhi, 2018.
5.	Matrices and Ordinary Differential Equations Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3), Manipulation (S2)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3), Manipulation (S2)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3), Manipulation (S2)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3), Manipulation (S2)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

*Alternate week

22CYT13 – CHEMISTRY FOR FOOD TECHNOLOGY							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course explores the basic principles of water treatment, electrochemistry, fuels & combustion, polymers and sustainable food processing. It aims to impart the fundamentals of chemistry towards innovations in Food Technology and also for societal applications.	
Unit – I	**WATER TECHNOLOGY**	**9**
Introduction – sources of water – impurities in water – types of water – hardness of water- expression of hardness (simple problems) – units of hardness –estimation of hardness of water by EDTA method – determination of alkalinity – disadvantages of using hard water in Industries – boiler troubles – scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming – softening of water: i) Internal treatment process – carbonate and calgon conditioning ii) External treatment method – demineralization process iii) Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods, Break-point of chlorination).		
Unit – II	**ELECTROCHEMISTRY**	**9**
Introduction – cells – types – representation of galvanic cell – electrode potential – Nernst equation (derivation of cell EMF) – calculation of cell EMF from single electrode potential – reference electrodes: construction, working and applications of standard hydrogen electrode, standard calomel electrode, glass electrode – EMF series and its applications – potentiometric titrations (redox) – conductometric titrations – mixture of weak and strong acid vs strong base.		
Unit – III	**FUELS AND COMBUSTION**	**9**
Introduction – classification of fuels – characteristics of a good fuel – combustion – calorific values – gross and net calorific values – theoretical calculation of calorific value by Dulong's formula – flue gas analysis by Orsat's method – solid fuels – coal and its varieties – proximate analysis – significance – metallurgical coke – Otto-Hoffman byproduct method – liquid fuel – refining of petroleum – manufacture of synthetic petrol – hydrogenation of coal – bergius process – knocking: spark ignition engine – octane number, compression ignition engine – cetane number – power alcohol and biodiesel – gaseous fuel – water gas – introduction of Bharat Stage Emission Standard (BSES) system.		
Unit – IV	**POLYMERS**	**9**
Introduction – terminology – classification – polymerization – types of polymerization (definition only)- structure and property relationship of polymers (mechanical, thermal) – plastics- difference between thermoplastics and thermosetting plastics – compounding of plastics- plastic moulding methods – compression, injection, extrusion and blow moulding methods – industrial polymers: preparation, properties and applications of PVC, PAN, polyurethane, polyesters – biodegradable polymers – classification and applications.		
Unit – V	**SUSTAINABLE FOOD PROCESSING**	**9**
Sustainability: green engineering technologies in the food processing industries – drivers for sustainable food Processing: legislative, economic, consumer, corporate performance – environmental impacts of food processing: energy, solid waste, water and wastewater – environmental impact assessment methods in food processing – carbon foot print, ecological foot print, life cycle assessment.		
		Total:45

TEXT BOOK:

1.	Wiley Editorial Board, "Wiley Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019, for Unit-I, II, III, IV.
2.	Sustainable Food Processing, Brijesh K. Tiwari, Tomas Norton, Nicholas M. Holden, John Wiley & Sons, New Jersey, United States, 2013, for Unit - V.

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A.& Manjula Rani K., "Applied Chemistry", 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.
2.	Palanna O., "Engineering Chemistry", McGraw Hill Education, New Delhi, 2018.
3.	Payal B. Joshi, Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the suitable water softening methods to avoid boiler troubles.	Applying (K3)
CO2	apply the principle of electrochemistry for various applications	Applying (K3)
CO3	apply the concepts of fuels and combustion for engineering applications	Applying (K3)
CO4	make use of concept of polymerization and fabrication process to explain the types of polymers, plastics and fabrication methods of plastics	Applying (K3)
CO5	apply the green engineering principle for sustainable food processing.	Applying (K3)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTT11 - FUNDAMENTALS OF BIOCHEMISTRY							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**PC**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge about the structure and properties of biomolecules, actions of enzymes and metabolism	
Unit – I	**Carbohydrates:**	**9**
Classification; Simple Sugars: mono and disaccharides, Hygroscopicity and solubility, optical rotation, muta rotation; Sweetness: structure-activity relationship and sweetness index; Dextrose Equivalent; Sugar alcohols; Oligosaccharides: structure and occurrence. Polysaccharides: Starch-amylose and amylopectin- properties. Cellulose. Pectins, gums and seaweeds – structure & properties. Dietary fibres - Food sources, functional role.		
Unit – II	**Lipids:**	**9**
Fatty acids - classification. Lipids -, classification - simple and compound lipids, sterols. Food lipids and health. Physical properties of fats and oils: crystal formation, polymorphism, melting point, plasticity. Shortening power of fats, smoke point. Chemical properties of fats – Hydrolysis, saponification, halogenation. Hydrolytic rancidity and oxidative rancidity. Chemical constants.		
Unit – III	**Proteins:**	**9**
Amino acids - Definition, structure and classification. Protein - classification and structural conformation, Food sources and biological role. Properties of proteins in food systems: solubility, hydration, foam formation & stabilization, gel formation, emulsifying effect. Denaturation.		
Unit – IV	**Enzymes:**	**9**
Introduction, Nature, classification and nomenclature of enzymes. Mechanism of enzyme action; active site; Specificity. Enzyme kinetics – Michelis - Menten equation, Factors affecting enzyme action, Immobilization methods,selected application of enzymes in food Industries.		
Unit – V	**Nucleic Acids and Energy Metabolism:**	**9**
Nucleic Acids: Composition and structure of DNA and RNA. Energy Metabolism: Glycolysis; TCA cycle; substrate level phosphorylation. Cellular respiration - electron transport chain. Fatty acid metabolism – beta oxidation and fatty acid synthesis.		
		Total:45

TEXT BOOK:

1. Satyanarayana U. and Chakrapani U., “Biochemistry”, 5th Edition, Elsevier, New Delhi, 2017.

REFERENCES:

1. Belitz H. D., Grosch W., and Schieberle P., “Food Chemistry”, 3rd Edition, Springer Verley, Berlin, 2008.
2. Jain J.L., Sunjay Jain and Nitin Jain, “Fundamentals of Biochemistry”, 7th Edition, S. Chand & Co., New Delhi, 2016.
3. Rastogi S.C., “Biochemistry”, 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the structure and properties of carbohydrates	Understanding (K2)
CO2	outline the structure and properties of lipids	Understanding (K2)
CO3	relate the structural and functional role of proteins	Understanding (K2)
CO4	classify the enzymes and interpret the enzyme action and their immobilization	Understanding (K2)
CO5	infer the structure of nucleic acids and illustrate the basics of energy metabolism	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSC11 - PROBLEM SOLVING AND PROGRAMMING IN C							
(Common to All Engineering and Technology branches except CSE, IT, CSD, AIDS & AIML)							
Programme & Branch	**All BE/BTech Engineering & Technology branches , except CSE, IT, CSD, AIDS & AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**2**	**4**
Preamble	The course aims to provide exposure to problem-solving through programming. It introduces all the fundamental concepts of C Programming. This course provides adequate knowledge to solve problems using C						
Unit – I	**Introduction to C and Operators:**						**9**
The structure of a C program – Compiling and executing C program – C Tokens – Character set in C – Keywords – identifiers- Basic data Types – Variables – constants – Input / Output statements – Operators							
Unit – II	**Control Statements and Arrays:**						**9**
Decision-making and looping statements, Arrays: Declaring, initializing and accessing arrays – operations on arrays – Two-dimensional arrays and their operations.							
Unit – III	**Functions:**						**9**
Functions: Introduction- Using functions, function declaration and definition – function call – return statement – passing parameters to functions: basic data types and arrays – storage classes – recursive functions							
Unit – IV	**Strings and Pointers:**						**9**
Strings: Introduction – operations on strings: finding length, concatenation, comparing and copying – string and character manipulation functions, Arrays of strings. Pointers : declaring pointer variables – pointer expression and arithmetic, pointers and 1D arrays, pointers and strings							
Unit – V	**User-defined Data Types and File Handling:**						**9**
User-defined data types: Structure: Introduction – nested structures– arrays of structure – structure and functions -unions – enumerated data type. File Handling : Introduction - opening and closing files – reading and writing data to files -Manipulating file position indicator : fseek(), ftell() and rewind()							
LIST OF EXPERIMENTS / EXERCISES:							
1.	Programs for demonstrating the use of different types of format Specifiers						
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational, and ternary operators						
3.	Programs for demonstrating the use of using decision making statements						
4.	Programs for demonstrating the use of repetitive structures						
5.	Programs for demonstrating one-dimensional arrays						
6.	Programs for demonstrating two-dimensional arrays						
7.	Programs to demonstrate modular programming concepts using functions						
8.	Programs to demonstrate recursive functions.						
9.	Programs to demonstrate strings (Using built-in and user-definedfunctions)						
10.	Programs to illustrate the use of pointers						
11.	Programs to illustrate the use of structures and unions						
12.	Programs to implement file Handling						
Lecture:45, Practical:30, Total:75							
TEXT BOOK:							
1.	Reema Thareja, “Programming in C ”, 2nd Edition, Oxford University Press, New Delhi, 2018.						

REFERENCES/ MANUAL / SOFTWARE:	
1.	Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
2.	Sumitabha Das, “Computer Fundamentals and C Programming”, 1st Edition, McGraw Hill, 2018.
3.	Balagurusamy E., "Programming in ANSI C", 7th Edition, McGraw Hill Education, 2017.
4.	Behrouz A. Forouzan & Richard F.Gilberg, “Computer Science A Structured Programming Approach Using C”, 3rd Edition, Cengage,2017.
5.	https://www.cprogramming.com/tutorial/c-tutorial.html

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop simple programs using input/output statements and operators	Applying (K3), Precision (S3)
CO2	identify the appropriate looping and control statements in C and develop applications using these statements	Applying (K3), Precision (S3)
CO3	develop simple C programs using the concepts of arrays and modular programming	Applying (K3), Precision (S3)
CO4	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3), Precision (S3)
CO5	make use of user-defined data types and file concepts to solve given problems	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MET11 - ENGINEERING DRAWING							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**ES**	**2**	**1**	**0**	**3**

Preamble	To impart knowledge on orthographic, isometric projections, sectional views and development of surfaces by solving different application oriented problems.	
Unit – I	**General Principles of Orthographic Projection:**	**6+3**
Importance of Graphics in Engineering Applications - Use of Drafting Instruments - BIS Conventions and Specifications - Size, Layout and Folding of Drawing Sheets - Lettering and Dimensioning - Projections of Points, Lines and Planes - General Principles of Orthographic Projection - First Angle Projection - Layout of Views - Projection of Points Located in all Quadrant and Straight Lines Located in the First Quadrant - Determination of True Lengths and True Inclinations and Location of Traces - Projection of Polygonal Surface and Circular Lamina Inclined to both Reference Planes.		
Unit – II	**Projections of Solid:**	**6+3**
Projections of Simple Solids Like Prisms, Pyramids, Cylinder and Cone when the Axis is inclined to One Reference Plane by Change of Position Method.		
Unit – III	**Sectioning of Solids:**	**6+3**
Sectioning of Solids - Prisms, Pyramids, Cylinder and Cone in Simple Vertical Position by Cutting Planes inclined to One Reference Plane and Perpendicular to the other - Obtaining True Shape of Section.		
Unit – IV	**Development of Surfaces:**	**6+3**
Development of Lateral Surfaces of Simple Solids Like Prisms, Pyramids, Cylinders and Cones - Development of Simple Truncated Solids Involving Prisms, Pyramids, Cylinders and Cones.		
Unit – V	**Isometric Projection and Introduction to AutoCAD:**	**6+3**
Principles of Isometric Projection - Isometric Scale - Isometric Projections of Simple and Truncated Solids Like Prisms, Pyramids, Cylinders and Cones - Conversion of Isometric Projection into Orthographic Projection - Introduction to AutoCAD.		
Lecture: 30, Tutorial:15, Total:45		

TEXT BOOK:

1.	Natarajan.K.V. “A Textbook of Engineering Graphics”,35th Edition, Dhanalakshmi Publishers, Chennai, 2022,

REFERENCES:

1.	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, 16th Edition, New Age International Publishers, Chennai, 2022.
2.	Basant Agrawal, Agrawal C.M., “Engineering Drawing”, 3rd Edition, McGraw Hill Education, 2019.
3.	Parthasarathy N.S., Vela Murali. “Engineering Drawing”, 1st Edition, Oxford University Press, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret international standards of drawings and sketch the projections of points, lines and planes	Applying (K3)
CO2	draw the projections of 3D primitive objects like prisms, pyramids, cylinders and cones	Applying (K3)
CO3	construct the various sectional views of solids like prisms, pyramids, cylinders and cones	Applying (K3)
CO4	develop the lateral surfaces of simple and truncated solids	Applying (K3)
CO5	sketch the isometric projections of simple and truncated solids and convert isometric drawing into orthographic projection	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	6	9	85				100
CAT2	6	9	85				100
CAT3	6	9	85				100
ESE	10	10	80				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CYL13 - CHEMISTRY LABORATORY FOR FOOD TECHNOLOGY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	0	0	3	1

Preamble	This course aims to impart hands on training in the determination of the water quality parameters such as hardness, alkalinity, chloride, DO, COD, iron, chromium and to develop the skills in handling different basic instruments and also aims to impart the basic concepts of volumetric, conductometric and pH meter experiments and thereby, to improve the analytical capability.

LIST OF EXPERIMENTS / EXERCISES:

1.	Assessment of the given water sample for the suitability of drinking / industrial purpose by estimating the carbonate, non-carbonate and total hardness by EDTA method.
2.	Estimation of Calcium and magnesium in food samples by complexometric titration.
3.	Estimation of alkalinity of river and borewell water collected from different places.
4.	Estimation of chloride ion in the given water sample using Argentometric method.
5.	Determination of dissolved oxygen in the given wastewater sample.
6.	Determination of COD in the given wastewater sample.
7.	Determination of molecular weight or polymer / liquid by Ostwald visometer.
8.	Determination of corrosion rate of iron in acidic medium.
9.	Estimation of sulphur present in fuel using electro-analytical techniques.
10.	Comparison of the acidity of the food samples using pH meter.
11.	Estimation of sodium using flame photometer (Demonstration).
12.	Estimation of iron using spectrophotometer (Demonstration).

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1. Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 2022.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	estimate the temporary & permanent hardness, Ca^{2+} & Mg^{2+}hardness and alkalinity of the given water sample.	Applying (K3), Precision (S3)
CO2	demonstrate the water quality parameters of water sample by estimating Chloride, DO and COD.	Applying (K3), Precision (S3)
CO3	determine the corrosion rate of iron, sulphur content in coal, acidic strength of samples and demonstrate the viscometer for the determination of molecular weight of a polymer.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3			3							
CO2	3	2	1	3			3							
CO3	3	2	1	3			2							

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22MEL11 - ENGINEERING PRACTICES LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1/ 2**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course is designed to provide a hands-on experience in basic of mechanical and electrical engineering practices.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – MECHANICAL ENGINEERING
1.	Prepare a Square / Rectangular / V-Shape Projection with its Counterpart for Mating and Perform the Drilling, Tapping, and Assembling Tasks from the given Square / Rectangular MS Plates using Modern Power Tools.
2.	Prepare T / L / Lap Joint from given Wooden Work Piece and Make a Box / Tray out of Plywood using Modern Power Tools.
3.	Perform the Thread Formation on a GI/PVC Pipe and Prepare a Water Line from the Overhead Tank that is Leak-Proof.
4.	Make a Butt / Lap / Tee Joint of MS Plate using Arc Welding Process and Welding Simulator.
5.	**Activity:** Prepare an Innovative Model with the Knowledge from Fitting / Carpentry / Plumbing / Welding Involving Modern Power Tools.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
6.	Wiring circuit for fluorescent lamp and Stair case wiring
7.	Wiring Circuit of Incandescent lamp using Impulse Relay
8.	Measurement of Earth Resistance
9.	Soldering of Simple Circuits and trouble shooting
10.	Implementation of half wave and full wave Rectifier using diodes

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Engineering Practices Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	plan the sequence of operations for effective completion of the planned models / innovative articles	Creating (K6) Manipulation (S2)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3) Manipulation (S2)
CO3	perform house wiring and realize the importance of earthing	Applying (K3), Manipulation (S2)
CO4	soldering with simple electronics circuits	Applying (K3), Manipulation (S2)
CO5	trouble shoot the electrical and electronic circuits	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22VEC11 - YOGA AND VALUES FOR HOLISTIC DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**1**	**1**

Preamble	Yoga or yogasanas are considered as art and science of healthy living by our ancient gurus. It is method to bring harmony of body and mind for general wellbeing. Yoga is considered as one of the greatest gifts to the world by Indians for healthy living. Students in particular are benefitted by learning yoga.	
Unit – I	**Introduction:**	**2**
The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga – Yoga is a Science and Art – Rules and Regulations of Asanas – Classifications of Yogasanas – Patanjali's Ashtanga Yoga – Pranayama – Mudras & Bandhas - Shatkarma (Cleansing Practice) - Streams of Yoga – Modern Trends in yoga.		
Unit – II	**Yoga and Mind:**	**2**
The Nature of Mind - Five Elements and the Mind - Meditation and the Mind - Functions of the Mind - Role of Yoga in Psychological problems: Mood Disorders, Major Depressive Disorder, Cyclothymic Disorder.		
Unit – III	**Yoga and Values, Diet:**	**2**
Human Values – Social Values – Role of Yoga in Personality Integration - Concepts of Natural Diet - Naturopathy Diet – Eliminative Diet – Soothing Diet – Constructive Diet.		
Unit – IV	**Asanas:**	**2**
Prayer - Starting & Closing - Preparatory practices – Loosening Practices – Meaning, Definitions and Objectives of Asanas - Principles of Practicing Asanas. Asanas: Standing – Sitting – Prone – Supine – Suryanamaskar.		
Unit – V	**Pranayama and Meditation:**	**2**
Breathing Practices for awareness - Definitions and Objectives of Pranayama - Principles of Practicing Pranayama. Pranayama: Nadi Shuddhi - Kapalabathi – Sitali – Sitkari – Bhranari – Ujjayi – Relaxation Techniques – Meditation.		

Lecture: 10, Practical: 10, Total:20

TEXT BOOK:

1. Swami satyananda saraswathi, "Asana pranayama mudra bandha", Bihar school of yoga, 4th Edition, 1969.
2. Swami mukthi Bodhanandha, "Hatha yoga pradipika", Bihar school of yoga, 4th Edition, 1985.

REFERENCES:

1. B.K.S. Iyenkar, "Yoga the path of holistic health", DK Limited, 2nd Edition, 1969.
2. Selvarasu, "Kriya cleansing in yoga", Aruvi yoga, 3rd Edition, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	realize the importance of yoga in physical health.	Applying (K3)
CO2	realize the importance of yoga in mental health.	Applying (K3)
CO3	realize the role of yoga in personality development and diet.	Applying (K3)
CO4	do the loosening practices, Asanas and realize its benefits.	Applying (K3)
CO5	do the practice of Pranayama, meditation and realize its benefits	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3		2	1			
CO2						3		2				
CO3						3		3				
CO4						3		2	3			
CO5						3		3				

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	20	30	50	-	-	-	100
ESE	-	-	-	-	-	-	-

* ±3% may be varied (CAT3 – 100 marks)

22TAM01 - தமிழர் மரபு							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**0**	**1**

Preamble	தமிழர்களின் மொழி, இலக்கியம், ஓவியங்கள், சிற்பக்கலைகள், நாட்டுப்புறக் கலைகள், வீர விளையாட்டுக்கள், திணைக் கோட்பாடுகள், இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பைப் பற்றிய அறிவை வழங்குவதே இந்த பாடத்தின் நோக்கமாகும்.

அலகு – I	**மொழி மற்றும் இலக்கியம்**	**3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு – II	**மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**	**3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு – III	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுக்கள்**	**3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு – IV	**தமிழர்களின் திணைக் கோட்பாடுகள்**	**3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு- சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும் கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு – V	**இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**	**3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறபகுதிகளில் தமிழ் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Total: 15

TEXT BOOK:

1. ஆ. பூபாலன், தமிழர் மரபு, VRB Publishers Pvt Ltd, 2022.

REFERENCES:

1. தமிழக வரலாறு- மக்களும் பண்பாடும்- கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித்தமிழ் - முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

COURSE OUTCOMES: படிப்பை முடித்தவுடன், மாணவர்கள்		**BT Mapped (Highest Level)**
CO1	தமிழ் மொழி மற்றும் இலக்கியத்தில் மதிப்புமிக்க கருத்துக்களை விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின் சிற்பம் மற்றும் அவர்களின் ஓவியங்கள் பற்றி விளக்க முடியும்.	Understanding (K2)
CO3	தமிழர்களின் நாட்டுப்புற மற்றும் தற்காப்புக் கலைகளைப் பற்றி சுருக்கமாகக் கூற முடியும்.	Understanding (K2)
CO4	தமிழர்களின் திணைக் கோட்பாடுகளைப் பற்றி விளக்க முடியும்.	Understanding (K2)
CO5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு பற்றி விளக்க முடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks)

22TAM01 - HERITAGE OF TAMILS							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**0**	**1**

Preamble	The objective of this course is to impart knowledge about Tamil language, literature, paintings, sculptures, folk arts, heroic games, doctrines, contribution of Tamils to Indian culture.	
UNIT I	**Language and Literature**	**3**
Language families in india - dravidian languages – tamil as a classical language - classical literature in tamil – secular nature of sangam literature – distributive justice in sangam literature - management principles in thirukural - tamil epics and impact of buddhism & jainism in tamil land - bakthi literature azhwars and nayanmars - forms of minor poetry - development of modern literature in tamil - contribution of bharathiyar and bharathidhasan.		
UNIT II	**Heritage - Rock Art Paintings to Modern Art – Sculpture**	**3**
Hero stone to modern sculpture - bronze icons - tribes and their handicrafts - art of temple car making - - massive terracotta sculptures, village deities, thiruvalluvar statue at kanyakumari, making of musical instruments - mridhangam, parai, veenai, yazh and nadhaswaram - role of temples in social and economic life of tamils.		
UNIT III	**Folk and Martial Arts**	**3**
Therukoothu – karagattam - villu pattu - kaniyan koothu – oyillattam - leather puppetry – silambattam – valari - tiger dance - sports and games of tamils.		
UNIT IV	**Thinai Concept of Tamils**	**3**
Flora and fauna of tamils & aham and puram concept from tholkappiyam and sangam literature - aram concept of tamils - education and literacy during sangam age - ancient cities and ports of sangam age - export and import during sangam age - overseas conquest of cholas.		
UNIT V	**Contribution of Tamils to Indian National Movement and Indian Culture**	**3**
Contribution of tamils to indian freedom struggle - the cultural influence of tamils over the other parts of india – self-respect movement - role of siddha medicine in indigenous systems of medicine – inscriptions & manuscripts – print history of tamil books.		
		Total: 15

TEXT BOOK:

1.	S.Muthuramalingam, M.Saravanakumar, Heritage of Tamils, Yes Dee Publishing Pvt Ltd, 2023.

REFERENCES:

1.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies).
2.	The Contribution of Tamil of the Tamils to Indian Culture(Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
3.	Keeladi – 'Sangam City C ivilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu).

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain valuable concepts in language and literature of tamils.	Understanding (K2)
CO2	illustrate about the tamils sculpture and their paintings.	Understanding (K2)
CO3	summarize about the tamils folk and martial arts.	Understanding (K2)
CO4	explain the thinai concept of tamils.	Understanding (K2)
CO5	explain the contribution of Tamils to the Indian National Movement and Indian culture.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks)

22TAM02 – தமிழரும் தொழில்நுட்பமும்							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 3**	**HS**	**1**	**0**	**0**	**1**

முன்னுரை	தமிழ் கலாச்சாரத்தோடு ஒன்றிய தொழில் நுட்பங்களை பற்றிப் எடுத்துரைத்தல்	
அலகு – I	**நெசவு மற்றும் பானை தொழில்நுட்பம்**	**3**
சங்க காலத்தில் நெசவு தொழில் – பானைத் தொழில்நுட்பம் கருப்பு சிவப்பு பாண்டங்கள் – பாண்டகளில் கீறல் குறியீடுகள்		
அலகு – II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**	**3**
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச்சிற்பங்களும், கோவில்களும் – சோழர் காலத்து பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரிகட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னை இந்தோ-சாரோசெனிக் கட்டிடக் கலை.		
அலகு – III	**உற்பத்தித் தொழில்நுட்பம்**	**3**
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச்சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள் – கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு – IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்**	**3**
அணை, ஏரி, குளங்கள், மதகு – சோழர்கால குமிழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.		
அலகு – V	**அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்**	**3**
அறிவியல் தமிழின் வளர்ச்சி – கணினிதத்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் சொற்குவைத் திட்டம்.		
		Total:15

TEXT BOOK:

1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்), உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016

REFERENCES:

1.	கீழடி-வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
2.	பொருநை-ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
3.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
4.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)

6.	The Contribution of the Tamil to Indian Culture (Dr.M.Valarmathi) (Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (Dr.K.K.Pillay) (Published by: The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: படிப்பை முடித்தவுடன், மாணவர்கள்		BT Mapped (Highest Level)
CO1	தமிழ் **கலாச்சாரம்** மற்றும் தமிழ் **சமூகத்தினுடைய நெசவு மற்றும் பானை தொழில்நுட்பம் பற்றி** விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின் **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்ப ஆற்றல்** பற்றி விளக்க முடியும்.	Understanding (K2)
CO3	தமிழர்களின் **உற்பத்தித் தொழில்நுட்பம்** பற்றி சுருக்கமாகக் கூற முடியும்.	Understanding (K2)
CO4	தமிழர்களின் **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்** பற்றி விளக்க முடியும்.	Understanding (K2)
CO5	தமிழர்களின் **அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் பற்றி விளக்க முடியும்**.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks)**

22TAM02 - TAMILS AND TECHNOLOGY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 3**	**HS**	**1**	**0**	**0**	**1**

Preamble	This course aims to impart the essential knowledge on the tamil culture and related technology	
UNIT – I	**WEAVING AND CERAMIC TECHNOLOGY**	**3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.		
UNIT – II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3**
Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.		
UNIT – III	**MANUFACTURING TECHNOLOGY**	**3**
Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel – Copper and gold – Coins as source of history – Minting of Coins – Beads making – industries Stone beads – Glass beads –Terracotta beads –Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.		
UNIT – IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.		
UNIT – V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3**
Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
		Total:15

TEXT BOOK:

1.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
2.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).

REFERENCES:

1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்), உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016
3.	கீழடி வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
4.	பொருநை ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)
6.	The Contribution of the Tamils to Indian Culture (Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (dr.K.K.Pillay) (Published by : The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain weaving and ceramic technology in tamil culture and tamil society.	Understanding (K2)
CO2	Illustrate about the design and construction technology.	Understanding (K2)
CO3	summarize about the manufacturing technology.	Understanding (K2)
CO4	explain the agriculture and irrigation technology.	Understanding (K2)
CO5	explain the significance of tamil in scientific and computing.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks)**

22GCL11 – FOUNDATION ENGINEERING LABORATORY I							
(Common to All BE/BTech branches)							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide foundational knowledge on engineering with hands-on experience on developing a prototype model with the basic knowledge of Computer-aided Design, Manufacturing Processes, 3D Printing Technology, Robotics and Embedded Control.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – Manufacturing (30 Hours)
1.	Selection of product, free hand sketching and detailing
2.	Construction of model using Arc/TIG/MIG/Gas/Spot welding operations
3.	Enhancing the model with sheet metal
4.	Creating the parts of the model using lathe
5.	Creating the parts of the model using milling and drilling machines
	PART B – Product Design and Development (30 Hours)
1.	Free hand sketching and detailing of the component
2.	3D part modelling of the component using CAD software
3.	Engineering Analysis of the component model
4.	Generate the component using 3D printer
5.	Value addition to the produced component using CNC milling machine, CNC laser cutting machine and CNC router
	PART C – Robotics (30 Hours)
1.	Design of electronic circuit and its debugging
2.	Interfacing of sensors, actuators and wireless communion modules with microcontroller
3.	Assembly of Tracker Robot with accessories
4.	Development of control strategies for motion control, path planning and obstacle avoidance
5.	Demonstration and testing of Robot in static environment
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	AutoCAD 2020 and SOLID WORKS 2018 Software

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop the prototype model using mechanical operations like welding, forming and machining processes	Applying (K3), Precision (S3)
CO2	sketch 3D model and enhance the prototype using modern machines like 3D printer, CNC milling machine, CNC Laser cutter and CNC Router	Applying (K3), Precision (S3)
CO3	design and develop the autonomous robot for real-time applications	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2				3	2		2		
CO2	3	3	3		3				3	2		2		
CO3	3	3	3		2				3	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GCL12 – FOUNDATION ENGINEERING LABORATORY II							
(Common to all BE/BTech branches)							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 /2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide a foundational knowledge on engineering with hands-on experience on the house wiring, Internet of Things and Web Technologies.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – Electrical Installation (30 Hours)
1.	Develop wiring diagrams using software tools.
2.	Identify and select suitable components for Energy Measurement and Circuit Protection
3.	Design a wiring circuit integrating Energy Meter, MCB and RCCB
4.	Develop a wiring circuit for incandescent lamp and fluorescent lamp
5.	Develop and Investigate Simple and Staircase Wiring for Residential Applications
6.	Design the Wiring Circuits for Calling Bell System and Dimmable Light
7.	Create wiring circuits for power loads
8.	Measurement of Earth Resistance and its connections.
	PART B – Internet of Things (30 Hours)
1.	Design a Single layer PCB layout designing
2.	Fabricate Single layer PCB printing
3.	Assembling, soldering and desoldering practice on single layer PCB
4.	GPIO programming in ESP8266
5.	Sensor and actuator interfacing with internet enabled microcontroller device
6.	Sensor and actuator calibration
7.	Integration of microcontroller based system with Cloud platform
	PART C – Web Technologies (30 Hours)
1.	Design a website for an application using HTML and CSS.
2.	Convert the designed website into responsive website using Bootstrap.
3.	Add dynamism to the website by using JavaScript and embed the Social Media components to the website.
4.	Incorporate database interaction to the website.
5.	Deploy the developed website in the server.
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Eric T.Freeman,Elisabeth Robson, ”Head First JavaScript Programming A Brain-Friendly Guide”, 1st Edition, O’Reilly , 2014.
3.	Eric T.Freeman,Elisabeth Robson, ”Head First HTML and CSS”,2nd Edition, O’Reilly , 2012
4.	Lynn Beighley,”Head First SQL”,1st Editin, O’Reilly,2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design electrical wiring circuits for buildings based on their requirement	Applying(K3), Precision (S3)
CO2	develop IoT based solutions and PCB for real world use cases.	Applying (K3), Precision (S3)
CO3	design and host an interactive dynamic website.	Applying(K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1					1					
CO2	3	2	2	1					1					
CO3	3	2	2	1					1					

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22EGT21 - COMMUNICATION SKILLS II							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Communication Skills I**	**2**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to equip students with the necessary skills to listen, read, write and speak so as to develop their linguistic and communicative competencies.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Sentence Patterns **-** Simple, Compound & Complex sentences **- Vocabulary:** Portmanteau words **-** One word substitution **- Listening:** Speeches from company CEOs **-** TV debates **Speaking:** Just-a-minute talk **-** Group discussion **- Reading:** Reading for Gist **- Writing:** Job application letter with resume **–** Transcoding		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Concord **- Vocabulary:** Phrasal verbs **-** Idioms & Phrases - **Listening:** Listening to celebrity talks - **Speaking:** Talking about celebrities - Practicing Pronunciation through web tools - **Reading:** Company correspondence, technical texts/working principles of a machine - **Writing:** Description: Person, Place**,** Process, Product and Picture		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Discourse markers **-** Transitional words and phrases **- Vocabulary:** Commonly confused words **- Listening:** Listening to guest lectures **- Speaking:** Technical & Non-technical presentations **-** Workshop presentations **- Reading:** Reputed company profiles, Business Plans **- Writing:** a dream job/company **-** Letter to the Editor **–** Biography & Autobiography **-** Checklist		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Degrees of Comparison **-** Punctuations **–** Fragments & run**-**ons **- Vocabulary:** British & American **-** Spelling & words **- Listening:** Listening to global accents **-** listening to motivational speeches **-** S**peaking:** Narrating personal milestones **-** Sports commentaries **-** Movie Enactment **- Reading:** Narrative passages **- Writing:** E mail **-** Agenda & Minutes of Meeting **-** Special & Technical reports		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Purpose and Function **-** If clause **-** Error detection **- Vocabulary:** Coding & Decoding **-** Alphabet test **- Listening:** Listening to sample HR Interviews **- Speaking:** Introduction to phonetics - Stress, rhythm & Intonation **–** Guided & unguided speeches/conversations **-** Giving feedback **–** Debate **- Reading:** Key Note speeches **-** Newspaper reports **-** short technical texts from journals **Writing:** Circulars **-** Critical Appreciation of a non-detailed text **-** Technical proposals		
		Total:45

TEXT BOOK:

1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.
2.	Murphy Raymond, "English Grammar in Use", 5th Edition, Cambridge University Press, New York, 2019.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 2, 3rd Edition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different accents and infer implied meanings	Applying (K3)
CO3	speak clearly, initiate and sustain a discussion and negotiate using appropriate communicative strategies	Creating (K6)
CO4	read different genres of texts, infer implied meanings and critically analyze and evaluate them	Understanding (K2)
CO5	produce different types of narrative, descriptive expository texts and understand creative, critical, analytical and evaluative writing	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2			1	3	1	1
CO2									2	3		1
CO3									2	3		2
CO4						1				3	1	1
CO5										3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		37	30			33	100
CAT2		7	50			43	100
CAT3		17	50			33	100
ESE		15	45			40	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS							
(Common to CIVIL, MECH, MTS, ECE, EEE, EIE & FT branches)							
Programme & Branch	**B.E & Civil, Mech, MTS, ECE, EEE, EIE & FT branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**1***	**2***	**4**

Preamble	To impart the knowledge of partial derivatives, evaluation of real and complex integrals, vector calculus and analytic functions to the students for solving the problems related to various engineering disciplines.	
Unit – I	**Functions of Several Variables:**	**9**
Functions of two or more variables – Partial derivatives – Total differential – Taylor's series for functions of two variables – Applications: Maxima and minima – Constrained maxima and minima – Lagrange's multiplier method.		
Unit – II	**Multiple Integrals:**	**9**
Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates – Volume as triple integrals.		
Unit – III	**Vector Calculus:**	**9**
Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Vector Integration: Introduction – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit – IV	**Analytic Functions:**	**9**
Functions of a complex variable – Analytic functions – Necessary and sufficient conditions (excluding proof) – Cauchy–Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic function – Construction of analytic function – Applications: Fluid flow – Conformal mapping: w = z + a, az, 1/z – Bilinear transformation.		
Unit – V	**Complex Integration:**	**9**
Introduction – Cauchy's theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent series – Singularities – Classification – Cauchy's residue theorem (without proof) – Applications: Evaluation of definite integrals involving sine and cosine functions over the circular contour.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Finding ordinary and partial derivatives
2.	Computing extreme values of function of two variables
3.	Evaluating double and triple integrals
4.	Finding the area between two curves
5.	Computing gradient, divergence and curl of point functions
6.	Applying Milne-Thomson method for constructing analytic function
7.	Determination of Mobius transformation for the given set of points
8.	Finding poles and residues of an analytic function

Lecture:45, Tutorials and Practical:15, Total:60

TEXT BOOK:

1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	Grewal B.S, "Higher Engineering Mathematics" 44thEdition, Khanna Publishers, New Delhi, 2018.
5.	Multivariable Calculus and Complex Analysis Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	compute the total derivatives and extreme values of multivariable functions.	Applying (K3), Manipulation (S2)
CO2	evaluate multiple integrals and apply them to compute the area and volume of the regions.	Applying (K3), Manipulation (S2)
CO3	apply the concepts of derivatives and line integrals of vector functions in engineering problems.	Applying (K3), Manipulation (S2)
CO4	construct analytic functions and bilinear transformations and determine the image of given region under the given conformal mapping.	Applying (K3), Manipulation (S2)
CO5	apply the techniques of complex integration to evaluate real and complex integrals over suitable closed curves.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

*Alternate week

22PHT23 – PHYSICS FOR FOOD TECHNOLOGY							
Programme & Branch	**B.Tech- Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the knowledge on magnetic materials, dielectric materials, ultrasonic waves, microwaves, nanomaterials, select crystal growth and materials characterization techniques. It also describes the applications of aforementioned topics in food technology.	
Unit – I	**Magnetic and Dielectric materials:**	**9**
Ferromagnetism – Domain theory of ferromagnetism – Hysteresis – Soft and hard magnetic materials – Applications: Metal detector and magnetic inductive flow meter – Dielectric materials – Dielectric constant – Types of polarization (qualitative) – Frequency and temperature dependence of polarization – dielectric loss – dielectric breakdown – Uses of dielectric materials in ohmic heating.		
Unit – II	**Ultrasonic and Microwaves:**	**9**
Ultrasonics – Properties – Magnetostrictive generator – Piezoelectric generator – Determination of velocity of ultrasonics in a liquid sing acoustic grating – Non-destructive testing – Flaw detection – Applications of ultrasonics in food industry – Microwaves – Conversion of microwaves into heat – Penetration depth – Applications of microwaves in food industry.		
Unit – III	**Nanomaterials:**	**9**
Nano scale – Surface-to-volume ratio – Quantum confinement – Nanostructures – Quantum well, quantum wire and quantum dot – Synthesis techniques: Ball milling, physical vapour deposition, chemical vapour deposition and sol-gel methods – Carbon nanotubes: structures, properties and synthesis by laser ablation method – Industrial applications of nanomaterials in food processing and packaging.		
Unit – IV	**Crystal growth:**	**9**
Nucleation – Classical theory of nucleation – Critical radius and critical free energy (qualitative) – Homogeneous and heterogeneous nucleation – Free energy formation of critical nucleus – Crystal growth techniques: Melt growth – Bridgman method – Solution growth – High temperature solution growth – Low temperature solution growth – Examples in food processing.		
Unit – V	**Materials characterization:**	**9**
Importance of materials characterization – X-ray diffraction(powder method) – Scanning electron microscope – Transmission electron microscope (qualitative) – UV-visible spectroscopy – Raman spectroscopy – Differential scanning calorimetry.		
		Total:45

TEXT BOOK:

1.	Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics", 11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019. (Units I,II,III,IV)
2.	Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, Boca Raton, 2008. (Unit V)

REFERENCES:

1.	Ludger O. Figura and Teixeira A., "Food Physics: Physical Properties – Measurements and Applications", 1st Edition, Springer, Germany, 2007.
2.	Raghavan V., "Materials Science and Engineering", 6th Edition, PHI Learning Pvt. Ltd., Delhi, 2015.
3.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of ferromagnetism to comprehend the working of metal detector, magnetic inductive flow meter and also to describe the phenomena related to dielectric polarization, dielectric loss and dielectric breakdown, and the application of dielectrics.	Applying (K3)
CO2	describe the production of ultrasonic wave, working of acoustic grating & non-destructive testing using ultrasonic waves and also to explain the uses of microwaves in food industry.	Applying (K3)
CO3	utilize appropriate techniques to prepare nanomaterials and carbon nanotubes, and to comprehend their features and applications.	Understanding (K2)
CO4	utilize appropriate theory and models of select crystal growth techniques to grow crystals.	Applying (K3)
CO5	apply the concepts of Raman effect, X-ray diffraction, matter waves and thermogram to describe the principle and working of select material characterization techniques.	Applying (K3)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	55	30				100
CAT2	15	55	30				100
CAT3	15	55	30				100
ESE	10	55	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTT21 - ENGINEERING PROPERTIES OF FOOD MATERIALS							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Food Technology**	**2 / 3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge on physical, thermal, optical, electromagnetic, rheological and textural properties of food materials and its measurement methods	
Unit – I	**Physical Properties:**	**9**
Importance of engineering properties, Physical properties of food materials- size, shape, volume, density, porosity and surface area – definitions and measurements, Frictional properties –coefficient of friction, angle of repose – types and its determination, rolling resistance and angle of internal friction – definition, Aerodynamic properties – Drag coefficient,Terminal Velocity and its application.		
Unit – II	**Thermal Properties:**	**9**
Definition of specific heat, enthalpy, thermal conductivity, thermal diffusivity, surface heat transfer coefficient. Measurement of specific heat, thermal conductivity – steady state and unsteady state methods, thermal diffusivity – Dickerson's method, Calorific value of food, Bomb calorimeter, Boiling point elevation and freezing point depression - definition, Applications of thermal properties.		
Unit – III	**Optical Properties:**	**9**
Refractive index of food items, Abbe's refractometer, Optical activity, Polarimeter, Gloss and glossimeter, color, translucency – Definitions and applications. Electromagnetic Properties: Electrical properties- electrical conductivity and its measurement, dielectric properties - measurement methods, effect on moisture, temperature and composition, microwave heating and other applications.		
Unit – IV	**Rheological Properties:**	**9**
Classification of rheology, Stress Strain behavior of Newtonian and Non- Newtonian fluids- Bingham and Non Bingham. Stress-strain relationships in solids, liquids and visco elastic behavior- stress relaxation test, creep test and dynamic test, stress-strain diagrams, Rheological models – Kelvin and Maxwell model. Viscosity – Types and its definitions, measurement methods - Capillary, Orifice, Falling and Rotational viscometers.		
Unit – V	**Textural Properties:**	**9**
Types of food textures, Texture measuring instruments- Compression, Snap Bending, Cutting Shear, Puncture, Penetration and TPA, Properties of food powders. Color: Interaction of object with light, Measurement methods -Spectrophotometer and Colorimeter, Color order systems- Munsel color system, CIE color system, Hunter lab color space, Lovibond system.		
		Total:45

TEXT BOOK:

1. Serpil Sahin and Servet Gulum Sumnu,"Physical Properties of Foods", 1st Edition, Springer, New York, 2006.

REFERENCES:

1. Rao M.A. and Rizvi S.S.H., "Engineering Properties of Foods", 4thEdition, CRC Press, New York, 2014.
2. Sahay K.M. and Singh K.K., "Unit Operations of Agricultural Processing", 2nd Edition, Vikas Publishing, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the various physical properties in food process design	Applying (K3)
CO2	outline the thermal properties of foods and its measurement methods	Understanding (K2)
CO3	make use of optical and electromagnetic properties of food materials in food processes	Applying (K3)
CO4	explain various rheological behavior of solid, liquid and viscoelastic food materials	Understanding (K2)
CO5	choose suitable textural and color measurement techniques for food materials	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ITC23 - PYTHON PROGRAMMING							
Programme & Branch	**BTech – Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**C Programming**	**2**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course deals with core python programming. It gives a comprehensive introduction to problem solving using python constructs and libraries.

Unit – I	**Introduction:**	**9**

Problem solving strategies – program design tools – Types of errors – Testing and Debugging- Basics: Literals – variables and identifiers – data types – input operation – comments – reserved words – indentation – Operators and Expressions – Decision Control Statements: Introduction – conditional statement – iterative statements – Nested Loops – break, continue and pass statements – else in loops.

Unit – II	**Lists, Tuples and Dictionary:**	**9**

Lists: Access, update, nested, cloning, operations, methods , comprehensions, looping – Tuple: Create, utility, access, update, delete, operations, assignments, returning multiple values, nested tuples, index and count method – Dictionary: Create, access, add and modify, delete, sort, looping, nested, built-in methods – list vs tuple vs dictionary.

Unit – III	**Strings and Regular Expressions:**	**9**

Strings: Concatenation , append, multiply on strings – Immutable – formatting operator – Built-in string methods and functions – slice operation – functions – operators – comparing – iterating – string module – Regular Expressions **–** match, search, sub, findall and finditer functions – flag options.

Unit – IV	**Functions and Modules:**	**9**

Functions: Introduction – definition – call – variable scope and lifetime – return statement – function arguments – lambda function – documentation strings – programming practices recursive function- Modules: Modules – packages – standard library methods – function redefinition.

Unit – V	**Object Orientation:**	**9**

Class and Objects: Class and objects – class methods and self – constructor – class and object variables – destructor – public and private data member. NumPy : NumPy Arrays – Computation on NumPy Arrays. Matplotlib : Line plots – Scatter Plots

LIST OF EXPERIMENTS / EXERCISES:

1.	Programs using conditional and looping statements
2.	Implementation of list and tuple operations
3.	Implementation of dictionary operations
4.	Perform various string operations
5.	Use regular expressions for validating inputs
6.	Demonstration of different types of functions and parameter passing
7.	Develop programs using classes and objects
8.	Perform computation on Numpy arrays
9.	Draw different types of plots using Matplotlib

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja., "Python Programming using problem solving approach", 3rd impression, Oxford University Press., New Delhi, 2017.

REFERENCES/ MANUAL / SOFTWARE:

1.	Nageswara Rao, "Core Python Programming", 2nd Edition, DreamTech Press, New Delhi, 2018.
2.	Jake Vander Plas, " Python Data Science Handbook Essential Tools for Working with Data", O'Reilly Publishers, 1st Edition, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use basic python constructs to build simple programs	Applying (K3), Precision (S3)
CO2	apply list, tuple and dictionary to handle variety of data.	Applying (K3), Precision (S3)
CO3	apply strings and regular expression for searching and retrieval	Applying (K3), Precision (S3)
CO4	solve the problems using functions and modules.	Applying (K3), Precision (S3)
CO5	apply object oriented concepts and perform data science operations using python	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MET22 - BASICS OF MECHANICAL ENGINEERING							
Programme& Branch	**BTech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**ES**	**3**	**0**	**0**	**3**
Preamble	To impart knowledge on basic concepts of boiler, steam properties, IC Engine and manufacturing technology.						
Unit – I	**Boilers:**						**9**
Boiler Classification – Fire tube and Water tube boilers - Cochran Boiler, Lancashire boiler, Locomotive Boiler, Babcock and Wilcox boiler, Fluidized Bed Boiler. Boiler mountings and Accessories - Performance and energy efficiency of boilers - Importance of boiler water treatment and blow down.							
Unit – II	**Steam Properties:**						**9**
Properties of steam - steam table usage and h-s chart - Dryness fraction of steam - Calorimeters – Tank or barrel type, throttling, separating, separating and throttling . Steam distribution systems - Application of steam in food process industries.							
Unit – III	**Internal Combustion Engines:**						**9**
Classification of IC Engines - Parts of IC Engine and their materials - Cycle of operation - Working principle of spark ignition and compression ignition engines - Two and Four stroke Engines – Cooling and Lubrication system - Emission norms for Petrol and Diesel vehicles - Methods of controlling emission from SI and CI engines.							
Unit – IV	**Mechanical Components and their Applications:**						**9**
Basic principle and applications of power transmission systems such as Belt, Rope, Chain and Gear drives - Function and working principle of Coupling, Clutch, Brake and Flywheel.							
Unit – V	**Manufacturing Technology**						**9**
Basic principle and applications of Metal forming processes, Forging, Extrusion, Sheet metal. Basic principle and applications of Metal Joining processes – Welding, Soldering and Brazing. Basics of 3D printing and CAD/CAM/CIM .							
							Total:45
TEXT BOOKS:							
1.	R.K.Rajput , “Thermal Engineering”, 11th Edition, Laxmi Publications, New Delhi, 2023, for Units I,II,III.						
2.	Venugopal K and Prabhu Raja V, “Basic Mechanical Engineering“ , Anuradha Publishers, Kumbakonam, 2000 for Units IV & V						
REFERENCES:							
1.	Pravin Kumar, “Basic Mechanical Engineering”, 1st Edition, Pearson Publishers”, New Delhi, 2013.						
2.	Mahesh M. Rathore. “Thermal Engineering”. 1st Edition, McGraw Hill Publications, New Delhi, 2010.						
3.	Rao P.N. “Manufacturing Technology - Foundry, Forming and Welding”, Volume - 1, 4th Edition, McGraw Hill Education Pvt Ltd., New Delhi, 2017.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify suitable boilers and their components to various appplications	Applying (K3)
CO2	interpret the properties of steam and infer the quality of steam using calorimeters	Understanding (K2)
CO3	explain the working principle of an internal combustion engine with its subsystems	Understanding (K2)
CO4	explain the basic principles of various mechanical components	Understanding (K2)
CO5	infer the fundamental concepts of manufacturing processes and CAD/CAM/CIM	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	70	10				100
CAT2	20	80					100
CAT 3	20	80					100
ESE	20	70	10				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22PHL23 - PHYSICS LABORATORY FOR FOOD TECHNOLOGY

Programme & Branch	B.Tech - Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of parameters such as hysteresis loss, velocity of ultrasonic waves, compressibility of a liquid, particle size, Young's modulus, rigidity modulus, specific resistance, thermal conductivity, viscosity, and thickness of thin film, and also to impart skills on writing coding / developing project / product related to societal requirement.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of hysteresis loss in a ferromagnetic material.
2.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of the liquid using ultrasonic interferometer.
3.	Determination of the particle size of the given powder using semiconductor laser.
4.	Determination of the Young's modulus of the material of the given beam using uniform bending method.
5.	Determination of the rigidity modulus of the metallic wire using torsional pendulum.
6.	Determination of the specific resistance of the given metallic wire using Carey-Foster's bridge.
7.	Determination of the thermal conductivity of a bad conductor using Lee's disc.
8.	Determination of the coefficient of viscosity of liquid using Poiseuille's method.
9.	Determination of thickness of a thin film using air-wedge arrangement.
10.	Writing coding for any one of the above experiments / developing a project / a product.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Physics Laboratory Manual / Record, Department of Physics, 1st Edition, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the hysteresis loss in ferromagnetic materials, the velocity of ultrasound in a liquid and the particle size of a powder material.	Applying (K3), Precision (S3)
CO2	determine the Young's modulus of a material, the rigidity modulus of a wire, the specific resistance of a metallic wire and the thermal conductivity of a bad conductor.	Applying (K3), Precision (S3)
CO3	determine the coefficient of viscosity of a liquid, the thickness of a thin film and develop a coding / project / product.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3					2	2		2	2	2
CO2	3	2	2	3					2	2		2	2	2
CO3	3	2	2	3					2	2		2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22MEL21 - BASICS OF MECHANICAL ENGINEERING LABORATORY							
Programme& Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**0**	**0**	**2**	**1**

Preamble	To provide practical exposure on various manufacturing processes in Mechanical Engineering.

LIST OF EXPERIMENTS / EXERCISES:

1.	Study on Steam boiler and its components.
2.	Study on various parts of IC engines.
3.	Draw the valve timing and port timing diagram for four stroke and two stroke engines.
4.	Dismantling and assembling of automotive transmission system
5.	To prepare a sand mold using Foundry tools
6.	Perform facing, turning and knurling operations in centre lathe
7.	Perform external thread cutting operations in centre lathe
8.	To form a component using hot forging and injection moulding process
9.	To form a component using sheet metal operation
10.	To prepare different weld joints like T / L / Lap weld joints using TIG / MIG welding
11.	To prepare different weld joints using Gas welding and Spot welding equipments
12.	To model a simple component using CAD software

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Pravin Kumar, “Basic Mechanical Engineering, Pearson Publishers”, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	find out various components of Boilers and IC engines	Applying (K3), Manipulation (S2)
CO2	perform the metal forming and joining process	Applying (K3), Precision (S3)
CO3	produce different profiles on metal parts by machining operations using lathe, and perform a solid modelling using CAD software	Applying (K3), Manipulation (S2)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2					3			1		3
CO2	3			2					3			1		3
CO3	3			2					3			1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22FTT31 - PROCESS FLUID MECHANICS							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**0**	**3**
Preamble	This course provides an introduction to the properties and behaviour of fluids. It introduces dimensional analysis and equations of Fluid flow and enables the students to apply in mixing, pumping and metering.						
Unit – I	**Fluid Statics and Flow phenomena:**						**9**
Nature of fluids **-** Physical properties of fluids. Fluid statics -Hydrostatic equilibrium. Application of fluid statics: manometers - continuous gravity decanter- storage Tank. Types of fluids: Compressible and incompressible fluids, Newtonian and Non–Newtonian fluids. Flow of Fluids : Concept of flow rates, velocity and type of flows							
Unit – II	**Equations of Fluid Flow:**						**9**
Continuity equation **-** Reynolds number **-** Fluid flow regimes**.** Bernoulli equation-Correction of Bernoulli equation for fluid friction-Application of Bernoulli equation for pump work. Shear stress and skin friction in pipes - Laminar and turbulent flow of fluids through closed conduits - Velocity profiles and friction factor for smooth and rough pipes- Friction loss due to sudden enlargement and contraction- Friction loss in fittings, valves and coils.							
Unit – III	**Flow Past Immersed Bodies:**						**9**
Pressure drop for flow of liquids through porous media. Motion of particles through fluids: Equation for one dimensional motion of spherical particle through fluid, terminal velocity, Hindered settling. Agitation of Liquids: Agitation Vessels **-** Types of impellers - Flow pattern in agitated vessel - Estimation of Power consumption in agitated vessels. Dimensional analysis -Rayleigh's method and Bukingham's π method.							
Unit – IV	**Transportation of Fluids:**						**9**
Classification of Pumps. Positive displacement pumps: operation, capacity and characteristics. Centrifugal pump: Performance, losses and characteristics. Calculation of power and discharge. Working principle and applications of Gear pumps, Lobe pumps, Screw pumps, diaphragm pumps, progressive cavity pumps, vacuum pumps, metering pumps and peristaltic pumps. Fans, blowers and compressors – Selection, types and applications. Pipelines for the transportation – sanitary aspects and material of construction							
Unit – V	**Metering of Fluids:**						**9**
Variable head meters: Orifice meter, Venturimeter, Pitot tube. Variable areameters: Rotameter. Working Principle and applications of Doppler Ultrasonic flow meters, Transit time flow meters, Magnetic flow meters, Tubine flow meters, Thermal flow meters, Positive displacement flow meters, Coriolis flowmeter and Surface Acoustic Wave flow meters. Notches and Weirs. Valves – Types, selection and applications.							
							Lecture:45
TEXT BOOK:							
1.	McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.						
REFERENCES:							
1.	Romeo T. Toledo, "Fundamentals of Food Process Engineering", 4th Edition, Springer, New York, 2018.						
2.	Paul Singh R., Dennis R. Heldman, "Introduction to Food Engineering", 5th Edition, Academic Publisher, 2013.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify fluids and apply hydrostatic equilibrium	Applying (K3)
CO2	derive and apply basic equations of fluid flow	Applying (K3)
CO3	analyze fluid flow through porous media and select suitable mixing equipment	Analyzing (K4)
CO4	select and examine the performance of pumps	Analyzing (K4)
CO5	explain the working principle and choose flow measuring devices and valves	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	45	5			100
CAT2	20	30	40	5			100
CAT3	25	30	40	5			100
ESE	20	30	40	5			100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTT32 – FOOD CHEMISTRY							
Programme & Branch	**B.Tech &Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course deals about the importance of micronutrients, food additives, modification of biomolecules and chemistry of muscle tissue.

Unit – I	**Minerals and Vitamins:**	**9**

Minerals: Major minerals - Calcium, Potassium, Sodium, Phosphorus. Minor minerals - Iron, Zinc, Iodine, Copper, Selenium. Functional role and deficiency. Vitamins: Definition, water soluble and fat soluble vitamins, sources, functions and deficiency symptoms.

Unit – II	**Changes during Processing:**	**9**

Cooking: objectives - methods – moist heat, dry heat and combination. Loss of nutrients and prevention - biochemical changes in carbohydrates - Gelatinization and retrogradation of starch - proteins and lipids. Parboiling of rice. Enzymatic browning reaction, non enzymatic browning reactions - caramelization, Maillard reaction

Unit – III	**Modification of Biomolecules:**	**9**

Modified starches, resistant starch. Starch hydrolysates – Maltodextrin, cyclodextrin and dextrin. Modification of proteins – chemical and enzymatic methods. Modification of fats - Hydrogenation - cis and trans isomers, interesterification, winterization. Biochemical changes during processing of foods – malting and baking.

Unit – IV	**Food Additives, Food colours and Flavours:**	**9**

Food additives: classification and purpose - Role of thickeners, stabilizers, sweeteners, emulsifiers, leaveners, colours, flavoring agents, flour improvers, anticaking agents, sequestrants, humectants, preservatives - examples. Food colours and Flavours: Natural and synthetic colourants - chlorophyll, carotenoids, betalains, anthocyanins and other phenols. Flavours – sensory perception of flavors, Molecular Mechanisms of Flavour Perception, specific and synthetic flavours, Taste and Other Saporous Substances, Vegetable, Fruit, and Spice Flavours, Flavours from Lactic Acid–Ethanol Fermentations, Flavour Volatiles from Fats and Oils.

Unit – V	**Chemistry of edible muscle Tissues:**	**9**

Structure of muscle-conversion of muscle to meat – natural and induced postmortem biochemical changes affecting meat quality. Chemistry of processed meats – curing, hydration and water retention, formation of gel matrix, fat immobilization and stabilization

Total:45

TEXT BOOK:

1. Srinivasan Damodaran, Kirk L. Parkin (Eds), Fennema's, "Food Chemistry", 5th Edition, CRC Press, Florida, 2017

REFERENCES:

1. Belitz H.D., Grosch W. and Schieberle P., "Food Chemistry", 4th and revised Edition, Springer Berlin Heideberg, 2008.
2. John M. deMan, John Finley, W. Jeffrey Hurst, Chang Lee, "Principles of Food Chemistry", 4th Edition, Springer International Publishing, Switzerland, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the nutritional importance of vitamins and minerals	Understanding (K2)
CO2	recognize the changes in food components during cooking, processing and storage	Understanding (K2)
CO3	select the carbohydrates, proteins and fats based on its role in processing	Applying (K3))
CO4	identify the role of food additive, colours and flavors in food processing	Applying (K3)
CO5	infer the biochemical changes in meat during processing	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	25	50	15	10			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTT33 - FOOD PROCESS CALCULATIONS							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**1**	**0**	**4**
Preamble	The course helps the student to understand fundamental and the stoichiometric calculations, material and energy balance associated with unit operations.						
Unit – I	**Units and Dimensions, Fundamental Calculations:**						**9+3**
Basic and derived units, unit conversions, use of model units in calculations, methods of expression, compositions of mixture and solutions, ideal and real gas laws – gas constant - calculations of pressure, volume and temperature using ideal and van der Waals equation, use of partial pressure and pure component volume in gas mixture calculations.							
Unit – II	**Material Balance Calculation:**						**9+3**
Stoichiometric principles, material balance without chemical reaction - application of material balance to unit operations: distillation, evaporation, crystallization, drying, blending of food ingredients and extraction.							
Unit – III	**Recycle Operations and Humidity and Saturation:**						**9+3**
Bypass and Recycle Operations: Bypass operation, recycle operations - block diagram, purging operations, purge ratio, recycle ratio and purge stream. Humidity and Saturation: Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity, wet and dry bulb temperature, dew point - Humidity chart usage.							
Unit – IV	**Energy Balance Calculation:**						**9+3**
Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, enthalpy changes in food. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction.							
Unit – V	**Combustion and Process Flow Sheet Calculation:**						**9+3**
Combustion: Combustion of solids, liquid and gas, determination of NHV and GHV. Determination of composition by Orsat analysis - Calculation of excess air, theoretical oxygen requirement. Process Flow Sheet Calculation: Material and Energy Balance for selected food Process.							
Lecture:45, Tutorial:15, Total:60							

TEXT BOOK:

1. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 8th Edition, Prentice Hall of India, New Delhi, 2013.

REFERENCES:

1. Stavros Yanniotis, “Solving Problems in Food Engineering”, 3rd Edition Springer, New York, 2008.
2. Romeo T. Toledo, Rakesh K. Singh, Fanbin Kong, “Fundamentals of Food Process Engineering”, 4th Edition, Springer Publishers, New York, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	make use of different systems of units and dimensions, calculate compositions of mixtures and solutions	Applying (K3)
CO2	outline the stoichiometry principles and apply material balance for different unit operations	Applying (K3)
CO3	apply material balance for bypass, recycle operations and perform humidification calculations	Applying (K3)
CO4	make use of energy balance for system without chemical reactions	Applying (K3)
CO5	make use of material and energy balance in various process and determine the GHV, NHV and composition of fuels	Analyzing (K4)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	60	20			100
ESE	5	5	75	15			100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTT34- REFRIGERATION AND COLD CHAIN MANAGEMENT							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**0**	**3**
Preamble	The course imparts the basic concepts of thermodynamics, refrigeration systems, low temperature storage systems and theoretical knowledge on cold chain management.						
Unit – I	**Introduction to Thermodynamics:**						**9**
Fundamental concepts of thermodynamics- systems, properties, process, functions, heat and work. Zeroth and First Law of Thermodynamics. Statement of first law for flow and non - flow process. Internal energy, enthalpy, heat capacities (CV and CP). Second Law of thermodynamics: Kelvin-Plank, Clausius statements, Carnot cycle, Entropy changes during processes.							
Unit – II	**Refrigeration Components:**						**9**
Introduction to refrigeration, unit of refrigeration capacity, Refrigerants - classification and thermodynamic properties, Ozone depletion potential, Reversed Carnot cycle, Limitations of reversed Carnot systems. Evaporator- dry and flooded type, liquid cooling evaporator. Condenser- water cooled, air cooled and evaporative condenser. Compressor - Reciprocating type compressors. Expansion valve - thermostatic expansion valve.							
Unit – III	**Refrigeration Systems:**						**9**
Refrigeration cycle – simple vapour compression and absorption system. p-h and T-s diagrams, determination of COP. Energy ratios and Power consumption of a refrigerating machine. Standard rating cycle and effect of operating conditions. Air refrigeration system – reversed Brayton cycle.							
Unit – IV	**Low Temperature Storage Systems:**						**9**
Pre-cooling systems, Cold storage- construction, insulation and operation. Design of cold storage unit. Calculation of refrigeration load in cold store. Prefabricated systems, walk-in-coolers. Frozen storage, Freezer types, Cryogenics – Linde and Claude system for liquefaction of air.							
Unit – V	**Cold Chain:**						**9**
Introduction, Components of cold chain. Refrigerated distribution and transport systems, Cold chain in retail, Information systems-Time temperature management – Application of RFID. Role of refrigeration in candy manufacture, beverage processing, bakery products, meat products, poultry products, fish products, fruit /vegetables and dairy products.							
							Total:45
TEXT BOOK:							
1.	Rajput R.K, "Refrigeration And Air-conditioning", 3rd Edition, S.K. Kataria and Sons, Delhi, 2012.						
REFERENCES:							
1.	Dellino C.V.J., "Cold and Chilled Storage Technology", 2nd Edition, Springer, US, 2011.						
2.	Narayanan K.V., **"**A Text Book of Chemical Engineering Thermodynamics**",** 2nd Edition, Pentice Hall of India, New Delhi, 2003.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of thermodynamics	Applying(K3)
CO2	outline the components of refrigeration system	Understanding(K2)
CO3	explain various refrigeration system and make use of refrigeration calculations	Applying(K3)
CO4	select appropriate low temperature storage systems	Applying(K3)
CO5	apply the concept of cold chain for storage and distribution of various food products	Applying(K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	40				100
CAT2	30	30	40				100
CAT3	30	30	40				100
ESE	25	25	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTT35 - FOOD PACKAGING TECHNOLOGY							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge about basics and recent advancements in food packaging materials, methods and food labelling.	
Unit – I	**Basics of Food Packaging**	**9**
Definitions and basic functions of a food package. Food package design and development. Physical and physico-chemical processes affecting product quality, migration from packaging to foods, predicting the shelf life of foods. Package standards and regulation. Labeling, bar coding.		
Unit – II	**Paper and Paperboard Packaging**	**9**
Paper and paperboard- manufacture, properties analysis and packaging aspects. Package types – pouches, sacks, cartons, boxes, tubes, tubs, labels, sealing tapes, cap liners and diaphragm.		
Unit – III	**Plastic Packaging**	**9**
Types of plastics used in packaging – PE, PP, PET, PVC, EVOH, PVA. Secondary conversion techniques – film, extrusion and thermal lamination. Printing of plastic films and rigid plastic containers. Natural extracts in plastic food packaging. Food contact and barrier properties. Sealability and closure.		
Unit – IV	**Metal cans and Glass Containers:**	**9**
Raw materials for can making –steel, aluminum. Can making processes – three piece welded cans, DWI, DRD cans – end making processes, coating, film laminates and inks, corrosion and sulphur staining. Flash 18 process, retorting equipment. Definition and composition. Glass container manufacture – melting, forming, surface treatments. Closure selection. Glass bottle design and specification.		
Unit – V	**Trends in Food Packaging:**	**9**
Active and intelligent packaging, modified atmosphere packaging - vacuum and inert gas packaging, biodegradable and edible packaging, aseptic packaging, self-heating and cooling cans. Recycling of non-biodegradable packaging materials		
		Total:45

TEXT BOOK:

1. Richard Coles and Mark J. Kirwan, "Food and Beverage Packaging Technology", 2nd Edition, Blackwell Publishing Asia Pvt Ltd, CRC press, USA, 2011.

REFERENCES:

1. Han Jung H, "Innovations in Food Packaging", 2nd Edition, Academic Press, USA, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer basic concepts in food packaging	Understanding (K2)
CO2	make use of paper and paperboards for various food applications	Applying (K3)
CO3	identify suitable plastic for packaging based on their properties	Applying (K3)
CO4	choose appropriate metal and glass containers for food packaging	Applying (K3)
CO5	select and adapt recent trends in food packaging	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1	20	64	16				100
CAT 2	20	64	16				100
CAT 3	20	64	16				100
ESE	16	52	32				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTL31 - FLUID FLOW LABORATORY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	0	0	2	1

Preamble	To impart practical knowledge required for handling Newtonian Fluids.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of discharge coefficient of Venturimeter
2.	Determination of discharge coefficient of Orificemeter
3.	Verifying relationship between friction factor and Reynolds number for flow through square ducts
4.	Verifying Darcy's equation for flow through circular pipes
5.	Determination of critical Reynolds number for flow through helical coils
6.	Determination of discharge coefficient of V- notch
7.	Verifying relationship between friction factor and Reynolds number for flow through annular pipes
8.	Determination of loss coefficient of valves and pipe fittings
9.	Estimation of performance characteristics of centrifugal pump
10.	Estimation of performance characteristics of reciprocating pump
11.	Virtual Lab : a. Demonstration and estimation of discharge coefficient of Venturimeter b. Demonstration and determination of energy loss in pipe

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	McCabe W.L., Smith J.C., and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.
3.	Perry Robert, "Perry's Chemical Engineers Hand book", 8th Edition, McGraw Hill, New York, 2007.
4	Gavhane K.A., "Unit Operations – I", 27th Edition, Nirali Prakashan Publications, Pune, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	estimate the discharge coefficient for variable area and head flow meters	Evaluating (K5), Precision (S3)
CO2	measure and analyze the flow of fluids through closed conduits, valves and pipe fittings	Evaluating (K5), Precision (S3)
CO3	evaluate the performance of pumps	Evaluating (K5), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2			1	3	2	2	2	3	2
CO2	3	3	3	3	2	1		1	3	2	2	2	3	2
CO3	3	3	3	3	1	1		1	3	2	2	2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTL32 - FOOD CHEMISTRY LABORATORY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	0	0	2	1

Preamble	To deal about analysis and estimation of biomolecules.

LIST OF EXPERIMENTS / EXERCISES:

1.	Qualitative tests for monosaccharide, disaccharides, polysaccharides
2.	Estimation of total carbohydrate in food product
3.	Extraction and analysis of oil (iodine number, saponification number, acid number)
4.	Estimation of protein by Lowry's method
5.	Determination of dextrose equivalent in modified starches
6.	Extraction and estimation of carotenoids and lycopene in fruits/vegetables
7.	Estimation of polyphenols in fruits/vegetables
8.	Estimation of flavanoids in fruits/vegetables
9.	Estimation of Vitamin C in fruits/vegetables
10.	Estimation of Iron in food samples
11.	Virtual Laboratory Experiments: a. Isoelectric precipitation of protein from milk

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Ranganna S., "Handbook of Analysis and Quality Control for Fruit and Vegetable Products", 2nd Edition, Tata McGraw Hill, New Delhi, 2008.
3.	Sadasivam S. and Manickam A., "Biochemical Methods", 3rd Edition, New Age International, New Delhi, 2018.
4	http://vlab.amrita.edu/?sub=3&brch=63&sim=158&cnt=1

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze and estimate macro and micronutrients in food products	Evaluating(K5), Precision (S3)
CO2	extract oil and analyze its properties	Evaluating (K5), Precision (S3)
CO3	extract and estimate phytochemicals in food products	Evaluating (K5), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	1		1	3	2	1	1	2	3
CO2	3	3	3	3	2	1		1	3	2	1	1	2	3
CO3	3	3	3	3	2	1		1	3	2	1	1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GET31- UNIVERSAL HUMAN VALUES							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3/6**	**HS**	**2**	**0**	**0**	**2**
Preamble	To make the student to know what they 'really want to be' in their life and profession, understand the meaning of happiness and prosperity for a human being. Also to facilitate the students to understanding of harmony at all the levels of human living, and live accordingly						
Unit – I	**Introduction:**						**6**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment of Human Aspirations – Relationships – Physical Facilities – Right Understanding.							
Unit – II	**Harmony in the Self and Body:**						**6**
Human Being and Body – Understanding Myself as Co–existence of Self ('I') and Body, Needs of the Self and Body, Activities in the Self and Body, Self ('I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmony in the Self ('I) – Understanding Myself – Harmony with Body.							
Unit – III	**Harmony in the Family and Society:**						**6**
Harmony in the Family – Justice – Feelings (Values) in Human Relationships – Relationship from Family to Society – Identification of Human Goal – Five dimensions of Human Endeavour.							
Unit – IV	**Harmony in Nature and Existence:**						**6**
Order of Nature – Interconnectedness – Understanding the Four order – Innateness – Natural Characteristic – Basic Activity – Conformance – Introduction to Space – Co–existence of units of Space – Limited and unlimited – Active and No–activity – Existence is Co–existence.							
Unit – V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics:**						**6**
Values in different dimensions of Human Living – Definitiveness of Ethical Human Conduct –Implications of Value based Living – Identification of Comprehensive Human Goal – Humanistic Education – Universal Human Order – Competence and Issues in Professional Ethics.							
							Total:30
TEXT BOOK:							
1.	Gaur R.R., Sangal R., Bagaria G.P., "A Foundation Course in Human Values and Professional Ethics", 1st edition, Excell Books Pvt. Ltd., New Delhi, 2016.						
REFERENCES:							
1.	Ivan Illich, "Energy & Equity", The Trinity Press, USA, 1974.						
2.	Schumacher E.F., "Small is Beautiful: a study of economics as if people mattered", Britain, 1973.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	restate the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society	Applying (K3)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self, the Co–existence of Self and Body	Applying (K3)
CO3	infer the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human–human relationships and explore their role in ensuring a harmonious society	Applying (K3)
CO4	transform themselves to co-exist with nature by realising interconnectedness and four order of nature	Applying (K3)
CO5	distinguish between ethical and unethical practices, and extend ethical and moral practices for a better living	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	75					100
CAT2	25	75					100
ESE	NA						100

* ±3% may be varied (CAT 1 & 2 – 50 marks & ESE – 100 marks)

22MAT41- NUMERICAL METHODS FOR ENGINEERS

(Common to Civil, Mechanical, Mechatronics, Automobile and Food Technology Branches)

Programme & Branch	BE - Civil, Mechanical, Mechatronics, Automobile and BTech - Food Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**4**	**BS**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear system of equations, ordinary and partial differential equations.

Unit – I	**Solution to Algebraic and Transcendental Equations:**	**9+3**

Iteration method – Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss – Jordan method – Iterative methods: Gauss Jacobi and Gauss – Seidel methods.

Unit – II	**Interpolation:**	**9+3**

Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.

Unit – III	**Numerical Differentiation and Integration:**	**9+3**

Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule – Simpsons 3/8th rule – Double integrals using Trapezoidal and Simpson's rules.

Unit – IV	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**

Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.

Unit – V	**Solutions of Boundary Value Problems in PDE:**	**9+3**

Solution of one dimensional heat equation – Bender –Schmidt recurrence relation – Crank – Nicolson method – One dimensional wave equation – Solution of two dimensional Laplace equations – Solution of Poisson equation.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Veerarajan T, Ramachandran T., "Numerical Methods", 1st Edition, McGraw Hill Education, Chennai, 2019.

REFERENCES:

1. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", 3rd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2007.
2. Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
3. Sastry, S.S, "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd, 2015.
4. Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO2	perform interpolation on given data using standard numerical techniques.	Applying (K3)
CO3	understand the concepts of numerical differentiation and integration	Applying (K3)
CO4	compute the solution of first order ordinary differential equations by numerical techniques..	Applying (K3)
CO5	apply various numerical techniques for solving partial differential equations.	Applying (K3)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80	-	-	-	100
CAT2	10	10	80	-	-	-	100
CAT3	10	10	80	-	-	-	100
ESE	10	10	80	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTT41 - HEAT TRANSFER OPERATIONS							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**ES**	**3**	**1**	**0**	**4**
Preamble	The course enable the students to study the phenomena of modes of heat transfer, heat exchangers, evaporators and its application in food processing operations.						
Unit – I	**Heat transfer Operations and conductions:**						**9+3**
Introduction to Heat transfer Operations: Introduction, Modes of Heat Transfer, role in food processing operations. Conduction: Fourier's law of heat conduction - One dimensional steady state heat conduction equation for flat plate, composite wall, hollow cylinder, composite cylinder, Thermal Conductivity - effect of temperature on thermal conductivity, Thermal Insulation							
Unit – II	**Convection:**						**9+3**
Natural and forced convection– Application of dimensional analysis for convection - Equations for forced and natural convection under laminar, transition and turbulent conditions. Individual and overall heat transfer coefficients and its relationship between them. Unsteady state heat transfer. Introduction to Fins.							
Unit – III	**Radiation:**						**9+3**
Black body concept - Radiation Properties–Stefan Boltzmann's law, emissivity and absorptivity. Concept of grey body – radiation between non-black surfaces –parallel planes, radiation shields.							
Unit – IV	**Heat Exchangers:**						**9+3**
Parallel and counter flow heat exchangers - LMTD - Heat exchangers effectiveness; number of transfer unit – use of correction factor charts - Fouling factor. Types of heat exchanger- working principles and applications: Single pass, multi pass heat exchangers, shell and tube heat exchanger, plate heat exchangers.							
Unit – V	**Evaporators:**						**9+3**
Types of evaporators – working principle and applications: Single effect evaporators, multiple effect evaporators -Feed forward and feed backward operations, Open pan evaporator, horizontal tube evaporator, vertical tube evaporator, long tube evaporator, forced circulation evaporator.							
Lecture:45, Tutorial:15, Total:60							
TEXT BOOK:							
1.	Gavhane K.A., "Heat Transfer SI Units", 13th Edition, Nirali Prakashan Publications, Pune, 2012						
REFERENCES:							
1.	Dutta Binay K., **"**Heat Transfer Principles and Applications**",** 1st Edition, Prentice Hall of India, New Delhi, 2015.						
2.	Earle R.L., **"**Unit Operations in Food Processing**",** 2nd Edition, The New Zealand Institute of Food Science and Technology, 2008.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the concept of heat conduction	Understanding(K2)
CO2	make use of equations for calculating convective heat transfer coefficients	Applying(K3)
CO3	apply the concepts of radiation to solve heat transfer problems	Applying(K3)
CO4	select a suitable heat exchanger and analyze the performance	Analyzing (K4)
CO5	choose evaporators and infer its performance	Applying(K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	45	45				100
CAT2	10	30	60				100
CAT3	10	20	50	20			100
ESE	10	30	50	10			100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTT42 – FOOD MICROBIOLOGY

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	0	0	3

Preamble	To get in depth knowledge in microbiology basics, identification and incidence of microbes in food, spoilage, diseases and its control.	
Unit – I	**Introduction:**	**9**
Introduction: Origin and Scope of Microbiology- History-Contribution by scientists. Three kingdom concept- Whitaker Five Kingdom concept-Classification of Microorganisms- Prokaryotes and Eukaryotes. Structure, reproduction and importance of bacteria, virus, fungi and algae in foods.		
Unit – II	**Classification and Identification:**	**9**
Classification and Identification: Classification of microbes based on nutritional requirements. Staining techniques- Simple staining, Differential staining, Special Staining. Culture media- types of media. Pure culture techniques- Cultivation, maintenance and preservation of media. Growth curve.		
Unit – III	**Incidence of Microorganisms:**	**9**
Incidence of Microorganisms: Primary sources of microbes in food, Parameters influencing the growth of microorganisms in food- Intrinsic and Extrinsic. Microbial Load assessment: SPC, MPN, DMC, Dye Reduction test, ATP measurement. Immunological methods: PCR, Fluorescent Antibody, ELISA.		
Unit – IV	**Microbial spoilage and its control:**	**9**
Microbial spoilage and its control: Types of food spoilage, Microbial spoilage of different types of foods– fruits and vegetables, meat and meat products, bakery products, dairy products, fermented foods and canned foods. Control of microorganisms: Physical agents, Chemical agents and their mode of action. Role of antibiotics.		
Unit – V	**Food Borne Diseases and Quality Control:**	**9**
Food Borne Diseases and Quality Control: Gastroenteritis, Listeriosis, Salmonellosis, Shigellosis, Vibriosis, Campylobacteriosis. Food toxins – Aflatoxin, Ochratoxin, Patulin, Botulin. Indicators of food product quality- Coliform bacteria- Indicators of food safety. Microbiological criteria for foods.		
		Total:45

TEXT BOOK:

1.	James M. Jay, Martin J. Loessner, David A. Golden, “Modern Food Microbiology”, 4th Edition, Springer Netherlands, 2012. Unit 1-2
2.	Frazier W.C., Westhoff D.C. and Vanitha N.M., “Food Microbiology”, 5th Edition, Tata McGraw Hill, New Delhi, 2014- Unit 3-5.

REFERENCES:

1.	Pelczar M.J., Chan E.C.S. and Krieg N.R., “Microbiology”, 5th Edition, Tata McGraw Hill, New York, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	recall the historical developments in microbiology and classify microorganisms	Remembering (K1)
CO2	outline appropriate techniques to identify and cultivate microorganisms	Understanding(K2)
CO3	summarize the importance of microorganisms in foods and quantify microbial load	Understanding(K2)
CO4	identify microbial spoilage in different foods and choose suitable control measures	Applying (K3)
CO5	infer the food borne diseases and quality control of foods	Understanding(K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	40	60					100
CAT3	20	40	40				100
ESE	40	40	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTT43 - MASS TRANSFER IN FOOD PROCESSING OPERATIONS

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Process Calculations	4	PC	3	1	0	4

Preamble	This course provides an insight to the diffusion process and mechanisms of mass transfer. The students will apply the mass transfer concepts to humidification, crystallization, distillation, extraction and leaching

Unit – I	**Mass Transfer Operations and Diffusion:**	**9+3**

Introduction to Mass Transfer Operations: Introduction, Classification and role of mass transfer operations in food processing. Diffusion: Ficks law of diffusion. Steady state molecular and eddy diffusion in gases and liquids. Measurement and prediction of diffusivity of gas and liquids, diffusion in solids. Introduction to unsteady state diffusion. Individual and over all mass transfer co-efficients.

Unit – II	**Theories of Mass Transfer and Analogies, Humidification and Crystallization:**	**9+3**

Theories of Mass Transfer and Analogies: Theories of mass transfer: Two Film, penetration- surface renewal. Analogy between heat, mass and momentum transfer: Reynolds, Chilton -Colburn, Taylor- Prandtl, Von-Karman Analogies. Humidification and Crystallization: Adiabatic saturation process and theory of wet bulb temperature - Measurement of humidity - Cooling towers and Spray Chambers. Principles of crystallization. Crystallizers - Types – Applications.

Unit – III	**Distillation:**	**9+3**

Vapour-Liquid Equilibria - Raoult's law and deviations from ideality. Methods of distillation: Simple distillation- Rayleigh equation - Flash vaporization- steam distillation- vacuum distillation. Tray and Packed Towers. Design of multistage tray towers for binary systems using McCabe-Thiele method

Unit – IV	**Liquid-Liquid Extraction:**	**9+3**

Equilibrium in ternary systems - Solvent selection criteria- equilibrium stage wise contact. Single stage extraction- Multi stage cross current and counter current operations. Extractors - working principle and applications: mixer settlers- packed towers - spray towers- perforated plate towers- rotating disc contactors - pulsed columns-Scheibel extractors-centrifugal extractors

Unit – V	**Leaching:**	**9+3**

Solid-liquid equilibrium - Factors affecting rate of leaching. Single and Multistage operations-Leaching Calculations in single stage. Leaching equipments – working principle and applications: Stationary bed and moving bed percolation type leaching equipments-Batch and continuous immersion type leaching equipments.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Anantharaman N., Meera Sheriffa Begam K.M., **"**Mass Transfer Theory and Practice**",** 1st Edition, PHI Publications, New Delhi, 2011.

REFERENCES:

1. Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill, New York, 2012.
2. Smith P.G., "Introduction to Food Process Engineering", 2nd Edition, Springer, New York, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify, explain and model the diffusion in gas, liquid and solid	Understanding(K2)
CO2	explain and make use of the concepts of humidification and crystallization	Applying (K3)
CO3	summarize various distillation processes and determine equilibrium stages in distillation tower	Evaluating (K5)
CO4	select suitable solvent and extraction equipments and perform extraction calculations	Applying (K3)
CO5	illustrate the principle and operation of leaching equipments and make use of leaching calculations	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	35	45				100
CAT3	15	35	50				100
ESE	15	35	50				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTT44 - FOOD PROCESS ENGINEERING - I							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4 / 5**	**PC**	**3**	**1**	**0**	**4**

Preamble	The course provides knowledge on basic unit operations such as post harvest processing, size reduction, mechanical separation, mixing and extrusion in food processing	
Unit – I	**Pre-Processing Operations:**	**9+3**
Post-harvest losses in field crops – Cleaning - Peeling - Grading and Sorting - Principles, types and equipment's. Moisture content – free moisture, bound and unbound moisture. Equilibrium moisture content - determination methods, models - Hysteresis effect. Water activity.		
Unit – II	**Size Reduction:**	**9+3**
Fibrous foods, Dry foods and Liquid foods – Calculation of Energy Used in Grinding. New Surface Formed by Grinding. Grinding and Cutting equipment's - Crushers, Hammer mills, Fixed head mills, Ball mills, Plate mills and Roller mills. Cutters - Slicers, Dicers, Shredder and Pulper. Size reduction in liquids		
Unit – III	**Mechanical Separation:**	**9+3**
Sedimentation in liquids - Gravitational sedimentation – Floatation -Sedimentation of particles in gas. Centrifugal separation – Velocity of particles – Radius of neutral zone – Measurement- Equipment's. Filtration – Constant rate and Constant pressure filtration – Area calculation- Equipment's, Sieving effectiveness and Applications		
Unit – IV	**Mixing:**	**9+3**
Characteristics of mixtures. Measurement of mixing - sample size, sample composition. Particle mixing and Liquid Mixing - mixing index. Mixing of different quantities. Rate of Mixing and Energy Input in Mixing. Mixing equipment's - Liquid Mixers, Powder and Particle Mixers, Dough and Paste Mixers.		
Unit – V	**Extrusion and Material Handling:**	**9+3**
Theory - Rheological properties and Operating Characteristics. Single and Twin screw extruders - Ancillary Equipment's. Applications and Effects on Foods. Types of handling and conveying system for food products - Belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Fellows P.J., "Food Processing Technology: Principles and Practice", 4rd Edition, Woodhead Publishing Ltd, New Delhi, 2016

REFERENCES:

1.	Earle R.L., "Unit Operations in Food Processing", 2nd Edition, Pergamon Press, U.K., 2004.
2.	Paul Singh R. and Dennis R. Heldman, "Introduction to Food Process Engineering", 5th Edition, Academic Press, USA, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify appropriate pre-processing operations and calculate moisture characteristics of food products	Applying (K3)
CO2	select suitable size reduction equipment for food materials	Applying (K3)
CO3	examine the role of mechanical separation operations in food processing	Applying (K3)
CO4	Identify the characteristics of the mixtures and select appropriate mixing equipment	Applying (K3)
CO5	explain the process of extrusion and select suitable material handling systems	Understanding(K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating(K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTL41 - HEAT AND MASS TRANSFER LABORATORY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	0	0	2	1

Preamble	To impart practical knowledge on heat and mass transfer that is required for process industries.

LIST OF EXPERIMENTS / EXERCISES:

1.	Estimation of individual heat transfer coefficient under Natural/Forced convection heat transfer
2.	Determination of Stefan Boltzman constant for radiation heat transfer
3.	Estimation of individual and overall heat transfer coefficient for heat transfer in shell and tube heat exchanger
4.	Estimation of individual and overall heat transfer coefficient for heat transfer in agitated vessel
5.	Estimation of individual heat transfer coefficient for heat transfer through bare tube heat exchanger
6.	Verifying the Raleigh's equation for the given system using simple distillation setup
7.	Determination of vaporization efficiency (Ev) and thermal efficiency (Et) of the given system using steam distillation setup
8.	Determination of the diffusivity of given liquid to air
9.	Studying the theoretical and actual recovery of solvent using leaching and Estimation of oil recovery using Expeller
10.	Determine % recovery of the overhead and bottom products of methanol water system under total reflux conditions of Packed column Distillation
11.	Virtual Lab: Demonstration of thermal Conductivity of a material

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	McCabe W.L., Smith J.C., and Harriot P. "Unit Operations of Chemical Engineering". 7th Edition, McGraw Hill, New York, 2005.
3.	Perry Robert. "Perry's Chemical Engineers Hand book". 8th Edition, McGraw Hill, New York, 2007.
4	Treybal. R.E. "Mass Transfer Operations".3rd Edition, McGraw-Hill, New York, 1981.
5.	Amirtha virtual lab tool :https://vlab.amrita.edu/

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	estimate heat transfer coefficient for heat exchangers	Evaluating (K5), Precision (S3)
CO2	determine Stefan Boltzmann constant and diffusivity coefficient	Evaluating (K5), Precision (S3)
CO3	evaluate the process/performance parameters for distillation, extraction, and leaching	Evaluating (K5), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2				3	2	2	1	3	2
CO2	3	3	3	3	2				3	2	2	1	3	2
CO3	3	3	3	3	2	1	1	1	3	2	2	1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTL42 - FOOD MICROBIOLOGY LABORATORY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	0	0	2	1

Preamble	To identify and characterize microbes associated with foods and to enumerate it.

LIST OF EXPERIMENTS / EXERCISES:

1.	Study experiments on microbiology lab equipments and safety practices
2.	Identification of microorganisms by Simple staining technique
3.	Identification of microorganisms by Gram staining technique
4.	Preparation of different culture media and microbial isolation using serial dilution technique
5.	Cultivation and enumeration of microorganisms using different plating method(Pour/Spread/Streak)
6.	Enumeration of microorganisms in spoiled bakery and confectionery products
7.	Microbial examination of blanched / pasteurized / sterilized/refrigerated / frozen foods
8.	Assessing the load of coliform bacteria as an indicator microorganism using MPN method
9.	Biochemical characteristics of microorganisms using IMViC test
10.	Antibiotic sensitivity for microorganisms
11.	Virtual lab: simple staining, gram staining, serial dilution, plating techniques, IMViC test

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	James G. Cappuccino, Natalie Sherman, " Microbiology A Laboratory Manual", 12, illustrated, Pearson, 2019.
3.	McLandsborough L., "Food Microbiology Laboratory", Taylor & Francis Group, 2017.
4	http://www.amrita.edu/create

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the morphology of microorganisms by different staining technique	Applying (K3), Precision (S3)
CO2	isolate the microorganisms from different food stuffs	Applying (K3), Manipulation (S2)
CO3	characterize the microorganisms using different methods	Analyzing(K4), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	2			3	2		1	1	3
CO2	3	3	2	2	1	2			3	2		1	1	3
CO3	3	3	2	2	2	2			3	2		2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GEL41 - PROFESSIONAL SKILLS TRAINING - I							
(Common to All BE/ BTech Engineering and Technology branches)							
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**EC**	**0**	**0**	**2**	**2**

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit – I	**Soft Skills – I :**	**20**
Soft skills and its importance: Pleasure and pains of transition from an academic environment to work environment-Need for change- Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuous knowledge upgradation-Self-confidence. Professional grooming and practices: Basics of corporate culture-Key pillars of business etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephone etiquette- Body Language.		
Unit – II	**Quantitative Aptitude and Logical Reasoning – I:**	**30**
Problem solving level I: Number System-LCM &HCF-Divisibility test-Surds and indices-Logarithms- Ratio-proportions and variation-Partnership-Time speed and distance-Data interpretation-data representation. Logical reasoning: Family tree-Deductions-Logical connectives-Binary logic Linear arrangements- Circular and complex arrangement		
Unit – III	**Written Communication & Verbal Aptitude**	**30**
Writing Skills: Writing strategies and formats Importance of Résumés Writing a Cover letter -Responding to Job Advertisements Professional e-mail Writing Responding to e-mails and business letters Technical Report writing Interpretation of Technical Data (Transcoding) Writing One-page Essays. Verbal Aptitude Synonyms Antonyms Homonyms One word substitution Idioms and Phrases Paired words Analogies Spelling test Cloze test using suitable verb forms using appropriate articles and prepositions; Spotting Errors Sentence Correction and Formation Grammar Based questions (Transformation : Active-Passive & Direct-Indirect); Rearranging Jumbled Sentences & Jumbled paragraphs, Identifying Facts, Inferences and Judgements statements		
		Total:45

TEXT BOOK:

1.	Edgar Thorpe and Showick Thorpe, “Objective English for Competitive Examination”, 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1.	Stephen Bailey, “Academic Writing: A practical guide for students”, Routledge, New York, 2011.
2.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individualand as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	Apply communication skills effectively to understand and deliver information in various written discourses grammatically with accuracy	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3		3		3	2		
CO2	3	2				3	3		3		3	2		
CO3		2				3	3		3	3	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EGL31 - COMMUNICATION SKILLS DEVELOPMENT LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3 / 4**	**HS**	**0**	**0**	**2**	**1**

Preamble	This course is designed to impart necessary skills to listen, speak, read and write in order to obtain better professional communication skills.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Self Introduction & Mock Interview
2.	Job Application letter with Resume
3.	Presentation: A Technical topic / Project report & a Case study
4.	Situational Dialogues / Telephonic Conversations
5.	Group Discussion
6.	Reading Aloud
7.	Listening Comprehension
8.	Writing Company Profiles
9.	Preparing reviews of a book/product/movie
10.	Pronunciation Test
	Total: 30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual
2.	Orell Digital Language Lab Software

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	enhance effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2	acquire professional skills required for workplace/higher education	Applying (K3), Naturalization (S5)
CO3	use English language skills effectively in various situations	Applying (K3), Articulation (S4)

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1									2	3		3
CO2									2	2		2
CO3									2	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTT51-FOOD PROCESS ENGINEERING - II							
Programme & Branch	**BTech Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Heat Transfer Operations**	**5**	**PC**	**3**	**0**	**0**	**3**
Preamble	To impart knowledge of drying, heating and cooling as preservation techniques in food processing.						
Unit – I	**Drying:**						**9**
Theory and mechanism of drying - Drying characteristics of materials. Psychrometric chart –applications. Thin layer and deep bed drying. Methods of drying agricultural materials - batch and continuous drying. Drying equipment design and performance of various drying equipment.							
Unit – II	**Types of Dryers:**						**9**
Tunnel Dryer, Belt Dryer, Drum Dryer, Spray Dryer, Fluidized Bed Dryer, Spouted bed dryer, Pneumatic Dryer, Rotary Dryer, Vacuum Drying, Freeze Drying, IR drying and Micro wave drying.							
Unit – III	**Preservation by Heating:**						**9**
. Methods of applying heat to food - Blanching, Pasteurization, Sterilization. Thermal death time relationships (D, Z and F values). Process calculations: General method, Ball's formula method. Sterilization – methods and equipments. UHT sterilization. Retort processing							
Unit – IV	**Preservation by Cooling:**						**9**
Chilling - Equipments, Cold storage. Freezing - Thermodynamics of food freezing, Phase diagrams, Ice crystals formation, Properties of frozen foods. Freezing time calculations, Freezing equipments. Freeze concentration.							
Unit – V	**Non thermal Preservation:**						**9**
. High Pressure Processing – Principles & Equipments. Pulsed Electric Fields – Mechanism and treatment system. Ultrasound – Fundamentals, Preservation and processing tool. Irradiation – Fundamentals and Biological effects. Hurdle Technology. Ohmic Heating – Fundamentals and Generic configurations.							
							Total:45
TEXT BOOK:							
1.	Fellows P.J., "Food processing Technology: Principles and Practice", 4th Edition, Woodhead Publishing Ltd., New Delhi, 2016.						
REFERENCES:							
1.	Sahay K.M. and Singh K.K., "Unit Operations of Agricultural Processing", 2nd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012.						
2.	Da-Wen Sun, "Emerging Technologies for Food Processing", 2nd Edition, Elsevier Academic Press, London, 2014.						

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize the drying mechanism of food materials	Understanding (K2)
CO2	classify and explain suitable dryers for food materials	Understanding (K2)
CO3	identify appropriate thermal preservation techniques for food materials	Applying (K3)
CO4	make use of low temperature processing as a preservation techniques	Applying (K3)
CO5	outline the principles and select suitable non thermal preservation techniques for food materials	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	75					100
CAT2	25	50	25				100
CAT3	20	50	30				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTT52 - FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

Programme &Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	P C	3	0	0	3

Preamble	To help the students to learn about the physiology, pre-processing, postharvest storage and various products of fruitsand vegetables	
Unit - I	**Physiology and Pre-processing of fruits and vegetables:**	**9**
Scope of Fruits and Vegetables Processing Industry in India and World-present status – constraints-prospects Classification of fruits and vegetables. Composition and nutrition aspects. Pre harvest and post-harvest changes. Concept of maturity indices-Factors leading to deterioration of fruits and vegetables. Methods to reduce post-harvest losses. Pre-processing of fruits and vegetables: Precooling, Cleaning, washing, sorting, grading peeling, blanching.		
Unit - II	**Post-harvest storage methods and Preservation Techniques:**	**9**
Ambient conditions. Application of refrigeration and freezing concept in post-harvest storage, Freezing methods-Air Blast Freezer, Immersion Freezer, Cryogenic Freezer. Hypobaric Storage, CAS. Irradiation, Waxing. Trends in Packaging fresh produce-MAP, Inertand Vacuum Packaging. Concentration-freeze drying –osmotic dehydration, brining, syruping, canning.		
Unit - III	**Processing Technology of fruits and fruit beverages:**	**9**
Unit operations involved in Juice preparation-equipments-screw type juice extractor, pulper, pressing, Rack and cloth press, Hydraulic Press, Filters, clarification and concentration by membranes. Classification of fruit juices- Squash, cordial, nectar, RTS. IMF products -Jam, Jelly, marmalade, candied preserves.		
Unit - IV	**Processing Technology of vegetable products:**	**9**
Preparation and processing parameters of vegetable wafers, soup powders, pulp, puree, pastes, sauces, ketchups, chutneys. Preparation of various types of pickles. Dehydrated vegetable and leafy products. Processing parameters of mushroom and baby corn. Crystallized fruit, glazed fruit, fruit toffee, fruit powders, fruit leather and tutti-frutti.		
Unit - V	**Hurdle Technology, Minimally Processed Fruits and Vegetables, Edible Coating:**	**9**
Types of hurdle, aspects of hurdle technology, stress- effect on fresh produce, shelf stable products. Factors affecting the shelf life and the quality of the minimally processed fruits and vegetables, physiology and biochemistry of the fresh cut fruits and vegetables. Processing, quality parameters and biochemical changes in the final quality of the fresh produce.		
	Total:45	

TEXT BOOK:

1. Srivastava R.P & Sanjeev Kumar, "Fruit and Vegetable Preservation: Principles and Practices", 3rd Edition, CBS Publishers &Distributors, New Delhi, 2014.

REFERENCES/ MANUAL / SOFTWARE:

1. S. Rajarathnam and R.S. Ramteke. “Advances in Preservation and Processing Technologies of Fruits and Vegetables”, 1stEdition, New India Publishing Agency, New Delhi, 2011.
2. U.D. Chavan and J.V. Patil., “Industrial Processing of Fruits and Vegetables”, 1st Edition, Astral International Pvt. Ltd., NewDelhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret physiological and biochemical changes in fruits and vegetables	Understanding (K2)
CO2	select suitable storage and preservation techniques for fruits and vegetables	Applying (K3)
CO3	apply different technology to process fruits into different fruit products	Applying (K3)
CO4	make use of techniques to process different vegetable products and other speciality products	Applying (K3)
CO5	interpret techniques involved in hurdle technology and minimal processing	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1								1			3	1
CO2	3	2	2			2				1			3	2
CO3	3	2	1	1						1			3	1
CO4	3	2	1	1						1			3	1
CO5	3	1	3			2				1			3	2
CO6	3	1								1			3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering(K1) %	Understanding(K2) %	Applying(K3) %	Analyzing(K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	10	50	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTT53 - BAKING AND CONFECTIONERY TECHNOLOGY

Programme & Branch	B.TECH. – FOOD TECHNOLOGY	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry	5	PC	3	0	0	3

Preamble	To provide insight knowledge about the different raw materials, equipment and products of bakery andconfectionery sectors.	
Unit - I	**Science Behind Baking:**	**9**
Classification of bakery products. Bakery Ingredients-Testing of raw materials and functions - flour, yeast, sugar, fat, egg, water, salt, coloring agents, flavoring agents, milk, milk powder, emulsifiers, leaveners, antioxidants and improvers.		
Unit - II	**Equipments in Bakery Industry and Rheology of dough:**	**9**
Handling of ingredients- dough mixers, dividers, rounder, sheeter, laminating equipments, fermentation enclosures and brew equipment, ovens and slicers. Farinograph, Amylograph, Alveograph, Extensograph.and Mixograph		
Unit - III	**Bread Making Process and Cake making:**	**9**
Chemistry of Dough Development. Bread making methods- Straight dough/bulk fermentation, Sponge and dough, Activated dough development, Chorleywood bread process, No time process. Characteristics of good bread- Internal and external characters. Bread defects/faults and remedies. Spoilage of bread. Cake making ingredients and their function. Methods for different types of cakes manufacture.		
Unit - IV	**Biscuit making and Confectionery:**	**9**
Ingredients and their functions. Types of biscuit dough – Developed dough, short dough's, semi-sweet, enzyme modified dough and batters. Biscuit manufacturing process, Wafers, puff pastry, chemically leavened bakery products. Classification of confectionery Products – Ingredients-Basic Technical considerations in sugar based confectionery		
Unit - V	**Confectionery Products:**	**9**
Composition and manufacturing process- Sugar boiled products-Candy, Toffees, fudge, caramel, aerated confectionery. Bubble gums and chewing gums. Chocolate Processing –chocolate shells, candy bars. Fruit confections. Confectionery product quality parameters, faults and corrective measures. Spoilage of confectionery products.		
		Total:45

TEXT BOOK:

1.	W. P. Edwards, "The Science of Bakery Products", United Kingdom: Royal Society of Chemistry,2015

REFERENCES:

1.	Weibiao Zhou and Y. H. Hui, "Bakery Products Science and Technology", 2nd Edition, Wiley Blackwell, US, 2014.
2.	Ferenc A. Mohos, "Confectionery and Chocolate Engineering: Principles and Applications", 1st Edition, Wiley Blackwell,UK, 2010.
3.	Samuel A. Matz, "Bakery Technology and Engineering", 3rd Edition, Springer, US, 2008.
4.	Yogambal Ashok kumar, "Text book of Bakery and Confectionery", 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the role of ingredients in bakery industry	Understanding (K2)
CO2	select appropriate equipment for baking process and relate the rheological properties of dough	Applying (K3)
CO3	identify and apply processing techniques for bread and cake manufacturing process	Applying (K3)
CO4	illustrate the processing techniques for preparation of miscellaneous bakery products and summarize the role of confectionery ingredients	Understanding (K2)
CO5	apply the processing techniques to formulate different confectionery products	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	40				100
CAT2	30	40	30				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTT54 - FOOD SCIENCE AND NUTRITION

Programme & Branch	BTech – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry	5 / 4	PC	3	0	0	3

Preamble	This course will deal about the importance of nutrients and its assimilation, energy balance and nutrition for differentage groups	
Unit – I	**Food Groups and Nutrition:**	**9**
Definition, six classes of nutrients, RDA, nutritional status and its assessment, nutritional requirement, malnutrition – over nutrition and under nutrition. Balanced diet: Diet planning principles, dietary guidelines; food groups; Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption and transport of nutrients		
Unit – II	**Carbohydrates - Sugars, Starch and Fiber:**	**9**
Digestion and absorption of carbohydrates, lactose intolerance; Glycemic and Non-glycemic carbohydrates, recommendations of sugar intake for health, health effects of fiber and starch intake, artificial sweeteners; Nutrition and Diabetes, GTT		
Unit - III	**Lipids and Proteins:**	**9**
Food Sources, Lipid digestion, absorption and transport; Functions of the triglycerides; essential fatty acids - n-3 and n-6 fatty acids; trans fatty acids, Medium Chain Triglycerides, phospholipids and sterols; Health effects and recommended intakes of lipids. Digestion and absorption of proteins; Functions of proteins; amino acids; Protein quality, methods of assessing protein quality; Recommended intakes of proteins; protein and amino acid supplements; Protein Energy Malnutrition - Marasmus and Kwashiorkor.		
Unit - IV	**Energy Value, Energy Balance and Body Composition:**	**9**
Calorific value of foods; basal metabolism, specific dynamic action of foods, Protein efficiency ratio, Net protein utilization, physiological energy value of foods. Energy balance – components – energy intake, energy expenditure, energy requirement. Body composition – Five levels of body composition – body composition techniques. Obesity- BMR and BMI calculations.		
Unit - V	**Nutrition for Different Age Groups:**	**9**
Factors to be considered in meal/menu planning. Pregnancy - nutrition requirements and food selection. Lactation - nutritional requirements. Infancy - nutritional requirements, breast feeding, infant formula. Introduction of supplementary foods. Early childhood. (Toddlers and Preschoolers) - Growth and nutrient needs, nutritional related problems, Feeding Pattern. School children - Nutritional requirements, Importance of snacks, school lunch. Adolescence - Growth, Nutrient needs, food choice, eating habits, factors influencing. Geriatic Nutrition - Factors affecting food intake and nutrients use, nutrient needs, nutrition related problems.		
		Total:45

TEXT BOOK:

1.	Srilakshmi B, "Nutrition Science", 6th Edition, New Age International Publishers, New Delhi, 2018

REFERENCES:

1.	Mann Jim and Stewart Truswell (Eds), "Essentials of Human Nutrition", 5th Edition, Oxford University Press, Oxford, 2017.
2.	Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy and Hester H. Vorster, "Introduction to Human Nutrition", 2ndEdition, Wiley Blackwell, UK, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the physiological and metabolic functions of nutrients	Understanding (K2)
CO2	select appropriate carbohydrate diet based on their health effects	Applying (K3)
CO3	outline the lipids and proteins based on their nutritional value	Understanding (K2)
CO4	interpret the energy value of foods and body composition and explain the energy balance	Understanding (K2)
CO5	classify nutrition requirement based on different age groups	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	25	75					100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTL51- FOOD PROCESS ENGINEERING LABORATORY

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Heat Transfer Operations	5	PC	0	0	2	1

Preamble	To impart knowledge on various properties of food materials involved in food processing

List of Exercises / Experiments:

1.	Determination of size, roundness, sphericity and 1000 grain weight of food grains.
2.	Determination of bulk density, true density and porosity.
3.	Determination of angle of repose for grain sample.
4.	Determination of co efficient of friction for grain sample.
5.	Experiment on paddy dehusker to determine the shelling efficiency.
6.	Determination of conveying efficiency and power requirement of different conveyor.
7.	Determination of separation efficiency of inclined belt separator.
8.	Experiment on analysis of particle size distribution using hammer mill and ball mill.
9.	Experiment on sedimentation
10	Experiment on drying characteristics of food material using different dryers.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Margarida Vieira and Peter Ho, “Experiments in Unit Operations and Processing of Foods”, 1st Edition Springer Science & Business Media, New York, 2008.
3.	Rao M. A. and Rizvi S.S.H., Engineering Properties of Foods, 4th edition, CRC Press, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	assess the performance of agro processing equipment	Evaluating(K5),Precision(S3)
CO2	determine the effectiveness of size reduction equipment	Evaluating(K5),Precision(S3)
CO3	interpret the drying characteristics of food materials using different dryers	Evaluating(K5),Precision(S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1					3	2		1	2	2
CO2	3	3	2	1					3	2		1	2	2
CO3	3	3	2	1					3	2		1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22FTL52– FRUIT AND VEGETABLE PROCESSING TECHNOLOGY LABORATORY

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	0	0	2	1

Preamble	To impart knowledge about the equipments processing parameters and evaluating the parameters of packagingmaterials suitable for different fruits and vegetable products

List of Exercises / Experiments :

1.	Study the effect of blanching treatment on the fruits and vegetables.
2.	Estimation of efficiency of screw press extractor and pulper.
3.	Development and analysis of squash and sauce
4.	Preparation of fruit bar comparison with commercial product.
5.	Formulation of jams and comparison with commercial product.
6.	Formulation of jellies / marmalade and comparison with commercial product.
7.	Estimation of bursting strength of packaging materials
8.	Determination of tear resistance of packaging materials
9.	Determination of tensile strength of different packaging materials
10.	Estimation of water absorption capacity and water vapour permeability of different packaging materials

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	FSSAI Manual of Methods of Analysis of Foods Fruit and Vegetable Products, 2016.
3.	Gordon L. Robertson, “Food Packaging and Shelf Life: A Practical Guide”, 1st edition CRC Press, USA, 2009.
4.	http://www.rpaulsingh.com/learning/virtual/virtual.htm

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	assess the changes occurred during fruits and vegetables blanching and also estimate the efficiency juice extraction equipment.	Evaluating(K5),Precision(S3)
CO2	prepare and characterize fruit/vegetable based products	Evaluating(K5),Precision(S3)
CO3	evaluate mechanical and water barrier properties of packaging materials	Evaluating(K5),Precision(S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1					3	2		1	2	2
CO2	3	3	2	1					3	2		1	2	2
CO3	3	3	2	1					3	2		1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22FTL53- BAKING AND CONFECTIONERY TECHNOLOGY LABORATORY

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	To provide insight practical knowledge about the different raw materials and products of bakery and confectionery sectors

List of Exercises / Experiments :

1.	Estimation of quality parameters of bakery ingredients.
2.	Estimation of wet and dry gluten content of wheat flour.
3.	Determination of dough rising capacity of leaveners
4.	Estimation of diastatic activity and maltose value of flour
5.	Estimation of water absorption power, alkaline water retention and sedimentation value of flour.
6.	Preparation and analysis of bread.
7.	Preparation and analysis of biscuits and cookies.
8.	Preparation and analysis of cake.
9.	Preparation of sugar boiled and cocoa based confectionery.
10.	Preparation of toffee and fudge.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory manual
2.	Duncan Manley, "Biscuit, Cracker and Cookie Recipes for the Food Industry", 1st Edition, Woodhead Publishing, England, 2001.
3.	Yogambal Ashokkumar, "Text book of Bakery and Confectionery", 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2012.
4.	http://www.bch.cuhk.edu.hk/vlab2/animation/fermentation/index.html

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	evaluate the quality of flour and other ingredients used for preparation of bakery products	Evaluating (K5), Precision (S3)
CO2	prepare the bakery product and evaluate its properties	Evaluating (K5), Manipulation (S2)
CO3	formulate confectionery products and perform sensory properties	Evaluating (K5), Manipulation (S2)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2		1		1	3	2		2	1	3
CO2	3	2	2	2		1		1	3	2		2	3	2
CO3	3	2	2	2		1		1	3	2		2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GEL51 - PROFESSIONAL SKILLS TRAINING - II							
(Common to All BE/ BTech Engineering and Technology branches)							
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**EC**	**0**	**0**	**80**	**2**
Preamble	This subject is to enhance the employability skills and to develop career competency						
Unit – I	**Soft Skills – II :**						**20**
Group discussions: Advantages of group discussions-Structured GD- Team work: Value of team work in organizations- Definition of a team, why team-Elements of leadership, disadvantages of a team, stages of team formation- Group development activities. Facing an interview: Foundation in core subject- industry orientation / knowledge about the company- professional personality- Communication skills-Activities before Interview, upon entering interview room, during the interview and at the end Mock interviews.							
Unit – II	**Quantitative Aptitude and Logical Reasoning – II:**						**30**
Problem solving level II: Money related problems-Mixtures-Symbol base problem-Clocks and calendars-Simple-linear-quadratic and polynomial equations-Special, equations-Inequalities-Sequence and series-Set theory-Permutations and combinations-Probability-Statistics-Data sufficiency- Geometry-Trigonometry-Heights and distances-Co-ordinate geometry-Mensuration. Logical reasoning: Conditionality and grouping-Sequencing and scheduling- Selections-Networks:-Codes; Cubes-Venn diagram in logical reasoning- Quant based reasoning-Flaw detection- Puzzles-Cryptarithms.							
Unit – III	**Reading & Speaking Skills**						**30**
Reading: Reading comprehension– Effective Reading strategies – Descriptive, Inferential, & Argumentative reading passages – Identifying and locating factual information within a text – global reading/skimming for general understanding – selective comprehension / scanning for specific information – detailed comprehension / intensive reading – understanding the development of an argument – identifying the writer's attitude and opinions – Reading news articles in business magazines, newspapers – Reading notices and book reviews –Interpreting graphic data & Advertisements. Speaking: Mock Interviews –Self-Introduction – Sharing of Real Time Experience; Conversational Practices –Role Play – Short Talks / TED Talks –Extempore; Giving a Presentation on Various Topics – Technical / Non-Technical Topics – Project Review Presentation – Oratory and Effective Public Speaking; Pair Discussion – Group Discussion – The process of Group Discussion – Strategies to be adopted – Skills Assessed – Telephonic Conversations & Skills – Negotiating Skills.							
							Total:45

TEXT BOOK:

1.	Edgar Thorpe and Showick Thorpe, "Objective English for Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1.	Aruna Koneru, "Professional Speaking Skills," Oxford University Press India, New Delhi, 2015.
2.	Thorpe, Showick and Edgar Thorpe, "Winning at Interviews," 5th edition, Pearson Education, India, 2013.
3.	Rizvi, Ashraf M, "Effective Technical Communication," 2nd Edition, McGraw Hill Education India, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individualand as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	apply reading and speaking skills effectively for various academic and professional purposes	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	0	0	0	3	3	0	3	0	3	2		
CO2	3	2	0	0	0	3	3	0	3	0	3	2		
CO3		2	0	0	0	3	3	0	3	3	3	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						

* ±3% may be varied (CAT 1,2 & 3 – 50 marks)

22FTT61 - DAIRY TECHNOLOGY

Programme & Branch	B.TECH. – Food Technology	Sem	Category	L	T	P	Credit
Prerequisites	Food Chemistry, Food Microbiology	6	PC	3	0	0	3

Preamble	To provide exposure to variety of technical operations in milk and milk product processing industry and help students discover their own professional directions for future development in dairy sector.	
Unit - I	**Physical chemistry of milk:**	**9**
Milk - Definition, Types of market milk, Composition of milk, Factors affecting composition, Properties of milk: Colour, Flavour, Specific Gravity, Boiling point, Freezing point, Acidity and pH, Viscosity		
Unit - II	**Collection, reception and pre-processing of raw milk:**	**9**
Practices for collection of raw milk, Raw milk shelf life extension systems, Cooling and transportation of raw milk, Platform tests of raw milk, Reception of raw milk, Filtration and Clarification of raw milk, Bactofugation of raw milk, Cooling and storage of raw milk		
Unit - III	**Unit operations of milk processing:**	**9**
Milk Standardization, Cream Separation, Milk Homogenization, Milk Pasteurization: HTST and LTLT pasteurization, Milk Sterilization, UHT Processing of milk, Packaging systems of milk: pouch filling, bottle filling, aseptic filling systems, Good Hygiene Practices (GHP) during milk production operations.		
Unit - IV	**Quality assurance of dairy products:**	**9**
Adulterants in milk and their detection, Defects in market milks, Defects in fat-rich products, Defects in concentrated milks, Defects in frozen dairy products, Defects in coagulated products, Defects in fermented products. Legal standards for milk and milk products		
Unit - V	**Cleaning and sanitization of dairy equipment:**	**9**
Aspects of cleaning: Trade obligations, moral obligations, legal obligations, Cleaning agents and methods, CIP flow system, types of CIP system: Centralized CIP system and decentralized CIP system, CIP cycle of equipments: silo, tanker, pasteurizer, Sanitizing agents and methods, Assessment of effectiveness of cleaning and sanitization.		
		Total:45

TEXT BOOK:

1. Sukumar De, "Outlines of Dairy Technology", 46th Edition, Royal Oxford University Press, New Delhi, 2019.

REFERENCES:

1. Hui,Y.H, "Dairy Science and Technology Handbook: Applications Science, Technology and Engineering", 3rd Edition,Wiley, New Delhi, 2014.
2. Ahmed,T. “Dairy Plant Engineering and Management”, Kitab Mahal,2012

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the physico-chemical properties of milk	Understanding (K2)
CO2	apply the acquired knowledge of raw milk collection, transportation and reception in practical scenarios	Applying (K3)
CO3	infer the technical aspects of unit processing operations of milk	Understanding (K2)
CO4	identify defects in milk and milk products	Applying (K3)
CO5	choose suitable cleaning operations in dairy industry	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 mark**

22FTT62 - FOOD QUALITY AND SAFETY							
Programme & Branch	**B.TECH. – FOOD TECHNOLOGY**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**PC**	**3**	**0**	**0**	**3**
Preamble	To give insight on food quality, safety and its regulatory standards.						
Unit - I	**Food quality and safety:**						**9**
Quality and Safety concepts. Characterization of food hazards – physical, chemical and biological. Food spoilage and food borneinfection –sources of food spoilage- microbial aspects in food safety-food toxicants and food poisoning –prevention. Cross contamination.							
Unit - II	**Quality Assurance and Safety operations in Food industry:**						**9**
Objectives, importance and functions of quality control and quality assurance. Quality Control and Assurance procedures, HACCP, Good Manufacturing Practice, Good Laboratory Practices, Good Hygiene Practices.							
Unit - III	**Sampling and Statistical Quality Control:**						**9**
Sampling- concept, methods and importance. Statistical Process and Quality Control – concept, importance and tools. Control charts: importance, types, design process, Control limits and errors, Process Capability.							
Unit - IV	**Quality and Safety Standards:**						**9**
Quality Standards – mandatory and optional standards. Mechanism of developing and fixing food standards. Food Safety Systems – ISO 22000, FSSC 22000. National organizations: BIS, CCFS, AGMARK and APEDA. Standards of Weights and Measures. Organic food certification-POP, NPOP. International organizations: ISO, CAC, WTO, USFDA, EIC.							
Unit - V	**Regulations for Food Business Operator:**						**9**
Food adulteration and food safety, Food laws — Food Safety and Standards Act (FSSAI), Prevention of Food Adulteration Act,Packaged Commodities Rules, Functions of Food Business Operator, QA Audit, IPR and Patents, Issues affecting consumers and industry – Genetically Modified Foods, Fortification, Pesticide Residues, Organic Foods, Food Additives.							
							Total:45
TEXT BOOK:							
1.	Inteaz Alli, "Food Quality Assurance: Principles and Practices", 2nd Edition, Taylor and Francis, UK, 2014.						
REFERENCES/ MANUAL / SOFTWARE:							
1.	Schmidt, R.H. and Rodrick, G.E, "Food Safety Handbook", 2nd Edition, John Wiley & Sons Inc, New Jersy, 2005.						
2.	Andres Vasconcellos J, "Quality Assurance for the Food Industry: A Practical Approach", 2nd Edition, CRC Press, NewYork, 2004.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the concepts of quality and safety in food processing	Understanding (K2)
CO2	apply principles of quality assurance and safety in food industries	Applying (K3)
CO3	analyze and categorize sampling and statistical quality control techniques	Applying (K3)
CO4	outline suitable food quality and Safety standards	Understanding (K2)
CO5	make use of various regulations for food business operator	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22MNT31 - ENVIRONMENTAL SCIENCE							
(Common to All BE/BTech branches)							
Programme & Branch	**All B.E/B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3 / 6**	**MC**	**2**	**0**	**0**	**0**

Preamble	This course provides an approach to understand the various natural resources, ecosystem, bio-diversity, pollution control & monitoring methods for sustainable life and also to provide knowledge and to create awareness for engineering students on biological sciences.	
Unit – I	**Environmental Studies and Natural Resources**	**5**
Introduction to Environmental Science – uses, over-exploitation and conservation of forest, water, mineral, food, energy and land resources–case studies		
Unit – II	**Ecosystem and Biodiversity**	**5**
Ecosystems: concept and components of an ecosystem -structural and functional features – Functional attributes (Food chain and Food web only). Biodiversity: Introduction – Classification – Bio geographical classification of India- Values of biodiversity – Threats and Conservation of biodiversity - case studies.		
Unit – III	**Environmental Pollution**	**5**
Environmental Pollution: Definition – causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Role of an individual in prevention of pollution - case studies.		
Unit – IV	**Environmental Monitoring**	**5**
Sustainability -three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.		
Unit – V	**Introduction to Biological Science**	**5**
Functions of Carbohydrates, lipids, proteins and nucleic acids - Cells and its organelles - plasma membrane, mitochondria and nucleus- Heredity and DNA - organization of DNA in cells - Genes and chromosomes- Cell division -Types of cell division- mitosis & meiosis - Cell cycle and molecules that control cell cycle.		
		Total:25

TEXT BOOK:

1.	Anubha Kaushik, and Kaushik C.P., “Environmental Science and Engineering”, 6th Multicolour Edition, New Age International Pvt. Ltd., New Delhi, 2018, for Unit-I, II, III, IV.
2.	Rastogi.SC, “Cells and Molecular Biology”, 2nd Edition, reprint, New Age International (P) Limited Publishers, New Delhi, 2008, for Unit-V.

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.
2.	Mukhtar Ahmad, “Text book of modern biochemistry", Volume I & II, Oxford & IBH Publishing Co. Pvt. LTD, Delhi, 1995.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the various natural resources and role of individual for its conservation	Understanding (K2)
CO2	elaborate the features of ecosystem and biodiversity to find the need for conservation.	Understanding (K2)
CO3	manipulate the sources, effects and control methods of various environmental pollution.	Applying (K3)
CO4	make use of the knowledge of EIA and environmental legislation laws towards sustainability.	Applying (K3)
CO5	explain the functions of carbohydrates, lipids, proteins, nucleic acids, Cells and its organelles	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	NA						
ESE	NA						

* ±3% may be varied (CAT 1, 2 – 50 marks)

22FTL61 - DAIRY TECHNOLOGY LABORATORY

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry, Food Microbiology	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	To deal about analysis and estimation of physicochemical properties of milk

List of Exercises / Experiments:

1.	Studies on titratable acidity and specific gravity of milk.
2.	Estimation of fat and solids-not-fat contents of milk and Analysis of thermal stability of milk.
3.	Detection of adulterants in milk.
4.	Studies on homogenization process of milk.
5.	Studies on standardization process of milk and Development of market milk.
6.	Development of flavoured and fortified milk.
7.	Development of coagulated milk product.
8.	Development of ghee.
9.	Development of spray dried milk powder
10.	Studies on Cream Separation from milk.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory manual.
2.	Sukumar De, “Outlines of Dairy Technology”, 46th Edition, Royal Oxford University Press, New Delhi, 2019.
3.	Hui,Y.H,, “Dairy Science and Technology Handbook: Applications Science, Technology and Engineering”, 3rd Edition, Wiley, New Delhi, 2014.
4.	Bylund, G, “Dairy Processing Handbook” 1st Edition, Tetra Pak Processing Systems AB, 2015.
5.	http://www.rpaulsingh.com/learning/virtual/experiments/heatexchanger/index.html

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze physico-chemical properties of milk	Analyzing (K4), Precision(S3)
CO2	assess the technical aspects of raw milk processing	Evaluating (K5), Manipulation(S2)
CO3	prepare dairy products and evaluate its properties	Evaluating (K5), Manipulation(S2)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	1		1	3	2		1	2	2
CO2	3	2	2	2	2	1		1	3	2		2	3	3
CO3	3	2	3	2	2	1		1	3	2		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22FTL62 - FOOD ANALYSIS LABORATORY

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry	6	PC	0	0	2	1

Preamble	To impart knowledge on analysis of various food products

List of Exercises / Experiments :

1.	Analysis of vegetable oils / Fats.
2.	Analysis of spices (Turmeric / Chilly).
3.	Analysis of Vinegar/ Tea/ Coffee.
4.	Analysis of Jam/Jelly/ Marmalade / Juices.
5.	Analysis of dehydrated vegetables and Fruits.
6.	Analysis of water.
7.	Analysis of salt/ sugar/ Jaggery.
8.	Detection of food Adulteration.
9.	Textural and Colour profile analysis of food material.
10.	Determination of energy value of foods.
11.	Virtual laboratory experiments a. Estimation of minerals by flame photometry – Demo. b. Determining water rehydration in pasta – Experimentation

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory manual
2.	Ministry of Health and Family Welfare, "Manual of Methods for the Analysis of Foods", Government of India, New Delhi, 2016.
3.	Sadasivam, S., and Manickam, A, "Biochemical Methods", 3rd Edition, New Age International, Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze various food products	Analyzing (K4), Precision (S3)
CO2	detect adulteration in food samples	Evaluating (K5), Precision (S3)
CO3	determine the textural and color profile of food materials	Evaluating (K5), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	1			1	3	2		2	3	3
CO2	3	2	3	3	1			1	3	2		2	2	3
CO3	3	2	3	3					3	2		2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTL63- FOOD PROCESS EQUIPMENT DESIGN AND DRAWING LABORATORY

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PC	0	0	2	1

Preamble	To design and draw various equipments used in food process operations

List of Exercises / Experiments :

1.	Studies of symbols and materials used for design and drawing.
2.	Design and drawing of pipes and fittings.
3.	Design and drawing of storage vessel.
4.	Design and drawing of agitated vessel.
5.	Design and drawing of double pipe heat exchanger.
6.	Design and drawing of shell and tube heat exchanger.
7.	Design and drawing of plate heat exchanger.
8.	Design and drawing of single effect evaporator.
9.	Design and drawing of cyclone separator.
10.	Design and drawing of rotary drier/spray drier
11.	Demonstration experiment on design and drawing of a food plant layout

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Dawande S.D., “Process Equipment Design Volume 1 and 2”, 5th Edition, Denett and Company, India, 2015.
3.	Joshi M.V. and Mahajan V.V., “Process Equipment Design”, 4th Edition, MacMillan India, New Delhi, 2009.
4.	Perry R.H. and Green D.W., “Chemical Engineers Handbook”, 8th Edition, McGraw-Hill, New York, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design the vessels and fittings required for food process operations	Applying (K3), Precision(S3)
CO2	design the heat exchangers and evaporators	Applying (K3), Precision(S3)
CO3	design the separating and drying equipment	Applying (K3), Precision(S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	1				3	2		1	2	2
CO2	3	2	3	2	1				3	2		1	3	2
CO3	3	2	3	2	1				3	2		1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22FTP61- PROJECT WORK I

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	EC	0	0	8	4

Total:60

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added food products and equipments using research tools and methods	Creating (K6)
CO4	analyze the experimental data and derive the valid conclusion	Analyzing (K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publications	Creating (K6)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTP62- PROJECT WORK I

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	EC	0	0	10	5

Total:60

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added food products and equipments using research tools and methods	Creating (K6)
CO4	analyze the experimental data and derive the valid conclusion	Analyzing (K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publications	Creating (K6)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GEP61– COMPREHENSIVE TEST AND VIVA

(Common to all BE/BTech branches)

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	EC	0	0	0	2

Total:60

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate knowledge in their respective programme domain.	Applying (K3)
CO2	defend any type of interviews, viva-voce, and aptitude tests conducted for career progression	Applying (K3)
CO3	exhibit professional etiquette and solve related engineering problems	Applying (K3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2					1	2	2	3	3	2
CO2	3	3	2	2					1	2	2	3	3	2
CO3	3	3	2	2					1	2	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTP71- PROJECT WORK II PHASE- I

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	EC	0	0	10	5

Total:90

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added food products and equipments using research tools and methods	Creating (K6)
CO4	analyze the experimental data and derive the valid conclusion	Analyzing (K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publications	Creating (K6)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTP72- PROJECT WORK II PHASE- I

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	EC	0	0	12	6

Total:90

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added food products and equipments using research tools and methods	Creating (K6)
CO4	analyze the experimental data and derive the valid conclusion	Analyzing (K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publications	Creating (K6)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GEI71- INDUSTRIAL TRAINING

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	EC	0	0	0	1

Total:20

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	take part in real time practices in food industries	Applying (K3)
CO2	apply the gained technical knowledge and skills to solve issues in food industry	Applying (K3)
CO3	work as an individual or lead a team independently in exhibiting managerial skills	Applying (K3))

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO3							1	3	3	3	3	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GCT71 - ENGINEERING ECONOMICS AND MANAGEMENT							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**HS**	**3**	**0**	**0**	**3**
Preamble	The aim of the course is to create fundamental knowledge on management by introducing concepts like economics, national income, marketing, operations management, accounting principles etc.						
Unit – I	**Micro Economics**						**9**
Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic Activities and Income.							
Unit – II	**Macro Economics, Business Ownership and Management concepts**						**9**
National Income and its Measurement Techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle - Forms of Business – Ownership Types. Management concepts: Taylor and Fayol's Principles – Functions of Management - Managerial Skills - Levels of Management - Roles of Manager.							
Unit – III	**Marketing Management**						**9**
Marketing - Core Concepts of Marketing - Four P's of Marketing - New Product Development – Intellectual Property Rights (IPR), Product Life Cycle - Pricing Strategies and Decisions.							
Unit – IV	**Operations Management**						**9**
Operations Management - Resources - Types of Production System - Site Selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.							
Unit – V	**Financial Management**						**9**
Accounting Principles – Financial Statements and its Uses – Depreciation - Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting - Significance –Traditional and Discounted Cash Flow Methods.							
							Total:45

TEXT BOOK:

1. Compiled by Department of Management Studies, Kongu Engineering College, "Economics and Management for Engineers", 1st Edition, McGraw Hill Education, Noida, 2013.

REFERENCES:

1. Geetika, Piyali Ghosh and Purba Roy Choudhury, "Managerial Economics", 3rd Edition, McGraw-Hill, New Delhi, 2018.
2. William J. Stevenson, "Operations Management", 14th Edition, McGraw-Hill Education, 2021.
3. William G. Nickels, James M. McHugh, Susan M. McHugh, "Understanding Business", 12th Edition, McGraw-Hill Education, New York, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify market equilibrium and interpret national income calculations and inflation issues	Applying (K3)
CO2	choose a suitable business ownership for their enterprise and illustrate managerial functions	Applying (K3)
CO3	infer marketing management decisions	Understanding (K2)
CO4	apply appropriate operation management concept in business situations	Applying (K3)
CO5	interpret financial and accounting statements and evaluate new proposals	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22FTP81- PROJECT WORK II PHASE- II

Programme & Branch	B.TECH. – Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	EC	0	0	8	4

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added food products and equipments using research tools and methods	Creating (K6)
CO4	analyze the experimental data and derive the valid conclusion	Analyzing (K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publications	Creating (K6)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22FTE01 - TECHNOLOGY OF SNACK AND EXTRUDED FOODS

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PE	3	0	0	3

Preamble	To have a knowledge on different categories of snack products including the process technology.

Unit - I	**Introduction:**	**9**

Current status of snack food industry in India. Types of snack food – Raw Vegetable Snack, Formed dough products from potato and maize derivatives, Half Products, Directly expanded extruded snack, Puffed Snacks, proprietary foods and other. Types and Functions of ingredients – structure forming materials, dispersed phase/filling materials, plasticizers/lubricants, soluble solids, nucleating substances, coloring and flavouring substances.

Unit - II	**Potato and Rice Based Snacks:**	**9**

Potato Chip - Pre cleaning and peeling, slicing, drying/frying, salting and seasoning, quality control. Fabricated potato snacks – potato flakes, potato granules, potato starch, ground and crushed dehydrated potato. Rice based Snacks – Products using whole grains – Gun puffed rice. Products using flours.

Unit - III	**Corn Based Snacks:**	**9**

Tortilla chip – Corn soaking and smoking, Grinding, Masa flour, Sheeting and Cutting, Baking and Frying. Popcorn – Popping methods, oil popping and dry popping. Commercial and industrial popcorn process. Flavorings and Applicators. Masa based snacks. Quality control for snack foods.

Unit - IV	**Extrusion Based Snacks:**	**9**

Extruders for making snacks. Pre-conditioning of raw materials used in extrusion process. Stages in extrusion. Second generation and Third generation snacks, Co extruded snacks, Breakfast cereals - Type and processing. Texturized vegetable protein - Definition and processing.

Unit - V	**Pasta Products:**	**9**

Pasta and Precooked pasta - Raw materials. Preparation of raw materials for extrusion and processing. Types of pasta products - Spaghetti, noodles, macaroni and similar products. Dry and frozen pasta products.

Total:45

TEXT BOOK:

1. Edmund W. Lusas and Lloyd W. Rooney, "Snack Food Processing", 1st Edition, CRC Press, Florida, 2001.

REFERENCES:

1. Robin Guy, "Extrusion cooking: Technologies and Applications", 1st Edition, CRC Press, Florida, 2001.
2. Panda H, "The Complete Technology Book on Snack Foods", 1st Edition, National Institute of Industrial Research, New Delhi, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify types of snacks and choose appropriate ingredient based on their functionality	Understanding (K2)
CO2	make use of potato and rice for the production of suitable snack foods	Applying (K3)
CO3	select suitable techniques for production of corn based snacks	Applying (K3)
CO4	explain the principles of extruder and processing techniques for extruded foods	Understanding (K2)
CO5	classify pasta products and explain the steps involved in their production	Understanding (K2)

Mapping of COs with POs and PSOs

COs/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12	PSO 1	PSO2
CO1	2	1	1							1		1	3	1
CO2	2	2	2	1						1		1	3	1
CO3	2	2	2	1						1		1	3	1
CO4	3	2	2	1						1		1	3	1
CO5	3	2	2	1						1		1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	30	70					100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE02-NANOTECHNOLOGY IN FOOD PROCESSING

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PE	3	0	0	3

Preamble	To provide knowledge about the synthesis of nano materials, its characterization and applications of nano particlesin food processing and food packaging.	
Unit - I	**Introduction to Nanotechnology:**	**9**
Introduction to Nanotechnology: Introduction to nano particles and nanotechnology, naturally occurring food nano substances, challenges for nutrient nano encapsulation, nano food particles and their bioavailability, designing food nano structures, public perception of nanotechnology food products		
Unit - II	**Synthesis of Nano Materials:**	**9**
Synthesis of Nano Materials: Introduction to synthesis of nanostructure materials, Bottom-up approach and Top-down approach. Physical methods - ball milling, sputtering, evaporation. Chemical methods - photochemical synthesis, electrochemical synthesis, co- precipitation method. Thermolysis route - spray pyrolysis. Biological methods – bacteria, fungi and actinomycetes.		
Unit - III	**Nanotechnology in Food:**	**9**
Nanotechnology in Food: Nanoparticles in functional foods, engineered nanoparticles in beverages, nanotechnology in meat processing, nanoemulsion formation, potential applications of milk nanotubes, nano engineered membranes, application of nanoparticles in delivery of flavors and aroma compounds.		
Unit - IV	**Nanotechnology in Food Packaging:**	**9**
Nanotechnology in Food Packaging: Bionano composites for food preservation, intelligent packaging, high barrier plastics, biodegradable food packaging nanocomposites, bioactive food packaging with nano diamond particles, nano materials incorporated flexible packaging materials for high pressure processing, new approaches in antibacterial food packaging, nano sensors for food quality.		
Unit - V	**Nanotechnology in Food Safety and Challenges in Nanomaterials Analysis:**	**9**
Nanotechnology in Food Safety and Challenges in Nanomaterials Analysis: Nano technology based rapid detection of chemical and biochemical contents in food, separation of food based pathogens using magnetic nanoparticles, challenges in nano materials analysis, sample pre-treatment methods, characterization of nano materials in food and biological matrices, nanomaterial detection and quantification methods.		
		Total:45

TEXT BOOK:

1.	Qasim Chaudhry, Laurence Castle and Richard Watkins, "Nanotechnologies in Food", 2nd Edition, RSC Publishing, UK,2017.

REFERENCES:

1.	Rai M., Ribeiro C., Mattoso L., and Duran N, "Nanotechnologies in Food and Agriculture", Springer InternationalPublishing, Switzerland, 2016.
2.	Guozhong Cao and Ying Wang, "Nanostructures and Nanomaterials: Synthesis, Properties, and Applications", 2ndillustrated revised Edition, World Scientific Publishing Co, Singapore, 2011.
3.	Qingrong Huang, "Nanotechnology in the Food, Beverage and Nutraceutical Industries", Elsevier Science, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the fundamentals of nanotechnology and the challenges / public perception of nano particles in food	Understanding (K2)
CO2	make use of appropriate method for manufacturing nano particles	Applying (K3)
CO3	solve the food quality issues by suitable nanotechnology based solutions	Applying (K3)
CO4	make use of nano materials incorporated packaging to extend shelf life of food	Applying (K3)
CO5	make use of nanotechnology in food analysis and characterization of nano particles	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE03-FERMENTATION TECHNOLOGY

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food microbiology, Food chemistry	5	PE	3	0	0	3

Preamble	To provide an insight about the concepts of fermentation process and products	
Unit - I	**Introduction and Food Fermentation:**	**9**
Introduction: Basic principles of food fermentation, Properties of fermented foods. Food Fermentation: Origin and history of food fermentation, Micro-organisms for fermentation, Starter Cultures and fermented products, Inoculum development for industrial fermentations, Criteria for transfer of Inoculums.		
Unit - II	**Fermentation media:**	**9**
Fermentation media: Natural and Synthetic media; Basic components of media -Role of buffers in media. Sterilization: Sterilizationof media and air-Calculation of del factor, Calculation of holding time at constant temperature.		
Unit - III	**Types of Fermentation & Design of fermenter:**	**9**
Types of Fermentation & Design of fermenter: Types - submerged, solid state, batch, fed- batch and continuous fermentations. Design of Fermenter: Fermenter construction- construction material, Temperature controls, Aeration and agitation systems-Oxygen requirement, Oxygen supply, determination of KLa values & factors affecting the operation of fermenter.		
Unit - IV	**Recovery and Purification of Fermentation products:**	**9**
Recovery and Purification of Fermentation products: Removal of microbial cells and other solid matter, foam separation,precipitation, filtration, centrifugation, cell disruption, membrane process, chromatography, drying and crystallization.		
Unit - V	**Production of Fermented Products:**	**9**
Production of Fermented Food Products: Meat fermentation-Sausages. Asianfermented foods- Koji, Soy sauce, Natto, Tempeh, and Miso. Production of Metabolites: Production of vitamins, amino acids, organic acids, enzymes, baker's yeast, Nisin, Xylitol, xanthan gum.		
		Total:45

TEXT BOOK:

1.	Stanbury P.F, Whitaker A. and Hall S.J , "Principles of Fermentation Technology", 3rd Edition, worth Heinemann, NewYork, 2016.

REFERENCES:

1.	Robert W. Hutkins, "Microbiology and Technology of Fermented Foods", 3rd Edition, CRC Press, UK, 2006.
2.	Hui Y.H., Lisbeth Meunier Goddik, JytteJosephsen, Wai Kit Nip and Peggy S. Stanfield, "Handbook of Food andBeverage Fermentation Technology", 1st Edition, CRC Press, UK, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the principles and concepts of fermentation	Understanding (K2)
CO2	select suitable media component and sterilization methods	Applying (K3)
CO3	identify the suitable fermentation process and construction of fermenter	Applying (K3)
CO4	choose appropriate techniques for recovery of fermented products	Applying (K3)
CO5	illustrate the production of different fermented products	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	CAT1	20	60	20			
CAT2	CAT2	20	40	40			
CAT3	CAT3	20	60	20			
ESE	ESE	20	60	20			

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE04- FOOD STORAGE AND INFESTATION CONTROL

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PE	3	0	0	3

Preamble	To understand about the effect of insects and pest on stored products and to learn about the methods tocontrol pest infestation	
Unit - I	**Fundamentals of Storage Infestation:**	**9**
Fundamentals of Storage Infestation: Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses - total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products.		
Unit - II	**Ecology of Insects and Storage Losses:**	**9**
Ecology of Insects and Storage Losses: Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.		
Unit - III	**Grain Storage and Management:**	**9**
Grain Storage and Management: Grain storage, Types of storage structures - traditional, improved and modern storage structures in current usage. Ideal seeds and commodities storage conditions. Important rodent pests associated with stored grains and their non-chemical and chemical control. Pest Birds — role and its management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods.		
Unit – IV	**Pest Control Measures:**	**9**
Pest Control Measures: Non-chemical control measures- ecological, mechanical, physical, cultural, biological andengineering. Chemical control- prophylactic and curative. Pesticides – characteristics, uses and precautions in handling. Integrated approaches to stored grain pest management.		
Unit - V	**Quality Control in Grains:**	**9**
Quality Control in Grains: Detection of insect infestation in stored food grains, losses in stored food grains — weevilled and unweevilled grains, determination of moisture content in stored food grains, Quality control aspects in FCI godowns, central warehouse. Demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality.		
		Total:45

TEXT BOOK:

1.	Narayanasamy P., Mohan S & Awaknavar J. S, "Pest Management in Store Grains", 1st Edition, Satish SerialPublishing House, New Delhi, 2009.

REFERENCES:

1.	Nair K.R, "Integrated Production and Pest Management", 1st Edition, Gene-Tech Books Publisher, New Delhi, 2009.
2.	Hagstrum D.W. & Subramanyam B, "Fundamentals of Stored Product Entomology", 1st Edition, AmericanAssociation of Cereal Chemists Inc, USA, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline possible sources of pest infestation in storage	Understanding (K2)
CO2	identify ecology of region specific insects and infer their impact on storage	Applying (K3)
CO3	choose appropriate storage structures and preventive measures for pests	Applying (K3)
CO4	select integrated pest management approach and curative measures in grain storage	Applying (K3)
CO5	utilize suitable quality control techniques in grain storage	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO 11	PO12	PSO1	PSO 2
CO1	3	2	1	1		1				1		1		3
CO2	3	2	2	2		1				1		1	1	3
CO3	3	2	2	2	2	2				1		1	1	3
CO4	3	2	2	1	2	2				1		2	1	3
CO5	3	2	2	1	1	3				1		2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE05- FOOD ADDITIVES AND NUTRACEUTICALS

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry	5	PE	3	0	0	3

Preamble	To provide deeper insight to students on role of food additives and nutraceuticals on food Product Development.	
Unit - I	**Food Preservatives and Antioxidants:**	**9**
Definition; Types and functions of food additives in food processing. Preservatives : Definition; natural preservatives; chemical preservatives; acidulants and low pH –organic acids and esters; sulphur dioxide and its salts; nitrites; antibiotics; surface preservation; Permitted preservatives in foods as per FSSAI. Antioxidants: Na tural and synthetic antioxidants; mechanism of antioxidant function; primary and secondary antioxidants; selection and application of antioxidants in foods; evaluation of antioxidant effectiveness –permitted antioxidants in foods. Sequestarants and its functions.		
Unit - II	**Food Colorants, Flavors, Emulsifiers and Stabilizers:**	**9**
Natural and synthetic colorants; inorganic pigments; application of colors in food industry; Non permitted colorants restriction on the use of colors in foods. Flavoring agents –concept of flavors in foods; natural flavors; nature identical flavors; artificial flavoring substances; restrictions on the use of flavoring agents in Foods. Emulsifiers and Stabilizers - Definition, properties of HLB value; function of emulsifiers and stabilizers in foods; permitted emulsifiers and stabilizers used in foods; - polyols –physical and chemical properties of polyols, application in food industry, permitted polyols in foods.		
Unit - III	**Safety, Regulation and Quality Standards:**	**9**
Safety limits of Food additives; FSSAI regulations And GRAS additives Risk assessment and risk benefit Indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, teratogenicity, neurotoxicity and behavioral effect, immune toxicity. Determination of the limit for addition – NOEL – Method of determining toxicity – LD50. FSSAI regulations and GRAS additives.		
Unit - IV	**Functional Foods and Nutraceuticals:**	**9**
Introduction, definition. Difference between functional foods and nutraceuticals. Examples for fortified functional foods. Plant and animal based nutraceuticals. Health benefits of Polyphenols, Flavonoids, Omega-3 Fatty Acids, Carotenoids. Technologies to recover Nutraceuticals compounds: Distillation, ultrahydrostatic pressure treatment, dense carbon-di-oxide treatment, encapsulation of nutraceuticals – materials, mechanical processes and chemical based processes, nano encapsulation.		
Unit - V	**Role in Health Promotion and Disease Prevention:**	**9**
Nutraceuticals in prevention and treatment of gastrointestinal disorder, Probiotics Cardiovascular and Chronic Diseases. End User Market Products with current product updates - supplements forms- tablets, capsules, powders, soft gels, gel caps, liquids; Nutraceuticals currently available in the market, regulation for nutraceuticals.		
		Total:45

TEXT BOOK:

1. Wildman, Robert E.C, "Book of Nutraceuticals and Functional Foods", 2nd Edition, CRC Press, New York, 2006

REFERENCES:

1. Belitz H.D., Grosch W. and Schieberle P, "Food Chemistry", 3rd Edition, Springer-Verley, Berlin, 2004.
2. Clare M. Hasler, "Regulation of Functional Foods and Nutraceuticals: A Global Perspective", 1st Edition, Wiley, Chicago, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	select appropriate preservatives and antioxidants.	Understanding (K2)
CO2	choose suitable food colours, flavours, emulsifiers and stabilizers	Applying (K3)
CO3	relate the safety, regulations and quality standards to food additives in food processing	Understanding (K2)
CO4	identify technology to recover nutraceuticals.	Applying (K3)
CO5	identify the effect of nutraceuticals in health promotion and disease prevention	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE06- FOOD ALLERGENS AND TOXICOLOGY

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry , Food microbiology	6	PE	3	0	0	3

Preamble	To provide knowledge on toxicology related to food and the human food chain.	
Unit - I	**Introduction to Food Toxicology:**	**9**
Definition and need for understanding food toxicology; Hazards -Microbiological, nutritional and environmental. Basics of immune response - humoral and cell mediated response. Allergen and mechanism of allergic response.		
Unit - II	**Natural Toxins, Food Allergy and Sensitivity:**	**9**
Toxins–Natural toxin in animal and plant foods. Microbial toxins- toxin characteristics. Chemistry of food allergens, celiac disease, asthma, food disorders associated with metabolism- lactose intolerance, favism. Antioxicants in foods and their functions		
Unit - III	**Toxicants Formed During Food Processing:**	**9**
Intentional direct additives: preservatives, nitrite and N- nitroso compounds, flavour enhancers, food colours . Indirect additives: residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N - nitrosamines, Acrylamide and their mode of action		
Unit - IV	**Assessment of Toxicants in Food Sampling:**	**9**
Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants. Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.		
Unit - V	**Instrumentation Techniques to Detect Toxins:**	**9**
Chromatography, Principles, procedure and applications of Thin layer chromatography, Gas chromatography column chromatography, Ion exchange chromatography and High performance liquid chromatography. Spectrophotometry, Principles, Instrumentation and applications of Atomic Absorption Spectrophotometry (AAS) and Atomic Emission Spectrophotometry (AES).		
		Total:45

TEXT BOOK:

1. Helferich, William and Carl K. Winter, "Food Toxicology", 1st Edition, CRC Press, New York Washington, 2001.

REFERENCES:

1. Labbe, Ronald G. and Santos Garcia, "Guide to Food Borne Pathogens", 2nd Edition, John Wiley and Sons, UK, 2001.
2. Cliver, Dean O., and Hans P. Riemann, "Food Borne Diseases", 2nd Edition, Academic Press, London, 2002.
3. Maleki, Soheila J. A., Wesley Burks, and RickiM.Helm, "Food Allergy", 1st Edition, ASM Press, USA, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the concepts of food toxicology	Understanding (K2)
CO2	classify toxins, allergens and interpret its sensitivity in human food chain	Understanding (K2)
CO3	identify toxicants formed during food processing	Applying (K3)
CO4	identify the risks involved in human exposure to toxicants	Applying (K3)
CO5	select suitable method for detection of toxins	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE07- MODERN SEPARATION PROCESS

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Process Engineering I , Food Process Engineering II	6	PE	3	0	0	3

Preamble	To learn about different separation techniques with its potential application.	
Unit - I	**Mechanism of Separation and Filtration Processes:**	**9**
Review of conventional processes. Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. Process concept, theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid – liquid separations involving a second liquid, Sirofloc filter.		
Unit - II	**Membrane based separation technique (MBSTs):**	**9**
Physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. Osmosis and osmotic pressure. Working principle, operation and design of reverse osmosis, ultrafiltration, microfiltration, electrodialysis and pervaporation. Gaseous separation by membranes, Membrane fouling – cleaning techniques.		
Unit - III	**Adsorption and Chromatography:**	**9**
Adsorption: Mechanism, Types and choice of adsorbents, Adsorption techniques–pressure swing and temperature swing cycles. Chromatography: Theory, paper chromatography, TLC, GC, HPLC, Affinity and Immuno-chromatography.		
Unit - IV	**Ionic Separation and Permeation:**	**9**
Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, Ion exchange chromatography and electrodialysis. Separations involving pervaporation and permeation techniques for solids, liquids andgases.		
Unit - V	**Other Separation Processes:**	**9**
Zone melting, Adductive crystallization, Supercritical fluid extraction, Oil spill Management, Application of modern separationtechniques for industrial effluent treatment.		
		Total:45

TEXT BOOK:

1. Seader J.D., Ernest J. Henley and Keith Roper D., "Separation Process Principles"**,** 3rd Edition, John Wiley and Sons Inc.,New York, 2011.

REFERENCES:

1. Roussel Ronald W., "Handbook of Separation Process Technology"**,** 1st Edition, John Wiley, New York, 2008.
2. Humphrey Jimmy L. and George E. Keller**,** "Separation Process Technology"**,** 1st Edition, McGraw-Hill PublishingCompany Ltd., USA, 1997.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
C O1	explain the concepts of separation and filtration techniques	Understanding (K2)
C O2	select suitable membrane process and cleaning techniques	Applying (K3)
C O3	classify and adapt appropriate adsorption and chromatography techniques	Understanding (K2)
C O4	apply the concepts of ionic separation and permeation	Applying (K3)
C O5	choose appropriate techniques for effluent treatment	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category *	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE08- BIOPROCESS ENGINEERING

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Microbiology, Food Process calculations, Food Process Engineering II	6	PE	3	0	0	3

Preamble	To provide the concepts of bioreactors, sterilization kinetics and models, stoichiometry of cell growth and productformation, rheological properties of fermented fluids and bio-product recovery methods.	
Unit - I	**Introduction and Design of Novel Bioreactors:**	**9**
Role of a bioprocess engineer, Kinetics of microbial growth, substrate utilization and product formation. Packed bed bioreactors, Bubble-column bioreactors, fluidized bed bioreactors, trickle bed bioreactors, airlift loop bioreactors, photo bioreactors,- Batch, fed-batch and continuous fermentations- ideal reactors for kinetics measurements- Ideal batch reactor, fed-batch reactors.		
Unit - II	**Sterilization Kinetics and Monod chemostat model:**	**9**
Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous. Kinetic modeling of cell growth. Models with growth inhibitors -substrate inhibition, product inhibition and inhibition by toxic compounds.		
Unit - III	**Stoichiometry of Cell Growth and Product Formation:**	**9**
Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass andproduct formation, maintenance coefficients, energetic analysis of microbial growth and product formation.		
Unit - IV	**Rheology of fermentation fluids and Mass Transfer in Bio-processing operations:**	**9**
Newtonian and Non -Newtonian fluids, Aeration and agitation, power requirement for gassed and ungassed systems, time calculation for mixing. Types of Mass transfer. Heat transfer in Bio-processing operations.		
Unit - V	**Bio Product Recovery Methods and Applications in Food Industry:**	**9**
Filtration, sedimentation, centrifugation, precipitation, cell disruption, chromatography, crystallization, lyophillisation, drying. Lactic Acid Production, Citric Acid Production, HFCS Production, Baker Yeast Production.		
		Total:45

TEXT BOOK:

1. Michael LShuler,Fikret Kargı, Matthew DeLisa, "Bioprocess Engineering Basic Concepts", 3rd Edition, Prentice Hall, India,2018

REFERENCES:

1. Paulin M. Doran, "Bioprocess Engineering Principles", 2nd Edition, Elsevier Science & Technology, India, 2012.
2. Mukesh Doble, Sathyanarayana , Gummadi N, "Biochemical Engineering", 1st Edition, Prentice Hall , India, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the kinetics of microbial growth and types of novel reactors	Understanding (K2)
CO2	outline the concepts of sterilization kinetics and monod chemostat models	Understanding (K2)
CO3	relate the principle of stochiometric concepts in cell growth and product formation	Understanding (K2)
CO4	translate the concepts of rheology and heat mass transfer for the fermentation fluids	Understanding (K2)
CO5	summarize the various bio product recovery methods and its application in food industries	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks**

22FTE09- EMERGING TECHNOLOGIES IN FOOD PROCESSING

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Process Engineering I, Food Process Engineering II	6	PE	3	0	0	3

Preamble	To impart knowledge effectively in various novel methods of food processing utilizing their advantages for food processing and preservation	
Unit - I	**High Pressure Processing and Pulsed Electric Field:**	**9**
High Pressure Processing of Foods: High Pressure Processing–Principle - Description, Packaging requirements, Uses and Effects on food quality. High Pressure Regulations. Other applications of high pressure - High pressure freezing, High Pressure thawing, High Pressure non-frozen storage. Application and limitations. Pulsed Electric Field Processing: Principle - Mechanism of action. PEF treatment systems – processing parameters. Applications. Safety aspects, Problems and challenges in PEF.		
Unit - II	**High Intensity Pulsed Light Technology and Cold Plasma:**	**9**
High Intensity Pulsed Light Technology: Principles of Pulsed Light Technology, Effect of Pulsed Light Technology on food products, enzymes and food properties. PLT systems. Irradiation of Foods. Cold Plasma: Plasma-properties-chemistry-generation methods-application-effects-limitations and toxicology.		
Unit - III	**Ultrasound and Ozonation:**	**9**
Ultrasound: Fundamentals of ultrasound, ultrasonic processing equipment, Inactivation of micro-organisms and enzymes. Application- mixing and homogenization, foam formation and destruction, precipitation of airborne powders, filtration and drying, extraction. Ozonation: Solubility, stability and reactivity of ozone. Antimicrobial properties of ozone. Ozone Treatment System. Food applications.		
Unit - IV	**Ohmic and Di-electric Heating:**	**9**
Ohmic Heating - Fundamentals, electrical conductivity. Generic Configurations -Batch Configuration, Transverse Ohmic heating and Collinear Ohmic heating. Product suitability for thermal treatments. Di-electrical Heating: Dielectric properties of foods. Dielectric heating, difference between MW and RF. Microwave heating – working principle. Microwave processing of foods – baking, thawing, drying, pasteurization and sterilization. Radio-frequency heating – material properties, adopting RF technology, heating and drying application. Limitations of Dielectric and RF heating.		
Unit - V	**Novel Hybrid Drying Technologies and Automation**	**9**
Novel Hybrid Drying Technologies: Need for hybrid drying systems. Hybrid systems - Heat pump drying, fluidized bed drying, combined microwave and vacuum drying, infra-red drying, superheated steam drying, pressure regulating drying, rotating jet spouted bed drying. Automation for food industry: Introduction - Recent trends in tools of automation in food processing – Computer vision systems, On-line sensors, Expert systems, Robot Technology, Computer Integrated Manufacturing		
		Total:45

TEXT BOOK:

1. Da-Wen Sun, "Emerging Technologies for Food Processing", 2nd Edition, Elsevier Academic Press, London, 2014.

REFERENCES:

1. Han, Jung H, "Packaging for Non-thermal Processing of Food", 1st Edition, Wiley-Blackwell, Oxford, 2007.
2. Mujumdar A.S, "Handbook of Industrial drying", 4th Edition, CRC Press, UK, 2014.
3. Misra N.N., Oliver Schluter and Patrick J. Cullen, "Cold plasma in Food and Agriculture: Fundamentals and Applications", 1stEdition, Academic Press, London, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of high pressure processing and pulsed electrical field for food processing.	Applying (K3)
CO2	make use of pulsed light technology and irradiation for food processing and preservation	Applying (K3)
CO3	utilize ultrasound and ozone techniques for food processing	Applying (K3)
CO4	apply ohmic and dielectric heating principles in food processing	Applying (K3)
CO5	choose novel drying techniques and adapt automation in food processing	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2				1		2
CO2	3	3	2	1	3	2				1		2
CO3	3	3	2	1	3	2				1		2
CO4	3	3	2	1	3	2				1		2
CO5	3	3	2	1	3	1				1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE10- PLANTATION AND SPICES PRODUCTS TECHNOLOGY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PE	3	0	0	3

Preamble	To provide an idea about the plantation crop & spices and their processing with special ingredients as flavouring material quality.

Unit - I	**Plantation Crops:**	**9**

Plantation Crops: Description of various types of Plantation crops. Processing of tea – Manufacturing of black tea, CTC tea, Green tea, Oolong tea, flavoured tea. Grading of Tea. Coffee– Occurrence, Manufacturing of coffee powder, instant coffee. Cocoa Processing – Cocoa liquor, cocoa powder manufacturing. Coconut– Processing and by products. Cashew nut and Oil palm Processing. Processing of tuber crops – tapioca. Processing of potatoes-processed potato products.

Unit - II	**Spices and Condiments:**	**9**

Spices and Condiments: Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of major spices and their health benefits. Importance in culinary preparations.

Unit - III	**Processing of spices:**	**9**

Processing of spices – Pepper, Chilli, Turmeric, Cardamom, Cinnamon, Clove, Vanilla and Ginger. Spices Products – Liquid products and Solid Products. Spice Oils–Concept and importance. Extraction methods-Solvent extraction, Steam distillation. Oleoresins - Extraction, Quality and Application of oleoresins. Importance of Cryogenic grinding of spices

Unit – IV	**Herbs & Flavouring materials:**	**9**

Herbs & Flavouring materials: Description of various types of herbs. Basil, Cilantro, Dill, Coriander, Mint, Oregano, Borage, Thyme,Bilva leaves, Safflower. Nutritive value and health benefits. Processing and post-harvest handling.

Unit - V	**Flavouring materials of natural origin:**	**9**

Flavouring materials of natural origin: Natural flavours, sources of natural flavouring materials — Herbs and spices. Microbiology of spices, gas sterilization of spices, gamma irradiation, heat treatment. Encapsulation of spice based flavours — methods and recent trends, Seasoning blend duplication and tricks.

Total:45

TEXT BOOK:

1. Kumar N., "Introduction to spices, plantation crops, medicinal and aromatic plants", 2nd Edition, Oxford and IBH Publishing, NewDelhi, 2006.

REFERENCES:

1. Panda H.,"Handbook on Spices and Condiments (Cultivation, Processing and Extraction)", 2nd Edition, National Institute of Industrial Research, New Delhi, 2010.
2. Peter K.V.,"Handbook of Herbs and Spices", 2nd Edition, Wood Head Publishing,USA,2012.
3. Minifie Bernard W., "Chocolate, Cocoa and Confectionery Technology", 3rd Edition, Aspen Publication, USA, 1999.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate the processing stages involved in plantation processing	Understanding(K2)
CO2	utilize functional properties of spices and herbs in product development	Applying(K3)
CO3	select processing steps required for spices processing	Applying(K3)
CO4	choose processing steps required for herbs processing	Applying(K3)
CO5	identify suitable flavouring materials for food processing	Applying(K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			1	1			1		1	2	2
CO2	3	2	3			2	1	1		1		1	2	2
CO3	3	2	2			1	1	1		1		1	2	2
CO4	3	2	3			2	1	1		1		1	2	2
CO5	3	2	2			2	2	1		1		2	3	2
CO6	3	2	1			1	1			1		1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category *	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	20	30	30				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTE11- ENZYMES IN FOOD PROCESSING

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food chemistry	7	PE	3	0	0	3

Preamble	To learn about enzymes and their application in processing and development of food products.	
Unit - I	**Enzyme kinetics and Production of industrial enzymes:**	**9**
Enzyme kinetics: Enzyme-Classification and Nomenclature, Units of Activity, General Characteristics. Enzyme Kinetics - Michaelis Menden Equation, Linear Plots / Km and Vmax. Production of industrial enzymes: Sources of enzymes, microbial fermentation and downstream processing, Enzyme formulation.		
Unit - II	**Enzymes in milk processing and brewing industry:**	**9**
Milk Processing: Milk clotting enzymes, Lactoperoxidase, Cheese-ripening enzymes, Lysozyme, Lactase, Lipase, Transglutaminase. Brewing: Malting, Brewhouse processing, Enzyme applications and their role during fermentation, Beer stabilization.		
Unit - III	**Enzymes in non alcoholic beverage:**	**9**
Enzymes in non alcoholic beverage: Application of enzymes in tea and cocoa processing. Role of the enzymes in fruit juice production, factors affecting the enzymatic activity. Enzymatic clarification of apple and guava juices, factors affecting the clarification of fruit juices.		
Unit - IV	**Enzymes in baking industry:**	**9**
Enzymes in baking industry: Enzymes for baking industry, Use of the proteinases, lipases and pentosans in baking industry, Starch degrading enzymes: sources, analysis and application of starch degrading enzymes. Hemicellulase, xylanases: sources, analysis and application.		
Unit - V	**Enzymes in meat processing:**	**9**
Enzymes in meat processing: Enzymes used for meat processing: protease and peptidase, lipases, trans glutaminase, oxidativeenzyme. Meat tenderization with added enzyme, Enzymatic generation of flavour in meat products, Restructuring of unheat meat.		

Total:45

TEXT BOOK:

1. Robert J. Whitehurst & Maarten van oort, "Enzymes in Food Technology", 2nd Edition, John Wiley & Sons, UK, 2009.

REFERENCES:

1. Muthusamy Chandrasekaran, "Enzymes in Food and Beverage Processing", 1st Edition, CRC Press, USA, 2016.
2. Robert Rastall, "Novel Enzyme Technology for Food Applications", 1st Edition, Wood head Publications, USA, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the enzyme kinetics and production of industrial enzymes	Understanding (K2)
CO2	select suitable enzymes for milk processing and brewing	Applying (K3)
CO3	choose appropriate enzymes for non alcoholic beverage production	Applying (K3)
CO4	apply and relate the effect of enzymes in baking process	Applying (K3)
CO5	make use of enzymes in processing of meat and meat products	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)

22FTE12 - DAIRY PRODUCTS TECHNOLOGY

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Dairy Technology	7	PE	3	0	0	3

Preamble	To explore the technology of variety of products and by-products developed from milk.	
Unit - I	**Coagulated Milk Products and Fermented Milk Products:**	**9**
Coagulated Milk Products: Definitions, Classification, Paneer: Types of paneer, Basic operations in Paneer Production; Cheese: Types ofcheese, Basic operations in Cheese Production. Fermented Milk Products: Definitions; Classification; Yoghurt: Types, Yoghurt Production- significance of each processing steps; Dahi: Types of dahi, Dahi Production; Preparation of Cultured Butter Milk.		
Unit - II	**Traditional dairy products:**	**9**
Classification of traditional dairy products, Khoa: Definition, varieties and standards, Methods of preparation of khoa, Gulab jamun: Product Description, Method of Preparation, Quality; Peda: Product Description, Method of Preparation, Quality; Burfi: Product Description, Method of Preparation, Quality; Shrikhand: Product Description, Method of Preparation, Quality.		
Unit - III	**Condensed Milk and Dried Milk:**	**9**
Condensed Milk: Definition, Classification, Legal Standards for Evaporated and Condensed Milks, Manufacture of Sweetened Condensed Milk, Manufacture of Evaporated Milk. Dried Milk: Definition, Classification, Legal Standards for dried milks, Manufacture of Non Fat Dry Milk, Manufacture of Whole Milk Powder,Manufacture of Instant Dried Milks.		
Unit - IV	**Fat Rich Dairy Products:**	**9**
Principles and methods of cream separation, Processing of cream, Consumer cream products; Composition and classification of butter,Process outlines of butter making, Continuous Butter Making; Methods of ghee preparation, Butter oil.		
Unit - V	**Frozen dairy products and Dairy By-products:**	**9**
Frozen dairy products: Definition, Classification, Composition of Ice cream, Other frozen desserts, Technological aspects of ice creammanufacture, Dried ice cream mix: Composition, Technology, Uses Dairy By-products: Definition, Types; Caseinates: Composition, Process of manufacture, Whey Protein products: Classification, Process ofmanufacture.		
		Total:45

TEXT BOOK:

1.	Sukumar De, “Outlines of Dairy Technology”, 46th edition Edition, Oxford University Press, New Delhi, 2019.

REFERENCES/ MANUAL / SOFTWARE:

1.	Edgar Spreer, “Milk and Dairy Product Technology”, CRC Press 2017.
2.	Pieter Walstra, Jan T. M. Wouters, Tom J. Geurts, “Dairy Science and Technology”, Taylor & Francis, UK, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the technology of coagulated milk products and fermented milk products	Understanding (K2)
CO2	explain the production of different traditional dairy products	Understanding (K2)
CO3	outline the technology of condensed milk and dried milk	Understanding (K2)
CO4	outline the technology of fat-rich dairy products	Understanding (K2)
CO5	summarize the manufacturing process of frozen dairy products and dairy by-products	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE13-TECHNOLOGY OF FATS AND OILS

Programme &Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry	7	PE	3	0	0	3

Preamble	To provide insight of the basic chemistry, properties and processing of fats and oils.	
Unit - I	**Properties of Oils and Fats:**	**9**

Properties of Oils and Fats: Oils and fats – sources, composition. Nutritional importance of fats and oils. Physical properties of fats and oils - color, odour, consistency, melting point, flash point, smoke point, solid fat index and refractive index. Chemical properties of fats and oils - iodine value, saponification value, free fatty acids, peroxide value.

Unit - II	**Vegetable Oil and Animal Fat Production:**	**9**

Vegetable Oil and Animal Fat Production: Industrial production of oils- seed handling and storage. Preparation of seed for extraction of oil. Processing- peanut oil, rice bran oil, sunflower oil, coconut oil and Palm oil. Production of cod liver oil. Method of extraction- cold pressing and hot pressing, Equipments- Filter press, hydraulic press. Production of margarine. Production of Lard.

Unit - III	**Solvent Extraction and Refining of Oils:**	**9**

Solvent Extraction and Refining of Oils: Solvent extraction – prepress and direct extraction, removal and recovery of solvent from miscella andextracted residue. Physical and Chemical Refining: Degumming - types, Neutralization, dewaxing/winterization, bleaching, deodorizing.

Unit - IV	**Modification of Oils and Modified Fat Products:**	**9**

Modification of Oils: Methods- Fractionation, Blending, Hydrogenation, Interesterification. Modified Fat products: spreads,mayonnaise. Shortenings in bakery products and confectionery lipids. Fat substitutes and its types, Non edible fat/ oil products.
Design and Application of Fat-Based Surfactants: Introduction to Surface and Interfacial Activity - Emulsion Formation methods and Stabilization – Applications

Unit - V	**Frying and Storage of Oil:**	**9**

Frying and Storage of Oil: Changes during storage of oil. Role of fat or oil in frying. Selection of frying oil. Applications of frying oil. Rancidity - atmospheric oxidation and enzyme action, Prevention of rancidity. Quality standards of oil, Packaging of oils and fats.

Total:45

TEXT BOOK:

1. Fereidoon Shahidi, "Bailey's Industrial Oil and Fat Products", 6th Edition, Wiley - Interscience, New Jersey, 2005.

REFERENCES:

1. Richard D. O'Brien, "Fats and Oils: Formulating and Processing for Applications", 3rd Edition, CRC Press, London, 2010.
2. Wolf Hamm & Richard J. Hamilton, "Edible Oil Processing", 2nd Edition, Wiley - Blackwell, UK, 2013.
3. O'Brien, Richard D, Walter E. Farr, and Peter J. Wan. "Introduction to Fats and Oils Technology", 2nd Edition, Champaign, Ill: AOCS Press, 2000

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the physical and chemical properties of fats and oils	Understanding (K2)
CO2	recommend suitable mechanical methods for oil extraction	Applying (K3)
CO3	apply solvent extraction and refining techniques to improve the quality of oil	Applying (K3)
CO4	develop modified fat/ oil products	Applying (K3)
CO5	identify the changes occurred during frying and storage of fats/oils	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering(K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE14 - PROCESS INSTRUMENTATION AND CONTROL

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	To impart knowledge on Laplace transformation for first and second order system, controllers, computer based automation and instrumentation in process industries.	
Unit - I	**Laplace Transform and First Order System:**	**9**
Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, Linearization and its application in process control.		
Unit - II	**Second Order System:**	**9**
Second order systems - Interacting system and non-interacting system, manometer, damped oscillator, dynamic response of second order system, Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatorproblems.		
Unit - III	**Controllers, Dynamic Response and its Stability:**	**9**
Controllers - Proportional, Proportional Integral, Proportional Derivative and Proportional Integral Derivative (PID). Dynamic behavior of feedback controlled processes. Effect of proportional, Integral, Derivative and composite control actions on the response of controlled processes. Stability for linear systems, Routh stability criterion and its limitations. Introduction to control system design by frequency, Bode diagram		
Unit - IV	**Automation:**	**9**
Control components of SCADA, working of SCADA, comparison of SCADA with DCS, comparison of PLC with RTU, Application and advantages of SCADA, Sensors and its classification.		
Unit - V	**Process Instruments:**	**9**
Principles of measurements - Static and dynamic response of instruments, Temperature measurements – Expansion Thermometer, filled system thermometers, thermocouple, optical pyrometers, radiation pyrometers. Pressure measurements - Manometers, bourdon gauge and bellows gauge, pressure measurement by vacuum. – Mccleod guage, Piraniguage. Level measurement – sight glass level indicator, float and tape liquid level gauge.		
		Total:45

TEXT BOOK:

1. Vyas, R.P, "Process Control and Instrumentation", 8th Edition, Dennet & Co, India, 2015

REFERENCES:

1. Stephanopoulos, S.G., "Chemical Process Control: An Introduction to Theory and Practice", 1st Edition, Prentice Hall of India, New Delhi, 2011.
2. Donald R. Cough anowr and Steven E. LeBlanc, "Process Systems Analysis and Control", 3rd Edition, Tata McGraw Hill Company Ltd., New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	make use of Laplace transformation for first order systems	Applying (K3)
CO2	apply Laplace Transformation for second order systems and determine its dynamic behavior	Applying (K3)
CO3	Make use of concepts of feedback controller and determine its dynamic response and stability	Applying (K3)
CO4	summarize the concept of computer based controls in automation	Understanding (K2)
CO5	select temperature, pressure and level measuring instruments	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	60	20				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE15- FUNDAMENTALS OF COMPUTATION FLUID DYNAMICS

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Heat transfer operations, Mass transfer in food processing operations	7	PE	3	0	0	3

Preamble	To impart knowledge about application of computational fluid dynamics in various fields of food processing.	
Unit - I	**Introduction to CFD:**	**9**
Introduction to CFD: Theory of CFD modeling - Conservation of mass, Momentum Equation, Energy Equation, Navier Stokes Equation. Classification of simple PDEs and fluid flow equations		
Unit - II	**Turbulence and Modeling:**	**9**
Turbulence and Modeling: Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows - Free turbulence models, turbulent flow calculations, Direct numerical simulation.		
Unit - III	**The Finite Volume Method for Diffusion Problems:**	**9**
The Finite Volume Method for Diffusion Problems: Introduction - One dimensional steady state diffusion, two dimensional and three dimensional diffusions. The central differencing scheme, The upwind differencing scheme, the hybrid differencing scheme, the power- law scheme, higher order differencing schemes.		
Unit - IV	**CFD Analysis:**	**9**
CFD software packages and tools, CFD analysis – Preprocessing, solving and post processing, CFD Applications in Food Processing, Spray Drying-Air Flow Pattern, Atomization, air-particle interaction, Residence time of the particle, Modeling in Bread Baking Process		
Unit - V	**Applications of CFD:**	**9**
Applications of CFD: Canning of foods, Canned solid liquid food mixtures, Bacterial Deactivation kinetics, analysis of fluid flow pattern during sterilization, Thermal processing of canned foods, Other applications in food processing.		
		Total:45

TEXT BOOK:

1. Anandharamakrishnan C, "Computational Fluid Dynamics Applications in Food Processing", Springer Science and Business Media, Germany, 2013.

REFERENCES:

1. Versteeg H.K. and Malalasekara W., “An Introduction to Computational Fluid Dynamics”, 2nd Edition, Pearson Education Ltd.,England, 2007.
2. Da-Wen Sun, “Computational Fluid Dynamics in Food Processing”, 1st Edition CRC Press, New York, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the equations involved in CFD modelling	Understanding (K2)
CO2	apply the turbulence model in fluid flow operations	Applying (K3)
CO3	make use of finite volume method for developing solution of steady state diffusionprocesses	Applying (K3)
CO4	infer the application of CFD in spray drying and bread baking processes	Analyzing (K4)
CO5	interpret the various applications of CFD in food processing	Evaluating (K5)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	10	10	30	30	20		100
ESE	10	20	30	30	10		100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE16- ENERGY MANAGEMENT IN PROCESS INDUSTRIES

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Heat transfer operations	7	PE	3	0	0	3

Preamble	To provide the knowledge on energy management, audit and conservation in many systems.	
Unit - I	**Energy Basics:**	**9**
Energy Scenario: Commercial and Non Commercial Energy, Primary Energy Resources, Commercial Energy Production, Energy Needs of Growing Economy, Energy and Environment. Basics of Energy and its various forms: Electricity basics: DC & AC currents, Electricity tariff, Load management and Maximum demand control, Power factor. Thermal basics: Thermal energy contents of fuel, Temperature & Pressure, Heat capacity, Sensible and Latent heat, Evaporation, Condensation, Steam, Moist air and Humidity & Heat transfer. Global Environmental Concerns: United Nations Framework Convention on Climate Change (UNFCC), Kyoto Protocol,Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF), Sustainable Development.		
Unit - II	**Energy Management and audits:**	**9**
Definition, Energy audit- need, Types of energy audit. Material and Energy balance: Facility as an energy system, Methods for preparing Process flow, Material and energy balance diagrams. Energy Monitoring and Targeting. Financial Management: Investment- need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return ; Cash flows, Risk and sensitivity analysis.		
Unit - III	**Energy conservation in Electrical Systems and Compressed air system:**	**9**
Basics of Electrical System: Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit. Electric motors: Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy. Types of air compressors, Compressor efficiency, efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test, Factors affecting the performance and efficiency.		
Unit - IV	**Energy conservation in Thermal systems and Waste Heat Recovery:**	**9**
Boilers: Types, Combustion in boilers, Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities. Steam System: Properties of steam, Assessment of steam distribution losses, Steam leak-ages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, Advantages and applications, commercially viable waste heat recovery devices, saving potential.		
Unit - V	**Energy conservation in Food Process Industries:**	**9**
Dairy Processing - Potential Energy Conservation measures in pasteurization, cooling, concentration and drying. Fruit and Vegetable Processing –energy flow in canned products, energy conservation measures in blanching, pasteurization, sterilization. Energy conservation in Baking and confectionery units. Thermo chemical Conversion of Food Processing Wastes for Energy Utilization –pyrolysis, gasification and liquefaction.		
		Total:45

TEXT BOOK:

1. Beggs Clive, "Energy: Management Supply and Conservation", 2nd revised Edition, Routledge, 2015.

REFERENCES:

1. Lijun Wang, "Energy Efficiency and Management in Food Processing Facilities", Taylor and Francis Group, 2019

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the energy sources and energy consumption	Understanding(K2)
CO2	plan and perform energy audits and survey	Applying (K3)
CO3	identify energy conservation opportunities in electrical systems and compressed air system	Applying (K3)
CO4	select energy conservation measures in thermal systems	Applying(K3)
CO5	apply energy conservation practices in food industries	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	60	20				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE17– TECHNOLOGY OF CEREALS, PULSES AND OIL SEEDS

Programme &Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	To learn the techniques involved in milling of various cereals, pulses, and oil seeds along with the recent advancements	
Unit - I	**Grain Properties:**	**9**
Grain Properties: Grains - Definition. Importance. Physical properties of grains. Structure, Composition and Nutritional value – paddy, wheat,maize, millet, oat, sorghum. Anti-nutritional factors and its methods of reduction. Grain storage systems - farm level storage, bagged storage, bulk storage, hermetic storage, outdoor storage. Losses during storage, Grain protection methods – physical and chemicalmethods. Integrated stored grain pest management		
Unit - II	**Milling of Paddy:**	**9**
Milling of Paddy: Rice milling flow sheet. Cleaning. Parboiling- traditional and improved methods, Physio–chemical changes during parboiling, Effect of parboiling on rice quality. Husking- Methods of husking, Huskers/Shellers – impact type, centrifugal dehusker,underrunner disc huller, rubber roll Sheller. Separation – indented tray and compartment type separator. Whitening – friction type and abrasive type whiteners. Color sorter. New quality control instruments. Byproducts from rice milling.		
Unit - III	**Milling of Wheat:**	**9**
Milling of Wheat: Types of wheat. Wheat milling – Simple and detailed flow sheet. Cleaning, Entoleter. Preparation of Wheat for Milling – wheat blending, tempering or conditioning, Chakki milling, Roller milling – break rolls and reduction rolls, operation and corrugation specification, Sifting – Plan sifters, Purifying - purifier. Milling performance evaluation. Functional properties of flour. Flour treatment – Enrichment, Enhancement of flour appearance, Improvement of functional properties. By products from wheat milling.		
Unit - IV	**Processing of Corn, Millet and Sorghum:**	**9**
Processing of Corn: Types of corn. Dry milling – Tempering, dehulling, degermination and milling. Wet milling – Steeping, Germ, fiber, starch and gluten separation, starch refinement. By products from corn milling. Millet and Sorghum Processing: Types of millets.Sorghum andmillet processing - cleaning, decortication, milling and classification, dry milled fractions. Food and Feed uses.		
Unit - V	**Milling of Pulses and Oil Seeds:**	**9**
Milling of Pulses: Legumes – Structure, Types, Nutritional and Anti-nutritional factors. Pulse Milling – Conditioning, Pitting, Oil/water treatment, drying, dehusking – TADD, CIAE design, Schule design, CFTRI design, Husk separation and grading, Splitting – Equipments. Milling - Dry and wet milling, Modern milling. Dehulling efficiency.Milling of Oil Seeds: Types of Oil seeds. Oil seed processing - Mechanical extraction – Hydraulic press, Screw press, Filter press. Mechanical extraction of coconut oil and palm oil. Cold pressing and Hot Pressing. Solvent extraction, Factors influencing extraction. Refining of oil. Hydrogenation. Winterization. Byproductsof oil extraction.		
		Total:45

TEXT BOOK:

1. Chakraverty A, "Post-Harvest Technology of Cereals, Pulses and Oil Seeds", 3rd Edition, Oxford IBH Publishing Co. Pvt. Ltd, New Delhi, 2017.

REFERENCES:

1. Kulp K. & Pont J.G, "Handbook of Cereal Science and Technology", 2nd Edition, Marcel Dekker Inc, New York, 2000.
2. Sahay K.M. & Singh K. K, "Unit Operations of Agricultural Processing", 2nd Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline grain properties and storage structures	Understanding(K2)
CO2	select suitable parboiling and milling methods for paddy	Applying (K3)
CO3	identify appropriate techniques for wheat milling and its enrichment	Applying (K3)
CO4	summarize the process involved in corn, sorghum and millet processing	Understanding(K2)
CO5	choose suitable technologies for processing of pulses and oil seeds	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering(K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	60	20				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE18- MEAT, FISH AND POULTRY PROCESSING

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Chemistry, Food Microbiology, Food Process Engineering I	7	PE	3	0	0	3

Preamble	To educate the students about processing, preservation, product development from meat, fish, poultry meat and egg and also ensuring quality

Unit - I	**Meat Processing:**	**9**

Types of meat and its sources, composition, structure of meat. Ante mortem handling, types of stunning, slaughtering of animals, inspection and grading of meat. Post-mortem changes of meat. Meat - tenderization, aging. Meat quality evaluation. Preservation of meat- curing, drying. Processed meat products - hamburgers, sausages and meat balls.

Unit - II	**Fish Processing:**	**9**

Types of fish, composition and nutritive value of fish. Harvesting of fish. Spoilage factors of fish. Post-mortem changes in fish. Preservation - freezing and individual quick freezing. Canning and smoking operations. Salting, drying of fish and pickling.

Unit - III	**Poultry Processing:**	**9**

Types and characteristics of poultry products. Unit operation in poultry processing. Pre-slaughter factors affecting poultry meat quality. Factors affecting the shelf-life of poultry meat. Sensory quality of poultry meat- colour, texture and flavour. Preservation techniques: chemical treatments, heating-microwave & IR, freeze drying and irradiation.

Unit - IV	**Egg Processing:**	**9**

Structure, composition, nutritive value of egg. Functional properties of eggs, Factors affecting egg quality and measures of egg quality. Preservation of egg by different methods. Egg powder processing-spray drying, foam mat drying.

Unit – V	**Hygiene and Sanitation:**	**9**

Modern abbatoirs, slaughter house and its features. Handling and maintenance of tools and core equipment. Cleaning and sanitation in meat plants. Food safety measures – GMP, GHP and HACCP in meat industries.

Total:45

TEXT BOOK:

1. Warriss P.D., "Meat Science: An Introductory Text", 2nd Edition, CABI Publications, UK, 2009

REFERENCES:

1. Hui Y. H., "Handbook of Meat and Meat Processing", 2nd Edition, CRC Press, USA, 2012.
2. George M. Hall., "Fish Processing: Sustainability and New Opportunities", 1st Edition, Wiley Blackwell Publications, USA, 2011.
3. Isabel Guerrero-Legarreta., "Handbook of Poultry Science and Technology: Secondary Processing", 1st Edition, John Wiley andSons Publications, UK, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the handling and processing of meat	Understanding (K2)
CO2	make use of fish processing and preservation techniques	Applying (K3)
CO3	apply suitable processing techniques for poultry products development	Applying (K3)
CO4	make use of appropriate techniques for egg preservation	Applying (K3)
CO5	Select suitable hygiene and sanitation procedures for meat industry	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	30				100
CAT3	20	60	20				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE19 - TRADITIONAL FOODS

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	To learn about the popular indigenous foods of India and other countries and also improvisation of such foods.	
Unit - I	**Introduction about Traditional Foods**	**9**

Introduction, Definitions of traditional foods, History of Indian Foods, Traditional classification of Indian Foods. Concepts of Ayurveda in health foods. Role of traditional foods in meeting macro and micronutrients, role in dietary patterns. Traditional foods versus Junk foods. Benefits of traditional foods. List of traditional foods of India and around the world. Fermented and unfermented traditional foods.

Unit - II	**Grain Based Traditional Foods**	**9**

Traditional cereal and legume based foods - Idli, Dosa, Dhokla, Selroti, Sez, Khaman, Bhattejaanr, Anarshe, Balam, Kishk, Soy sauce, Kinema, Tarhana, Hawaijar, Ogi, Kenkey, Pozol, Injera, Kisera. Traditional millet based foods. Traditional cereal-based fermented beverages - Beer, sake, Koozhu, Bouza, Chicha, Mahewu, Boza, Kunu-zaki.

Unit - III	**Fruits, Vegetables, Dairy, Meat and fish based Traditional Foods**	**9**

Sauerkraut, Fermented or Pickled cucumber, Kimchi, Traditional cassava foods - Fufu, Mingao, Farinha, Cassava rice, Sago wafers,Macroni, Gari. Traditional Dairy Foods: Traditional and improved methods of Khoa, Chhana, Paneer, Shrikhand, Ghee. meat, fishbased traditional and fermented foods.

Unit - IV	**Minimal Processing and Health aspects of Traditional Foods**	**9**

Minimal Processing of Traditional Foods - Photochemical and non-photochemical processes Health Aspects of Traditional Foods: Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses

Unit - V	**Laws and Regulations of Traditional Foods: Past, Present and Future**	**9**

Introduction, Development of Food Regulations and Food Law, From Past to Present: A Global Perspective, Current Frameworks and Issues-Food safety and international standards, Trade standards and regulation of Middle east, Africa, China and south east Asia and Latin America, Intellectual Property: Geographical Indications (GIs),The Future: Traditional Foods in a Global Marketplace.

Total:45

TEXT BOOK:

1. McElhatton, Anna & El Idrissi, Mustapha Missbah , "Modernization of traditional food processes and products", 1st Edition, Springer, USA, 2016.

REFERENCES:

1. Mohammed Al-Khusaibi, Nasser Al-Habsi & Mohammad Shafiur Rahman, "Traditional Foods: History, Preparation, Processing andSafety", 1st Edition, Springer, UK, 2019.
2. V.K. Joshi., “Indigenous Fermented Foods of South Asia”, 1st Edition, CRC Press, 2016.
3. Jyoti Prakash Tamang, Kasipathy Kailasapathy , “Fermented Foods and Beverages of the World”, 1st Edition, CRC Press, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the historical and traditional perspective of foods and food habits	Understanding (K2)
CO2	explain the preparation of grain based tradition foods	Understanding (K2)
CO3	illustrate production of fruits and vegetables, dairy based traditional foods	Understanding (K2)
CO4	apply minimal processing techniques in traditional foods in concern with health aspects	Applying (K3)
CO5	summarize the laws and regulations related to traditional foods	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	20	40	40				100
ESE	40	40	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE20- REACTION ENGINEERING

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	To give knowledge on reaction kinetic principles and different type of reactors.	
Unit - I	**Kinetics of Homogeneous reactions:**	**9**

Kinetics of Homogeneous reactions: Reaction Kinetics, Classification of reaction systems, Rate equation, Rate constant, Reaction Mechanism, Order of the reaction, Kinetic models for non-elementary reaction, Testing kinetic model. Temperature dependent term of a rate equation: Arrhenius law, collision theory and transition theory.

Unit - II	**Analysis of Batch Reactor Data:**	**9**

Analysis of Batch Reactor Data: Analysis of experimental reactor data, Integral and differential method, constant volume batch rector, and varying volume batch reactor, Integral method analysis of rate data, Integral rate equation for different order reactions: constant and variable volume systems, Temperature and reaction rate.

Unit - III	**Ideal Reaction for a Single Reactor:**	**9**

Ideal Reaction for a Single Reactor: Ideal reactors: Batch, Semi-batch, Steady state plug flow reactor, Steady state mixed flow reactor.

Unit - IV	**Design for Single and Multiple Reactions:**	**9**

Design for Single Reactions: Size comparison of Single reactors, multiple reactor system, Recycle rector Design for Multiple Reactions: Reactions in Parallel, Reactions in Series, Yield and Selectivity, Qualitative treatment: Plug flow, Batch and Mixed flow reactor, Product distribution.

Unit - V	**Non Ideal Flow:**	**9**

Non-ideal flow: The residence time distribution as a factor performance; residence time functions and relationship between them in reactor. Models for non-ideal flow: Dispersion model and Tank in series model.

Total:45

TEXT BOOK:

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley India Pvt. Ltd, New Delhi, 2006.

REFERENCES:

1. Scott Fogler H, "Essentials of Chemical Reaction Engineering", 2nd Edition, Pearson Education, 2020
2. Smith, J. M, "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill, New York, 1981.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer reaction kinetics and mechanism	Applying (K3)
CO2	analyze batch reactor data	Analyzing (K4)
CO3	understand ideal reactors and develop performance equation	Applying (K3)
CO4	examine reactor system for single and multiple reaction	Applying (K3)
CO5	understand different non ideal flow models and perform RTD Analysis	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	50	20			100
CAT2	10	20	50	20			100
CAT3	10	30	60				100
ESE	10	20	50	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE21- MODELING, SIMULATION AND SOFT TOOLS FOR FOOD TECHNOLOGISTS

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	To impart knowledge on modeling and simulation of different food processing operations	
Unit - I	**Introduction to Modeling:**	**9**
Introduction to Modeling: Definition of terms: System, Entity, attributes, activity, state of systems. Physical, Mathematical and Chemical Systems. Modeling - Principles of model formulation, Representation of Model, Fundamental Laws, Types of Modeling Equations, Black Box Principles, Boundary Condition, Validation of model. Benefits of modeling in food processing.		
Unit - II	**Models in Fermentation and Modified Atmospheric Packaging:**	**9**
Models in Fermentation: Introduction, Biological models - Genetic models, growth models, killing-off models and productions models. Technological models - heat transfer models, oxygen transfer models and mixing models. Economic models and mixed models. Models in Modified Atmospheric Packaging: Principle and methods, macro, micro and meso level models.		
Unit - III	**Modeling of Cooling and Freezing Processes:**	**9**
Modeling of Cooling and Freezing Processes: Introduction, modeling product heat load during cooling - single tank model and tank network model. Modeling product heat load during freezing. Numerical solution of heat conduction equation with phase change. Finite different models and element model. Modeling of combined heat and mass transfer - porous, non-porous foods, foods with impermeable skin and frozen foods.		
Unit - IV	**Modeling of Thermal Process:**	**9**
Modeling of Thermal Process: Types, basic equations - Microbiological and quality kinetics, thermal transport equations. Conduction equations, complex models for non-uniformity and convective flows, sterilization of liquids foods and foods containing particulates. Models for microwave and ohmic heating. Models for heat transfer equipments – evaporators, heat exchangers.		
Unit - V	**Soft Tools for Modeling of Food Processes:**	**9**
Soft Tools for Modeling of Food Processes: Soft tools for Sensory analysis, Mathematical analysis, data treatment tools, design toolsand software.		
		Total:45

TEXT BOOK:

1. Tijskens L.M.M., Hertog T.M. & Nicolai B.M, "Food Process Modeling", 1st Edition, CRC Press, UK, 2001.

REFERENCES:

1. Babu B.V, "Process Plant Simulation", 1st Edition, Oxford University Press, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the concepts of modeling in food processing	Understanding (K2)
CO2	illustrate the modeling concepts in fermentation and MAP	Understanding (K2)
CO3	choose suitable mathematical models in cooling and freezing processes of foods	Applying (K3)
CO4	select the models to be used in thermal processing of foods	Applying (K3)
CO5	make use of appropriate software for modeling processes	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE22 - BEVERAGE TECHNOLOGY

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food Process Engineering I, Food Chemistry	7	**PE**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge on process involved in development of different beverages and quality assessment.	
Unit - I	**Introduction and Traditional Beverages**:	**9**
Current status of beverage industry in India- Types of beverages- Non-Alcoholic and Alcoholic. Nutritional and therapeutic benefits. Raw materials - Water, Sweeteners, Bulking agents, Acidulants, Emulsifiers, Stabilizers, Flavoring and Coloring agents. Traditional Beverages – Neera, Sugar cane juice, Tender coconut water and Herbal water.		
Unit - II	**Non Alcoholic Beverages**:	**9**
Natural Fruit based beverages, Fermented non alcoholic beverages (kombucha, kefir), Synthetic/Artificial beverages. Carbonated beverages- Properties of carbon dioxide, carbonation – carbonators. Preparation of syrup, filling and packaging. Measurement of carbonation. Dairy based beverages – whey based beverages and flavored milk.		
Unit - III	**Alcoholic Beverages:**	**9**
Types of alcoholic beverages. Wine – types – production and defects. Beer – Types – Production and defects. Distilled beverages –Brandy, Whiskey, Rum, Gin – Production and defects.		
Unit - IV	**Specialty Beverages:**	**9**
Coffee and Instant Coffee production. Recent trends in coffee based beverages – Cappuccino, Mocha, Espresso and Latte. Production of Tea based beverages – Instant Tea, Tea Concentrates, RTD Tea beverages. Malt beverages– Branded malt beverages in market. Cocoa Based Beverages. Sportbeverages – Physiological needs and formulation.		
Unit - V	**Quality Assurance in Beverage Industry:**	**9**
Effective application of quality controls- Sanitation and Hygiene in Beverage industries. Quality of water in beverages. Threshold limits of ingredients according to FSSAI, EFSA & FDA. Packaging standards for beverages and recent trends.		

Total:45

TEXT BOOK:

1.	Philip R. Ashurst, “Chemistry and Technology of Soft Drinks and Fruit Juices”, 2nd Edition, Blackwell Publishing Ltd., UK, 2005

REFERENCES:

1.	Paquin P., “Functional and Speciality Beverage Technology”, 1st Edition, Wood Head Publishing in Food Science Technology and Nutrition, USA, 2009.
2.	Bamforth, “Brewing: New Technologies”, 1st Edition, Woodhead Publishing Limited, England, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the ingredients for production of beverages	Understanding (K2)
CO2	make use of suitable techniques for development of non-alcoholic beverages	Applying (K3)
CO3	explain the production of alcoholic beverages and identify the defects	Applying (K3)
CO4	apply the knowledge of processing specialty beverages	Applying (K3)
CO5	apply the regulatory aspects for the quality control in beverage industry	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE23- PRODUCTION OF FIELD AND HORTICULTURE CROPS

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	To provides an insight on role of agricultural practices on production of field and horticultural crops.	
Unit - I	**Agronomy:**	**9**
Definition of agriculture and agronomy – Factors affecting crop growth – climate and weather parameters – Soil fertility and productivity. Crops – Classification, Crop adaptation and Distribution – Principles of plant distribution, Theories governing adaptation, Major Crops. Intensive cropping – Multiple cropping, Intercropping, Multistoried cropping. Crop Rotation, Cropping Patterns & Systems, Crop Production. Seasons and System of Farming		
Unit - II	**Soils:**	**9**
Soil Phases – Liquid, Solid, Gaseous. Properties of soils – Physical Properties, Soil / Irrigability, Soil Water. Major soils in India – Alluvial, Black Soils, Red soils, Desert soils, Tarai soils, Saline and acid soils. Major soils in southern India		
Unit - III	**Tillage and Seeds Sowing:**	**9**
Characteristics of good tillage – Types of tillage – Modern Concepts of tillage – Tillage implements – Primary, Secondary, inter cultural and special purpose. Seeds - Seed rate - Sowing methods - Germination - Crop stand establishment - Planting geometry		
Unit - IV	**Irrigation and water management:**	**9**
Source of water – Surface and sub- surface. Crop water requirement, Irrigation requirement. Methods of irrigation – Gravity, Tank and Lift irrigation. Irrigation schedule and management. Measurement of irrigation. Soil moisture constants.		
Unit - V	**Nutrient Management:**	**9**
Classification of Essential Elements - Based on the Relative Quantity, Chemical Nature, General Function, Mobility in Plants. Nutrients– Role, Deficiency, Method of Control and Toxicity - Organic Manures - Green Manure and Green Leaf Manure - Fertilizers - Classification - Bio Fertilizers - Factors Affecting Manures and Fertilizers Use - Time of Application - Method of Application – Integrated Nutrient Management.		
		Total:45

TEXT BOOK:

1. Chandrasekaran, B., K. Annadurai and E. Somasundaram, "A Text book of Agronomy", 1st Edition, Scientific publishers, Jodhpur,2005

REFERENCES:

1. Yellamanda Reddy. T and G.H SankaraReddi, "Principles of Agronomy", 1st Edition, Kalyani Publishers, Ludhiana, 2007.
2. Mukund Joshi, "Text book of field crops", 1st Edition, PHI Learning Pvt. Ltd, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the crop characteristics and crop production	Understanding (K2)
CO2	select soils type suitable for particular crop production	Applying (K3)
CO3	identify the tillage methods and sowing methods	Applying (K3)
CO4	construct irrigation plan as per crop water requirement	Applying (K3)
CO5	select suitable measures for management of nutrients	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	60	20				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE24- CANE SUGAR TECHNOLOGY

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Heat transfer operations, Food Process Engineering I, Food Process Engineering II	7	PE	3	0	0	3

Preamble	To provides the knowledge on various unit operations involved in the sugar cane processing and its by-products	
Unit - I	**Introduction and Pre-processing Operation:**	**9**
Introduction and Pre-processing Operation: Overview of sugar industry - composition of sugarcane, sugarcane parts and growthphase, manufacturing process of sugarcane juice, types of cane sugar, terminology. Harvesting indices, Cane cutting — Manual and Mechanical, Transportation, Cane conveyor, Washing, Shredding.		
Unit - II	**Juice Extraction:**	**9**
Juice Extraction: Crushing –Types of crushers, crushing efficiency. Extraction of juice – methods. Accumulators – types. Maceration. Theory of cane diffusivity. Types of diffusers. Factors influencing Extraction of cane juice. Operating conditions and their influence on sucrose extraction, Weighing of juice - Maxwell Boulogne Scale and Magnetic Flow Meters.		
Unit - III	**Juice Clarification and Concentration:**	**9**
Juice Clarification: Importance, methods, clarifying agent, bleaching agent. Role of pH, non-sugars, colloids and gums in cane juice clarification. Lime - specification, storage. Preparation of Milk of Lime (MOL), clarifier types, MOL tanks, lime pumps, use of hydrated lime powder. Sulphur -specification and storage, production of sulphur dioxide gas. Juice Concentration: Importance- types of heaters- construction and working of tubular heater, Direct Contact Heater (DCH), Plate Heater (PHE), advantages and disadvantages. Evaporator- types- performance measures.		
Unit - IV	**Crystallization and Refining:**	**9**
Crystallization and Refining: Sugar boiling, Nucleation and crystal growth, super saturation and meta stable stage, seeding — shock seeding, true seeding. Crystallizers. Refining - Brown sugar, importance of refining, Affination, clarification, carbonation, sulphitation, phosphitation, decolorization, centrifugation - dewatering of sugar. Drying. Bagging and storage. Factors affecting sugar refining process.		
Unit - V	**Manufacturing of Jaggery/ Gur and other by products:**	**9**
Manufacturing of Jaggery/ Gur and other by products: Extraction of Juice, Clarification of Gur, Concentration of Juice, Drying and grading of Gur, Storage of Gur. Byproducts - Drying and uses of Bagasse - Back strap Molasses - Characteristics of Molasses. Direct Utilization of Molasses - Distilling Industries - Applications in animal feed – Biogas – Biofertilizers production- Inverted syrup.		
		Total:45

TEXT BOOK:

1. Kulkarni D.P, "Cane Sugar Manufacture in India", 1st Edition, The Sugar Technologists Association of India, 2009.

REFERENCES:

1. Heriot T.H.P, "The Manufacture of Sugar from the Cane and Beet", 1st Edition, Read Books, New York, 2008.
2. Peter Rein, "Cane Sugar Engineering", 2nd Edition, Verlag Dr. Albert Bartens KG, Germany, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline sugarcane constituents and pre-processing operations	Understanding (K2)
CO2	make use of suitable sugarcane juice extraction process	Applying (K3)
CO3	choose appropriate clarification and concentration methods for sugarcane juice	Applying (K3)
CO4	plan sequential steps involved in sugar crystallization and refining	Applying (K3)
CO5	apply the acquired knowledge for manufacturing of cane sugar by-products	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22GEE01 - FUNDAMENTALS OF RESEARCH							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**GE**	**3**	**0**	**0**	**3**

Preamble	This course familiarizes the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit – I	**Introduction to Research**	**9**
Introduction to Research: Types and Process of Research - Outcomes of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords.		
Unit – II	**Literature Review**	**9**
Literature Review: Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit – III	**Research Methodology**	**9**
Research Methodology: Appropriate Choice of Algorithms/Methodologies/Methods – Data Collection – Primary Data Analysis – Experimental Methods and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations.		
Unit – IV	**Journals and Papers**	**9**
Journals and Papers: Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study.		
Unit – V	**Reports and Presentations**	**9**
How to Write a Report - Language and Style - Format of Project Report - Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc - Different Reference Formats. Presentation using PPTs. Research Tools.		
		Total:45

TEXT BOOK:

1. Walliman, Nicholas. “Research Methods: The basics”. 2nd edition, Routledge, 2017., for Units I, II, III, IV & V

REFERENCES:

1. Mishra, S.B. and Alok, S. “Handbook of research methodology” Educreation Publishing, 2017
2. Kumar, Ranjit. “Research Methodology: A step-by-step guide for beginners”. SAGE Publications Limited, 2019.
3. Nayak, J.K. and Singh, P. “Fundamentals of Research Methodology Problems and Prospects”. SSDN Publishers & Distributors, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	list the various stages in research and categorize the quality of journals	Applying (K3)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		40	50	10			100
CAT2		30	50	10	10		100
CAT3		20	30	30	10	10	100
ESE		40	40	10	10		100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTE25 - WASTE MANAGEMENT AND BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES

Programme &Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	To provide an insight on utilization of food industrial waste for developing valuable products	
Unit – I	**Introduction on Waste and disposal strategies:**	**9**

Introduction : Different Sources of waste from Food Industries and their availability in India, nature of different waste, potentials and prospects of developing by products in India. Characteristics of Industrial Waste and disposal strategies : Classification of waste, characterization of waste, magnitude of waste generation in different food processing industries, importance of waste management, Economical aspects of waste
treatment and disposal, Strategies for minimizing waste, Application of 3R's and Life Cycle Assessment (LCA).

Unit – II	**Waste utilization in Cereal Food Industries:**	**9**

Waste utilization in Cereal Food Industries: Waste utilization from rice mill – thermal and biotechnological uses of rice husk- pyrolysis and gasification of rice husk- cement preparation and different thermal applications- utilization of rice bran- stabilization – defatted branutilization.

Unit – III	**By Products from Oil Seed and Tuber Processing Industries:**	**9**

By Products from Oil Seed and Tuber Processing Industries: Oil processing industries – Introduction, De-oiled cake, animal feed, fertilizer, bio sorbents, waxes, soap stock, cocoa butter replacer. Tuber processing industries- Introduction, enzyme production,biogas, bakers yeast, bio-ethanol, animal feed, corn syrup, organic acids, nutraceuticals.

Unit - IV	**By Products from Animal Product based Industries:**	**9**

By Products from Animal Product based Industries: Dairy industry - Introduction- opportunities – whey, bio surfactants, bacteriocin.Meat, fish, poultry processing industries- bio active peptide, protein extract, gelatin, heparin, pepsin, bio molecule from bone and blood, keratinform animal hair, bone meal, meat meal, chondroitin sulfate, squalene, fish oil, micro nutrients- vitamins and minerals, pigments.

Unit - V	**Utilization of Fruits, Vegetables and Food Packaging Waste:**	**9**

Utilization of Fruits and Vegetables waste: processes for waste utilization from fruits and vegetable industries –Pectin, essential oils, antioxidants, and organic acids. Distillation for production of alcohol, SCP production, by products of sugar industry. Handling of Food Packaging Waste: Handling and treatment, far waste, incineration of solid food waste and its disposal.

Total:45

TEXT BOOK:

1. Vasso Oreopoulou & Winfried Russ, "Utilization of By-Products and Treatment of Waste in the Food Industry", 1st Edition,Springer Science and Business Media, USA, 2006.

REFERENCES:

1. Chandrasekaran M., "Valorization of Food Processing By-Products", 1st Edition, CRC Press, USA, 2016.
2. Keith Waldron, "Handbook of waste management and co-product recovery in food processing", 1st Edition, Wood head Publishing Ltd, England, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify food waste and explain the strategies for waste minimization	Understanding (K2)
CO2	utilize the wastes from cereal industries for developing byproducts	Applying (K3)
CO3	make use of wastes from oilseeds and tuber processing industries for developing byproducts	Applying (K3)
CO4	utilize the animal processing industries waste for developing byproducts	Applying (K3)
CO5	apply the concept of waste utilization of fruit and vegetable, sugar and packaging industries	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

*Test / Bloom's Category**	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	60	20				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE26- FOOD PROCESS PLANT LAYOUT AND SAFETY

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	To give the knowledge about the plant layout and design considerations, different hazards and Industrial safety

Unit - I	Introduction and Plant Location:	9

Introduction: Classifications of food industries - Plant design concepts - situations giving rise to plant design problems - general design considerations - differences in design of food processing and non-food processing plants. Feasibility study: Steps involved including planning of the study - collection of information - information flow diagrams — market analysis, technical analysis and preparation of feasibility report. Plant location: Factors affecting plant location, their interaction with plant location, theory models for evaluation of alternate locations. Plant size: Economic plant size - factors affecting the plant size - raw materials availability, market demand, competition in the market - return on investments. Procedures for estimation of economic plant size - break even analysis and optimization techniques

Unit - II	Plant Layout, Equipment selection and Utilities:	9

Plant Layout: considerations involved in planning an efficient layout. Types of layouts. Preparation and development of layout for different food processing Industries. Equipment symbols-flow sheet symbols - electrical symbols - graphic symbols for piping systems including pipe fitting and valves. Standards for space requirements - distances between critical plant areas and for setting different plant facilities. Development of the pilot layout: Size and structure of the pilot plant, minimum and maximum size, types and applications. Equipment selection and Utilities: Process equipment - material handling equipment — service equipment- valves and fittings - instruments and controls- considerations involved in equipment selection. Services and Utilities: Estimation of Services such as Cafeteria, locker rooms, water closets, sinks, parking lots, exercise area. Office Layout. Line Balancing and Line balancing Techniques

Unit - III	Food Plant Building and Construction:	9

Food Plant Building: General requirements and considerations for construction, materials and floors. Drains and drain layout. Ventilation, fly control, mould prevention, illumination in food plants. Requirements of the steam, refrigeration, water, electricity, Cleaning , sanitization, CIP system, dust removal and fire protection. Materials of construction and colour coding: Characteristics of suitable construction material: Stainless steel, Aluminum, Nickel and Monel, Plastic Materials. Maintenance of Food Plant Building: Safety Colour Code, Roof Inspection, Care of Concrete floors. Colour Coding: Colour — Code System - Specific Hazards Colour codes for buried pipes and cables. Colour Scheme for pipes.

Unit - IV	Industrial Safety and Safety Performance:	9

Industrial Safety: Process industries, potential hazards, toxic chemicals and physical safety analysis, high pressure, high temperature operation, radioactive materials, safe handling and operation of machineries. Safety Performance: Safety Appraisal, effective steps to implement safety procedures, periodic inspection and safety procedures; proper selection and replacement of handling equipment, personal protective equipments.

Unit - V	Accidents, Health Hazards and Legal Aspects:	9

Accidents: Industrial accidents–accident costs–identification of accident spots, remedial measures, identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fire prevention and fire protection. Health Hazards And Legal Aspects: Health hazards – occupational – industrial health hazards – health standards, and rules – safe working environments – parliamentary legislations – factories act – Labour welfare act – ESI Act – Workmen Compensation Act.

Total:45

TEXT BOOK:

1. Sean Moran , "Process plant layout", 2nd Edition, Butterworth-Helnemann, New York, 2017.

REFERENCES:

1. Basudev panda , "Industrial Safety Health Environment and Security", 1st Edition, Laxmi publications, New Delhi, 2013.
2. George D.Saravacor, Athanasios E.Kostropoulos, "Design Food Processes and Food Processing Plants", 1st Edition, Springer,New York , 2012.
3. Antonio Lopez-Gomez, Gustavov.Barbosa-Canovas , "Food Plant Design", 1st Edition, CRC Press , New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify suitable plant location and feasibility for food Industries.	Applying (K3)
CO2	select suitable plant layout for food processing industries	Applying (K3)
CO3	infer the requirements of food industry and food process equipment construction	Understanding (K2)
CO4	apply the acquired knowledge for prevention of industrial hazards	Applying (K3)
CO5	outline the health hazards and legal aspects in industries	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating(K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE27 - AGRI BUSINESS MANAGEMENT AND RETAIL MARKETING

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	To understand the management aspects of agricultural business and retail operations.	
Unit - I	**Introduction on Agribusiness and Marketing:**	**9**
Definition, Structure, Features of agribusiness, Importance of agribusiness, Role of agriculture in Indian economy, Linkages among sub Marketing and distribution in Agribusiness: Marketing of agriculture inputs, models and theories of agricultural marketing, Characteristics of production, consumption and marketable surplus of agribusiness in India. Distribution management — storage, warehousing and transportation management of agricultural products; marketing agencies/intermediaries		
Unit - II	**Export and Financial in Agribusiness:**	**9**
objectives of pricing policies, Marketing policies and practice for agribusiness - determinants of price, Export of Agro products: legal requirements, steps and issues, Selection of market and channels of Export. Financial in Agribusiness: Assessment of financial requirement of agribusiness unit, Working capital management - concept and components of working capital, need for working capital in agribusiness, inventory for agribusiness. agribusiness financing systems - functioning of cooperative credit institutions, commercial banks, regional rural banks, NABARD		
Unit - III	**Small scale Agribusiness and Retailing:**	**9**
Small Scale Industry in Indian Economy, Development: definition, importance, growth stages, and entrepreneurial opportunities in modern agriculture. Overview of retailing: Concept of retailing, importance of developing and applying retail strategy, strategic options for retailers, types of retail markets, Forms of retailing: direct marketing, electronic retailing, Retailing implications of consumer demographics and lifestyles, consumer decision making process.		
Unit - IV	**Retail Management and Planning:**	**9**
Retail management: definition, importance and elements, functions of retail manager, Retail planning: definition, characteristics, importance, classification of retail planning, steps in planning, identification of consumer characteristics and needs, Considerations in planning retail strategy mix, food-oriented retailers. Managing retail business: Setting up retail organization, Strategic Profit model of asset management, blueprint of retail business operation.		
Unit - V	**Retail Organization and Directing:**	**9**
Organization- definition, characteristics, importance, steps in retail organization process, Directing: Supervision, leadership, functions of leader, types of communication, Nature of communication.		

Total:45

TEXT BOOK:

1. David Van Fleet, Ella Van Fleet & George J. Seperich, "Agribusiness: Principles of Management", 1st Edition, Cengage Learning,USA, 2013.

REFERENCES:

1. Barton A Weitz, Dhruv Grewal & Micheal Levy, "Retailing Management", 11th Edition, McGraw-Hill Education, New Delhi, 2022.
2. Barry R. Berman, Joel R. Evans & Patrali M. Chatterjee, "Retail Management", 13th Edition, Pearson Education Limited, UK,2017.
3. Jay T. Akridge, Freddie Barnard & Frank J. Dooley, "Agribusiness Management", 4th Edition, Routledge, New York, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the importance of agribusiness industry, working of retailing works and factors influencing it	Understanding (K2)
CO2	summarize the contribution of small scale agri-industry and sustainable competitive advantage throughoptimization of available resources	Understanding (K2)
CO3	plan and identifying more insight about consumer buying segment	Applying (K3)
CO4	make use of good communication, team-building, leadership and applied management skills to developa business	Applying (K3)
CO5	develop management skills relevant for human capital use and plan merchandise presentation to influence customer's buying decision	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE28 - INDUSTRIAL WASTE WATER TREATMENT

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	To provide knowledge on treatment of different industrial effluents	
Unit - I	**Physical Methods:**	**9**
Introduction: Classification and characterization of wastes from different industries. Need for treating wastes, COD, BOD content Physical Methods: Principles of Screening – Mixing, Equalization – Sedimentation - Filtration, back washing – Accelerated gravity separation – Evaporation- Adsorption– Principles, - Membrane separation - Reverse Osmosis, nanofiltration, ultrafiltration – electrodialysis.		
Unit - II	**Chemical Methods:**	**9**
Chemical Methods: Principles of Chemical treatment – Coagulation, flocculation, Precipitation, floatation. Ion exchange, Electrolytic methods, Solvent extraction, ozonation, advances oxidation/reduction –disinfection.		
Unit - III	**Aerobic Biological Treatment:**	**9**
Biological Treatment - Aerobic: Objectives of biological treatment – significance – kinetics of biological growth. Biological treatment process: aerobic suspended growth treatment process-activated sludge process, aerated lagoons, stabilization ponds, oxidation ditch - aerobic attached growth treatment process-trickling filters.		
Unit - IV	**Anaerobic Biological Treatment:**	**9**
Biological Treatment- Anaerobic: Suspended growth treatment process-anaerobic digestion, USAB reactors Anaerobic attachedgrowth treatment process-Rotating biological contactors anaerobic, filter process expanded bed.		
Unit - V	**Solid Waste Management and Design of Wastewater Plant:**	**9**
Solid Waste Management: Sludge treatment process- sludge thickening, sludge digestion, sludge conditioning, sludge dewatering, thermal reduction and disposal of sludge. Composting, incineration, Pyrolysis, Briquetting. Design Aspects: Selection of unit operations and processes - Design of water treatment plant units – aerators, flocculation, clarifier, filters, chlorinators and thickeners.		
		Total:45

TEXT BOOK:

1. Metcalf & Eddy, "Waste water Engineering, Treatment and Reuse", 4th Edition, Tata McGraw-Hill, New Delhi, 2003

REFERENCES:

1. Qasim S.R., Motley E.M & Zhu G, "Water Works Engineering: Planning, Design and Operation", 2nd Edition, Prentice Hall, NewDelhi, 2006.
2. Lawrence K. Wang, Yung-Tse Hung & Nazih K. Shammas , "Handbook of Environmental Engineering Physicochemical TreatmentProcesses", 1st Edition, Springer Science & Business Media, New Jersey, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify different industrial wastes and choose appropriate physical method of treatment	Applying (K3)
CO2	select suitable chemical method for waste water treatment	Applying (K3)
CO3	outline waste water treatment by aerobic method	Understanding (K2)
CO4	interpret anaerobic treatment of industrial effluent	Understanding (K2)
CO5	plan a wastewater treatment unit and manage solid waste	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTE29- ANALYTICAL INSTRUMENTS IN FOOD INDUSTRIES

Programme & Branch	B.Tech &Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Food chemistry	8	PE	3	0	0	3

Preamble	To provide knowledge on role of analytical instruments in food industries.	
Unit - I	**Spectrometry:**	**9**
Spectrometry: Classification of Instrumental methods– Electromagnetic radiation – electromagnetic spectrum, Interaction of electromagnetic radiation with matter. Colorimetry and Visible spectrometry – Theory, Block diagram aspects of Instrumentation and applications. Ultra violet spectroscopy – Theory, instrumentation - Single and Double beam, applications. Infrared spectroscopy – Theory, Fundamental Vibrations, Instrumentation, Applications.		
Unit - II	**NMR spectroscopy, Flame photometery and Thermal methods:**	**9**
NMR spectroscopy &Flame photometery: NMR spectroscopy - Principle, Chemical shift, Instrumentation, applications. Flame photometer: Principle, Instrumentation and applications. Thermal methods – Thermogravimetry, Differential thermal analysis, Differential Scanning Calorimetry, Instrumentation and Applications.		
Unit - III	**XRD, Atomic Absorption Spectroscopy, Polarimetry and Refractometry:**	**9**
X-Ray &Atomic Absorption Spectroscopy: X-ray diffraction Principle, Instrumentation, various methods of diffraction and applications. Atomic Absorption Spectroscopy: Theory, Instrumentation, applications. Polarimetry and Refractometry: Introduction on specific rotation, optical activity, refractive index, Principle and instrumentation. Saccharimetry- Analysis of Sugar.		
Unit - IV	**Conductance, Potential measurements and Electrophoresis:**	**9**
Conductance, Potential measurements and Electrophoresis: Definitions, conductance measurements, applications, Types, advantages and disadvantages of Conductometric titrations. Potential measurements: pH determination, Potentiometric Titrations. Electrophoresis: Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, PAGE and SDS –PAGE.		
Unit - V	**Chromatographic Techniques:**	**9**
Chromatographic Techniques: Paper chromatography, Thin Layer Chromatography, Column Chromatography - Gel permeation chromatography, Gas chromatography, HPLC- Principle, Reverse and Normal Phase, Instrumentation and Applications.		
		Total:45

TEXT BOOK:

1. Chatwal, Gurdeep R & Anand, Sham K, "Instrumentation Methods of Chemical Analysis", Himalaya Publications, Bombay, 2003.

REFERENCES:

1. Skoog Douglas A., West Donald M., Holler F James & Crouch Stanley R, "Analytical Chemistry: An Introduction", 7th Edition,South-Western, Australia, 2000.
2. Willard H.H., Merritt L.L., Dean J.A & Settle F.A, "Instrumental Methods of Analysis", 7th Edition, CBS Publishers & Distributors,New Delhi, 1988.
3. Rouessac F, "Chemical Analysis: Modern International Method and Techniques", 7th Edition, Wiley, New Delhi, 1999.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the interaction of electromagnetic radiation with matter and UV-Visible, IR usage	Understanding (K2)
CO2	apply AAS, NMR & Thermal techniques to analyze different food materials.	Applying (K3)
CO3	utilize X- ray diffraction, flame photometery and Polarimetry techniques to analyse food materials	Applying (K3)
CO4	make use of conductance, potential measurement and electrophoresis for analysis and separation of components.	Applying (K3)
CO5	outline analysis of food materials by different chromatographic techniques	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	20	60				100
CAT3	20	60	20				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTX01- BAKING TECHNOLOGY

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	0	2	4

Preamble	To gain knowledge on science and technology of various bakery products	
Unit - I	**Science Behind Baking:**	**9**

Science Behind Baking: Current status of Bakery Industry in India, Classification of bakery products. Bakery ingredients and their functions-flour, yeast, sugar, fat, egg, water, salt, coloring agents, flavoring agents, milk, milk powder, emulsifiers, leaveners, antioxidants and improver.

Unit - II	**Bakery Equipment:**	**9**

Equipment: Handling of ingredients- dough mixers, dividers, rounder, sheeter, laminating equipment, fermentation enclosures and brew equipment, ovens and slicers. Rheology of dough-Farinograph, Amylograph, Alveograph, and Extensograph.

Unit - III	**Bread Making Process:**	**9**

Bread Making Process: Chemistry of dough development. Bread making methods - Straight dough/Bulk Fermentation, sponge and dough, activated dough development, Chorley wood bread process. No time process Characteristics of good bread- Internal and external characters. Bread defects/faults and remedies. Spoilage of bread-Causes, detection and prevention.

Unit - IV	**Biscuit and cookies:**	**9**

Biscuit and cookies: Comparison of Biscuits and Cookies, Types of Dough - Developed dough, short dough's, semi-sweet, enzyme modified dough and batters. Methods of biscuit and cookie manufacture. Stability of biscuit and cookie products. Quality attributes in cookies and biscuits.

Unit - V	**Cakes and other bakery products:**	**9**

Cakes and other bakery products: Cake – Types, Cake making- Ingredients and their function, Methods for different types of cakes manufacture, Faults in cake manufacture, Miscellaneous bakery products production - Wafers, puff pastry, and chemically leavened bakery products, Quality attributes of bakery products.

List of Exercises / Experiments :

1.	Estimation of quality parameters of bakery ingredients.
2.	Estimation of wet and dry gluten content of wheat flour.
3.	Determination of dough rising capacity of yeast.
4.	Estimation of diastatic activity and maltose value of flour
5.	Estimation of water absorption power, alkaline water retention and sedimentation value of flour.
6.	Preparation and analysis of bread.
7.	Preparation and analysis of biscuits.
8.	Preparation and analysis of cake.
9.	Preparation and analysis of cookies.
10.	Preparation and analysis of puff pastry.

Lecture: 45, Practical:15, Total:60

TEXT BOOK:

1.	Samuel A. Matz, "Bakery Technology and Engineering", 3rd Edition, Chapman and Hall, London, 2005.

REFERENCES:

1.	Cauvain Stanley P & Young Linda S, "Technology of Bread Making", 3rd Edition, Springer, US, 2015.
2.	Servet Gulum Sumnu& Serpil Sahin, "Food Engineering Aspects of Baking Sweet Goods", 1st Edition, CRC Press, USA, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the role of ingredients for production of bakery products	Understanding (K2)
CO2	select appropriate equipment for baking process	Applying (K3)
CO3	identify and apply processing techniques for bread manufacturing process	Applying (K3)
CO4	choose suitable processing techniques for preparation of biscuits and cookies	Applying (K3)
CO5	make use of various methods for cakes, wafers and pastry	Applying (K3)
CO6	analyze the quality of ingredients used for in preparation of bakery products	Analyzing (K4), Precision (S3)
CO7	evaluate the quality of flour based on gluten content, sedimentation value and diastatic activity	Evaluating (K5), Precision (S3)
CO8	prepare bakery product and evaluate it sensory characteristics	Evaluating (K5), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									2		
CO2	3	2	1		1	1						2		
CO3	3	3	2	1	1	1						2		
CO4	3	3	2	1	1	1						2		
CO5	3	3	2	1	1	1						2		
CO6	3	3	2	3		1			3	2	2	1		
CO7	3	3	2	3		1			3	2	2	2		
CO8	3	3	3	3		1			3	2	2	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	30	35	35				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTO01- FOOD PROCESSING TECHNOLOGY

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To provide insight about the processing and preservation methods used for various food materials.	
Unit - I	**Introduction:**	**9+3**
Scope of food science and technology, Food - Definitions and functions, Sources of food, scope and benefit of industrial food preservation, Constituents of foods, RDA, malnutrition and balanced diet. perishable, non-perishable food commodities, Food as source of energy.		
Unit - II	**Ambient Temperature Processing:**	**9+3**
Size reduction of solids, size reduction of liquids, mixing, forming, separation- centrifugation, filtration, extraction, concentration - theory and equipments.		
Unit - III	**High Temperature preservation:**	**9+3**
Introduction, Principles and methods - Canning& retorting, – flowsheet, blanching, pasteurization - packed and unpacked foods, Sterilization - in-container and UHT sterilization, evaporation and distillation - theory and equipments, drying and dehydration - mechanism and types.		
Unit - IV	**Low Temperature preservation:**	**9+3**
Introduction-need &methods - Chilling and Freezing - theory and equipments, principle and effect on food quality, refrigerated and cold storage. Controlled atmosphere and modified atmosphere storage, Freeze concentration.		
Unit - V	**Food Fermentation and Irradiation**	**9+3**
Theory of fermentation, Types of Fermentation, equipments, effect on foods, fermented food products - soy sauce, curd, sauerkraut, vinegar - role in human health. Theory and mechanism of action, sources of irradiation, equipments, applications in foods, effect on food materials.		

Lecture: 45, Tutorial :15,

Total:60

TEXT BOOK:

1.	Fellows P.J., **"**Food processing Technology: Principles and Practice**",** 3rd Edition, Woodhead Publishing Ltd., New Delhi, 2009

REFERENCES:

1.	Paul Singh R and Dennis R. Heldman, **"**Introduction to Food Process Engineering**"**, 5th Edition, Academic Press, USA, 2014
2.	Sivasankar, B., "Food Processing and Preservation**"**, Prentice Hall of India, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify different sources and types of food products	Understanding (K2)
CO2	explain various ambient temperature processing of foods	Understanding(K2)
CO3	select suitable high temperature preservation techniques	Applying (K3)
CO4	make use of various low temperature food preservation techniques	Applying (K3)
CO5	classify the types of fermentation, irradiation and interpret their role on food quality	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTX02 - PROCESSING OF MILK AND MILK PRODUCTS

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	2	4

Preamble	To impart the knowledge on milk processing and to exploit new uses for milk and its components	
Unit - I	**Processing of market milk:**	**9**
Practices for reception, chilling, clarification, and storage of raw milk. Homogenization of milk: Definition, pretreatment of milk, theoriesof homogenization, synchronization of homogenization with HTST; Pasteurization of milk: Definition, Classification and Process flow		
Unit - II	**Manufacture of special milks:**	**9**
Reconstituted and recombined milks, Flavoured milks, homogenized/ vitaminized milks. Lactose-hydrolysed milk. Aseptic packaging: Types of packaging approaches for sterilization of packages. Filling systems.		
Unit - III	**Manufacture of Coagulated products**:	**9**
Channa and paneer: Preparation and preservation; Prospects for mechanization of paneer manufacturing/packaging process, innovative approaches and integration with emerging technologies, Physico-chemical changes during manufacture and storage of paneer and channa		
Unit - IV	**Technology of fat-rich dairy products**:	**9**
Technology of Butter manufacturing, over-run in butter, control of fat loss, defects in butter, rheology of butter. Technology of ghee manufacturing, innovations in ghee manufacturing process, packaging of ghee; Manufacture of butter oil		
Unit - V	**Manufacture of Cheese:**	**9**
Cheddar, Gouda, Swiss, Mozzarella, Cottage cheese, Changes during manufacture and ripening of Cheddar Cheese, factors leadingto losses during processing and handling; Manufacture of processed Cheese, Cheese spread and Processed Cheese foods.		

List of Exercises / Experiments :

1.	Preparation of homogenized market milk.
2.	Preparation of sterilized milk.
3.	Preparation of flavoured milk
4.	Preparation of fermented milk
5.	Preparation of yoghurt.
6.	Preparation of khoa.
7.	Preparation of channa.
8.	Preparation of paneer.
9.	Preparation of butter.
10.	Preparation of ghee.

Lecture: 45, Practical:15, Total:60

TEXT BOOK:

1.	Sukumar De, “Outlines of Dairy Technology”, 7th Edition Royal Oxford University Press, New Delhi, 2010.

REFERENCES:

1.	Laboratory Manual
2.	Birendra Kumar Mishra, “Dairy and Food Processing Industry: Recent Trends”, Astral International, 2014
3.	Y. H. Hui, “Dairy Science and Technology Handbook: Applications Science, Technology and Engineering”,3rd Edition, Wiley, NewDelhi, 2014

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand various aspects of milk process operations and physico-chemical properties of milk	Understanding (K2)
CO2	make use of technical knowledge in manufacture of special milks.	Applying (K3)
CO3	utilize technical knowledge in manufacture of coagulated milk products.	Applying (K3)
CO4	apply the technical knowledge in manufacture of fat rich dairy products.	Applying (K3)
CO5	make use of technical knowledge in manufacture of cheese and cheese products.	Applying (K3)
CO6	utilize the technical knowledge in preparation of homogenized milk	Applying (K3)
CO7	utilize the technical knowledge in preparation of paneer.	Applying (K3)
CO8	utilize the technical knowledge in preparation of butter.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1			1						1	2	1
CO2	3	2	2		2	1						2	3	2
CO3	3	2	2		2	2		1				2	3	3
CO4	3	2	2			2		1				2	3	2
CO5	3	2	2			2		1				2	3	2
CO6	3	2							3	2		1	3	2
CO7	3	2							3	2		1	3	2
CO8	3	2	1			1		1	3	2		1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
CAT3	40	40	20				100
ESE	40	40	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTX03- PROCESSING OF FRUITS AND VEGETABLES

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	2	4

Preamble	To provide the outline about physiology, post harvest changes, preservation and processing of various fruits and vegetables products	
Unit - I	**Physiology and post harvest changes of fruits and vegetables:**	**9**
Scope of Fruits and Vegetables Processing Industry in India and World-present status. Classification of Fruits and Vegetables, Physiological Development, Harvesting methods, Postharvest changes of fruits and vegetables, Methods of reducing post harvest changes.		
Unit - II	**Preprocessing Operations and Storage Methods:**	**9**
Precooling, Evaporative Cooling, Washing, Peeling, Grading, Blanching. Storage methods: Storage of fruit and vegetables - under ambient conditions, low temperature storage.		
Unit - III	**Preservation of Fruits and Vegetables products:**	**9**
Chilling, Freezing, Pasteurization, Sterilization, Irradiation, Waxing, Edible coating, Controlled Atmospheric Storage (CAS),Modified Atmospheric Storage (MAS).		
Unit - IV	**Fruit beverages:**	**9**
Classification of fruit beverages, Juice, Squash, cordial, Juice concentrate, nectar, Ready to Serve (RTS). Fermented fruit beverages – Wine, vinegar production. Juice making equipment.		
Unit - V	**Processing of fruits and vegetables products:**	**9**
Production of Intermediate Moisture Foods (IMF) - jam, jellies and marmalades, Defects in Jam and Jelly. Candied preserve, fruitbar, tutti fruity, fruit powder, Fermented vegetables products – Pickle, sauerkraut.		

List of Exercises / Experiments :

1.	Studies on blanching treatment on the fruits and vegetables
2.	Determination and comparison of peeling efficiency of different peeling methods
3.	Studies on waxing /edible coating of fruits and vegetables
4.	Preparation and analysis of squash
5.	Determination of juice extraction efficiency of screw press and pulper
6.	Preparation of jam and comparison with commercial product
7.	Preparation of jelly
8.	Preparation of fruit bar
9.	Preparation and study on characteristics of sauce.
10.	Preparation and analysis of fruit powder

Lecture: 45, Practical:15, Total:60

TEXT BOOK:

1.	Srivastava R.P & Sanjeev Kumar, "Fruit and Vegetable Preservation: Principles and Practices", 3rd Edition, CBS Publishers & Distributors, New Delhi, 2014.

REFERENCES:

1.	Rajarathnam S & Ramteke R.S, "Advances in Preservation and Processing Technologies of Fruits and Vegetables", 1st Edition, New India Publishing Agency, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret physiological and post harvest changes in fruits and vegetables	Understanding (K2)

CO2	select suitable storage and pre processing for fruits and vegetables	Applying (K3)
CO3	choose suitable preservation techniques employed for fruits and vegetables	Applying (K3)
CO4	make use of techniques to process different fruit beverages	Applying (K3)
CO5	develop various fruits and vegetable products	Applying (K3)
CO6	interpret the changes of fruits and vegetables upon blanching	Analyzing (K4), Manipulation (S2)
CO7	assess the performance of fruit processing equipments	Evaluating (K5), Precision (S3)
CO8	prepare and evaluate the characteristics of fruit/ vegetable based products	Evaluating (K5), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1			1						1	2	1
CO2	3	2	2		2	1						2	3	2
CO3	3	2	2		2	2		1				2	3	3
CO4	3	2	2			2		1				2	3	2
CO5	3	2	2			2		1				2	3	2
CO6	3	2							3	2		1	3	2
CO7	3	2							3	2		1	3	2
CO8	3	2	1			1		1	3	2		1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
CAT3	40	40	20				100
ESE	40	40	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTO02- PRINCIPLES OF FOOD SAFETY

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	To give insight on food hazards, safety aspect in food processing and regulations on food safety.

Unit - I	**Introduction:**	**9**

Food safety- Definition; General principles of food safety. Need for food safety; Characterization of food hazards - physical, chemical and biological. Food spoilage and food borne infection hazards-sources of food spoilage and microorganisms- microbial problems in food safety-food toxicants and food poisoning – prevention. Cross contamination.

Unit - II	**Physical and Chemical food hazard :**	**9**

Metals, mineral (soil, engine oil, stones), plant (leaves, twigs, pods and skins), animal (hair, bone, excreta, blood, insects, larvae). Major pathways by which chemical residues and contaminants enter the food chain, Agrochemicals and veterinary drugs, packaging materials, process equipment and ingredient impurities. Food Adulterants, Food additives- permissible limits, concept of safe food.

Unit - III	**Safety operations in Food processing :**	**9**

Plant Sanitation- Sanitizers, Cleaning chemistry CIP, Sanitation equipment. Personal hygiene, Good Manufacturing Practices: Prerequisites for Food Safety. HACCP-Concepts, implementation. Safety and Innovative Food Packaging. The Principles of Modern Food Hygiene.

Unit - IV	**Safety Aspects of Water:**	**9**

Safety aspects of drinking water (microbiological and chemical) - the epidemiological triangle diseases caused by drinking of contaminated water , risks and advantages of chlorination of water ,bottled water - origin of water- nutritional and physiological aspect – setting of guideline values (microbiological and chemical), Regulations for bottled water.

Unit - V	**Food Safety Regulations:**	**9**

History of Food Safety Regulation. Food safety and Standards Act (FSSAI) – organizational chart – role of individual authority – principles to be followed - Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers. Food safety Management Systems.

Total:45

TEXT BOOK:

1. Schmidt, R.H. and Rodrick, G.E.**"**Food Safety Handbook**"** 2nd Edition, John Wiley & Sons Inc, New Jersy, 2005.

REFERENCES:

1. Kees A. van der Heijden **"**International Food Safety Handbook: Science, International Regulation, and Control", 1st Edition, CRC Press, 1999.
2. Rajesh Mehta and J. George "Food Safety Regulation Concerns and Trade- The Developing Country Perspective", 1st Edition , Macmillan India Ltd., New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the concept of food safety and appraise on microbial food safety	Understanding (K2)
CO2	interpret physical and chemical food hazards	Understanding (K2)
CO3	identify implementation of suitable safety protocols in food processing	Applying (K3)
CO4	infer the safety aspects of water	Understanding (K2)
CO5	summarize the food safety regulations	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	1	3			3	1	1		1		1		
CO2	3	1	3			3	1	2		1		2		
CO3	3	2	3			3	1	2		1		2		
CO4	3	2	3			3	1	2		1		2		
CO5	3	2	3			3	1	2		1		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	60	20				100
CAT3	40	60					100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTO03- FUNDAMENTALS OF FOOD PACKAGING AND STORAGE

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	To provide the knowledge about food packaging materials, methods and food storage practices	
Unit - I	**Food Packaging Materials:**	**9**
Definitions and basic functions of a food package. Role of packaging. Packaging materials and their types - Paper-based packaging, Metal packaging, Glass containers, Plastics, Natural materials. Food package design and development.		
Unit - II	**Food Packaging Closures and sealing systems:**	**9**
Closures – functions, construction, types. Heat Sealing – Conductance, Impulse, Dielectric, Induction, Ultrasonic, Hot-Wire andHot-Knife Sealing. Peelable Seals - Adhesive, Cohesive and Delamination Peels, Heat Seal Coatings, Nano composite Heat Sealants. Cold Seals. Packaging operations - bottling, canning, wrapping, cartooning, form fill sealing.		
Unit - III	**Packaging materials performance:**	**9**
Physical and physico-chemical processes affecting product quality, migration from packaging to foods. Logistics activity - specific and integration issues. Distribution performance testing. Package standards and regulation. Printing Processes, Inks, Adhesives and Labeling of Packaging Materials. Bar coding.		
Unit - IV	**Grain storage engineering:**	**9**
Storage of grains – biochemical changes during storage – production, distribution and storage capacity – ecology, storage factors affecting losses, storage requirements, bag and bulk storage – rat proof godowns and rodent control –method of stacking – preventive method, bio-engineering properties of stored products – function		
Unit - V	**Cold, MA & CA Storages:**	**9**
Cold storage, Controlled and Modified atmosphere storage — effects ofnitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities Determination of cooling load.		

Total:45

TEXT BOOK:

1.	Richard Coles and Mark J. Kirwan, "Food and Beverage Packaging Technology", 2nd Edition, Blackwell Publishing Asia Pty Ltd, CRC press, USA, 2011 (1-3 units).
2.	Narayanasamy P., Mohan S and Awaknavar J. S, "Pest Management in Store Grains", 1st Edition, Satish Serial Publishing House, New Delhi, 2009 (4&5 units).

REFERENCES:

1.	Han Jung H., “Innovations in Food Packaging”, 2nd Edition, Academic Press, USA 2013.
2.	Robertson Gordon L, “Packaging: Principles and Practice”, 3rd Edition, Marcel Dekker Inc,USA, 2012.
3.	Nair K.R., “Integrated Production and Pest Management”, 1st Edition, Gene-Tech Books publisher, Delhi, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain about the functions and types of food packaging	Understanding (K2)
CO2	make use of suitable sealing method depending on the application	Applying (K3)
CO3	infer the interaction between food, packaging material and labels	Understanding (K2)
CO4	select appropriate storage structures and preventive measures for pests	Applying (K3)
CO5	adapt suitable storage methods for grain storage	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			1		1		1		1		
CO2	3	3	2			1				1		1		

CO3	3	3	2			1		1		1		1		
CO4	3	3	2			1				1		1		
CO5	3	3	2	1	1	1				1		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTO04- FOOD INGREDIENTS

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	To provide the knowledge about the different types of food ingredients used in food products	
Unit - I	**Macro Nutrients:**	**9**
Introduction to Macronutrients: Carbohydrates: classification - chemical composition and structure properties, nutritive roles – Important carbohydrates as ingredients in food application. Protein and Amino acids: classification, essential amino acids- protein structure, properties and application. Lipids: Classification – Nutritive importance- properties and food applications.		
Unit - II	**Food Additives-I:**	**9**
Food Additives-I: Definition, need and classification of food additives. Sweeteners: Classification- Artificial sweeteners & Non-nutritive sweeteners; Health implications; Role in food processing. Stabilizers, Thickeners and Emulsifiers: Introduction; types; applications in food processing; leavening agents, flour improving agents. Anti-caking agents and Humectants: Introduction; Types; Role in food processing.		
Unit - III	**Food Additives-II:**	**9**
Food Additives-II: Acidulants - Introduction; types; Role in food processing. Preservatives: Introduction; Classification- Natural & chemical preservatives; Mode of action; Role in Food processing. Antioxidants: Introduction; Types of antioxidants -natural & synthetic; Mode of action in foods; Chelating agents- Naturally & synthetic; Mode of action in foods; Applications of antioxidants and chelating agents. Antimicrobial Agents: Classification- Role- application in foods.		
Unit - IV	**Food Colorant and Flavorant:**	**9**
Food colorants: Introduction; Natural & Synthetic food colorants; classification- Chemical nature; Impact on health- legal aspects- application in foods processing. Flavoring agents: Introduction; Classification of flavors- natural & synthetic; flavor enhancer/ potentiator; Importance of taste and flavours; Role of flavoring agents in food processing.		
Unit - V	**Nutraceuticals and phytochemicals:**	**9**
Nutraceuticals and phytochemicals: Definition, Classification. Dietary supplements, Functional foods - their legislation and health claims, Natural occurrence of certain phytochemicals. Antioxidants, flavonoids, omega –3 fatty acids, carotenoids, dietary fiber, phytoestrogens; Nutraceuticals for effective control of disease. Role of nutraceuticals on health. Safety, adverse effect and interactions of nutraceuticals.		

Total:45

TEXT BOOK:

1. Shakuntala Manay, N. & Shadaksharaswamy, "Food Facts and Principles", 3rd Edition, New Age International (P) Limited, NewDelhi, 2008.

REFERENCES:

1. Branen, A.L., Davidson, P.M. & Salminen S, "Food Additives", 2nd Edition, Marcel Dekker, New York, 2001.
2. Wildman, Robert E.C., Robert Wildman & Taylor C. Wallace (Eds), "Handbook of Nutraceuticals and Functional Foods", 2nd Edition, CRC Press, New York, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	classify macro nutrients and infer their nature	Understanding (K2)
CO2	apply the food additives to improve the quality of food product	Applying (K3)
CO3	choose the food additives to improve the shelf life of food product	Applying (K3)
CO4	select the food colors and flavors to improve the acceptability of the food product	Applying (K3)
CO5	summarize various functional foods and nutraceuticals	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2			1				1				
CO2	3	1	2			2				1		1		

CO3	3	1	2			2				1		1		
CO4	3	1	2			2		1		1		2		
CO5	3	1	2			2		1		1		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22FTO05 - FOOD AND NUTRITION

(Offered by Department of Food Technology)

Programme & Branch	All BE/BTech Engineering & Technology branches except Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	To impart knowledge on importance of nutrients and its assimilation, energy in human nutrition and nutrition during life cycle.	
Unit - I	**Introduction to Food and Nutrition:**	**9**
Definition, six classes of nutrients, RDA-General Principles of Deriving RDA, Reference Body Weights of Indians, ReferencePerson, Recommended Dietary Allowances for Indians, Uses and limitations of RDA. Nutritional status and its assessment, Malnutrition – over nutrition and under nutrition, deficiency disease. Functions of food, Functions of Nutrients, Balanced diet.		
Unit - II	**Digestion, absorption and Transport of Carbohydrates :**	**9**
Basic concept: Digestion in mouth, stomach, pancreas, bile, intestine. Digestion, absorption and transport of carbohydrates,lactose intolerance; Glycemic and Non-glycemic carbohydrates, recommendations of sugar intake for health, health effects of dietary fiber, artificial sweeteners.		
Unit - III	**Digestion, absorption and Transport of Lipids and Proteins:**	**9**
Food Sources, Lipid digestion, absorption and transport; Functions of the triglycerides; essential fatty acids - CↃ-3 andCↃ-6 fatty acids; trans fatty acids, Health effects and recommended intakes of lipids. Digestion and absorption of proteins; Functions of proteins; amino acids; Protein quality, methods of assessing protein quality; Recommended intakes of proteins.		
Unit - IV	**Energy in Human nutrition:**	**9**
Energy and its unit, Energy Balance, Assessment of Energy Requirements—deficiency and excess, Determination of Energy infood, BMR. and its regulation, specific dynamic action of foods, Obesity and BMI calculations.		
Unit – V	**Nutrition during life cycle:**	**9**
Factors to be considered in meal/menu planning. Pregnancy -Nutritional requirements and modification of existing diet and supplementation, Lactation - nutritional requirements, breast feeding, infant formula, Infancy - nutritional requirements. Introduction of supplementary foods. Nutritional needs of toddlers, preschool, school going children- and adolescents - Dietary management. Geriatic Nutrition - Factors affecting food intake and nutrients use, nutrient needs.		

Total:45

TEXT BOOK:

1.	Swaminathan,M. “Handbook of Food and Nutrition”, 1st Edition, The Bangalore Press, 2018

REFERENCES:

1.	Sumanti R. Mudambi, Rajagopal, M.V., “Fundamentals of Food, Nutrition and Diet Therapy”, 6th Edition, New AgeInternational Publishers, New Delhi, 2018
2.	Srilakshmi B., “Nutrition Science”, 6th Edition, New Age International Publishers, New Delhi,2018

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the physiological and metabolic functions of nutrients	Understanding(K2)
CO2	select appropriate carbohydrate diet based on their health effects	Applying (K3)
CO3	classify and choose lipids and proteins based on their nutritional value	Applying (K3)
CO4	explain energy requirement for human	Understanding (K2)
CO5	infer the nutrition requirement during life cycle	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1			3				1				

CO2	3	3	2			2				1		1		
CO3	3	3	2			2				1		1		
CO4	3	3	2			1				1		1		
CO5	3	2	3			2				1		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	20	40	40				100
CAT3	40	60					100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22CEX01 - Remote Sensing and its Applications

Programme& Branch	B.E. & CIVIL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	OE	3	0	2	4

Preamble	This course gives the knowledge on the remote sensing and its working principles. It also describes the Image processing techniques using GIS for real time applications which motivates towards innovations in the relevant fields.	
Unit – I	**Principles of Remote Sensing:**	**9**
Definition - Components of Remote sensing - EMR Spectrum - EMR interactions with atmosphere - EMR interactions with Earth - Spectral signature curves of Earth surface features – Concept of Photogrammetry- IFOV – Stereoscope and Its applications.		
Unit – II	**Orbits and Platforms:**	**9**
Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites .		
Unit – III	**Sensing Techniques:**	**9**
Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV –Orbital and sensor characteristics of live Indian earth observation satellites.		
Unit – IV	**Data products and interpretation:**	**9**
Photographic and digital products – Types, levels and open source satellite data products –- selection and procurement of data– Visual interpretation: basic elements and interpretation keys – Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification.		
Unit – V	**Remote Sensing for Urban Planning:**	**9**
Urban Area Definition and Characterization–Base Map Preparation – Urban Land use Classification –Visual and Digital Techniques for Land use Mapping - Urban Structure and Patterns– Urban Land Cover Classification –Feature Extraction techniques –Change Detection – Sprawl Detection and Characterization - Mapping of Urban Morphology –Building Typology		

LIST OF EXPERIMENTS / EXERCISES:

1.	Study of Toposheet ,Aerial Photographs and Satellite Images.
2.	Data Input – Onscreen Digitisation – Creation of Point, Line and Polygon layers.
3.	Geo-referencing the base image.
4.	Preparation of Base Map from Survey of India Toposheets.
5.	Extracting area of Interest (AOI).
6.	Preparation of Land use map using Satellite Data.
7.	Preparation of Land cover map using Satellite Data.
8.	Testing stereovision with test card and Stereoscopic acquity.
9.	Mirror stereoscope- base lining and orientation of aerial photographs.
10.	Use of parallax bar to find the height of point.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1. Thomas Lillesand, Ralph W. Kiefer, Jonathan ChipmanThomas Lillesand, Ralph W. Kiefer & Jonathan Chipman, "Remote Sensing and Image Interpretation", 7th Edition, Willey Publications, United States, 2015.

REFERENCES/ MANUAL / SOFTWARE:

1. George Joseph, Jeganathan C, "Fundamentals of Remote Sensing", 3rd Edition, Universities Press (India) Private limited, Hyderabad, 2018.
2. Basudeb Bhatta, "Remote Sensing and GIS", 2nd Edition, Oxford University Press, Oxford, 2011.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	associate the principles of EM spectrum to categories the earth features in an image and the sensor properties for various applications of remote sensing	Understanding (K2) Precision (S3)
CO2	classify the usage about different types of satellites and their orbits	Understanding (K2)
CO3	discuss the different types of remote sensors	Understanding (K2)
CO4	demonstrate the concepts of interpretation of satellite imagery	Applying (K3) Precision (S3)
CO5	organize Remote Sensing procedure for Mapping of Urban Elements and their Processes	Applying (K3) Precision (S3)

Mapping of Cos with Pos and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30				100
CAT2	30	40	30				100
CAT3	10	40	50				100
ESE	30	40	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CEO01 - Disaster Management							
Programme& Branch	**B.E. & CIVIL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**OE**	3	1	0	4

Preamble	To get idea about the various natural hazards like Earthquakes, slope stability, floods, droughts and Tsunami and the mitigation measures.	
Unit – I	**Introduction to Disasters:**	**9+3**
Definition - Disaster, Hazard, Vulnerability, Resilience, Risks - Disasters: Types of disasters - Earthquake, Landslide, Flood, Drought, Fire, Forest Fire, Industrial and Technological Disasters, Climate Change- Classification, Causes, Impacts – Do's and Don'ts during disaster - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change.		
Unit – II	**Pre and Post Disaster Risk Reduction Strategies:**	**9+3**
Disaster cycle - Phases of Disaster - Disaster Mapping - Predictability, forecasting and Warning - Disaster Preparedness Plan - Land- use Zoning for Disaster Management - Preparing Community through IEC - Disaster Mitigation - Disaster Relief: Search, Rescue and Evacuation - Shelter for Victims - Livestock and Relief Measures - Clearance of Debris and Disposal of the Dead - Control of Situation - Damage Assessment -Rehabilitation: Social and economic Aspects - Reconstruction and Rehabilitation as means of Development.		
Unit – III	**Inter-Relationship between Disasters and Development:**	**9+3**
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Landuse etc. - Climate Change Adaptation - IPCC Scenario and Scenarios in the context of India.		
Unit – IV	**Disaster Management in India:**	**9+3**
Disaster Management Act 2005 - Hazard and Vulnerability profile of India, Roles and responsibilities of community, Panchayat Raj Institutions/Urban Local Bodies (PRIs/ULBs), NGO's States, Centre - Disasters of India and Lesson learnt from it.		
Unit – V	**Applications of Science and Technology for Disaster Management:**	**9+3**
Geo-informatics in Disaster Management (RS, GIS & GPS)- Early Warning and Its Dissemination-Land Use Planning and Development Regulations-Disaster Safe Designs and Constructions-Structural and Non Structural Mitigation of Disasters - Institutions for Disaster Management in India.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Singhal J.P., "Disaster Management", 1st Edition, Laxmi Publications, India, 2007.

REFERENCES:

1. Gupta.M.C., "Manual on natural disaster management in India", NIDM, New Delhi, 2000.
2. "National Disaster Management Policy", Government of India, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	diagnose the different forms of disaster and their causes.	Understanding (K2)
CO2	construct a disaster management cycle with disaster risk reduction measures	Applying (K3)
CO3	interpret the various effects of development projects	Applying (K3)
CO4	identify the agencies involved to manage the disaster in india	Understanding (K2)
CO5	summarize the role of technology in disaster	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	10	30	60				100
CAT3	30	70					100
ESE	20	50	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CEO02 - Introduction to Smart Cities							
Programme& Branch	**B.E. & CIVIL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**OE**	3	0	0	3

Preamble	To understand and explain national smart city mission of India, components, policies, challenges and future of smart city in India.	
Unit – I	**Introduction:**	**9**
Definitions – Evolution – Features and strategies – Challenges – India 100 smart cities policy and mission, smart city planning and development, financing smart cities development. Governance of smart cities – case studies in India.		
Unit – II	**Smart Urban Mobility and Smart Energy:**	**9**
Need for urban mobility – multiple perspectives – objectives – components – emerging concepts and strategies – ICT supported smart mobility systems – policy priorities. Introduction to smart energy – urban density and energy use – objectives – elements of smart energy management system – strategies – smart grid – challenges.		
Unit – III	**Water and Waste Management:**	**9**
Smart water management – definitions – water resource and cycle – functions and objectives – steps in implementation – benefits – policy challenges. Smart waste management – approaches and implementation – existing systems – strategies – challenges and polices.		
Unit – IV	**Smart Environment and Smart Buildings:**	**9**
Global background of environmental concerns – concept of environmental resources - basic environmental challenges – smart environment – stakeholders – ICT framework for environmental management. Intelligent buildings – objectives – components – systems of smart building – benefits, challenges.		
Unit – V	**E- Governance and ICT:**	**9**
Governance challenges in new era – history of smart governance – functions and objectives – ICT in governance – system infrastructure – benefits, challenges and future vision. Taxonomy of layers of ICT architecture – major technology areas – components – emerging technologies in ICT – challenges and concerns in ICT.		
		Total:45

TEXT BOOK:

1. Anilkumar P.P, "Introduction to Smart Cities", 1st Edition, Pearson India Education Service Pvt Ltd, Noida,Uttar Pradesh, India, 2019.

REFERENCES:

1. Germaine R. Halegoua, "Smart Cities", 1st Edition, The MIT Press Essential Knowledge Series, London, England, 2020.
2. Andy Pike, Andres Rodriguez-Pose & John Tomaney, "Handbook of Local and Regional Development", 3rd Edition, Taylor & Francis, United Kingdom, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss the importance, features and case histories of smart cities in India	Understanding (K2)
CO2	describe mobility and energy in smart city	Understanding (K2)
CO3	explain water and waste management techniques in smart city	Understanding (K2)
CO4	model smart environment and smart buildings	Applying (K3)
CO5	plan e-governance and ICT in smart city	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	10	30	60				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CEO03 - Environmental Health and Safety							
Programme& Branch	**B.E. & CIVIL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	3	0	0	3

Preamble	To enhance the knowledge in regulation and statutory requirements relevant to Environmental, Health and Safety.	
Unit – I	**Occupation, Safety and Management:**	**9**
Occupational Safety - Health and Environmental Safety Management - Principles & practices - Role of Management in Industrial Safety - Organization Behaviour - Human factors contributing to accident.		
Unit – II	**Monitoring for Safety, Health & Environment:**	**9**
Bureau of Indian Standards on Safety and Health: 14489 - 1998 and 15001 - 2000 - ILO and EPA Standards - Principles of Accident Prevention - Definitions - Incident - accident - injury - dangerous - occurrences - unsafe acts - unsafe conditions - hazards - error - oversight - mistakes.		
Unit – III	**Education, Training and Employee Participation in Safety:**	**9**
Element of training cycle - Techniques of training, design and development of training programs - Training methods and strategies types of training - Competence Building Techniques (CBT) - Employee Participation: Purpose - methods - Role of trade union in SHE.		
Unit – IV	**Management Information System:**	**9**
Sources of information on Safety, Health and Environment - Compilation and collation of information - Analysis & use of modern methods of programming - storing and retrieval of MIS for Safety, Health and Environment - QCC HS Computer Software Application and Limitations.		
Unit – V	**Legislation on Safety, Health & Environment:**	**9**
Overview of SHE - The factories act, 1948 (Amended) and Rules - Contract Labour Act - Social Accountability - SA 8000 - Water (Prevention & Control of Pollution) Act 1974 and Rules - Air (Prevention & Control of Pollution) Act 1981 and Rules - Environment Protection Act.		
		Total:45

TEXT BOOK:

1.	Narayanan K.T., "Safety, Health and Environment Handbook", 1st Edition, McGraw Hill, New Delhi, 2017.

REFERENCES:

1.	Nicholas P.Cheremisinoff & Madelyn L.Graffia, "Environmental and Health & Safety Management- A Guide to Compliance", 1st Edition, William Andrew Publisher, Norwich, 1995.
2.	David Yates W., "Safety Professional's Reference & Study Guide", 2nd Edition, CRC Press Publishers, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concept of EHS and their framework.	Applying (K3)
CO2	identify the monitoring principles in workplace systems.	Applying (K3)
CO3	choose the need of training and methods of EHS.	Applying (K3)
CO4	organize the safety auditing management systems and their prevention techniques.	Applying (K3)
CO5	identify the key steps involved in HSE legislations.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	15	40	45				100
CAT3	25	40	35				100
ESE	20	45	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CEO04 - Infrastructure Planning and Management							
Programme& Branch	**B.E. & CIVIL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NA**	**8**	**PE**	3	0	0	3

Preamble	To understand and explain the basic concepts of infrastructure and the challenges to successful infrastructure planning and implementation.	
Unit – I	**Basic Concepts Related to Infrastructure:**	**9**
Introduction to infrastructure, Governing Features, Historical overview of Infrastructure development in India, Infrastructure Organizations & Systems		
Unit – II	**Infrastructure Planning:**	**9**
Typical infrastructure planning steps, Planning and appraisal of major infrastructure projects, Screening of project ideas, Life cycle analysis, Multi-criteria analysis for comparison of infrastructure alternatives, Procurement strategies, Scheduling and management of planning activities, Infrastructure Project Budgeting and Funding, Regulatory Framework, Sources of Funding		
Unit – III	**Private Involvement in Infrastructure:**	**9**
Overview of Infrastructure Privatization - Benefits of Infrastructure Privatization - Problems and Challenges in Infrastructure Privatization		
Unit – IV	**Challenges to Successful Infrastructure Planning and Implementation:**	**9**
Mapping and Facing the Landscape of Risks in Infrastructure Projects, Economic and Demand Risks - Political Risks - Socio-Environmental Risks - Cultural Risks in International Infrastructure Projects - Legal and Contractual Issues in Infrastructure - Challenges in Construction and Maintenance of Infrastructure.		
Unit – V	**Strategies For Successful Infrastructure Project Implementation:**	**9**
Risk Management Framework for Infrastructure Projects, Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Introduction to Fair Process and Negotiation, Negotiating with multiple Stakeholders on Infrastructure Projects.		
		Total:45

TEXT BOOK:

1.	Neil S Grigg, "Infrastructure Engineering and Management", 1st Edition, John Wiley & Sons, 1988.

REFERENCES:

1.	Ronald Hudson W., Ralph Haas & Waheed Uddin, "Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation", 1st Edition, McGraw-Hill, New Delhi, 1997.
2.	World Development Report: Infrastructure for Development, 1994.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basic concepts related to Infrastructure	Understanding (K2)
CO2	demonstrate the various analysis techniques in infrastructure planning	Applying (K3)
CO3	explain the role of private sector in infrastructure growth	Understanding (K2)
CO4	explain the challenges in infrastructure planning and management	Understanding (K2)
CO5	carry out strategic planning for successful Infrastructure Project implementation.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30				100
CAT2	30	40	30				100
CAT3	30	40	30				100
ESE	30	40	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CEO05 - Environmental Laws and Policy							
Programme& Branch	**B.E. & CIVIL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**PE**	3	0	0	3

Preamble	To enhance the basic concepts of environmental regulations to ensure environmental safety along with the amendments.	
Unit – I	**Overview of Environment & Law:**	**9**
Origin of Environmental Law - Indian Constitution and Environmental Protection - Multilateral Environmental agreements and Protocols - Montreal Protocol, Kyoto agreement, Rio declaration - Environmental Protection Acts.		
Unit – II	**Environment Protection Mechanisms:**	**9**
Introduction to Public Interest Litigation - Forest Cases & Responses (Case Laws) - Right to Information Act - Introduction to Environment Tribunals -The National Green Tribunal Act, 2010.		
Unit – III	**National Environmental Laws:**	**9**
Environmental Law and the Indian Constitution - The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and Forest Conservation Act, 1980 - Panchayats Extension to Scheduled Areas (PESA) Act 1996 - Wildlife Protection Act, 1972 - Land Acquisition Act, 1894 - Tenure & Property Rights and Community Rights.		
Unit – IV	**Environment (Protection) Act 1986:**	**9**
Provisions of Act - Delegation of powers - Role of state and central government - Siting of industries - Coastal zone regulations - Responsibilities of local bodies - Legislation's on Solid waste Management (MSW, Biomedical, Plastic, E-waste & Hazardous waste)		
Unit - V	**Role of Regulatory Boards:**	**9**
Sustainable Development - Roles and functions of Regulatory bodies and Local bodies - Significance - Organisational setup - TNPCB - CPCB -TWAD Board - CMWSSB - Case Studies.		
		Total:45

TEXT BOOK:

1.	Aruna Venkat, "Environmental Law and Policy", 1st Edition, PHI learning private limited, New Delhi, 2011.

REFERENCES:

1.	CPCB, "Pollution Control Acts, Rules and Notifications issued there under Pollution Control Series -PCL/2/1992", 1st Edition, Central Pollution Control Board, New Delhi, 1997.
2.	Shyam Divan & Armin Roseneranz, "Environmental law and policy in India", 1st Edition, Oxford University Press, New Delhi, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the origin and behaviour of environmental protection acts.	Understanding (K2)
CO2	illustrate the environmental protection mechanisms based on environmental indicators.	Understanding (K2)
CO3	describe the national environmental policies for enhanced ecology.	Understanding (K2)
CO4	classify the significance of federal and state environmental protection acts.	Understanding (K2)
CO5	recommend the code of ethics given by pollution regulatory boards to safeguard the environment.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40		100				
CAT2	40		100				
CAT3	35		100				
ESE	35		100				

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MEX01 - RENEWABLE ENERGY SOURCES

Programme & Branch	All BE/BTech branches except Mechanical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	0	2	4

Preamble	This course discusses various technologies behind renewable energy conversion process and the challenges in integrating power from renewable energy plants with grid.

Unit – I	**Grid Integration of Renewable Energy**	**9**

Global Energy Use- Energy Status in India -Lifetime of Fossil Fuels- Energy Conversion Technologies - Thermodynamic Efficiency – Variability – Intermittency - Dispatchability - Electric Grid Infrastructure - Integrating Renewable Energy into the Grid - Smart Grid - Secure Communication in the Smart Grid.

Unit – II	**Solar Energy and Wind Energy**	**9**

Solar Energy: Solar Radiation – Measurements of Solar Radiation and Sunshine - Solar Thermal Collectors –Flat Plate and Concentrating Collectors - Fundamentals of Solar Photo Voltaic Conversion – Solar PV Systems-Types- Design of a Standalone Solar PV System - Solar PV and Thermal Applications - Building Integrated Solar- Challenges – Economics- Leadership in Energy Environment Design (LEED) Certification.

Wind Energy: Basic Terms – Types - Horizontal Axis Wind Turbine-Vertical Axis Wind Turbine - Building Integrated Wind Turbines - Wind Turbine Generator and its Performance - Wind Turbine Applications - Recent Developments in Offshore Wind Turbines and Energy Storage - Hybrid Systems - Challenges - Economics.

Unit – III	**Bioenergy**	**9**

Biomass Resources - Biomass Conversion Technologies - Factors Affecting Biogas Production -Biogas Plant – Types – KVIC Model - Deenbandhu Model - Cogeneration Plant in Rice Mill- Ethanol Production - Energy Recovery from Urban Waste. Transportation –Challenges - Economics.

Unit - IV	**Geothermal Energy and Ocean Energy**	**9**

Geothermal Energy: Geothermal Resources-Structure of Earth's Interior - Electricity Production - Conversion Technology - Challenges - Economics.

Ocean Energy: Ocean Thermal Plants - Types-Tidal Plants – Types - Energy Estimation - Grid Interfacing of Tidal Power - Wave Energy Conversion Machines–Types – Buoy - Dolphin - Oscillating Water Column - Duck -Challenges - Economics.

Unit – V	**Direct Energy Conversion Systems and New Energy Sources**	**9**

Direct Energy Conversion Systems: MHD Generators – Thermoelectric Power Generation.

New Energy Sources: Hydrogen – Generation – Storage - Transport and Utilization - Applications - Power Generation – Transport - Hydrogen Economy - Safety Issues - Fuel Cell – Principle –Types.

LIST OF EXPERIMENTS / EXERCISES:

1.	Evaluate the cut in speed of the wind turbine.
2.	Analyze the effect of the variation of Tip speed ratio on the Coefficient of power of wind turbine.
3.	Determine the thermal energy gain at the focal point of a concentrating collector.
4.	Determine the efficiency of solar (Liquid/Air) collector.
5.	Plot the effect of variation of tilt angle on the PV module output.
6.	Plot the effect of variation of Solar intensity on the PV module output.
7.	Study on rooftop Solar PV plant.
8.	Study on weather monitoring station.
9.	Study the battery management system of solar PV module.
10.	Innovative model development based on renewable energy sources.

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	John Twidell., "Renewable Energy Resources", 4th Edition, Routledge ,New York, 2021.
REFERENCES/ MANUAL / SOFTWARE:	
1.	Kothari D.P., Singal K.C., Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2022.
2.	Rai G.D., "Non-Conventional Energy Sources", 6th Edition, Khanna Publishers, New Delhi, 2022.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the concepts behind the integration of renewable energy .	Applying (K3)
CO2	describe the working and applications of solar and wind energy systems and evaluate the performance of solar and wind energy system	Applying (K3) Manipulation (S2)
CO3	illustrate the bio-energy production techniques and the challenges in energy conversion	Applying (K3)
CO4	explain the working of geothermal and Ocean energy conversion technologies along with their economics and challenges.	Applying (K3)
CO5	explain the direct energy conversion systems and new energy sources.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 3 – 50 marks & ESE – 100 marks)

22MEX02 DESIGN OF EXPERIMENTS							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
		6	**OE**	**3**	**0**	**2**	**4**
Pre requisite	Nil						

Preamble	The course explores the fundamentals of experimental design, single factor and multifactor experiments, optimization techniques like ANOVA, Factorial Design, Response Surface Methodology, Taguchi Method.

UNIT – I	**Experimental Design Fundamentals**	**9**
Importance of Experiments - Experimental Strategies-Basic Principles of Design-Terminology - ANOVA-Steps in Experimentation - Sample Size - Normal Probability Plot - Linear Regression Model.		
UNIT – II	**Multifactor Experimental Design**	**9**
Classical Experiments: Factorial Experiments - Terminology-Factor Levels - Interactions-Treatment Combination-Randomization-Two Level Experimental Designs for Two Factors and Three Factors. Three Level Experimental Designs for Two Factors and Three Factors- Factor Effects - Factor Interactions - Fractional Factorial Design - Saturated Designs-Central Composite Designs - Illustration Through Numerical Examples.		
UNIT – III	**Analysis and Interpretation Methods**	**9**
Measures of Variability-Ranking Method-Column Effect Method-Plotting Method-Analysis of Variance (ANOVA) in Factorial Experiments-YATE's Algorithm for ANOVA-Regression Analysis-Mathematical Models from Experimental Data-Illustration Through Numerical Examples.		
UNIT – IV	**Special Experimental Designs**	**9**
Fractional Factorial Design - Nested Designs - Split Plot Design-Introduction - Response Surface Methodology - Experiments with Random Factors - Rules for Expected Mean Squares - Approximate F-Tests.		
UNIT – V	**Taguchi Methods**	**9**
Steps in Experimentation-Design using Orthogonal Arrays-Data Analysis-Robust Design - Control and Noise Factors-S/N Ratios-Parameter and tolerance design concepts - Case Studies.		

List of Exercises / Experiments :

1. Design of experiments for turning operations by Taguchi method.
2. Design of experiments for milling operations by Taguchi method.
3. Optimize the parameters which affects the quality of CNC turning operation by Taguchi method.
4. Optimize the parameters which affects the quality of CNC milling operation by the Taguchi method.
5. Process parameter optimization in turning using central composite design method.
6. Process parameter optimization in turning using the Box–Behnken design method.
7. Process parameter optimization in surface grinding by Response Surface Method
8. Mathematical model development for turning operation
9. Mathematical model development for milling operation
10. Mathematical model development for drilling operation

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Douglas C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley and sons, United States, 2020.

REFERENCES/MANUAL/SOFTWARE:

1.	Phillip J.Rose, **"**Taguchi Techniques for Quality Engineering", 2nd Edition, McGraw Hill, 2005.
2.	Nicolo Belavendram,"Quality by Design; Taguchi techniques for industrial experimentation", Prentice Hall, London, 1995.
3.	Krishnaiah, K and Shahabudeen, P, "Applied Design of Experiments and Taguchi Methods", PHI learning private Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**

CO1	understand the fundamental concepts in experimental design.	Understanding (K2)
CO2	identify and design the single and multifactor experiments.	Applying (K3)
CO3	select suitable analysis and interpretation methods for experimental results and also develop mathematical model using regression analysis.	Applying (K3) Articulation (S4)
CO4	apply the concepts of special experiment designs and conduct experiments using response surface method	Applying (K3) Manipulation (S2)
CO5	analyze the concepts of taguchi experiment design for practical problems and conduct experiments using taguchi method	Analyzing (K4) Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	40	45				100
CAT2	10	35	55				100
CAT3	10	25	45	20			100
ESE	15	25	40	20			100

* ±3% may be varied (CAT 1, 2 3 – 50 marks & ESE – 100 marks)

22MEO01 FUNDAMENTALS OF ERGONOMICS							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides the basic concepts of ergonomics and various tools and techniques involved in designing comfortable and safe workplace.	
Unit – I	**Introduction to Ergonomics**	**9**
Fundamentals of Ergonomics / Human Factors - Disciplines - Physical - Cognitive and Organizational - Needs of Ergonomics in Workplace - Ergonomic Principles - Applications - Ergonomic Evaluation - Questionnaire Survey.		
Unit – II	**Anthropometry**	**9**
Human Body - Structure and Function - Types of Anthropometric Data - Application of Anthropometry in Design - Anthropometric Measuring Techniques - Statistical Treatment of Data and Percentile Calculations.		
Unit – III	**Posture and Movement**	**9**
Posture : Biomechanical Background - Physiological Background - Sitting - Standing Change of Posture - Hand and Arm Postures **Movement:** Lifting - Carrying - Pulling - Pushing - Repetitive Motions - Rapid Upper Limb Assessment (RULA) – Rapid Entire Body Assessment (REBA) and Ovako Working Posture Assessment (OWAS) Method.		
Unit – IV	**Work Counter Behavior and Perception**	**9**
Work Counter: Environmental Issues - Physical Work Capacity - Factors Affecting Work Capacity - Communication and Cognitive Issues. **Information Processing and Perception:** Interaction with Machines - Mental Workload.		
Unit – V	**Work System Evaluation and Safety**	**9**
Work system Evaluation: Contribution of Ergonomics to Workstation Design - Analysis of Workplace Design - Work Envelopes - Workplace Evaluation Tools - Case Studies. **Safety:** Occupational / Ergonomic Safety and Stress at Various Workplace - Health Management Rules - Scope of Ergonomics in India - Case Studies.		
		Total:45

TEXT BOOK:

1.	Bridger, Robert. “Introduction to Human Factors and Ergonomics”, United Kingdom, CRC Press, 2017.

REFERENCES:

1.	Pamela McCauley-Bush, "Ergonomics: Foundational Principles, Applications, and Technologies", 1st Edition, Taylor & Francis, CRC Press, New York, 2011.
2.	Dul, Jan, and Weerdmeester, Bernard. “Ergonomics for Beginners: A Quick Reference Guide”, 3rd Edition. United Kingdom, Taylor & Francis, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	define ergonomics and its components.	Understanding (K2)
CO2	make use of anthropometry of data in product design..	Applying (K3)
CO3	examine the common risk factors and areas for ergonomic improvement.	Applying (K3)
CO4	apply ergonomic principles in assigning task to the workers	Applying (K3)
CO5	plan the essential elements for an effective ergonomics programme.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2				2						1		
CO2	2		2		3	3						1		
CO3	2			1	2	3	2					1		
CO4	2					3	1					1		
CO5	2				2	3						1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	45	35				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	10	45	45				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22MEO02 PRINCIPLES OF MANAGEMENT AND INDUSTRIAL PSYCHOLOGY							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course provides the principles, theory and practice of management followed in organizations. In addition, it covers the skills to meet the challenges of management, human behavior in a diverse and complex environment.

Unit – I	**Principles of Management**	**9**

Definition and Significance of Management - Evolution of Modern Management - Scientific Management - Development of Management Thought - Approaches to the study of Management - Basic Functions of Management.

Unit – II	**Planning and Organizing**	**9**

Planning: Objectives and Strategies - Policies and Planning Premises - Decision Making – Organizing: Nature and Process – Organization Structure- Premises - Departmentalization - Decentralization - Organizational Culture

Unit – III	**Staffing, Leading and Controlling**	**9**

Staffing: Selection and training - Placement - Performance Appraisal - Career Strategy - Organizational Development. Leading: Managing Human Factor - Leadership – Communication. Controlling: Process of Controlling - Controlling Techniques - Productivity and Operations Management - Preventive Control - Industrial Safety.

Unit – IV	**Industrial Psychology- Job Analysis and Organization Development**	**9**

Industrial Psychology: Introduction - Concept and Meaning - Characteristics and Scope - Historical Development - Individual Behavior. Job Analysis: Importance- Conducting Job Analysis – Job Evaluation – Internal and External Pay Equity - The Legal Process – Organization Development: Managing Change – Empowerment – Down Sizing- Work Schedules.

Unit – V	**Employ Satisfaction, Motivation and Group Behavior**	**9**

Employ Satisfaction: Measuring Job Satisfaction – Consequences of Dissatisfaction. Employee Motivation: Organizational Communication - Group Behavior, Teams, and Conflict - Stress Management- Predisposition – Sources – Consequences – Managing Stress.

Total:45

TEXT BOOKS:

1.	Harold Koontz & Heinz Weihrich., "Essentials of Management: An International, Innovation and Leadership Perspective",11th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2020 for Units I,II,III.
2.	Michael G Aamodt., "Industrial Psychology", 7th Edition, Cengage Learning, India, 2013 for Units IV,V.

REFERENCE:

1.	Spector, P.E., “Industrial and organizational psychology: Research and practice”. John Wiley & Sons, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the theory and the practice of management.	Understanding (K2)
CO2	Infer the knowledge of planning and organizing activities in an industry	Understanding (K2)
CO3	present the functions of staffing, leading and controlling of an organization	Understanding (K2)
CO4	develop an intuitive understanding of the job analysis and employee selection in an organization.	Understanding (K2)
CO5	Identify employee satisfaction and understand the art of managing groups.	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2					2				2	1			
CO2	2					2				2	1			
CO3	2					2				2	1			
CO4	2					2				2	1			
CO5	2					2				2	1			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	35	65					100
CAT2	35	65					100
CAT3	35	65					100
ESE	40	60					100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22MEO03 WASTE HEAT RECOVERY SYSTEM AND STORAGE							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course explores the fundamentals of waste heat recovery and thermal energy storage technologies applicable for diverse industrial processes to enhance energy efficiency and sustainability.	
Unit – I	**Introduction**	**9**
Thermodynamics Laws -Types of Waste Heat Sources - Principles of Energy Conversion - Rankine Cycle, Combined Cycles - Diesel Engines and Power Plant - Combined Plants- Potential for Energy Conservation -Total Energy Approach.		
Unit – II	**Waste Heat Recovery Systems**	**9**
Heat Transfer Fundamentals- Conduction, Convection, and Radiation- Selection Criteria for Waste Heat Recovery Technologies - Recuperators - Regenerators -Economizers - Plate Heat Exchangers - Thermic Fluid Heaters - Waste Heat Boilers - Fluidized Bed Heat Exchangers - Heat Pipe Exchangers - Heat Pumps – Sorption Systems.		
Unit – III	**Cogeneration**	**9**
Introduction - Topping Cycle -Bottoming Cycle – Combined Heat and Power (CHP) Cycle - Steam Turbine Co-generation Systems – Gas Turbine Co-generation Systems – Reciprocating IC Engines Co-generation Systems – Combined Cycles Co-generation Systems – Advantages of Co-generation Technology- Co-generation Application. - Basic Performance Calculations. Selection of Cogeneration Technologies.		
Unit – IV	**Thermal Energy Storage**	**9**
Thermal Energy Storage, Sensible and Latent Heat - Sensible Heat Storage Materials- Ice Storage- Phase Change Materials – Thermochemical Storage - Molten Salt, Metal Hydrides, Sorption Materials - Hybrid Thermal Energy Storage Systems – Potential for Energy Storage – Mass and Energy Balance Analysis of Thermal Energy Storage.		
Unit – V	**Economic and Environmental Considerations**	**9**
Investment Cost – Economic Concepts – Measures of Economic Performance – Procedure for Economic Analysis – Examples – Procedure for Optimized System Selection and Design – Load Curves - Sensitivity Analysis – Regulatory and Financial Framework. Sustainability and Environmental Impact of Waste Heat Recovery, Co-generation and Energy Storage Systems.		
		Total:45

TEXT BOOKS:

1.	Hussam Jouhara “Waste Heat Recovery in Process Industries “John Wiley & Sons, 2022. for Units I,II.
2.	Horlock, J. H “Cogeneration--combined heat and power (CHP) : thermodynamics and economics” Krieger Publishing Company; Reprint edition, 1996 for Unit III.
3.	Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010. for Unit IV.
4.	David Flin, “Cogeneration - A User's Guide” Institution of Engineering and Technology, London, United Kingdom, 2009. for Unit V

REFERENCES:

1.	Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
2.	Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
3.	Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983
4.	De Nevers, Noel., Air Polllution Control Engineering, McGrawHill, New York,1995

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basic thermodynamic principles and concepts of waste heat recovery and energy storage systems.	Understanding (K2)
CO2	acquire knowledge pertaining to various waste heat recovery systems and their applications.	Applying(K3)
CO3	apply the principles of energy conversion and distribution to design of cogeneration systems.	Applying(K3)
CO4	Identify and analyze the sensible, latent, and thermochemical storage systems and their applications.	Understanding (K2)
CO5	Evaluate the economic viability and environmental impact of heat recovery and storage system	Applying(K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	45	30				100
CAT2	15	40	45				100
CAT3	25	40	35				100
ESE	25	40	35				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22MEO04 SAFETY MEASURES FOR ENGINEERS							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course explores the knowledge on safety aspects, procedures and guidelines to be followed in various industries, while performing various types of activities in electrical, chemical industries with appropriate personal personnel protection equipment's and risk assessment procedures.	
Unit – I	**Safety Management and Accident Prevention**	**9**
Safety Management: Need for Safety - Safety and Productivity - Safety Management Techniques - Job Safety Analysis – Safety Sampling Technique - Incident Recall Technique - Plant Safety Inspection. **Accident Prevention**: Nature and Causes of Accidents - Accident Proneness - Cost of Accident - Accident Prevention Methods - Accident Reporting and Investigation - Safety Education and Training.		
Unit – II	**Electrical and Fire Safety**	**9**
Usefulness and Hazards of Electricity - Statutory Provisions - Indian Standards - Effects of Electrical Parameters on Human Body - Safety Measures for Electric work - Overload and Other Protections - Portable Electrical Apparatus - Electric Work in Hazardous Atmosphere - Static Electricity - Energy Conservation and Safety Fire Phenomena - Classification of Fire and Extinguishers - Statutoryand other standards - Design for Fire Safety - Fire Prevention and Protection System - Explosion Phenomena - Inspection, Maintenance and Training for Fire Protection.		
Unit – III	**Safety in Chemical Industry**	**9**
Types of Chemical Industry - Statutory Provisions - Indian Standards – Types of Chemical Hazards & Controls – Material(Property)Hazards and Controls – Storage Hazards & Controls - Process Hazards & Controls - Utility Hazards & Controls – Pollution Hazards & Controls - Instrumentation for Safe Plant Operations - Safe Transfer of Chemicals - Inspection, Testing & Maintenance - Work Permits of Hazardous Work- case studies		
Unit – IV	**Personnel Protection Equipment (PPE)**	**9**
Need and Limitation - Statutory Provisions - Indian & Other standards - Selection and Classification - Non Respiratory Equipment - Respiratory Equipment - Training, Maintenance, Precaution and Care of PPE - Detection Equipment - PPE Testing Procedures & Standards		
Unit – V	**Risk Assessment**	**9**
Basic Concepts of Risk - Safety Appraisal, Analysis and Control Techniques - Accident Investigation, Analysis and Reporting - Hazardand Risk Assessment Techniques - Reliability Engineering - Major Accident Hazard (MAH) Control - On-site and Off-site Emergency Plans.		
		Total:45

TEXT BOOK:

1.	Mistry K.U., "Fundamentals of Industrial Safety and Health", 2nd Edition, Siddharth Prakashan, Ahmedabad, 2008.

REFERENCES:

1.	John Cadick, Mary CapelliSchellpfeffer& Dennis Neitzell, "Electrical Safety Handbook", 4th Edition, McGraw-Hill Education, 2012.
2.	Davies V.J. &Thomasin K., "Construction Safety Hand Book", 2nd Edition, Thomas Telford Ltd., London, 1996
3.	Rao S, Jain R.K. & Saluja H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", 2nd Edition, Khanna Publishers, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perceive the safety management concepts and accident prevention methods.	Understanding (K2)
CO2	apply appropriate measuring and /or insulating equipment, use of fire extinguishers and safe earthing practices.	Applying (K3)
CO3	identify the hazards in chemical industries during transporting, storing and processing to ensure safe plant operations.	Applying (K3)
CO4	select the PPE based on the type of industry and standards	Applying (K3)
CO5	implement the techniques like risk assessment disaster management and emergency preparedness with the proper knowledge on accident prevention.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1					3	2	1						
CO2	1					3	2	1						
CO3	1					3	2	1						
CO4	1					3	2	1						
CO5	1					3	2	1						
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	45	40				100
CAT2	20	40	40				100
CAT3	30	30	40				100
ESE	30	35	35				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22MEO05 ENERGY CONSERVATION IN THERMAL EQUIPMENTS							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge on the methods to conserve energy in thermal equipment after a detailed evaluation of the performance parameters.	
Unit – I	**Basics of Energy**	**9**
Energy – Forms of Energy – Power – Units – Estimation of Energy Requirement – Electricity – Voltage – Current – Resistance – Measurement of Electrical Quantities - Energy Efficiency and Conservation – Plant Energy Performance – Production Factor Plant Energy Performance – Energy Audit and Survey Instruments - Energy related CO_2 emissions – Strategies for Energy Savings in Industries.		
Unit – II	**Energy Conservation in Steam System**	**9**
Steam Phase Diagram - Steam Distribution - Steam Pipe Design and Sizing – Steam Traps – Selection – Operation – Maintenance - Performance Assessment Methods -– Energy Saving Opportunities.		
Unit – III	**Energy Conservation in Boilers and Furnaces**	**9**
Boiler: Water Treatment – Water to Steam Conversion – Hot Water Systems – Heat transfer Coefficients – Boiler Performance Assessment using Direct and Indirect Method – Energy Conservation Opportunities. **Furnace:** Performance Evaluation – General Fuel Economy Measures- Estimation of fuel savings.		
Unit – IV	**Energy Conservation in Air conditioners**	**9**
Load Characteristics and Calculation - Factors Affecting Cooling Rate - Air conditioner – Working – Types – Efficiency – Sizing - Energy Conservation Opportunities – Energy Monitoring and Control System.		
Unit – V	**Cogeneration**	**9**
Need – Classification – Commercial Cogeneration Systems – Factors and Technical Parameters Influencing the Selection of Cogeneration Systems – Energy Savings through Cogeneration Systems - Relative Merits of Cogeneration Systems – Performance Assessment.		
		Total:45

TEXT BOOK:

1.	Guide Books for National Certification Examination for Energy Managers and Auditors, 4th Edition, Bureau of Energy Efficiency, 2015.

REFERENCES:

1.	Sonal Desai, "Handbook of Energy Audit", 1st Edition, McGraw Hill Education, New Delhi, 2017.
2.	Stephan A Roosa, Steve Doty, Wayne C Turner, "Energy Management Handbook", 9th Edition, River Publishers, New York, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the basics of energy with reference to energy conservation.	Understanding (K2)
CO2	explain the energy conservation opportunities in steam system.	Applying(K3)
CO3	discuss the energy conservation opportunities in boilers and furnaces.	Applying(K3)
CO4	elucidate the energy conservation opportunities in air conditioners.	Applying(K3)
CO5	quantify the energy savings through cogeneration	Applying(K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2				1	1	3					1		
CO2	2					1	3					1		
CO3	2		2			1	3					1		
CO4	2		2			1	3					1		
CO5	3		2			1	2					1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	15	50	35				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22MEO06 CLIMATE CHANGE AND NEW ENERGY TECHNOLOGY							
Programme & Branch	**All BE/BTech branches except Mechanical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides an overview on global and national climate change implications. In addition, the future energy technologies for sustainable development are also covered in this course.	
Unit – I	**Climate Change**	**9**
Preliminary Concepts of Climate Change - International Climate Policy - Causes of Climate Change - Enhanced Greenhouse Effect – Green House Gases in Atmosphere - Global Warming - Effects of Global Warming - Climate Change Scenario of India - Impact of Climate Change on Agriculture – Forest - Water Resources - Monsoon System of India.		
Unit – II	**Energy Transition**	**9**
Personal Energy Needs - Personal Carbon Dioxide Balance - Carbon Dioxide Sequestration - Combined Heat and Power System - Energy Transition in Heat Sector - Transport Sector - Electricity Sector - Direct and Indirect Emissions in Energy Sector - Net-zero Emissions - Carbon-free Technology.		
Unit – III	**Renewable Energy System**	**9**
Solar Thermal Systems - Domestic Solar Water Heating – Space Heating - Solar PV Systems - Designing Stand-alone Systems - Designing Grid-connected Systems - Renewable Power Plants – Solar Photovoltaic Power Plants - Concentrating Solar Thermal Power Plants - Grid-connected Wind Turbines - Geothermal Heat and Power Plants - Biomass Heat and Power Plants.		
Unit – IV	**Battery Technologies**	**9**
Introduction to Batteries – Electrochemical Principles and Reactions - Classification - Primary Batteries - Types - Service Time - Voltage Data - Service Life - Ohmic Load Curve - Effect of Operating Temperature on Service Life - Reserve Batteries – Types - Secondary Batteries – Types - Discharge Curves - Terminal Voltages - Plateau Voltage - Lead Acid Batteries – Construction – Application – Battery Performance Evaluation - Factors Affecting Battery Performance - Advanced Batteries for Electric Vehicles.		
Unit – V	**Energy Storage Technology**	**9**
Demand for Power Systems - Overview of Energy Storage Technologies - Energy Storage Methods – Electrical Storage Systems - Efficiency of Energy Storage systems -Thermal Energy Storage (TES) using Phase Change Materials - Energy Conservation with TES - Planning and Implementation of TES - Environmental impact of TES systems.		
		Total:45

TEXT BOOKS:

1.	Volker V. Quaschning, “Renewable Energy and Climate Change”, 2nd Edition, Wiley Publications, USA, 2019 for Units I,II,III.
2.	Beard Kirby W, “Linden’s Hand Book of Batteries”, 5th Edition, McGraw Hill Book Company, New York, 2019 for Units IV,V.

REFERENCES:

1.	Ibrahim Dincer and Marc A. Rosen, “Thermal Energy Storage: Systems and Applications”, 3rd Edition, Wiley Publications, USA, 2021
2.	Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, “Fundamentals and Applications of Renewable Energy”, 1st Edition, McGraw Hill Book Company, New York, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the global and Indian climate change scenario	Applying (K3)
CO2	illustrate the energy transition mechanism in transport and electricity sectors.	Applying (K3)
CO3	design renewable energy systems for heat and power.	Applying (K3)
CO4	classify the batteries and explain the performance evaluation methods for primary and secondary batteries	Applying (K3)
CO5	describe the working of electrical and thermal energy storage systems.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22MTO01 - DESIGN OF MECHATRONICS SYSTEMS							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on system design, devices and products in achieving an optimal balance between basic mechanical structure and its control.	
Unit - I	**Fundamentals of Mechatronics Systems:**	**9+3**
Introduction - Key elements – Mechatronics design process –Types of Design: Traditional and Mechatronics design - Integrated product design - Advanced approaches in Mechatronics - Industrial design and ergonomics, Safety. Case study: Study of Mechatronics systems.		
Unit - II	**System Modelling:**	**9+3**
Introduction - Model categories - Fields of application - Model development - Model verification - Model validation - Simulators and Simulation – Design of mixed system: Electro mechanical system design – Model transformation – Domain independent description forms: Bond graph and Block Diagram - Simulator coupling. Response study: Mathematical modelling of open loop systems.		
Unit - III	**System Interfacing:**	**9+3**
Introduction – Elements of data acquisition and control system – Overview of I/O process - Installation of I/O card and software – TIA/EIA serial interface standards (RS232/422/485) – General Purpose Interface Bus (IEEE 488) - GUI card – Ethernet switch - Man Machine Interfaces. Response study: Real time data acquisition system.		
Unit - IV	**Case Study on Mechatronics Systems:**	**9+3**
Semi-active Wheel Suspension - Internal Combustion Engine with Drive Train - Camera Winder - Auto focus Camera - Disk Drive – Transducer calibration system - Strain gauge weighing system - Controlling temperature of a hot/cold reservoir using PID – pH Control system. Response study: Simulation of closed loop control of systems.		
Unit - V	**Case Study on Advanced Systems:**	**9+3**
Machine tool control system - Electronics engine management system - Pick and place industrial manipulator – Autonomous mobile robot - Artificial Intelligence in Mechatronics - Fuzzy controlled washing machine.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Devdas Shetty & Richard A. Kolk, "Mechatronics System Design", 2nd Edition, CT Cengage Learning, Stamford, 2011.

REFERENCES:

1.	Bolton W., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 6th Edition, Pearson Education Limited, New York, 2015.
2.	Robert H. Bishop, "The Mechatronics handbook. Fundamentals and modeling", 2nd Edition, CRC Press, London, 2008.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the necessary components for mechatronics system design	Understanding (K2)
CO2	model the Mechatronics system	Understanding (K2)
CO3	select the suitable interface for mechatronics system	Understanding (K2)
CO4	develop the physical system based on mechatronics design process	Applying (K3)
CO5	build the mechatronics systems for real time applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1										3		
CO2	2	1			2							3		
CO3	3	1			2							3		
CO4	3	2	1	1	3							3		
CO5	3	2	1	1	3							3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	85					100
CAT2	15	85					100
CAT3	15	55	30				100
ESE	5	60	35				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTX01 - DATA ACQUISITION AND VIRTUAL INSTRUMENTATION							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the basics, programming techniques, data acquisition and interfacing techniques of Virtual Instrumentation (VI) and its applications.	
Unit - I	**Virtual Instrumentation:**	**9**
Block diagram and architecture of a virtual instrument- Data -flow techniques - Graphical programming in data flow - Comparison with conventional programming– Graphical user interfaces – Controls and Indicators – 'G' programming/ modular programming.		
Unit - II	**VI Software Tools:**	**9**
Data types – Data flow programming – Editing, Debugging and Running a Virtual Instrument – Graphical programming palettes and tools – Function and Libraries – Structures: FOR Loops- WHILE loops- Shift Registers - CASE structure - Event Structure - Flat sequence - Feedback node - Expression node - Formula nodes - Sequence structures - Timed looped structures.		
Unit - III	**VI Programming Techniques:**	**9**
Arrays and Clusters – Bundle/ Unbundle and Bundle /Unbundle by name – Plotting data: graphs and charts – String and File I/O: High level and Low level file I/O's– Local and global variables - Sub-VI.		
Unit - IV	**Data Acquisition Hardware:**	**9**
Basics of DAQ hardware and software – Concepts of data acquisition and terminology – Installing hardware and drivers –NIMAX Configuring and addressing the hardware – Digital and Analog I/O function – Real time data acquisition – USB based DAQ-MyRIO.		
Unit - V	**VI applications:**	**9**
TCP/IP VI's – PXI – Instrument control – Image acquisition – Motion control – Signal processing/ analysis – Control design and simulation.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Develop Graphical programming using For loops, While loops with shift registers, feedback nodes
2.	Develop Graphical programming using Arrays functions and Multi-dimensional arrays
3.	Develop Graphical programming using Local variables, Global variables, Case structures and Sequence structures
4.	Develop Graphical programming using Timed structures, Formula nodes and Event structures
5.	Develop Graphical programming using Waveform graph, Waveform chart and XY graph
6.	Develop Graphical programming using String functions, editing, formatting and parsing string
7.	Develop Graphical programming using Clusters operations: Assembling clusters and disassembling clusters
8.	Develop Graphical programming using File Input / File Output function, Read / Write a file
9.	Interface data acquisition hardware with graphical environment for real time measurements using MyRIO system
10.	Interface data acquisition hardware with graphical environment for real time measurements using MyDAQ system

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Jeffery Travis & Jim Kring, "LabVIEW for Everyone: Graphical programming made easy and Fun", 3rd Edition, Pearson Education, India, 2009.

REFERENCES:

1.	Gupta, Joseph & John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, India, 2010.
2.	Rick Bitter, Taqi Mohiuddin & Matt Nawrocki, "LabVIEW Advanced Programming Techniques", 2nd Edition, Taylor & Francis Group, NA, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate the basic concepts of Virtual Instrumentation	Understanding (K2)
CO2	interpret the software tools in Virtual Instrumentation using GSD platform	Applying (K3)
CO3	develop programming concepts in graphical programming environment	Applying (K3)
CO4	interface data acquisition hardware with software tools	Applying (K3)
CO5	develop programming concepts with advanced software tools	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	35	50				100
CAT2	10	35	55				100
CAT3	10	35	55				100
ESE	5	40	55				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MTX02 - FACTORY AUTOMATION							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the fundamental knowledge about automation in the field of production and assembly lines.	
Unit – I	**Overview:**	**9**
Automation overview, Requirement of automation systems, Architecture of factory automation system, Basic components of automation – Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, Process control valves.		
Unit – II	**Programmable Automation Controllers:**	**9**
Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, PLC selection, PLC installation, Basic discrete I/o programming and maintenance of PLC using timer/counter functions.		
Unit – III	**Communication and Control Systems:**	**9**
Man-machine interface, Computer aided process control hardware and software, Process related interfaces, Communication and networking, Data transfer techniques, Computer based data acquisition system, Internet of things (IoT) for plant automation.		
Unit – IV	**SCADA:**	**9**
Definition – Elements of SCADA – SCADA control – Remote terminal units – Master station – Interfacing PLC with SCADA – Data logging and trending.		
Unit – V	**Robots for Factory Automation:**	**9**
Basic construction and configuration of robot, Pick and place robot, Welding robot, Robots in Sorting, Mobile robots, Cobots and Humanoid robots.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Introduction to programming /simulation/communication software for PLC programming
2.	Logical testing of I/O's and its interfacing with PLC for a given case study
3.	Level control using PLC
4.	Interfacing Pneumatic cylinders with PLC
5.	Introduction to HMI programming using software
6.	Interfacing PLC and HMI
7.	Data logging and trending using PLC & HMI for a given case study
8.	Studies on ABB robot functions and programming

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Bolton W., "Mechatronics", 6th Edition, Pearson Education, New Delhi, 2019.

REFERENCES/ MANUAL / SOFTWARE:

1.	Petruzella Frank D., "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2019.
2.	Stuart Boyer A., "SCADA Supervisory Control and Data Acquisition", 4th Edition, ISA, USA, 2016.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the different types of sensors, actuators and PLC used in automation system	Understanding (K2)

CO2	infer the knowledge about communication and control system in real time interfacing	Understanding (K2)
CO3	adapt the concepts of SCADA for factory automation	Applying (K3)
CO4	interpret the basic configuration and application of robot in factory automation	Applying (K3)
CO5	develop plant level automation for real process plant using PLC/SCADA/ robotics	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	5	95					100
CAT2	5	50	50				100
CAT3	5	55	40				100
ESE	10	50	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MTO02 - ROBOTICS							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides the basic knowledge about industrial manipulator, its control, design and applications	
Unit – I	**Introduction to Robotics:**	**9+3**
Types and components of a robot- Classification of robots - Closed loop and open loop control systems. Kinematics systems: Definition of mechanisms and manipulators- Social issues and safety.		
Unit – II	**Robot Kinematics and Dynamics:**	**9+3**
Kinematic Modelling: Translation and rotation representation- Coordinate transformation- DH parameters- Jacobian-Singularity and Statics. Dynamic Modelling: Equations of motion- Euler-Lagrange formulation.		
Unit – III	**Sensors and Vision System:**	**9+3**
Sensor - Contact and Proximity, Position, Velocity, Force, Tactile. Introduction to Cameras- Camera calibration- Geometry of image formation - Vision applications in robotics.		
Unit – IV	**Robot Control and Actuation Systems:**	**9+3**
Basics of control: Transfer functions, Control laws: P, PD, PID - Non-linear and advanced controls. Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings - Parameters for selection of actuators.		
Unit – V	**Control Hardware and Interfacing:**	**9+3**
Embedded systems: Architecture and integration with sensors, Actuators, Programming for robot applications.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Saha S.K., "Introduction to Robotics", 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

REFERENCES:

1.	Niku Saeed B., "Introduction to Robotics: Analysis", PHI Learning, New Delhi, 2011.
2.	Ghosal A., "Robotics: Fundamental Concepts and Analysis", Oxford, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the features of an industrial robots with end effector	Understanding (K2)
CO2	perform kinematic and dynamic analyses with simulation	Applying (K3)
CO3	select various sensors for robotics	Understanding (K2)
CO4	identify different control and actuation systems for robots	Understanding (K2)
CO5	Integrate mechanical and electrical hardware for robot programming and applications	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	65	20				100
CAT2	15	65	20				100
CAT3	10	60	30				100
ESE	10	55	35				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTO03 - 3D PRINTING AND DESIGN							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course is designed to impart knowledge and skills related to 3D printing technologies, selection of materials and equipments to develop a product.	
Unit – I	**3D Printing & CAD for Additive Manufacturing:**	**9+3**
Introduction: Process - Classification, Additive v/s Conventional Manufacturing processes. Application Domains: Aerospace- Electronics- Health Care- Defense – Automotive – Construction - Food Processing - Machine Tools. CAD Data formats- Data translation- Data loss- STL format.		
Unit – II	**Additive Manufacturing Techniques:**	**9+3**
Stereo-Lithography- LOM- FDM- SLS- SLM- Binder Jet technology; Process parameter- Process Selection for various applications. Reverse engineering – Steps for 3d printing technology.		
Unit – III	**Materials:**	**9+3**
Metals, Non-Metals, Ceramics; Various forms of raw material-Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties; Support Materials		
Unit – IV	**Additive Manufacturing Equipment:**	**9+3**
Process Equipment-Design and process parameters; Governing Bonding Mechanism; Common faults and troubleshooting; Process Design		
Unit – V	**Post Processing & Product Quality:**	**9+3**
Post Processing- Requirement and Techniques. Product Quality- Inspection and testing - Defects and their causes.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Chee Kai Chua and Kah Fai Leong, “3D Printing and Additive Manufacturing - Principles and Applications”, World Scientific, Singapore, 2017.

REFERENCES:

1.	Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, New Delhi, 2021.
2.	Gibson I., Rosen D. W. & Stucker B., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, USA, 2010.
3.	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, Germany, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the need of additive manufacturing in real world applications	Understanding (K2)
CO2	choose appropriate technique for AM applications	Applying (K3)
CO3	select a specific material for the given application	Applying (K3)
CO4	identify the process parameters of different AM process	Applying (K3)
CO5	ensure the quality of the AM product	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1										3		
CO2	2	1			2							3		
CO3	2	1			2							3		

CO4	2	3	1	2	2						2	2		
CO5	2	3	1	2	2						2	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	33	67					100
CAT2	10	42	38				100
CAT3	10	42	38				100
ESE	6	60	34				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MTO04 - DRONE SYSTEM TECHNOLOGY							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course strives to identify and introduce Drones or UAVs (Unmanned Aerial Vehicles) as piloted by remote control or on board computers through computer vision and artificial intelligence technologies.	
Unit – I	**Unit Title: Introduction to Unmanned Aerial Vehicles (UAV):**	**9**
Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas.		
Unit – II	**Unit Title: Unmanned Aerial System (UAS) components:**	**9**
Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations		
Unit – III	**Unit Title: Basic Concepts of Flight:**	**9**
Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.		
Unit – IV	**Unit Title: Drone Equipment Maintenance:**	**9**
Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.		
Unit – V	**Unit Title: Regulatories and Regulations:**	**9**
Homeland regulatory: FCC, FAA. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations. Operational considerations like liability / legal issues, ethical implications.		
		Total:45

TEXT BOOK:

1.	Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 5th Edition, John Wiley & Sons, NA, 2022

REFERENCES:

1.	Randal W. Beard & Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", 1st Edition, Princeton University Press, Newjersy, 2012.
2.	Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", 1st Edition, CRC press, Florida, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer knowledge on the development and potential of UAV in professional activities	Understanding (K2)
CO2	interpret the features and characteristics of an unmanned aerial system	Applying (K3)
CO3	infer on flight operation and control using drone	Applying (K3)
CO4	realize the drone equipment maintenance and repair	Understanding (K2)
CO5	interpret the regulatory measures and regulations in UAV operation	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	65	20				100
CAT2	15	65	20				100
CAT3	30	70	-				100
ESE	5	65	30				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTO05 - MICRO AND NANO ELECTROMECHANICAL SYSTEMS							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**22PHT13 - Physics for Mechatronics Engineering, 22CYT23 - Chemistry for Mechatronics Engineering**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides introduction to the basic concepts of MEMS and NEMS. It familiarizes the concept of fabrication, manufacturing and packaging of Micro System and applications of Micro and Nano product for various applications.	
Unit – I	**Microsystems, Microsensors and Actuators**	**9**
Overview-Microsystems - Working principle of Microsystems - Micro sensors - Micro actuation techniques - Micropump – Micromotors – Microvalves – Microgrippers.		
Unit – II	**Micro System Fabrication**	**9**
Substrates - Single crystal silicon wafer formation - MEMS materials - Photolithography - Ion implantation - Diffusion - Oxidation - CVD - Physical Vapor Deposition - Deposition by epitaxy – Etching process.		
Unit – III	**Micro System Manufacturing and Design**	**9**
Bulk Micro manufacturing - Surface Micromachining – LIGA – SLIGA. Micro system packaging – Materials - Die level - Device level - System level - Packaging techniques - Surface bonding - Wire bonding – Sealing - Design considerations- Micro System Applications		
Unit – IV	**Introduction and Overview: Nanoscale Materials**	**9**
Mendeleyev's Periodic Table of Elements and Electronic Configurations - Nanoengineering and Nanoscience - Carbon Nanoelectronics: Carbon Nanotubes - Analysis of Carbon Nanotubes - Classification of Carbon Nanotubes		
Unit – V	**Modeling of Nanoelectromechanical Systems**	**9**
Introduction to Modeling, Analysis, and Simulation of NEMS - Newtonian Mechanics - Functional Nano-Electro-mechanical Systems - Piezoactuators: Steady-state models and Characteristics.		
		Total:45

TEXT BOOK:

1.	Tai-Ran Hsu, "MEMS And Microsystems: Design And Manufacture", 1st Edition, McGraw-Hill Education Pvt. Ltd, New Delhi, 2002.
2.	Lyshevski, S.E, "Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering", 2nd Edition, CRC Press, 2005.

REFERENCES:

1.	Marc Madou, "Fundamentals of Microfabrication", 2nd Edition, CRC Press, New York, 2002.
2.	Zhang, Dan, Wei, Bin, "Advanced Mechatronics and MEMS Devices II", 1st Edition, Springer International Publishing, NA, 2017.
3.	Takahata, K, "Advances in Micro/Nano Electromechanical Systems and Fabrication Technologies" 1st Edition, InTech, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basics of micro sensors and micro actuators	Understanding (K2)
CO2	identify the suitable fabrication process of microsystem	Understanding (K2)
CO3	develop the micro systems for various applications	Applying (K3)
CO4	elucidate the function of nanoscale materials	Understanding (K2)
CO5	Infer the concept of Nano-electronic devices	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	5	60	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MTO06 - VIRTUAL AND AUGMENT REALITY IN INDUSTRY 4.0							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course familiarizes the basic concepts of virtual reality and also analyze the kinematics and dynamic behaviors of VR Environment through geometric modelling.	
Unit – I	**Introduction to Augmented Reality:**	**9**
System structure of augmented reality; Key technology in AR; General solution for calculating geometric & illumination consistency in the augmented environment, Augmented Reality Methods.		
Unit – II	**Virtual Reality and Virtual Environments:**	**9**
The historical development of VR: Classic components of a VR system, Virtual environments, Requirements for VR, Benefits of virtual reality. Hardware technologies for 3D user interfaces: Visual displays, Auditory displays, Haptic displays, Choosing output devices for 3D user interfaces.		
Unit – III	**Geometric Modelling:**	**9**
Geometric modelling: Introduction – From 2D to 3D – 3D space curves – 3D boundary representation - Geometrical Transformations: Introduction – Frames of reference – Modelling transformations – Instances –Picking – Flying – Scaling the VE – Collision detection. ~~A~~ Generic VR system: Introduction –Virtual environment –Computer environment – VR Technology – Model of interaction – VR systems.		
Unit – IV	**Navigation Systems:**	**9**
Human factors: Introduction –Eye - Ear- Somatic senses – VR Hardware: Introduction – Sensor hardware – Head-coupled displays – Acoustic hardware – Integrated VR systems - VR Software: Introduction – Modelling virtual world – Physical simulation – VR toolkits – Introduction to VRML.		
Unit – V	**VR Applications in Manufacturing:**	**9**
Introduction to Productivity Enhancement Platforms: Virtual prototyping spaces, Virtual collaborative working spaces, Augmented and virtual assistance, Telepresence - Applications of VR in Robotics: Robot teleoperation.		
		Total:45

TEXT BOOK:

1. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", 1st Edition, Morgan Kaufmann, USA, 2009.

REFERENCES:

1. John Vince., "Virtual Reality Systems ", 1st Edition, Pearson Education Asia, US, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basic concept and framework of Augmented & virtual reality	Understanding (K2)
CO2	establish an insight to virtual environment	Understanding (K2)
CO3	realize the multimodal user interaction and perception in VR using geometric modelling and control mechanisms	Applying (K3)
CO4	apply computing tools for the development of VR environment	Applying (K3)
CO5	develop virtual reality for manufacturing applications	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85					100
CAT2	15	55	30				100
CAT3	15	55	30				100
ESE	5	60	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUX01 - AUTOMOTIVE ENGINEERING							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the knowledge on working principle of automotive components and various alternative fuel resources recommended for automotive engines.	
Unit – I	**Engines and Exhaust systems:**	**9**
Engine components: Cylinder block - Cylinder head - Sump - Manifolds - Gaskets - Cylinder - Piston - Rings - Connecting rod - Piston pins - Crank shaft - Bearings - Valves - Mufflers. Simple Carburetor - Port and Valve Timing diagram - Engine cooling and Lubrication systems - MPFI and CRDI - Exhaust systems - SCR - EGR - Catalytic converter - DeNox Trap - Emission standards in India		
Unit – II	**Transmission Systems:**	**9**
Clutch - Types and Construction - Clutch operation - Electromagnetic - Mechanical - Hydraulic - Vacuum. Gear Boxes: Manual and Automatic - Simple Floor Mounted Shift Mechanism - CVT - Dual Clutch transmission - Over Drives - Transfer Box - Fluid flywheel - Torque converter - Propeller shaft - Slip Joint - Universal Joints - Differential and Rear Axle.		
Unit – III	**Steering, Brakes and Suspension:**	**9**
Wheels and Tyres - Wheel Alignment Parameters. Steering: Steering Geometry - Types of steering gear box - Davis and Ackermann steering mechanism - Power Steering - Electronic Steering - Types of Front Axle. Suspension systems: Types of suspension springs - Shock absorbers. Braking Systems: Types and Construction - Hydraulic brakes - Air brakes - Antilock Braking System.		
Unit – IV	**Chassis Frame, Battery and Lighting System:**	**9**
Chassis construction - Truck chassis - Four-wheel drive chassis - Body on frame - Semi integral and integral type - Loads acting on frame. Types of batteries - Construction, Operation and Maintenance. Electrical systems: Lighting - Wiring circuit.		
Unit – V	**Automotive accessories and Alternate Energy Sources:**	**9**
Head lights - Switches - Indicating lights. Accessories: Direction indicators - Windscreen wiper - Horn - Speedometer - Heaters - Air conditioner. Use of Natural Gas, LPG, CNG, LPG, Bio diesel, Shale gas, Liquid nitrogen, Ethanol and Hydrogen in Automobiles - Fuel Cells.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Dismantling and Assembling of Two stroke Petrol Engine
2.	Dismantling and Assembling of Four Stroke Petrol Engine
3.	Dismantling and Assembling of Four Stroke Diesel Engine
4.	Dismantling and Assembling of Constant Mesh Gear Box
5.	Dismantling and Assembling of Synchromesh Gear Box
6.	Dismantling and Assembling of Differential and Live Axles
7.	Dismantling and Assembling of Hydraulic and Pneumatic Braking Systems
8.	Dismantling and Assembling of Recirculating Ball and Rack & Pinion Steering Systems
9.	Fault diagnosis in Automotive Electrical Wiring Circuit
10.	Dismantling and Assembling of Horn, Wiper and Starter Motor

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Dr. Kirpal Singh., "Automobile Engineering Volume 1 & 2", 14th Edition, Standard Publishers Distributors, New Delhi, 2017 & 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Tom Denton., "Automobile Electrical and Electronics Systems", 4th Edition, Edward Arnold Publishers, 2013.

2.	Ganesan V., "Internal Combustion Engines", 4th Edition, Tata McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the IC engine components and exhaust system by dismantling and assembling	Applying (K3)
CO2	execute the various types of transmission and steering systems	Applying (K3)
CO3	develop the suspension, brake and steering systems of automobile	Applying (K3)
CO4	design the circuit for automotive electrical systems and illustrate the types of chassis	Applying (K3)
CO5	execute the various automotive accessories and alternate fuel sources in automobiles	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO01 - AUTOMOTIVE ELECTRONICS							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To acquire knowledge on basic automotive electrical and electronics systems for main functions in vehicles like charging, starting, ignition, fuel control and engine management	
Unit - I	**Charging and Starting systems:**	**9+3**
Introduction - Requirements of the charging system - Charging system principles – Alternators - Smart charging - Advanced Charging system technology - Alternator developments - Requirements of the starting system - Starter motors and circuits - Types of starter motor - Advanced starting system technology - Electronic starter motor control and stop-start system		
Unit - II	**Ignition systems:**	**9+3**
Ignition system fundamentals - Electronic ignition - Constant dwell systems- Constant energy systems - Hall Effect pulse generator - Inductive pulse generator - Dwell angle control (open loop) - Capacitor discharge ignition - Electronic spark advance - Distributor less ignition - Coil on plug (COP) ignition - spark plugs		
Unit - III	**Fuel control:**	**9+3**
Combustion - Engine fueling and exhaust emissions - Emissions and driving cycles - Fuel injection - Double fuel injectors - Diesel fuel injection - Electronic control of diesel injection - Rotary pump system - Common rail system - Electronic unit injection (EUI) - Diesel lambda sensor - air–fuel ratio		
Unit - IV	**Engine management:**	**9+3**
Combined ignition and fuel injection system - Exhaust emission control - Engine design - Catalytic converters - Closed loop lambda control - Engine management systems - Other aspects of engine management system.		
Unit - V	**Vehicle Safety and Comfort:**	**9+3**
Anti-lock brakes - Traction and stability control - Active suspension - Automatic transmission - Other chassis electrical systems - Advanced chassis systems technology - Comfort and safety - Seats, mirrors and sun-roofs - Central locking and electric windows - Cruise control - Airbags and belt tensioners - Advanced comfort and safety systems technology - Cruise control and system response - Radio suppression calculations		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Tom Denton., "Automobile Electrical and Electronic Systems", 5th Edition, Routledge, United Kingdom, 2017.

REFERENCES/ MANUAL / SOFTWARE:

1.	William Ribbens., " Understanding Automotive Electronics an Engineering Perspective", 8th Edition, Elsevier Science,2017.
2.	Robert Bosch GmbH., "Bosch Automotive Handbook", 10th Edition , Wiley, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design and implement the electrical circuits for charging and starting systems	Applying (K3)
CO2	describe the layout and types of ignition system used in gasoline engine	Understanding (K2)
CO3	execute the different elements of fuel injection systems in engines.	Applying (K3)
CO4	explain about the role of electronic control in engine management system	Understanding (K2)
CO5	carryout the various safety and comfort systems in vehicles	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	3	1	1								1		
CO2	3	3	1	1								1		
CO3	3	3	1	1								1		
CO4	3	3	1	1								1		
CO5	3	3	1	1								1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	15	50	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO02 - VEHICLE MAINTENANCE							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on maintenance and servicing of various systems in automobiles.	
Unit - I	**Maintenance procedure and tools:**	**9+3**
Maintenance need, policies – Classification of maintenance – Service intervals - Automotive service procedures – Workshop operations, vehicle insurance -Towing and recovering - Safety – Personnel, equipment and vehicles. Fire safety - First aid - Shop hand tools – Measuring instruments.		
Unit - II	**Engine Maintenance:**	**9+3**
General Engine service- Dismantling of Engine components- Engine repair - Working on the underside, front, and top of engine, Condition checking of seals, gaskets, and sealants in engine- Cooling system service, lubrication system service, Fuel system service - Electronic fuel injection and engine management service. Fault diagnosis using Scan tools, On and Off Board Diagnostics. Exhaust system - Servicing for parts of emission control systems.		
Unit - III	**Driveline Maintenance:**	**9+3**
Clutch - General checks, adjustment and service. Transmission and transaxle - Dismantling, identifying, checking and reassembling. Removing and replacing propeller shaft. Servicing of yokes, cross of universal joint and constant velocity joints. Rear axle service - Removing axle shafts, bearings. Servicing of differential assembly.		
Unit - IV	**Chassis Maintenance:**	**9+3**
Maintenance of suspension systems -Macpherson strut, coil spring, leaf spring and shock absorbers. Maintenance of steering systems- Rack and pinion steering, Recirculating ball type steering, Worm type steering and Power steering. Maintenance of Brake systems- Bleeding of brakes. Maintenance of wheel**-** Tire wear, tire rotation, Tire change, Wheel balance and Wheel alignment.		
Unit - V	**Electrical and HVAC Maintenance:**	**9+3**
Electrical: Maintenance of battery, starting, charging and lighting systems. **HVAC Maintenance**: Maintenance of A/C system parts-compressor, condenser, expansion valve and evaporator. Replacement of A/C hoses- Leak detection- AC Charging.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	William H. Crouse and Donald l. Anglin, "Automotive Mechanics"., 10th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	Ed May & Les Simpson., "Automotive Mechanics" Volume I and II", 8th Edition, McGraw Hill Education, New Delhi, 2009.
2.	Jigar A. Doshi, Dhruv U. Panchal &Jayesh P. Maniar, "Vehicle Maintenance and Garage Practice", PHI Learning Pvt. Ltd, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	discuss the importance of maintenance, workshop practices, tools and safety requirements for automobiles	Understanding (K2)
CO2	explain the maintenance procedure of engine and its sub-systems	Understanding (K2)
CO3	illustrate the maintenance related issues with transmission and drive line	Understanding (K2)
CO4	identify the service practices in the steering, brake, suspension and wheel	Understanding (K2)
CO5	asses the maintenance cum troubleshooting aspects in electrical and air-conditioning systems.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					2		
CO2	3	2			2		2					2		

CO3	3	2					2					2		
CO4	3	2					2					2		
CO5	3	2					2					2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	15	65	20				100
ESE	15	70	15				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO03 - PUBLIC TRANSPORT MANAGEMENT							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on motor vehicle act, vehicle taxation, vehicle insurance and transport operation structure	
Unit - I	**Introduction:**	**9**
Personnel management - Objectives and functions – Psychology -Sociology and their relevance to organization. Drivers and conductors: Job description -Employment tests – Interviewing - Training procedure and psychological tests.		
Unit - II	**Motor Vehicle Act:**	**9**
Short titles and definitions - Laws governing to use of motor vehicle & vehicle transport - Traffic rules and signs - Licensing of drivers & conductors - Responsibility of driver. Accidents - Causes & analysis. Rules regarding construction of motor vehicles - Registration of vehicle - State and interstate permits - Liabilities and preventive measures - Offenses and penalties - Different types of forms - Government motor vehicle administration structure.		
Unit - III	**Taxation and Insurance:**	**9**
Objectives, structure and methods of levying taxation - Onetime tax - Tax exemption - Tax renewal and online tax payment. Insurance: Insurance types - Significance and renewal- Furnishing particulars of vehicles involved in an accident - Duty of driver in case of an accident -Hit and Run case -Surveyor and loss assessor - surveyor's report -Motor Accident Claims Tribunal -Solatium Fund.		
Unit - IV	**Transport Operation:**	**9**
Structure of passenger transport organizations - Depot layouts and requirements -Route planning - Scheduling of passenger transport vehicles - Preparation of timetable and fare structure - Methods of fare collection - Structure of goods transport organizations - Scheduling of goods transport vehicles - Management Information System (MIS) in goods transport operation - Storage & transportation of petroleum products -Operation cost, revenues and records.		
Unit - V	**Maintenance Management:**	**9**
Service advisor - Roles and Responsibilities - Job card and service record preparation - Trial run to understand customer complaints - Time and cost analysis for repair works - Precautions before carrying out repair works -Training procedure for mechanic - Inventory control in stores - Customer longue requirements - Customer feedback systems - Workshop Maintenance software.		
		Total:45

TEXT BOOK:

1.	"Motor Vehicle Act"., Govt. of India Publications.

REFERENCES:

1.	Santosh Sharma., "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi, NA.
2.	Patankar P G., "Road Passenger Transport in India", CIRT, Pune.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate interviewing and training procedures for drivers and conductors	Understanding (K2)
CO2	exemplify public & vehicle issues with help of motor vehicle act	Understanding (K2)
CO3	identify appropriate tax and insurance policies for their own vehicle	Understanding (K2)
CO4	discuss the operation cost and revenues of transport operation	Understanding (K2)
CO5	explain the management principles involved in maintenance	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3	2				3		

CO2	3	2				3	3	2				3		
CO3	3	2				3	3	2				3		
CO4	3	2				3	3	2				3		
CO5	3	2				3	3	2				3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO04 - AUTONOMOUS VEHICLES							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	To acquire knowledge on the concept of automated driving techniques and the contribution of artificial intelligence with case studies of an autonomous vehicle.	
Unit – I	**Automated Driving:**	**9**
Introduction to ADV - Safety - Vehicle and its occupants – External people and property - Service and repair - IMI TechSafe.		
Unit – II	**Advanced driver assistance systems:**	**9**
Introduction to ADAS - Example Systems - Adaptive Cruise control - Obstacle Avoidance Radar - Basic reversing aid – Radar - Stereo Video Camera - Rear Radar - Functional Safety and Risk.		
Unit – III	**Automated driving technologies:**	**9**
Introduction - Road to Autonomy – Perception - Lidar Operation - Sensor Positioning - Automated Driving System – Mapping - Other technologies – Connectivity - Artificial Intelligence - Top-down and Bottom-up AI - Deep learning - End to End Machine Learning.		
Unit – IV	**Social and human issues:**	**9**
Introduction - Public reaction to CAVs – Insurance - Mobility as a Service - Global Overview - UK - European union – US - japan and china.		
Unit – V	**Case studies:**	**9**
Nvidia – Bosch - Google (Waymo) - Tesla Autopilot – Audi - Jaguar Land Rover - Toyota Guardian – FLIR - First sensor AG.		
		Total:45

TEXT BOOK:

1.	Tom Denton., "Automated Driving and Driver Assistance Systems", 1st Edition, Routledge, Taylor & Francis Group, United Kingdom, 2020.

REFERENCES:

1.	Maurer, Markus, J. Christian Gerdes, Barbara Lenz, and Hermann Winner., “Autonomous driving: technical, legal and social aspects” Springer Nature, 2016.
2.	Coppola, Pierluigi, and Domokos Esztergár-Kiss., “Autonomous Vehicles and Future Mobility”, Elsevier, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the safety aspects of autonomous vehicles.	Understanding (K2)
CO2	describe advanced driver assistance systems for autonomous vehicles.	Understanding (K2)
CO3	illustrate automated driving technologies with sensor positioning.	Applying (K3)
CO4	apply the artificial intelligence techniques to autonomous vehicles.	Applying (K3)
CO5	analyse the specifications of autonomous vehicles from various manufacturers.	Analyzing (K4)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	45	35				100
CAT3	10	35	20	35			100
ESE	10	40	35	15			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ECX01 - BASICS OF ELECTRONICS IN AUTOMATION APPLIANCES							
(Offered by Department of Electronics and Communication Engineering)							
Programme & Branch	**All BE/BTech Branches except Electronics and Communication Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	To understand the working principles of electronics in appliances and identity the applications of sensors in electronic Device.	
Unit – I	**Introduction to Electronic Components:**	**9**
Switches – Mechanical switches – Poles and throws – Push-button switches – Resistors – Capacitors – Diodes – Transistors – Power Source – Batteries – Soldering – Safety – Applications.		
Unit – II	**Electronics and Sensors in Practice:**	**9**
Motors and controllers – Sensors – Accelerometers – Digital compasses or Magnetometers – Light and Color sensors – Infrared remote – Microwave oven – Television (TV) – Washing machine – Air Conditioner (AC) – Vacuum cleaner		
Unit – III	**Electronics in Automotive System Gadgets**:	**9**
Basics of electronic engine control: Concept of an electronic engine control system- Cruise control electronics- Antilock braking system- Electronic suspension control system - Blind spot detection- Automatic collision avoidance system		
Unit – IV	**IoT Enabled Automation System Architecture:**	**9**
Towards industrial and societal automation and digitization - Arrowhead framework architecture- Engineering of an arrowhead compatible multi domain facility - Component-based engineering methodology- Safety and security engineering of IoT automation systems. Case study: Complex system management and automation		
Unit – V	**Electronic Product Safety Standards:**	**9**
Product Safety Standards: What Is a Standard, Structure of the product safety standard - Conformity to product safety standards- Types of product safety standards- Objectives for products safety standards- product safety standard developers- Means of Protection- Constructive aspects related to EMC- Serviceability.		

EXPERIMENTS:

1.	Measurement of temperature using Thermistor
2.	Measurement of temperature using Thermocouple
3.	Measurement of torque/ Strain using Strain Gauge
4.	Speed measurement using Encoder and Opto-coupler
5.	Measurement of displacement using Potentiometer
6.	Measurement of displacement using LVDT / Capacitive transducer

Lecture: 45 Practical: 30 Total:75

TEXT BOOK:

1.	Westcott, S., & Westcott, J. R, "Basic Electronics: Theory and Practice", 3rd Edition Stylus Publishing, LLC,2020, for Units I, II.
2.	William B. Ribbens, "Understanding Automotive Electronics an Engineering Perspective", 8th Edition, Elsevier UAS,2017 , for Unit III.

REFERENCES:

1.	SteliLoznen, Constantin Bolintineanu, Jan Swart,"Electrical Product Compliance and Safety Engineering", Artech House Publishers, 1st Edition, 2017, for Unit IV
2.	BY Jerker Delsing, "IoT Automation - Arrowhead Framework", CRC Press, USA, 1st Edition 2017, for Unit V

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand basic of electronic components	Understanding(K2)
CO2	demonstrate real life electronic appliances	Understanding(K2)

CO3	conceptualize the connected device architecture	Applying(K3) / Precision(S3)
CO4	relate electronics in modern automotive	Understanding(K2) / Precision(S3)
CO5	relate the requirements of safety standard for different products	Understanding(K2) / Precision(S3)

Mapping of COs with POs and PSOs													
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2								2	2		
CO2	2	2	2			2	2				2	2		
CO3	2	2	2	2		2	2	3			2	2		
CO4	2	2	2	2		2	2	3			2	2		
CO5	2	2	2	2		2	2	3			2	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80	-	-	-	-	100
CAT2	10	60	30	-	-	-	100
CAT3	20	80	-	-	-	-	100
ESE	20	65	15	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ECX02 – IMAGE PROCESSING							
Programme & Branch	**All BE/BTech Branches except Electronics and Communication Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**
Preamble	This course enables the students to learn and apply the various Digital Image Processing techniques on real time images						
Unit - I	**Digital Image Fundamentals:**						**9**
Brightness– Contrast– Hue– Saturation– Mach band effect, Image sampling– Quantization, Basic relationship between pixels-Color image fundamentals – RGB– HSI models - Need for transforms - DFT-DCT- Haar Transform							

Unit - II	Image Enhancement and Restoration:	9
Image Enhancement: Basic intensity transformations – Piecewise linear transformation functions, Histogram equalization - Spatial and Frequency domain filtering: Smoothing and sharpening filters.		
Unit - III	**Image Restoration**	**9**
Image Degradation model - Noise distributions– Median – Geometric mean – Harmonic mean – Contra harmonic mean filters – Order Statistics filters – Inverse and wiener filtering – Constrained least square filtering.		
Unit - IV	**Image Segmentation, Representation and Description:**	**9**
Point, line and edge detection – Basics of intensity thresholding – Region based segmentation : Region growing – Region splitting and merging, Morphology – dilation and erosion – opening and closing		
Unit - V	**Image Compression:**	**9**
Fundamentals: Fidelity Criteria – Types of redundancy – Huffmann – Run length coding – Arithmetic coding –Block Transform Coding - Lossless and Lossy Predictive coding		

LIST OF EXPERIMENTS / EXERCISES:

	Simulation of the following Image Processing techniques:
1.	Finding DCT of an input image
2.	Image enhancement using basic intensity transformation techniques.
3.	Contrast enhancement using Histogram Equalisation
4.	Edge Detection in images using image sharpening masks
5.	Restoration of an original image by the addition of noise (Gaussian & Impulse)
6.	Morphological operation on an input image

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Rafael C Gonzalez & Richard E Woods, "Digital Image Processing", 4th Edition, Pearson Education, New Delhi, 2020

REFERENCES/ MANUAL / SOFTWARE:

1.	Jayaraman S, Esakkirajan S & Veerakumar T, "Digital Image Processing", 1st Edition, 22nd Reprint, Tata McGraw Hill, New Delhi, 2018.
2.	Alan C. Bovik, “The Essential Guide to Image Processing”, 1st Edition, Academic Press, 2009
3.	Anil K Jain, "Fundamentals of Digital Image Processing", 4th Edition, PHI Learning, New Delhi, 1995.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the fundamental concepts and image transforms	Applying (K3) / Precision (S3)
CO2	apply Image enhancement in both spatial and frequency domain to improve the quality of images	Applying (K3) / Precision (S3)
CO3	Use image restoration techniques to restore the original images from noisy images	Applying (K3) / Precision (S3)
CO4	identify the features and region of interest of an image using segmentation, representation and description techniques for image classification	Applying (K3) / Precision (S3)
CO5	employ image compression algorithms on digital images	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	2	2	3				2	2		2		
CO2	3	2	2	2	3				2	2		2		
CO3	3	2	2	2	3				2	2		2		
CO4	3	2	2	2	3				2	2		2		
CO5	3	2	2	2					2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30	-	-	-	100
CAT2	10	60	30	-	-	-	100
CAT3	10	60	30	-	-	-	100
ESE	10	60	30	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ECX03- PCB DESIGN AND FABRICATION

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Branches except Electronics and Communication Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	2	4

Preamble	To fabricate PCB boards	
Unit – I	**Introduction to PCB Designing Concepts:**	**9**
Types of components used in PCB - Types of PCBs: Single layer - Double layer and Multi-layer PCB - Flexible PCB - PCB manufacturing basics		
Unit – II	**PCB Design Considerations:**	**9**
General, Mechanical and Electrical considerations - Design rules for Analog, Digital and High frequency circuits - Electromagnetic Interference/ Compatibility (EMI/ EMC).		
Unit – III	**Design and Simulation of PCB:**	**9**
Electronic Design Automation (EDA) Tools – Single layer PCB, Two layer PCB - Circuit design and simulation - Creating footprint, Placement and routing, Generating Gerber file for single layer PCB.		
Unit – IV	**PCB Fabrication Techniques:**	**9**
Image transfer techniques - Plating techniques: Immersion, Electro less, Electroplating, Solder Mask, Etching techniques, Mechanical operations		
Unit – V	**Circuit Tracing and Testing:**	**9**
Soldering techniques - Testing PCB - Environmental concern - Case studies: Power supply, Wien-bridge oscillator.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Study of CAD for PCB Design
2.	Soldering and de-soldering the components on the PCB including SMD devices

3.	Design and Simulation of 230V AC to 5V/9V/12V DC Power Supply in CAD Tool
4.	Design, simulating, assembling and soldering of IR Sensor Module
5.	Preparation of layout from the circuit design
6.	Troubleshooting of single layer and multi-layer PCB
7.	Miniproject

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Khandpur R.S., "Printed Circuit Board: Design, Fabrication, Assembly and Testing", 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2017 for Units I,II, IV,V.
2.	Laboratory Manual for Unit III.

REFERENCES/ MANUAL / SOFTWARE:

1.	Mehta S.D, "Electronic Product Design", 1st Edition, S Chand Publications, New Delhi, 2011.
2.	Clyde Coombs, "Printed Circuits Handbook", 6th Edition, McGraw Hill Professional, New Delhi, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	classify the different types of PCBs	Understanding (K2)
CO2	outline the PCB design rules and considerations	Understanding (K2)
CO3	apply the PCB design rules to develop and simulate single layer PCB	Applying (K3)/ Precision (S3)
CO4	experiment with a single layer PCB for a given circuit	Applying (K3)/ Precision (S3)
CO5	identify and rectify the faults in a PCB	Applying (K3)/ Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70	-	-	-	-	100
CAT2	30	50	20	-	-	-	100
CAT3	20	50	30	-	-	-	100
ESE	20	50	30	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ECO01- WEARABLE DEVICES							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches except Electronics and Communication Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**
Preamble	To understand the concept of wearable Sensors and its applications in various sectors						
Unit – I	**Data Acquisition and Sensor Characteristics :**						**9**
Sensors, Signals, and Systems-Sensor Classification-Units of Measurements-Sensor Characteristics: Transfer Function-Span (Full-Scale Input)- Full-Scale Output-Accuracy-Calibration-Calibration Error-Hysteresis-Nonlinearity-Saturation-Repeatability-Dead Band-Resolution-Special Properties-Output Impedance-Excitation-Dynamic Characteristics-Environmental Factors-Reliability-Application Characteristics-Uncertainty							
Unit – II	**Position, Displacement and Level Sensors :**						**9**
Potentiometric Sensors-Gravitational Sensors-Capacitive Sensors-Inductive and Magnetic Sensors-Optical Sensors-Ultrasonic Sensors-Radar Sensors-Thickness and Level Sensors							
Unit – III	**Sensors for Wearable Devices :**						**9**
Pressure Sensors-Flow Sensors- Acoustic Sensors-Humidity and Moisture Sensors-Light Detectors-Radiation Detectors-Temperature Sensors							
Unit – IV	**Chemical Sensors :**						**9**
Chemical Sensor Characteristics-Specific Difficulties-Classification of Chemical-Sensing Mechanisms-Direct Sensors-Complex Sensors-Chemical Sensors Versus Instruments							
Unit – V	**Scope of Wearable Devices:**						**9**
Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Smart watches, Smart glasses, fitness trackers, Wearables: Challenges and Opportunities, Future and Research Roadmap.							
							Total:45

TEXT BOOK:

1.	Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 5th edition., Springer, 2016, for Units I, II, III, IV.
2.	Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications" Elsevier, 2nd Edition., 2020 for Unit V.

REFERENCES:

1.	Subhas Chandra Mukhopadhyay, "Wearable Electronics Sensors - For Safe and Healthy Living",Ist Edition Springer 2015
2.	A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai. ",Ist Edition 2015
3.	Er. R.K. Rajput, "Electronic Measurements and Instrumentation", S. Chand & Company",Ist Edition 2009
4.	M. Mardonova and Y. Choi, "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, vol. 11, p. 547, 2018, for Unit V (Case Study)

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the concepts of Data Acquisition and Sensor Characteristics	Understanding(K2)
CO2	discuss the concepts of various wearable Position, Displacement and Level Sensors	Understanding(K2)
CO3	acquire knowledge on Sensors for Wearable devices	Understanding(K2)
CO4	describe the different chemical sensors in wearable	Understanding(K2)
CO5	apply the usage of wearable devices as assistive devices, diagnostic devices and other modern applications	Applying(K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70	-	-	-	-	100
CAT2	30	70	-	-	-	-	100
CAT3	20	40	40	-	-	-	100
ESE	20	40	40	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

2ECX04-ELECTRONIC HARDWARE AND TROUBLESHOOTING

(Offered by Department of Electronics and Communication Engineering)							
Programme & Branch	**All BE/BTech Branches except Electronics and Communication Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**2**	**0**	**2**	**3**

Preamble	To test and troubleshoot electronic hardwares	
Unit – I	**Introduction to Electronic Hardware Troubleshooting and Failure Analysis:**	**6**
Problem Solving analysis-Circuit faults-Troubleshooting methods-Safety considerations-Testing basic components-Semiconductors-Integrated Circuits-Electron tubes-Ultra capacitors-Inductors.		
Unit – II	**Troubleshooting Industrial Controls Device:**	**6**
Electronic Test Instruments: Digital multimeter-Oscilloscope, Troubleshooting industrial controls: Fundamentals-Types of controllers-Repair and Testing procedures-Preventive maintenance.		
Unit – III	**Troubleshooting Consumer Electronic Systems:**	**6**
Electric wiring circuit repair-Lighting and control system repair-TV distribution system repair- Fiber optic communication repair-Case study: Color CRT TV monitor troubleshooting.		
Unit – IV	**Troubleshooting Digital Circuits:**	**6**
Analog and Digital circuits: Binary Code-Logic gates-Digital technologies-Voltage specifications-Troubleshooting techniques, Opens and shorts: Open circuit- Open inputs - Open outputs- Short circuit, Installation and replacement of an IC chip, Troubleshooting equipment for digital circuits.		
Unit – V	**PCB Manufacturing, Maintenance and Safety Aspects:**	**6**
Troubleshooting biomedical equipment: Electrical safety and safety equipment-Trouble shooting: ECG systems-EEG systems-Ultra sound machines-X-ray machines.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Dismantling and Assembling of electronic hardware.
2.	Troubleshooting of digital circuits
3.	Troubleshooting of Shift registers
4.	Troubleshooting of speakers and amplifiers
5.	Troubleshooting of home appliances – Radio / TV
6.	Troubleshooting of PCB of Mobile phone/Modem

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1.	Daniel R. Tomal& Aram S. Agajanian, "Electronic Troubleshooting", 4th Edition, McGraw-Hill Education, New Delhi, 2014,

REFERENCES/ MANUAL / SOFTWARE:

1.	Khandpur .R.S, "Troubleshooting Electronic Equipment: Includes Repair And Maintenance", 2nd Edition, McGraw-Hill Education, New Delhi, 2011.
2.	Shashi Bhushan Sinha, "Handbook of Repair and Maintenance Of Domestic Electronics Appliances handbook", 1st Edition, BPB Publications, 2017.
3.	Michael Jaygeier, "How to Diagnose and Fix Everything Electronic", 2nd Edition, McGraw-Hill Education, New Delhi, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain troubleshooting principles for testing and point out the failures of electronic equipment.	Understanding (K2)
CO2	interpret the use of testing tools and instruments for troubleshooting electronic hardware.	Understanding (K2)
CO3	identify the faults and troubleshoot the home appliances using multimeter.	Applying (K3)/ Precision (S3)
CO4	apply troubleshooting principles for testing of digital circuits and amplifiers.	Applying (K3)/ Precision (S3)

CO5	apply troubleshooting principle of Biomedical equipment.	Applying (K3)/ Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60	-	-	-	-	100
CAT2	30	50	20	-	-	-	100
CAT3	20	40	40	-	-	-	100
ESE	20	50	30	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ECO02- OPTICAL ENGINEERING

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches except Electronics and Communication Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	To study about the various optical fiber modes, configuration and transmission characteristics of optical fibers

Unit – I	Introduction To Optical Fibers :	9
Introduction-general optical fiber communication system- basic optical laws and definitions-optical modes and configurations -mode analysis for optical propagation through fibers- transverse electric and transverse magnetic modes- fiber materials-fiber fabrication techniques-fiber optic cables-classification of optical fiber		
Unit – II	**Transmission Characteristic Of Optical Fiber :**	**9**
Attenuation-absorption --scattering losses-bending losses-core and cladding losses-signal dispersion –inter symbol interference and bandwidth-intra model dispersion-material dispersion- waveguide dispersion-polarization mode dispersion-intermodal dispersion-characteristics of single mode fiber-R-I Profile-cutoff wave length-dispersion calculation-mode field diameter.		
Unit – III	**Optical Sources And Detectors :**	**9**
Sources: Intrinsic and extrinsic material-direct and indirect band gaps-LED-LED structures-LASER diodes-modes and threshold conditions-Rate equations-external quantum efficiency-resonant frequencies-structures and radiation patterns, **Detectors:** PIN photo detector-Avalanche photo diodes-Photo detector noise-noise sources-SNR-detector response time-Avalanche multiplication noise-temperature effects-comparisons of photo detectors.		
Unit – IV	**Optical Receiver and Measurements :**	**9**
Fundamental receiver operation-preamplifiers-digital signal transmission-error sources-Front end amplifiers-digital receiver performance-probability of error. Optical power measurement-attenuation measurement-dispersion measurement- Fiber Numerical Aperture Measurements- Fiber cut- off Wave length Measurements		
Unit – V	**Optical Communication Systems And Networks :**	**9**
System design consideration Point – to –Point link design –Link power budget –rise time budget, WDM –Passive DWDM Components-Elements of optical networks-SONET/SDH Optical Interfaces-SONET/SDH Rings and Networks-High speed light wave Links-OADM configuration-Optical ETHERNET-Soliton.		
		Total:45

TEXT BOOK:

1.	P Chakrabarti, "Optical Fiber Communication‖, McGraw Hill Education (India) Private Limited, 2016 for Units I, II, III.
2.	GredKeiser, "Optical Fiber Communication‖, McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013 for UnitsIV, V.

REFERENCES:

1.	John M.Senior, "Optical fiber communication‖" , Pearson Education, second edition.2007.
2.	Rajiv Ramaswami, "Optical Networks", 2nd Edition, Elsevier , 2004

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	realize basic elements in optical fibers, different modes and configurations	Understanding (K2)
CO2	explain the transmission characteristics associated with dispersion and polarization techniques.	Understanding (K2)
CO3	apply optical sources and detectors with their use in optical communication system.	Applying (K3)
CO4	construct fiber optic receiver systems, measurements and coupling techniques	Applying (K3)
CO5	interpret optical communication systems and its networks.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60	-	-	-	-	100
CAT2	20	50	30	-	-	-	100
CAT3	20	40	40	-	-	-	100
ESE	20	50	30	-	-	-	100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22EEO01 – SOLAR AND WIND ENERGY SYSTEMS

Programme & Branch	All BE/BTech Branches Except EEE	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims in imparting the concepts and nuances of solar and wind energy systems along with its detailed design procedures and analysis.

Unit – I	**Introduction to Solar PV:**	**9+3**

Solar cell – Parameters of solar cell – Solar PV module – Ratings and parameters – Measuring module parameters – Solar PV module arrays – Factor affecting electricity generation by a solar cell and solar PV module.

Unit – II	**Types of PV Systems:**	**9+3**

Stand alone, grid connected and hybrid systems – Battery parameters – Battery selection – Charge controllers – DC-DC converters – Inverters – MPPT – Components of grid connected PV systems.

Unit – III	**Solar PV System Design:**	**9+3**

Design methodology for solar PV system: Approximate design of solar PV system – Solar PV system design chart – Look up table for solar PV system design – Installation and troubleshooting of solar PV power plants.

Unit – IV	**Introduction to WECS:**	**9+3**

Power output from an ideal turbine – Aerodynamics – Power output from practical turbines – Energy production and capacity factor – Methods of generating synchronous power – DC shunt generator with battery load – AC generators.

Unit – V	**Wind Power Plant Design:**	**9+3**

Site preparation – Electrical network – Selection of low voltage and distribution voltage equipment – Losses – Wind farm costs.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems – A Manual for Technicians, Trainees and Engineers", 1st Edition, PHI learning Private Limited, New Delhi, 2013 for Units I, II & III
2.	Gary L.Johnson, "Wind Energy Systems", Electronic Edition, Manhatan, KS, 2006 for Units IV & V

REFERENCES:

1.	Chetan Singh Solanki, "Solar Photovoltaics – Fundamentals, Technologies and Applications", 2nd Edition, PHI learning Private Limited, New Delhi, 2011.
2.	Spera, D.A., "Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering", 2nd Edition, ASME, New York, 2009.

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1	outline the parameters and ratings of solar cell and modules	Understanding (K2)
CO2	make use of various components intended for solar PV system design	Applying (K3)
CO3	apply the design procedures for solar PV systems towards installation	Applying (K3)
CO4	identify the required components for wind energy conversion system	Understanding (K2)
CO5	examine the design and installation procedures for WECS	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3			1	1					1		
CO2	3	3	2			1	1					1		
CO3	3	3	2			1	1					1		
CO4	3	2	3			1	1					1		
CO5	3	3	2			1	1					1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	30	40	30				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22EEO02 – ELECTRICAL WIRING AND LIGHTING							
Programme & Branch	**All BE/BTech Branches Except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Lighting becomes one of the essential requirements for the humans on day-to-day activities. Hence it is necessary to educate an engineer in the aspects of Domestic and Industrial Lighting. The idea of the subject is to educate the electrical engineers on the aspect of Introduction to Wiring and its Design considerations, Installations, Light and Luminaires and Light sources.	
Unit – I	**Introduction:**	**9+3**
Electric supply system – List of Electrical Symbols and its interpretation – Electrical Diagrams – System of connection of Appliances and accessories – Example circuits – Panel Boards – Earthing – Different types of wires, wiring system, methods and materials – Fuse Calculation and Circuit breakers – Wiring Tools – IE rules for wiring		
Unit – II	**Domestic Wiring:**	**9+3**
Three phase four wire distribution system – Protection – General requirements of electrical installations – Testing of installations – Types of Loads – Service connections – Service mains – Sub-Circuits – Location of main board and Distribution board – Guidelines for installation of fittings – Voltage drop and size of wires – safety		
Unit – III	**Industrial Wiring:**	**9+3**
Electrical installation for residential buildings - Estimating and costing of material – Solved examples for residential buildings with Problems – Electrical installations for commercial buildings –Electrical installations for small industries		
Unit – IV	**Illumination:**	**9+3**
Introduction – Terms & Definitions – Laws of Illumination – Polar curves – Photometry – Basic principles of Light control – Types of Lighting Schemes – Design of Lighting Schemes – Methods of Lighting calculation with Problems – Factory, Street & Flood Lighting		
Unit – V	**Light Sources:**	**9+3**
History of the electric lamp – Arc lamps – Incandescent Lamps – Gaseous discharge lamps: Sodium vapour discharge lamp, High pressure mercury vapour discharge lamp, Mercury iodide lamp, Neon lamp, Fluorescent Tubes, CFL – LED's		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Raina K.B & Bhattacharya S.K, "Electrical Design Estimating and Costing", 2nd Edition, New Age International Publishers, 2017 for Unit I,II,III
2.	Gupta J.B, "Utilization of Electric Power and Electric Traction", 10th Edition, S.K.Kataria& Sons, 2012 for Unit IV,V

REFERENCES:

1.	Pritchard D.C, "Lighting", 6th Edition, Routledge, 2016
2.	Ronald N. Helms, "Illumination Engineering for energy efficient luminous environments", 1st Edition, Prentice–Hall, Inc, 1980

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	discuss the various methods in wiring	Understanding (K2)
CO2	infer the different design considerations in Domestic wiring	Understanding (K2)
CO3	demonstrate the various Electrical Installations	Applying (K3)
CO4	describe the various lighting and its controls	Understanding (K2)
CO5	demonstrate the various types of light sources	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1		

CO2	3	2	1									1		
CO3	3	2	1	1	1							1		
CO4	3	2	1									1		
CO5	3	2	1	1	1							1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO03 – ELECTRICAL SAFETY							
Programme & Branch	**All B.E/B.Tech Branches Except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course imparts the knowledge about the electrical hazards and its safety measures in electrical systems.	
Unit – I	**Hazards Of Electricity:**	**9+3**
Introduction: Objective of safety - Safety Oath, National safety day – Types of safety – Common safety measures – Types of Hazards – Hazards associated with electrical current and voltage – Electrical safety. Definition of terms: Electric shock, Arc and blast. Shock: Impact of electric shock – Influencing factors. Arc – Initiation of Arc – Impacts of Arc – Arc energy release: Arc energy input – Arcing voltage – incident energy – measurement – copper calorimeter – Stoll curve.		
Unit – II	**Personnel Protection Equipment (PPE):**	**9+3**
Flash and thermal protection: Glossary of terminologies – flame resistant, arc thermal performance value (ATPV), energy breakthrough (EBT) – ASTM standard for clothing materials – choice of clothing – flame and non-flame resistant materials – guidelines for selection – Flash Suit. Head Protection: Hard hats – ANSI Z 89.1 standard – Eye Protection - requirements of safety glasses, goggles – selection - Face shield. Hearing Protection – Requirement –ear plugs and ear muffs – Noise reduction ratio – thumb rule. Arm and Hand Protection: Rubber gloves – ASTM standards – leather protective glove – level of protection. Foot and leg protection and respiratory protection.		
Unit – III	**Electrical Safety Equipment:**	**9+3**
Voltage measuring instruments: Safety voltage measurement – contact and non-contact type testers – selection criteria. Rubber Insulating equipment: Rubber mats, blankets, covers, line hoses and sleeves – Inspection techniques – standards. Insulated tools – hot sticks – cherry picker – standards for tools – safety barriers and signs – safety tags, lock and locking devices. Fire extinguishers – fire safety against electrical fire – types of extinguishers.		
Unit – IV	**Safety Earthing Practices:**	**9+3**
Step potential, touch potential – types of grounding- advantages- Distinction between system grounding and equipment grounding – Functional requirement of earthing systems – earth electrodes – types. – Earth resistance measurements- Residual Current Device -composition of RCD-operation- advantages.		
Unit – V	**First Aid and Rescue:**	**9+3**
First Aid: First aid against electric shock, choking, poisoning, wounds and bleeding, burns and scalds, fractures and dislocations, heat stroke and snake bite. Rescue: Primary rescue methods – American Red Cross method. Types: elevated rescue, confined space rescue and ground level rescue. Regulatory Bodies: Functionality – IEEE, IEC, ASTM, NFPA and OSHA.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	John Caddick., Mary Capelli Schellpfeffer& Dennis Neit zell., “Electrical Safety Handbook” , 4th Edition, McGraw Hill Publishers, 2012.

REFERENCES:

1.	Rao.S, Jain R.K &Saluja H.L., “Electrical Safety, Fire Safety Engineering and Safety Management”, 2nd Edition, Khanna Publishers, 1997.
2.	Peter E. Sutherland., “Principles of Electrical Safety” IEEE Press Series on Power Engineering, John Wiley and Sons, New Jersy, March 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the various terminologies and hazards related to electrical safety	Understand (K2)
CO2	identify and apply the personnel protection equipment for a typical industry	Applying (K3)
CO3	apply the various measuring and insulating equipment’s for electrical safety	Applying (K3)
CO4	apply the safety earthing practices for LV and HV system	Applying (K3)
CO5	understand the functionality of international regulatory bodies, first-aid and rescue procedures	Understand (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	1				1	1			1	1		
CO2	3	1	2				1	1			1	1		
CO3	3	1	2				1	1			1	1		
CO4	2	1	3				1	1			1	1		
CO5	1	2	3				1	1			1	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	30	30	-	-	-	100
CAT2	40	20	40	-	-	-	100
CAT3	50	40	10	-	-	-	100
ESE	30	40	30	-	-	-	100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO04 – ANALOG AND DIGITAL ELECTRONICS							
Programme & Branch	**All B.E/B.Tech Branches Except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart knowledge on the analog and digital electronics that aids the students to perform the design and analysis of various electronic and digital logic circuits	
Unit – I	**Bipolar Junction Transistor:**	**9+3**
Construction and operation of a Transistor – Currents in transistor – Input and Output characteristics of a transistor in CE, CB and CC configurations– Current gain in CE, CB and CC configurations – Operating point – Stability and stability factor: Fixed bias circuits and Voltage-divider bias - Hybrid model of BJT.		
Unit – II	**FET, MOSFET and UJT:**	**9+3**
Construction and characteristics of JFET – Parameters of JFET – FET in CS, CD and CG Configurations – Construction, characteristics of MOSFET in Depletion and Enhancement mode – Applications of MOSFET – Construction, theory of operation and characteristics of UJT – UJT as relaxation oscillator.		
Unit – III	**Combinational Circuits:**	**9+3**
Design Procedure – Binary Addition – Binary Subtraction – Decoders – Encoders – Multiplexers – Demultiplexers – Code Conversion: Gray to Binary, Binary to gray, BCD to Binary, Binary to BCD – Magnitude comparators: 1 bit, 2 bit.		
Unit – IV	**Sequential Circuits:**	**9+3**
Latches and Flip-flops – SR, JK, D, T Flip-flops – Master slave Flip-flop - Conversion of one type of flip-flop to another type – Operating characteristics of Flip-flops – counters – Shift registers – Universal Shift registers.		
Unit – V	**Logic Families and Memory devices:**	**9+3**
Transistor Transistor Logic (TTL): Two-input TTL NAND Gate – Emitter Coupled Logic (ECL) - Inverter: Complementary Metal Oxide Semiconductor (CMOS) Logic – Comparison of Logic families for their performance. Memory Types: Memory Devices: Static RAMs (SRAMs) - Dynamic RAMs (DRAMs). Read-Only Memory (ROM) organization – Types of ROMs: PROM, EPROM & EEPROM.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Sedha R.S., "A Textbook of Applied Electronics ", 4th Edition, S.Chand & Co. Ltd., New Delhi, 2014 for Units I,II.
2.	Soumithra Kumar Mandal, “Digital Electronics Principles and Applications”, Eleventh Reprint Edition, Tata Mc Graw Hill, New Delhi, 2017

REFERENCES:

1.	Salivahanan S. and Suresh Kumar N., "Electronic Devices and Circuit ", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017.
2.	Anand Kumar.A, “Fundamentals of Digital Circuits” 4th Edition, Prentice Hall of India, Chennai, 2016
3.	Salivahanan, S and Arivazhagan, —Digital Circuits and Design‖, 4th Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Analyse the characteristics and stability of BJT	Applying (K4)
CO2	acquire knowledge about the operation and characteristics of FET and UJT	Understanding (K2)
CO3	Illustrate combinational logic circuits using logic gates.	Applying (K3)
CO4	Design counters and shift registers using flip-flops.	Analyzing (K3)
CO5	identify the logic families and memory devices	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	30	20			100
CAT2	10	30	60				100
CAT3	10	40	50				100
ESE	5	35	40	20			100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO05 - POWER ELECTRONICS AND DRIVES							
Programme& Branch	**All B.E/B.Tech Branches Except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course is designed to impart knowledge about the characteristics of power semiconductor devices, working principle of rectifier, chopper, DC to AC converter and AC to AC converter	
Unit – I	**Unit Title:** Power Semi-Conductor Devices:	**9+3**
Introduction – Power BJT – Power MOSFET - IGBT – SCR - Construction, Principle of operation, Static and Dynamic characteristics - Thyristor Protection – Series and parallel connections of thyristors.		
Unit – II	**Unit Title:** AC Converters:	**9+3**
Single phase controlled rectifiers with R, RL Loads: Estimation of RMS load voltage and RMS load current - Principle of AC voltage controller - Single Phase AC Voltage Controllers - Principle of cycloconverter - Single Phase to Single Phase Cycloconverter: step down and step up.		
Unit – III	**Unit Title:** DC Converters:	**9+3**
Principle of Step Up and Down Chopper – Chopper Control Strategies – SMPS - Single Phase Bridge Inverters - PWM Inverters: Single, Sinusoidal PWM technique - UPS		
Unit – IV	**Unit Title:** DC Drives	**9+3**
Elements of Electrical drives - Speed Control of DC Motors – Ward Leonard Scheme – Drawbacks – single phase fully controlled rectifier control of dc separately excited motor – chopper controlled separately excited DC drives.		
Unit – V	**Unit Title:** AC and Special Machine Drives	**9+3**
Three phase induction motor Drive: V/f control - Synchronous Motor Drives: self-controlled synchronous motor drive employing load commutated thyristor inverter - Brushless DC motor drives - permanent magnet stepper motor Drives – Drives for specific applications: Textile mills – Steel rolling mills.		

Lecture: 45, Tutorial :15, Total:60

TEXT BOOK:

1.	Bimbhra P.S., "Power Electronics", 6th Edition, Khanna Publishers, New Delhi, 2018
2.	Dubey G.K. "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2019.

REFERENCES:

1.	Singh M.D. and Khanchandani, "Power Electronics", 2nd Edition, Tata McGraw-Hill, New Delhi, 2017.
2.	Vedam Subrahmanyam "Electric Drives: Concepts and Applications", 2nd Edition, McGraw-Hill, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	choose various power semiconductor devices based on their construction, operation and characteristics	Understanding (K2)
CO2	explain the working principle of ac converter and compute its performance parameter	Understanding (K2)
CO3	Classify and explain the working principle of dc converters	Understanding (K2)
CO4	Apply power converters for speed control of DC drives	Applying (K3)
CO5	Understand the operation of AC Drive and special machines Drives and its control schemes for various industrial applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**2**	**3**	**1**					**1**					
CO2	**3**	**2**	**3**	**1**	**1**	**1**			**1**					
CO3	**3**	**1**	**3**	**1**	**1**	**1**			**1**					
CO4	**3**	**2**	**3**	**1**	**1**	**1**			**1**					

CO5	**3**	**1**	**3**	**1**	**1**	**1**			**1**					
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														
ASSESSMENT PATTERN - THEORY														
Test / Bloom's Category*	**Remembering (K1) %**		**Understanding (K2) %**		**Applying (K3) %**		**Analyzing (K4) %**		**Evaluating (K5) %**		**Creating (K6) %**		**Total %**	
CAT1	20		60		20								100	
CAT2	20		50		30								100	
CAT3	20		50		30								100	
ESE	20		50		30								100	
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)														

22EEO06 - SENSORS AND ACTUATORS							
Programme & Branch	**All B.E/B.Tech Branches Except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course helps the students to impart the knowledge to interface various sensors and actuators in embedded applications.

Unit – I	**Inductive Transducers**	**9+3**

Introduction: Difference between sensor, and transducer- Principles- Classification of sensors- Static and Dynamic characteristics of sensors – Environmental parameters – Characterization
Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer- Inductive proximity sensor

Unit – II	**Capacitive & Radiation Sensors**	**9+3**

Capacitive transducers: - The parallel plate Capacitive sensor – Serrated plate Capacitive sensor – Variable Permittivity Sensor – Electro static transducer
Radiation Sensors: Types of photosensistors/photo detectors**:** The Photo emissive Cell and the Photomultiplier - The Photoconductive Cell- Photovoltaic and Photo junction Cells - Position-sensitive Cell**.** Fibre optic sensors: Liquid level sensing – Fluid flow sensing

Unit – III	**Thermal and Magnetic Sensors**	**9+3**

Thermal Sensors: Gas Thermometric Sensors - Acoustic Temperature Sensor - Resistance Change Type Thermometric Sensors-Thermoemf Sensors
Magnetic Sensors: Sensors and the principles – Magneto Resistive sensors – Hall effect Sensors – Inductance and Eddy current sensors – Angular/Rotary movement sensors – Switching magnetic sensors

Unit – IV	**Smart sensors and Applications of sensors**	**9+3**

Smart Sensors: Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Standards for Smart Sensor Interface, MEMS
Sensors Applications: On-Board Automobile Sensors – Home Appliance sensors-Aerospace sensors-Medical Diagnostic sensors-Sensors for environmental monitoring.

Unit – V	**Actuators**	**9+3**

Thermo Mechnaical Actuators -Optical Actuators - Capacitive Actuators -Magneto strictive Actuators -Motors as actuators: Operation principles-BLDC Motors-AC motors-Stepper Motors-Linear Motors-Piezo electric actuators

Lecture: 45, Tutorial :15, Total:60

TEXT BOOK:

1.	Patranabis, Sensors and Transducers, 2nd Edition, PHI, 2022. Unit I, II, III, IV

REFERENCES:

1.	De Silva and Clarence W, Sensors and Actuators Engineering System Instrumentation, 2nd Edition, CRC Press, 2015.
2.	Nadhan Ida, Sensors, Actuators, and Their Interfaces: A Multidisciplinary Introduction, Sci Tech Publishing, 2013
3.	Jacob Fraden, Handbook of Modern sensors: Physics, Design and Applications, 5th Edition, Springer, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the theory and working behind the inductive transducers	Understanding (K2)
CO2	Describe the construction and working of Capacitive and Radiation sensors	Understanding (K2)
CO3	Elaborate the various types of thermal and magnetic sensors and its principle of operation	Understanding (K2)
CO4	demonstrate the working of various types of sensors used in real world applications	Applying (K3)
CO5	Illustrate the working principle of Actuators and electrical actuating systems	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			1						1		

CO2	3	2	1			1						1		
CO3	3	2	1			1						1		
CO4	3	2	1			1						1		
CO5	3	2	1			1						1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85					100
CAT2	15	85					100
CAT3	10	60	30				100
ESE	10	70	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO07 – ENERGY CONSERVATION AND MANAGEMENT

Programme & Branch	All B.E/B.Tech Branches Except EEE	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course aims in imparting the procedures of energy audit, energy management and financial management. Also it aims to impart knowledge on energy conservation opportunities in thermal utilities, electrical system, lighting Systems and in buildings

Unit – I	**Introduction:**	**9+3**

Classification of Energy - Energy Scenario - Energy Needs of Growing Economy - Energy Pricing in India – Energy and Environment - Energy Conservation Act. Energy Audit: Types and Methodology - Energy Audit Instruments - Role of energy managers and auditors

Unit – II	**Thermal Utilities:**	**9+3**

Steam – Introduction, Properties of steam, Steam distribution systems, Boilers- Types and Classification- Performance Evaluation of Boilers – Losses in Boiler – Energy Conservation opportunities in boilers, Waste heat recovery - Classification and benefits

Unit – III	**Electrical and Lighting System:**	**9+3**

Introduction to Electric Power Supply Systems - Electrical Load Management and Maximum Demand Control- Power factor improvement and its benefit, Basic Parameters and Terms in Lighting systems - Luminous performance Characteristics of commonly used luminaries and Energy saving opportunities in lighting systems

Unit – IV	**Energy Conservation in Buildings and ECBC:**	**9+3**

About ECBC – Building Envelope, Fenestrations, Insulation, HVAC, Lighting, Water pumping, Inverter – Elevators and Escalators – Star Labeling for existing buildings

Unit – V	**Financial Management:**	**9+3**

Investment – need, Appraisal and criteria, financial analysis techniques – Simple payback period – Return on investment – Net present value – Internal rate of return – Cash flows, Risk and sensitivity analysis – Financing options – Energy performance contracting and role of ESCOs.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Guide Books for National Certification Examination for energy managers and Auditors, 3rd Edition, Bureau of Energy Efficiency,2010

REFERENCES:

1.	Wayne C. Turner & Steve Doty, “Energy Management Handbook”, 6th Edition, The Fairmont Press, GA,2006
2.	Barny L. Capehart, Wainey C. Turner, William J. Kennedy, “Guide to Energy Management”, 7th Edition, The Fairmont Press, GA, 2012

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the importance of energy, energy conservation and energy audit	Understanding (K2)
CO2	appraise the energy saving opportunities in thermal systems	Understanding (K2)
CO3	predict the energy saving opportunities in lighting systems	Applying (K3)
CO4	appraise the energy conservation in buildings and ECBC	Understanding (K2)
CO5	analyze the different financial management techniques	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1					1	1	1			1		

CO2	3	1					1	1	1			1		
CO3	3	2	1				1	1	1			1		
CO4	3	1					1	1	1			1		
CO5	3	3	2		1		1	1	1			1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	40	40				100
CAT3	20	40	30	10			100
ESE	20	40	30	10			100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO08- MICROPROCESSORS AND MICROCONTROLLERS INTERFACING							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To get acquaintance with the architecture of 8085 processor and 8051 controller, apply the embedded programming concepts for interfacing peripherals with the controller and to understand the applications of microcontrollers

Unit – I	**8085 Microprocessor:**	**9+3**

Introduction to 8085 Microprocessor - Architecture - Pin Configuration – Interrupts–Instruction Set –Addressing Modes–Timing Diagrams–Memory Interfacing –Simple Assembly Language Programs for arithmetic operations.

Unit – II	**8051 Microcontroller:**	**9+3**

Introduction to 8051 Microcontroller – Architecture – Memory Organization–Special Function Registers – Program Counter – PSW register –Stack – Instruction set –Addressing modes

Unit – III	**8051 Programming:**	**9+3**

I/O Ports – Timer (Mode 1) / Counter– Serial Communication –Interrupt (Timer, Serial communication) – Programming in Embedded C: I/O port programming–Timer programming-Counter programming-Serial port programming-Interrupt programming.

Unit – IV	**Peripheral Interfacing with 8051:**	**9+3**

Programming in Embedded C: Keypad –LCD – Seven segment LED –Sensors–A/D and D/A converters–DC Motor – Stepper motor – Servo motor.

Unit – V	**Applications of Microcontrollers:**	**9+3**

Smart card reader, Automated meter reading system, Washing machine, Speedometer, 3D printers, Healthcare monitoring systems (only block diagram approaches)

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems Using Assembly and C”, 2nd Edition, Pearson Education, New Delhi, 2013
2.	Soumitra Kumar Mandal, “Microprocessors and Microcontrollers Architecture, Programming and System Design 8085,8086 and 8051”, 8th Edition, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2013

REFERENCES:

1.	Senthil Kumar N., Saravanan M., Jeevananthan S, “Microprocessor and Microcontroller”, 12th Impression, Oxford University Press, New Delhi, 2015
2.	Krishna Kant, “Microprocessors and Microcontrollers: Architecture, programming and system design 8085, 8086, 8051, 8096”, 2nd edition, PHI Learning Pvt. Ltd, New Delhi, 2012
3.	

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic concepts of 8085 microprocessor	Understanding (K2)
CO2	summarize the basic concepts of 8051 microcontroller	Understanding (K2)
CO3	write embedded c programs for 8051	Applying(K3)
CO4	interface peripheral devices with 8051 microcontrollers	Applying(K3)
CO5	recognize microcontroller-based applications	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85	-	-	-	-	100
CAT2	10	45	45	-	-	-	100
CAT3	10	45	45	-	-	-	100
ESE	5	55	40	-	-	-	100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO09 - PROGRAMMABLE LOGIC CONTROLLER AND SCADA							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course imparts knowledge about basic concepts of programmable logic controllers, programming languages, advanced PLC programming, process of SCADA system and also apply this knowledge to develop automation system in industrial applications.
Unit – I	**Introduction to Programmable Logic Controller:** **9+3**
Overview of Programmable Logic Controller – Parts of PLC – Principle of operation - I/O Modules: Discrete, Analog, Special – I/O Specifications – CPU – Memory design and types – Programming devices – Recording and Retrieving data –PLC programming languages.	
Unit – II	**Basic PLC Programming:** **9+3**
Fundamentals of Logic – Hardwired logic versus Programmed Logic - Program Scan– Relay-Type Instructions - Instruction addressing – Branch and Internal relay instructions – Entering the Ladder diagram – Electromagnetic Control relays – Contactors – Motor Starters – Manual operated switches and mechanically operated switches.	
Unit – III	**Advanced PLC Programming:** **9+3**
Programming Timers: On delay timer and off delay timer instruction – retentive and cascade timer functions- Programming Counters – Program Control Instructions - Math Instructions – Sequencer and Shift Register Instructions. PLC Applications: Bottle filling system –Traffic light control system	
Unit – IV	**PLC Installation and Troubleshooting:** **9+3**
PLC Enclosures – Electrical Noise – Leaky Inputs and Outputs – Grounding – Voltage Variations and Surges – Program Editing – Programming and Monitoring – Preventive Maintenance – Connecting PC and PLC. Application: PLC Based VFD Drive for AC Pump with Level Control Sensor and Tank.	
Unit – V	**SCADA and its application:** **9+3**
Introduction to SCADA – A brief history of SCADA –Real-time systems – Remote control – Communications: communication system components – protocol-modems- Remote terminal units (RTUs) – Master terminal units (MTUs) Applications: Real time Revisited - Scanning and communications.	
Lecture:45, Tutorial:15, Total:60	

TEXT BOOK:

1.	Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Tata McGraw-Hill , New Delhi, 2019.
2.	Stuart A. Boyer, “SCADA: Supervisory Control and Data Acquisition”, 4th Edition, ISA Press, USA, 2016.

REFERENCES:

1.	Webb John W and Reis Ronald A, "Programmable Logic Controllers - Principles and Applications", 5th Edition, PHI Learning Private Limited, New Delhi, 2002.
2.	Bolton W, “Programmable Logic Controllers”, 5th edition, ELSEVIER, New York, 2009

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the PLC hardware and programming languages for various applications	Understanding (K2)
CO2	develop PLC ladder logic programming for industrial problems	Applying (K3)
CO3	design a PLC system, component, or process to meet a set of specifications	Applying (K3)
CO4	install and troubleshoot the PLC in real time	Applying (K3)
CO5	apply SCADA in real time applications to meet industrial automation	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	1	1		1			1			1		
CO2	3	2	1	1		1			1			1		
CO3	3	2	1	1		1			1			1		
CO4	3	1				1			1			1		
CO5	3	2	1	1		1			1			1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	40	40	20				100
ESE	40	40	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEEO10 – VLSI SYSTEM DESIGN							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To expose the knowledge of VLSI System Design in terms of modeling of MOS transistors, designing CMOS logic circuits with its fabrication techniques and programming various digital logic circuits using Verilog Hardware Description Language in different modeling
Unit – I	**Introduction** **9+3**
CMOS Logic – CMOS Fabrication and Layout – Physical Design – Design Verification – Fabrication, packaging and Testing	
Unit – II	**Unit Title: MOS Transistor Theory** **9+3**
Introduction – MOS transistor operating regions – Long Channel VI characteristics – Non ideal I-V effects - DC transfer characteristics	
Unit – III	**Unit Title: CMOS Processing Technology** **9+3**
Introduction – CMOS technologies – Stick Diagram – Layout diagram – Layout Design Rules – CMOS Process Enhancement – Technology related CAD Issues – Manufacturing Issues	
Unit – IV	**Unit Title: VERILOG HDL–I** **9+3**
VLSI Design Flow – Dataflow modelling – Continuous Assignments – Delays – Expressions, operators, operands – Operator Types – Dataflow modelling Examples – Behavioural modelling – Structured Procedures - Procedural Assignments –Timing controls – Conditional statements - Multiway branching -Loops - Behavioural modelling Examples	
Unit – V	**Unit Title: VERILOG HDL–II** **9+3**
Tasks and Functions – Difference between tasks and functions – Tasks – Functions – Useful Modelling Techniques – Switch level modelling Elements - Switch level modelling Examples	
Lecture:45, Tutorial:15, Total:60	

TEXT BOOK:

1.	Neil H. E. Weste & David Money Harris, “CMOS VLSI Design A Circuits and Systems Perspective” Fourth Edition, Pearson education, New Delhi, 2017 Unit I, II, III
2.	Samir Palnitkar, “Verilog HDL: Guide to Digital Design and Synthesis”, Second Edition, Pearson Education, New Delhi, 2017. Unit IV, V

REFERENCES:

1.	Pucknell, Douglas A & Eshragian, K., “Basic VLSI Design”, Third Edition, Prentice Hall India, Pvt Ltd, 2015.
2.	A.Albert Raj & T.Latha, “VLSI Design”, Prentice Hall India Learning Private Limited, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Comprehend the principles of CMOS Logic and its physical design process.	Understanding (K2)
CO2	Explain MOS transistor characteristics.	Applying (K3)
CO3	Describe CMOS fabrication techniques, layout design rules and different manufacturing issues	Understanding (K2)
CO4	Apply Verilog HDL modeling for different digital logic circuits in dataflow modelling and behavioural modelling.	Applying (K3)
CO5	Model different digital logic circuits using Verilog HDL in Switch level modeling.	Applying (K3)

Mapping of COs with POs and PSOs

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

CO5	3	3	3	1	3				2		2	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	70	20				100
CAT2	10	60	30				100
CAT3	10	30	60				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO11- INDUSTRIAL AUTOMATION							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course is aimed to impart knowledge on the technologies used for the automation in industries.	
Unit – I	**Introduction:**	**9+3**
Architecture of the basic three level Integrated Industrial Automation Systems – Field level for sensors actuators and smart devices, Control level for process and motion control functions, Distributed control system - Supervisory level for Data logging and Acquisition systems – DAS and SCADA for Management functions - Integrated automation through bus structure at the different levels.		
Unit – II	**Field Level Equipment-Sensors:**	**9+3**
Field level equipment – Sensors and measurement systems for Temperature, Pressure, Force, Displacement and speed measurement - Flow measurement techniques – Measurement of level, humidity, pH.		
Unit – III	**Field Level Equipment- Actuators:**	**9+3**
Introduction to Actuators – solenoids, on/off valves-Proportional Flow Control Valves – Hydraulic Actuator Systems – Principles, Components and Symbols – Pumps, fans and Motors – Pneumatic Control Systems – System Components-Integrated Control Systems using Smart sensors, Hart communication protocol.		
Unit – IV	**Process Controls:**	**9+3**
Introduction to process control – Automatic Process Control – Need for Automatic Process Control in Industry – Mathematical Modeling of Processes – First, Second and Higher Order Process Systems – Feed Forward Control – Cascade Control – Ratio Control – Selective Control Systems – Split-Range Control – Adaptive Controls – Inferential Control – Interacting Control Systems – Multi Variable Control.		
Unit – V	**PLC and HMI Controls:**	**9+3**
Introduction to PLC-s, PLC-s and Relay controls – PLC processor modules -input/output modules – Parallel /Local and Serial / Remote I/O modules-power supplies for I/O modules – Selection of PLC based on I/O counts and Scan times, PLC programming Languages – Ladder logic, functional block diagram-On/ Off logic functions, timer / counter, Register functions – control instructions – PID controls, Arithmetic and other Math instructions – sequencer Instructions.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Krishnaswamy K, “Process Control”, 2nd Edition, New Age International(P) Ltd, NewDelhi, 2015 for Units I, II, III, IV
2.	Frank D. Petruzella, “Programmable Logic Controllers”, 5th edition, McGraw Hill, New Delhi, 2019 for Unit V.

REFERENCES:

1.	NPTEL web book on Industrial Automation and controls by Mr. S.Mukhopadhyay and Mr.S.Sen of IIT, Kharagpur.
2.	Bill Drury, “The Control Techniques Drives and Controls Handbook”, 2nd Edition, IET Power and Energy Series, 2009.
3.	Lukas, Michael P., — Distributed Control Systemsll, Van Nostrand Reinfold Company, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the integrated industrial automation system	Understanding (K2)
CO2	utilize the Field level equipment-sensors for different industrial applications	Applying (K3)
CO3	utilize the Field level equipment-Actuators for different industrial applications	Applying (K3)
CO4	understand the Process controls in Industries	Understanding (K2)
CO5	apply the concepts of PLC in control oriented Industrial applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1					1		1			1		
CO2	3	2	1	1			1		1			1		

CO3	3	2	1	1			1		1			1		
CO4	3	1					1		1			1		
CO5	3	2	1	1			1		1			1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	40	40				100
CAT3	10	50	40				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

20EEO12 – ELECTRIC VEHICLE							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course is aimed to introduce the fundamental concepts and principles of various Electric Vehicle technologies with an insight into configuration, propulsion system, energy sources and hybrid electric vehicles	
Unit – I	**Introduction to EVs:**	**9**
Importance of Different Transportation Development Strategies to Future Oil Supply - History of EVs - General Description of Vehicle Movement - Configurations of EVs - Performance of EVs: Traction Motor Characteristics - Tractive Effort and Transmission Requirement - Vehicle Performance - Tractive Effort in Normal Driving - Energy Consumption.		
Unit – II	**Electric Propulsion Systems:**	**9**
Induction Motor Drives: Basic Operation Principles of Induction Motors - Power Electronic Control - Field Orientation Control - Voltage Source Inverter for FOC - Permanent Magnetic BLDC Motor Drives: Basic Principles of BLDC Motor Drives - BLDC Machine Construction and Classification - SRM Drives: Basic Magnetic Structure - Modes of Operation - Sensor less Control.		
Unit – III	**Power Sources and Energy Storages:**	**9**
Electrochemical Batteries: Electrochemical Reactions - Thermodynamic Voltage - Specific Energy - Specific Power - Energy Efficiency - Battery Technologies - Lead–Acid Battery - Nickel-Based Batteries - Lithium-Based Batteries – Ultracapacitors - Ultra-High-Speed Flywheels - Hybridization of Energy Storage.		
Unit – IV	**Hybrid Electric Vehicles:**	**9**
Concept of Hybrid Electric Drive Trains - Architectures of Hybrid Electric Drive Trains: Series Hybrid Electric Drive Trains (Electrical Coupling) - Parallel Hybrid Electric Drive Trains (Mechanical Coupling) - Hybrid Drive Trains with Both Torque and Speed Coupling.		
Unit – V	**Fuel Cell Hybrid Electric Drive Train:**	**9**
Operating Principles of Fuel Cells - Fuel Cell System Characteristics - Fuel Cell Technologies - Fuel Supply - Fuel Cell Hybrid Electric Drive Train Design: Configuration - Control Strategy - Parametric Design.		
		Total:45

TEXT BOOK:

1.	MehrdedEhsani, YiminGao& Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Edition, CRC Press, USA, 2010.

REFERENCES:

1.	IqbalHussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC Press, USA, 2011.
2.	Chris Mi, AbulMasrur M & David WenzhongGao, "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives", 1st Edition, Wiley Publication, UK, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the importance and different configurations of electric vehicles	Understanding (K2)
CO2	distinguish the characteristics of various motor drives for EVs	Understanding (K2)
CO3	identify the importance of energy storage systems in EVs	Applying (K3)
CO4	illustrate the concept of hybrid electric drive trains	Applying (K3)
CO5	demonstrate the concept of fuel cell drive train in Hybrid EVs	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1		1	1		1			1		
CO2	3	2	1	1		1	1		1			1		

CO3	2	3	1	1		1	1		1			1		
CO4	3	2		1		1	1		1			1		
CO5	3	2	1	1		1	1		1			1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	30	40	30				100
CAT3	20	40	40				100
ESE	30	40	30				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO13 – E-WASTE MANAGEMENT

Programme & Branch	All BE/BTech Branches except EEE	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	This course covers various aspects of Waste from Electrical and Electronic Equipment, E-waste disposal along with recycling with an integrated approach. It also gives an insight into the management of special waste and domestic hazardous waste.

Unit – I	**Introduction**	**9**

Waste Electrical and Electronic Equipment (WEEE) - The Scale of the Problem - Electronics Recycling - Treatment Options for WEEE - Material Composition of WEEE - Socio-economic Factors - International Perspective - Barriers to Recycle - Health and Safety Implications – Influence factors - Materials Used in Manufacturing Electrical and Electronic Products - Soldering and the Move to Lead-free Assembly - Printed Circuit Board Materials - Mobile Phones – Televisions - WEEE Engineering Thermoplastics.

Unit – II	**Waste Disposal and Recycling**	**9**

Introduction - Landfill - Pollution from Landfills - Landfill Gas - Landfill-site Construction – Burning - Energy Recovery/Energy from Waste (EFW) - Advanced Thermal Processing - Pollution from Incineration – Recycling and recovery: Separation and Sorting – Treatment - Outputs and Markets - Emerging Technologies – Separation – Treatments – Extraction.

Unit – III	**Integrated Approach to E-waste Recycling**	**9**

Introduction - Recycling and Recovery Technologies - Sorting/Disassembly - Crushing/Diminution - Separation - Emerging Recycling and Recovery Technologies - Automated Disassembly - Comminution – Separation - Thermal Treatments - Hydrometallurgical Extraction - Dry Capture Technologies - Biotechnological Capture - Sensing Technologies - Design for Recycling and Inverse Manufacturing - Printed Circuit Boards - Recycling - Characteristics of PCB Scrap - Emerging Technologies - Sector-based Eco-design

Unit – IV	**Recycling of Display Devices and ERP**	**9**

Introduction - Overview of Liquid Crystals - Classification - Architecture - Liquid Crystal Displays Based on Nematic Mesophase - Manufacturing Process – Environmental Lifecycle Analysis – Toxicity of LCD Constituents – Recycling. European Recycling Platform (ERP): Founding Principles – Structure - Scope of services - Operational Model - Key Performance Indicators.

Unit – V	**Special Waste & Domestic Hazardous Waste Management**	**9**

Introduction - Existing Rules for the management of wastes - Guidance from the Integrated Solid Waste Management (ISWM) Hierarchy - Plastic Waste - Bio-medical Waste - Slaughterhouse Waste – E-Waste Management rules 2016 - Waste Tyres - Lead Battery Waste - Action Points for Awareness Generation.

Total:45

TEXT BOOK:

1. Hester R.E., Harrison R.M., “Electronic waste management”, 1st Edition, Royal Society of Chemistry (RSC) publishers, Cambridge-UK, 2009
2. “Municipal Solid waste Management Manual Part II”, 1st Edition, CPHEEO, Ministry of Urban Development, Govt. of. India, New Delhi, 2016

REFERENCES:

1. Johri R., “E-waste: implications, regulations, and management in India and current global best practices”, 1st Edition, TERI Press, New Delhi, 2008.
2. Tchobanoglous G., Theisen H., Viquel S.A., “Integrated Solid Waste Management: Engineering, Principles and Management issues”, 1st Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the challenges and issues of E-wastes and its source of emerging with its barriers for recycling it.	Understanding (K2)
CO2	infer handling and processing the E wastes and its disposal & recovery.	Understanding (K2)
CO3	apply the treatment methods for the E waste recycling technologies.	Applying (K3)
CO4	understand the recycling procedures of LCD devices and infer the European Recycling Platform scheme	Understanding (K2)
CO5	utilize the waste disposal management rules and guidance for handling the special wastes and domestic hazardous waste management.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1				1						1		
CO2	3	1				1	2					1		
CO3	3	2	1	1		1						1		
CO4	3	1				1	2					1		
CO5	3	2	1	1		1						1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50					100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	30	50	20				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22EEO14 - EMBEDDED SYSTEM DESIGN							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge about the Building Blocks of Embedded System along with various networking protocolsand provides a brief idea of IoT architecture and its related protocols towards building an IoT infrastructure.	
Unit – I	**Introduction to Embedded Systems:**	**9**
Introduction to Embedded Systems – Structural units in Embedded processor, selection of processor & memory devices – DMA – Memory management methods – Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.		
Unit – II	**Embedded Networking Protocols:**	**9**
Embedded Networking: Introduction, I/O Device Ports & Buses – Serial Bus communication protocols: RS232 standard – RS422 – RS 485 – CAN Bus – Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – Need for device drivers.		
Unit – III	**ARM Processor and Programming:**	**9**
ARM7 Processor - Introduction - RISC features - Levels in architecture, Functional description - processor and memory organization - Data alignment and byte ordering - ARM Instruction Set Architecture (ISA) - pipelining – Simple Assembly Language Programming – Architectural support: High Level Languages - System development – Operating systems.		
Unit – IV	**ARM7TDMI based SoC:**	**9**
LPC2148: Peripherals, Memory mapping for data, code and peripherals, pin configuration, pin connect block, GPIO Peripheral - Nested vectored interrupt controller & Interrupts in LPC2148 - ADC, DAC and RTC in LPC2148 - Timer in LPC2148 and its various modes of operations.		
Unit – V	**ARM7 protocols and Operating Systems:**	**9**
LPC2148: UART protocol and its implementation in LPC2148 - SPI protocol and its implementation in LPC2148 - I2C protocol and its implementation in LPC2148. RTOS Introduction: RTOS Necessity - Operating system services - CPU metrics - RTOS Task scheduling models - OS security issues - Design cycle in the development phase for an embedded system - Issues in Embedded System Design		
		Total:45

TEXT BOOK:

1.	Kamal R, “Embedded systems: architecture, programming and design”, second edition, Tata McGraw-Hill Education, New Delhi, 2011.
2.	Wayne Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Morgan Kaufman Publishers, San Francisco, second edition, 2008.

REFERENCES:

1.	Furber SB, “ARM system-on-chip architecture”, second edition, Pearson Education; 2000.
2.	Chattopadhyay S, “Embedded System Design”, second edition, PHI Learning Pvt. Ltd.; 2013.
3.	UM10139 – lpc214x User manual - https://www.nxp.com/docs/en/user-guide/UM10139.pdf

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the basic building blocks of embedded systems.	Understanding (K2)
CO2	identify and distinguish the various communication protocols of embedded system.	Applying (K3)
CO3	understand the architecture of ARM7 processor and its programming.	Understanding (K2)
CO4	Interface the peripherals of ARM7 processor with the external world.	Applying (K3)
CO5	Understand various on chip communication protocols of ARM7 and RTOS concepts.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	1	2	1	1	1		1		1	1	1		
CO2	3	2	1	1	1	1	2				2	1		
CO3	3	1	2	1	1	1		1		1	1	1		
CO4	3	2	2	2	1	1	2				2	1		
CO5	3	1	2	1	1	1		1		1	1	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	20	55	35				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO15 - ENERGY STORAGE SYSTEMS AND CONTROLLERS							
Programme& Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course aimed to introduce the fundamental concepts and principles of various energy storage systems that aids in various real time applications.	
Unit – I	**Introduction to Energy Storage Systems**	**9**
Overview of energy storage systems (ESS) - Historical context of ESS - Drivers for ESS deployment - Classification of ESS technologies - Battery: Components of Cells and Batteries – Classification - Operation of a Cell - Theoretical Cell Voltage, Capacity, and Energy		
Unit – II	**Electrochemical and Mechanical Energy Storage Technologies**	**9**
Electrochemical Energy Storage Systems: Construction, operation and Working Principle of Lithium-ion, Sodium-ion, Solid-state batteries **Mechanical Energy Storage Systems**: Construction, operation and Working Principle of Pumped Hydro Storage (PHS) - Compressed Air Energy Storage (CAES) - Flywheel Energy Storage Systems (FESS)		
Unit – III	**Other Energy Storage Technologies**	**9**
Ultracapacitors: Features- Basic Principles of Ultracapacitors - Hydrogen Storage Systems: Types of fuel cells -hydrogen oxygen cells, hydrogen air cell, alkaline fuel cell, and phosphoric fuel cell. -Thermal Energy Storage using Phase Change Materials (PCM)		
Unit – IV	**Energy Storage Applications:**	**9**
Grid-scale Energy Storage Applications: Load Shifting, Frequency Regulation, Voltage Support, Peak Shaving, Renewable Integration, Black Start **Distributed Energy Storage Applications**: Residential Energy Storage, Commercial Energy Storage, Electric Vehicles Charging, Micro grids		
Unit – V	**Controllers for Energy Storage Systems**	**9**
Principles of charge controllers -Types of charge controllers-Charging strategies for energy storage systems, Battery Management Systems (BMS): Principles of BMS-Functions and components of BMS-Battery safety and performance-BMS integration with other controllers		
		Total:45

TEXT BOOK:

1.	David Linden, Thomas B. Reddy, "Handbook of Batteries", 4th Edition, McGraw-Hill, New Delhi, 2011.

REFERENCES:

1.	Mehrdad Ehsani, YiminGao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicle", 2nd Edition, CRC Press, New Delhi, 2018.
2.	NihalKularatna, KosalaGunawardane, “Energy Storage Devices for Renewable Energy-Based Systems”, 2nd Edition, Elseivier, 2021
3.	SandeepDhundhara, Yajvender Pal Verma, “Energy Storage for Modern Power System Operations”, Wiley, 2021

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the basics of energy storage systems and battery.	Understanding (K2)
CO2	summarize the construction and selection of battery.	Understanding (K2)
CO3	describe the construction and working principle of secondary batteries.	Understand(K2)
CO4	explain the construction and working principle of Ultra capacitor and Fuel cell	Application (K3)
CO5	identify the different types of controllers used in energy storage systems and their roles in managing the flow of energy.	Understand(K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70	-	-	-	-	100
CAT2	30	70	-	-	-	-	100
CAT3	30	50	20	-	-	-	100
ESE	10	70	20	-	-	-	100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO16 - DIGITAL IMAGE PROCESSING							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables the students to learn and apply the various Digital Image Processing techniques on real time images.	
Unit – I	**Digital Image Fundamentals:**	**9**
Elements of digital image processing systems, Elements of visual perception– Brightness– Contrast– Hue– Saturation– Mach band effect, Image sampling– Quantization, Basic relationship between pixels, Color image fundamentals – RGB– HSI models- Colour image quantization		
Unit – II	**Image Transforms:**	**9**
Need for transforms, DFT and its Properties: Separable – Spatial shift – Periodicity –Scaling – Orthogonality – Rotation, DCT, KLT, and SVD.		
Unit – III	**Image Enhancement and Image Restoration**	**9**
Image Enhancement: Basic intensity transformations – Piecewise linear transformation functions, Histogram equalization, Spatial filtering: Smoothing and sharpening Filters, Frequency domain filtering: Smoothing and sharpening filters – Homomorphic filters **Image Restoration:** Degradation model – Noise distributions– Median – Geometric mean – Harmonic mean – Contra harmonic mean filters – Order Statistics filters – Inverse and wiener filtering – Constrained least square filtering- Performance metrics-BSNR-ISNR-Applications		
Unit – IV	**Image Segmentation, Representation & Description:**	**9**
Point, line and edge detection – Basics of intensity thresholding – Region based segmentation: Region growing – Region splitting and merging, Image representation: Chain codes, – Boundary descriptors – Regional descriptors		
Unit – V	**Wavelets And Multiresolution Processing:**	**9**
Subband coding – The Haar Transform – Multiresolution Expansion – Series Expansion – Scaling Function – Wavelet Function – Wavelet Transform in One Dimension- The Wavelet Series Expansion – The Discrete Wavelet Transform – The Continuous Wavelet Transform – The Fast Wavelet Transform – Wavelet transform in two dimensions– Applications in image denoising - Image fusion-Steganography		
		Total:45

TEXT BOOK:

1.	Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”,4th Edition, Pearson Education, Chennai,2016.

REFERENCES:

1.	Jayaraman S, Esakkirajan S and Veerakumar T, “Digital Image Processing”,1st Edition 17th reprint, Tata McGraw Hill, New Delhi,2016
2.	Chanda B, Dutta Majumder D, “Digital Image Processing and analysis”, 2nd Edition, PHI learning,New Delhi,2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Illustrate the fundamental concepts of digital image processing, 2D sampling and Colour image models.	Applying (K3)
CO2	Apply DFT, DCT, KLT, SVD and Haar transformations on an image	Applying (K3)
CO3	Implement the image enhancement & image restoration techniques	Applying (K3)
CO4	Explain image segmentation, representation and description techniques for image classification	Understanding (K2)
CO5	Apply the multi resolution processing over images using wavelet transform.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		
CO1	3	2	1	1							1	1		
CO2	3	2	1	1							1	1		

CO3	3	3	3	1	2						1	1		
CO4	3	3	3	1	2						1	1		
CO5	3	2	1	1							1	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO17-AI TECHNIQUES IN ENGINEERING APPLICATIONS							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course enables the students to learn and apply the Artificial Intelligence techniques on real time applications.	
Unit – I	**ROBOTICS IN ENGINEERING**	**9**
Introduction to Robotics and AI integration - Evolution of Robotics in Engineering- Types of Robots and their Applications - AI Algorithms for Robot Control - Collaborative Robotics and Human-Robot Interaction		
Unit – II	**AI IN MANUFACTURING**	**9**
Introduction to AI in Manufacturing - Enhancing Production Processes with AI - Quality Control and Defect Detection using AI - AI-driven Supply Chain Optimization - Predictive Maintenance and Cost Reduction in Manufacturing		
Unit – III	**LOGISTICS AND SUPPLY CHAIN MANAGEMENT (SCM) WITH AI**	**9**
Overview of Logistics and SCM- AI Applications in Transportation and Route Optimization - Demand Forecasting and Inventory Management using AI - AI for Predicting Delays and Improving Efficiency - Case Studies: AI Implementation in Supply Chains		
Unit – IV	**AUTONOMOUS SYSTEMS AND APPLICATIONS**	**9**
Understanding Autonomous Systems and AI- AI in Self-Driving Vehicles and Robotics- AI in Autonomous Drones and Spacecraft - Applications of AI in Autonomous Systems - Safety and Ethical Considerations for Autonomous Systems		
Unit – V	**AI IN CIVIL AND AEROSPACE ENGINEERING**	**9**
AI for Structural Design and Optimization - Predictive Analysis for Civil Engineering Projects - AI in Aerospace Design and Aerodynamics - Autonomous Aircraft and Spacecraft using AI - Case Studies: AI Implementation in Civil and Aerospace Engineering		
		Total:45

TEXT BOOK:

1.	Nikolaus Correll, Bradley Hayes, Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, Algorithms" The MIT Press,2022

REFERENCES:

1.	
2.	
3.	

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1		Applying (K3)
CO2		
CO3		
CO4		
CO5		

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		
CO1	**3**	**2**	**1**	**1**										
CO2	**3**	**3**	**2**	**2**										
CO3	**3**	**2**	**1**	**1**										
CO4	**3**	**3**	**2**	**1**										

CO5	**3**	**2**	**2**	**2**										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO18 –SMART GRID TECHNOLOGIES							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course content is designed to study about micro grid standalone autonomous system, smart grid technologies, information and communication technologies. It is used to get familiarized with smart metering and control of smart grid systems. The course also aims in imparting knowledge on power electronics and energy storage.	
Unit – I	**Microgrid Concept:**	**9**
Introduction – Renewable Power Generation – Grid Connected Wind Power – Grid Connected PV Power – Microgrid Concept and Structure – Operation Modes.		
Unit – II	**Microgrid Planning and Energy Management:**	**9**
Introduction – Microgrid planning- Forecasting techniques – Energy Management – Emission reduction and Economical Optimization – Robust Energy Consumption Scheduling in Interconnected Microgrids.		
Unit – III	**Smart Grid and Communication Technologies**	**9**
Introduction to Smart grid – Smart grid initiatives – Overview of technologies required for smart grid – Information and communication technologies – Data communication – Communication technologies for smart grid – Information security for smart grid.		
Unit – IV	**Sensing, Measurement, Control and Automation Technologies:**	**9**
Smart metering and demand side integration – Distribution automation equipment – Distribution management systems – Transmission system operation.		
Unit – V	**Power Electronics and Energy Storage:**	**9**
Power electronic converters – Power electronics in smart grid – Power electronics for bulk power flows – Energy storage.		
		Total:45

TEXT BOOK:

1.	Hassan Bevrani, Bruno Francois &ToshifumiIse, “Microgrid Dynamics and Control”, 1st Edition, Wiley, 2017 for Units I & II.
2.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, 1st Edition, Wiley & Sons Ltd, 2012 for Units III, IV & V.

REFERENCES:

1.	Chowdhury S, Chowdhury S.P &Crossley P, “Microgrids and Active Distribution Networks”, 1st Edition, The Institution of Engineering and Technology, 2009.
2.	Tony Flick & Justin Morehouse, “Securing the Smart Grid Next Generation Power Grid Security”, 1st Edition, Elsevier, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concepts of micro grid.	Understanding (K2)
CO2	assess the micro grid planning and energy management	Understanding (K2)
CO3	analyze the smart grid and its communication technologies.	Applying (K3)
CO4	interpret the sensing, measurement, control and automation technologies.	Applying (K3)
CO5	examine about the power electronics in smart grid and energy storage.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			2							2		
CO2	3	1			2							2		
CO3	3	2	1	1	2			3				2		

CO4	3	2			2			2				2		
CO5	3	2			3			3				2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	30	60	10				100
CAT3	20	60	20				100
ESE	20	60	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EEO19- BIOMASS ENERGY SYSTEMS							
Programme & Branch	**All BE/BTech Branches except EEE**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	Biomass energy has evolved through chemical, biological and thermal conversion process. The requirement of learning the nuances of biomass has become significantly important and in fact, this subject addresses the need of biomass, biogas and bio diesel in a comprehensive manner.	
Unit – I	**Introduction:**	**9**
Biomass energy usage – Overall energy needs – Sources of biomass available – Units and conversions – Problems and issues – Advantages and disadvantages in use of biomass as energy source.		
Unit – II	**Biomass Conversion Process**	**9**
Overview – Chemical and biological conversion processes – Thermal conversion process – Hybrid conversion process – Application of biomass conversion products.		
Unit – III	**Biogas Production:**	**9**
Introduction – Biomass parameters in anaerobic digestion – Advantages and disadvantages of anaerobic digestion process – Biogas conversion process and digester designs – Design of biogas digester – Biogas utilization.		
Unit – IV	**Bio-Diesel Production:**	**9**
Introduction – Vegetable oil and animal fat characteristics – Fatty acid composition – Basic oil properties – Oil Extraction processes – Oil refining process – Transesterification - Engine performance and exhaust emissions.		
Unit – V	**Biomass Combustion**	**9**
Introduction – Types of biomass combustion systems – Co-combustion of biomass and co-firing with coal – Slagging and fouling issues with agricultural biomass – Determining melting point of biomass ash pellets – Applications of biomass combustion systems.		
		Total:45

TEXT BOOK:

1.	Sergio Capareda., "Introduction to Biomass Energy Conversions", 1st Edition, CRC press, India, 2013.

REFERENCES:

1.	Kothari D.P., Singal K.C., Rakesh Ranjan., "Renewable Energy Sources and Emerging Technologies", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2011.
2.	John Twidell, Tony Weir., "Renewable Energy Resources", 3rd Edition, Routledge, New York, 2015.
3.	Ibrahim Garbie, “Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0”, Springer., Switzerland, 2016

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the nature and principle of biomass energy extraction systems	Understanding (K2)
CO2	illustrate various biomass conversion process	Understanding (K2)
CO3	interpret biogas production and digester design	Applying (K3)
CO4	categorize various techniques for bio-diesel refining process	Applying (K3)
CO5	access different types of biomass combustion process	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			1	2				1	1		

CO2	2	3	2			1	1				1	1		
CO3	2	2	3			1	1				1	1		
CO4	2	2	3			1	1				1	1		
CO5	2	2	3			1	1				1	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 60 marks & ESE – 100 marks)

22EIO01 - BIOMEDICAL INSTRUMENTATION AND APPLICATIONS
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/Btech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To impart the knowledge of some human anatomy and measuring bio potentials using bio electrodes with specific instruments which is most commonly used in hospitals. Also understand the fundamental concept of various biomedical imaging techniques and learn the advanced physiological assistive medical devices

Unit – I	**Human Physiological Systems:**	**9+3**
Cell and its structure – Resting and action potentials – Different systems of human body: Circulatory system – Respiratory system – nervous system – Components of the Bio medical instrument system – strain gauge as pressure transducer – photoelectric type resistive transducer – piezoelectric ultrasonic transducer.		
Unit – II	**Bio Potential Electrodes:**	**9+3**
Micro electrode-depth and needle electrode-surface electrodes. Biomedical Electrical signal measurement: ECG, EEG, EMG, EOG and ERG: Lead systems, recording methods and typical waveforms.		
Unit – III	**Biomedical Non Electrical Signal Measurement:**	**9+3**
Phonocardiography – GSR- Blood pressure Measurement: Sphygmomanometer, MEMS based catheter tip pressure sensor, ultrasonic blood pressure monitor. Spirometer – Blood pH measurement – Ear oximeter – Pulse oximeter – Lung volumes, respiration and cardiac rate.		
Unit – IV	**Biomedical Imaging Systems:**	**9+3**
X-ray machine – Computer tomography – Thermography – Ultrasonic imaging systems – Magnetic resonance imaging – PET – SPECT – FMRI – Magnetic Particle Imaging.		
Unit – V	**Physiological Assist Devices:**	**9+3**
Ventricular asynchronous pacemaker – AC Defibrillator – Heart lung machine – Kidney machine – Audiometer – Biothesiometry-Vibroscreen – Biotelemetry – Telemedicine.		

Lecture:45, Tutorial :15, Total:60

TEXT BOOK:

1. Khandpur R.S," Handbook of Biomedical Instrumentation", 2nd Edition, Tata McGraw-Hill , New Delhi ,2017.

REFERENCES:

1. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, John Wiley and Sons, NewYork, 2015.
2. Andrew G. Webb, "Principles of Biomedical Instrumentation" 1st Edition, Cambridge University Press, United Kingdom, 2018
3. Arumugam. M, "Bio-Medical Instrumentation", 2nd Edition, Anuradha Agencies, Kumbakonam, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basic principles and phenomena of Biomedical Engineering	Understanding (K2)
CO2	record the bioelectric potentials using bio potential electrode through bio signal recording devices	Applying (K3)
CO3	measure biomedical signal parameters through medical instruments	Applying (K3)
CO4	summarize the basic principles in medical imaging techniques	Understanding (K2)
CO5	illustrate the physiological assist devices	Applying (K3)

Mapping of COs with Pos and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				2		1					2	2
CO2	3	2	1	1	1	2		1					3	3
CO3	3	2	1	1	1	2		1					3	3

CO4	3	1				2		1					2	2
CO5	3	2	1	1	1	2		1					3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO02 - INDUSTRIAL AUTOMATION
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/Btech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To provide solution towards better control action for various process applications	
Unit – I	**Introduction To Industrial Automation:**	**9+3**
Automation – Industrial Automation vs. Industrial Information Technology – Role of automation in industry – Types of production systems – Types of Automation Systems – The Functional Elements of Industrial Automation – Industrial Sensors and Instrument Systems – Industrial Actuator Systems – Industrial Control Systems – The Architecture of Elements: The Automation Pyramid.		
Unit – II	**Programmable Logic Controllers (PLCs) An Overview:**	**9+3**
Parts of a PLC –Principle of operation. PLC Hardware Components: Discrete I/O Modules- Analog I/O modules – The Central Processing Unit (CPU) – Programming Terminal Devices. Converting Relay Schematics into PLC Ladder Programs. Programming Timers: Timer Instructions – Types of timers – On-Delay Timer Instruction – Off-Delay Timer Instruction – Retentive Timer.		
Unit – III	**Advanced PLC Programming:**	**9+3**
Programming Counters: Counter Instructions – Up-Counter – Down – Cascading Counters – Program Control Instructions: Master Control Reset Instruction – Subroutine Functions. Data Manipulation Instructions: Data Compare Instructions. Math Instructions: Addition Instruction – Subtraction Instruction – Multiplication Instruction – Division Instruction.		
Unit – IV	**Process Control, Network Systems, and SCADA:**	**9+3**
Types of Processes – Structure of Control Systems – On/Off Control – PID Control – Motion Control – Data Communications – Supervisory Control and Data Acquisition (SCADA) – Human Machine Interfaces (HMIs) – Introduction to DCS		
Unit – V	**Internet of Things – An Overview:**	**9+3**
Introduction – Internet of Things Definition Evaluation – IoT Architectures – IoT Data Management and Analytics – Communication Protocols – Internet of Things Applications – Security – Identity Management and Authentication – Privacy – Standardization and Regulatory Limitations.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Tata McGraw Hill Education Private Limited, India, 2019 for Unit 1,2,3,4.
2.	Rajkumar Buyya & Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms", 1st Edition, Morgan Kaufmann (Imprint of Elsevier), USA, 2016 for Unit 5

REFERENCES:

1.	https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-01(SM)(IA&C)%20((EE)NPTEL).pdf
2.	https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-02(SM)(IA&C)%20((EE)NPTEL).pdf

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the concepts about basics of automation system	Understanding (K2)
CO2	develop programming with PLC	Applying (K3)
CO3	analyze theory of operation in advanced PLC and SCADA	Applying (K3)
CO4	interpret the architectural interfaces and operation about DCS	Understanding (K2)
CO5	illustrate the advanced technologies, opportunities, challenges to bring out industry 4.0	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											2	2
CO2	3	2	1	1	1								3	3
CO3	3	2	1	1	1								3	3

CO4	3	1										2	2
CO5	3	1										2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	10	40	50				100
CAT3	30	70	-				100
ESE	10	50	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO03 - PLC PROGRAMMING AND ITS APPLICATIONS
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	To develop and implement the Programmable controller based Industrial Automation	
Unit - I	**Programmable Logic Controllers (PLCs) An Overview:**	**9+3**
Introduction - Parts of a PLC - Principle of operation - PLCs versus Computers - PLC Size and Applications. PLC Hardware Components: The I/O Section - Discrete I/O Modules- Analog I/O modules - Special I/O modules - I/O Specifications – The Central Processing Unit (CPU) – Programming Devices – Recording and Retrieving – PLC Workstations.		
Unit - II	**Basics of PLC Programming and Programming Timers:**	**9+3**
Processor Memory Organization – Program Scan – PLC Programming Languages – Relay-Type Instructions – Instruction Addressing – Branch Instructions – Internal Relay Instructions – Examine IF CLOSED and IF OPEN – Modes of Operations. Seal-In Circuits – Latching Relays – Converting Relay Circuit into Ladder Programs. Timers: Timer Instructions – On-Delay Timer Instruction – Off-Delay Timer Instruction – Retentive Timer – Cascading Timers.		
Unit - III	**Programming Counters and Program Control Instructions:**	**9+3**
Counters: Counter Instructions – Up-Counter – Down-Counter – Cascading Counters – Incremental Encoder-Counter Applications – Combining Counter and Timer Functions. Program Control Instructions: Master Control Reset Instruction – Jump Instruction – Subroutines – Temporary End Instruction – Suspend Instruction.		
Unit - IV	**Advanced PLC Programming:**	**9+3**
Data Manipulation Instructions: Data Manipulation – Data Transfer Operations – Data Compare Instructions-Math Instructions: Introduction – Addition Instruction – Subtraction Instruction – Multiplication Instruction – Division Instruction – Other Word-Level Math Instructions – File Arithmetic Operations.		
Unit - V	**Applications:**	**9+3**
Detecting the standing bottles on the conveyor - Sequential control - Batch Process Control – Direct On Line Start / Stop - First in Priority control - Automatic Door opening and closing - Entry/Exit Control of the Underground Car Parking.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.

REFERENCES:

1.	John W. Webb & Ronald A. Reis, "Programmable Logic Controllers: Principles and Application", 5th Edition, Pearson Education India, India, 2015.
2.	http://instrumentation tools.com/learn-programmable-logic-controller-plc/

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	gain knowledge on the basic components of programmable automation	Understanding (K2)
CO2	interpret various programming logics and languages of PLC	Applying (K3)
CO3	develop hardware wiring and programming with PLCs	Applying (K3)
CO4	implement the concepts of timer and counter based sequence control	Applying (K3)
CO5	apply programmable controller based in industrial applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											2	2
CO2	3	2	1	1	1								3	3
CO3	3	2	1	1	1								3	3

CO4	3	2	1	1	1							3	3
CO5	3	2	1	1	1							3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO04 - VIRTUAL INSTRUMENTATION
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	Virtual instrumentation is a powerful concept for control, measuring, testing and analysis of real time problems. This course aims at giving an adequate exposure and practice in LabVIEW programming and DAQ system to overcome the limitations of classical methods.	
Unit – I	**Introduction to Virtual Instrumentation:**	**9+3**
Virtual Instrumentation- Programming Requirements- Drawbacks of Recent Approaches- Virtual Instruments Versus Traditional Instruments- Advantages of VI- Creating Virtual Instruments Using LabVIEW- Virtual Instrumentation in the Engineering Process- Graphical Programming and Textual Programming- Advantages of LabVIEW- LabVIEW Environment- Dataflow Programming- G Programming.		
Unit – II	**Basic Tools, Loops and Graphs:**	**9+3**
Front Panel-Block Diagram Tools and Palettes- Repetition and Loops: FOR Loop, While Loop, Shift Registers, Tunnels, Feedback Nodes, Local and Global Variables – Arrays-Clusters-Waveform Charts-Waveform Graphs-XY Graphs-Intensity Graphs and Charts-Digital Waveform Graph-3D Graphs.		
Unit – III	**Programming with Structures:**	**9+3**
Structures: Case Structure, Sequence Structures, Customizing Structures, Timed Structures, Formula Nodes, Event Structure, MathScript-Strings-File I/O-State Machine.		
Unit – IV	**Data Acquisition:**	**9+3**
Interface Buses: RS 232, RS422, RS485, GPIB and USB. Hardware Aspects: Signal Grounding-Signal Conditioning-Digital I/O Techniques-Data Acquisition in LabVIEW-Hardware Installation and Configuration-Components of DAQ-DAQ Signal Accessory-DAQ Assistant-DAQ Hardware- DAQ Software.		
Unit – V	**Tools and Applications:**	**9+3**
Signal processing and Analysis Tools-Control System Design and Simulation Tools-Signal, Voltage and Current measurement using general purpose DAQ Card-Bio-Medical Signal Acquisition using NI-ELVIS –Temperature Measurement.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. S.Sumathi , P.Surekha, “LabVIEW based Advanced Instrumentation Systems”, 1st Edition, Springer Berlin, Heidelberg, 2007.

REFERENCES:

1. Jovitha Jerome, “Virtual Instrumentation Using LabVIEW”, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the Virtual Instrumentation concepts	Applying (K2)
CO2	apply structured programming concepts in developing LabVIEW programs	Applying (K3)
CO3	build LabVIEW programs using structures, nodes and state machine concepts	Applying (K3)
CO4	utilize DAQ System to solve real time problems	Applying (K3)
CO5	apply knowledge on various tools in practical works	Applying (K3)

Mapping of COs with Pos and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	15	40	45				100
CAT3	15	60	30				100
ESE	20	40	40				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22EIO05 - INDUSTRY 4.0 WITH INDUSTRIAL IoT
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	To transform the industrial processes through the integration of modern technologies such as sensors, communication, and computational processing.	
Unit – I	**Introduction to Industrial IoT and Industry 4.0:**	**9**
Introduction - IoT Background and History, IIoT key technologies, IoT and IIoT similarities and differences – Innovations and the IIoT – Intelligent devices – Key opportunities and benefits: Digital and human workforce – Industrial Internet use-cases - Industry 4.0: Characteristics and design principles.		
Unit – II	**IIoT Architectures:**	**9**
IIoT Reference Architecture – Industrial Internet Architecture Framework – Five Functional domains – Three tier architecture topology – Connectivity: Key system characteristics, Connectivity security and functional characteristics – Functions of communication layer – Overview of Predictive Maintenance Architecture.		
Unit – III	**IIoT WAN Technologies and Protocols:**	**9**
Need of Protocols – Legacy Industrial protocols – Modern Communication protocols: Industrial Ethernet, Encapsulated Field Bus, Standard Ethernet. IIoT device Low-Power WAN optimized technologies for M2M: SigFox, LoRaWAN, nWave, Dash7, Ingenue RPMA, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio.		
Unit – IV	**Industrial IoT Security and Governance:**	**9**
Introduction – Security threats and vulnerabilities of IoT – Industrial challenges – Evolution of Cyber attacks: cyber attacks and solutions – Strategic principles of cyber security – cyber security measures - Industrial IoT security architecture: IIoT architecture patterns – four Tier IIoT security model- Management risks with IIoT.		
Unit – V	**Industrial IoT Analytics and Applications:**	**9**
Software Defined Networks: Difference between SDN and NFV – Cloud and Fog - Big Data and Analytics in IIoT. Recent Technological components of Robots: Industrial Robotic applications – Industrial application of AR: Maintenance, assembly, operation and training.		
		Total:45

TEXT BOOK:

1.	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, 1st Edition, Apress Media, NewYork, 2016.

REFERENCES:

1.	Alp Ustundag and EmreCevikcan, “Industry 4.0: Managing the Digital Transformation”, Springer series in Advanced Manufacturing, Switzerland, 2018.
2.	DimitriosSerpanos and Marilyn Wolf, “Internet-of-Things (IoT) Systems, Architectures, Algorithms, Methodologies”, Springer International Publishing AG, Switzerland, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explore the basics of industrial internet of things	Understanding (K2)
CO2	interpret the concepts of various architectures and components	Understanding (K2)
CO3	design and implement protocols and sensors for IIoT	Applying (K3)
CO4	impart the knowledge of IIoT security layers	Understanding (K2)
CO5	apply IIoT in real time Industrial applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3							1					1	1
CO2	3	1						1					2	2
CO3	3	2	1	1	1			1					3	3

CO4	3	1						1					2	2
CO5	3	2	1	1	1			1					3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85					100
CAT2	10	50	40				100
CAT3	5	35	60				100
ESE	10	50	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO06 - INDUSTRIAL DATA COMMUNICATION
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	To educate on the basic concepts of data communication, different industrial communication protocols and wireless communication.	
Unit – I	**Serial communication:**	**9**
Serial Communication: OSI reference model – Protocols – RS-232 overview, RS-232 interface standard (CCITT V.24 interface standard) – Half-duplex operation of the RS-232 interface – Limitations – RS-485 overview – The RS-485 interface standard – RS-485 vs RS-422 – The 20 mA Current loop.		
Unit – II	**Copper Cable and Fiber Optics Cable Communication:**	**9**
Copper cable: Characteristics – Cable selection – Coaxial cables – Twisted-pair cable – Distribution/installation standards – Connector standards. Fibre optics Communication: Fiber-optic cable components – Cable parameter – Types of optical fiber – Basic cable types – Connecting fibers.		
Unit – III	**MODBUS, PROFIBUS PA/DP/FMS and TCP/IP:**	**9**
MODBUS: Modbus Overview – MODBUS protocol structure – Function codes – query response cycle, transmission mode, Message Formatting. PROFIBUS PA/DP/FMS: PROFIBUS protocol stack- The PROFIBUS communication model- Relationship between application process and communication – Communication objects. TCP/IP – TCP/IP overview: Introduction – Internet Layer Protocols (Packet Transport) – Host-to-host layer: end to end reliability. TCP/IP troubleshooting: Introduction – Common problems – Typical network layer problems – Transport layer problems.		
Unit – IV	**HART and Foundation Field Bus:**	**9**
HART: HART Introduction – HART and smart instrumentation – Physical layer, Data link and application layer – HART Commands. Foundation Field Bus: Introduction – The Physical layer and Wiring Rules, The Data link layer, The Application layer, The User layer, Error detection and diagnostics - High-speed Ethernet (HSE)		
Unit – V	**Industrial Ethernet and Wireless Communication**	**9**
Industrial Ethernet: Introduction – 10 Mbps Ethernet – 100 Mbps Ethernet – Gigabit Ethernet – Industrial Ethernet. Wireless communication: Satellite systems – Wireless LANs- Radio and wireless communication : Introduction – components of radio link – radio spectrum and frequency allocation – Radio MODEMs.		
		Total:45

TEXT BOOK:

1.	Deon Reynders, Steve Mackay, Edwin Wright, "Practical Industrial Data Communications", 1st Edition, Elsevier, 2005.

REFERENCES:

1.	Forouzan, Behrouz A., "Data communication and Networking", 5th Edition, Tata McGraw-Hill, New Delhi, 2013.
2.	William L.Schweber, "Data Communications", 1st Edition, Tata McGraw-Hall, 2009.
3.	Steve Mackay, Edwin Wright, Deon Reynders," Practical Industrial Data Networks: Design, Installation and Troubleshooting", 1st Edition, Elsevier, 2005.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Make use of the essentials of the communication system and learn the serial communication interface	Understanding(K2)
CO2	Interpret knowledge about Copper cable and fiber optic cable communication	Understanding(K2)
CO3	Examine the suitability of various communication protocols	Understanding(K2)
CO4	Identify the architecture and applications of HART and Field bus	Applying (K3)
CO5	Examine the concepts of Industrial Ethernet and wireless communications	Understanding(K2)

Mapping of COs with Pos and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1							2	2

CO2	3	1				1							2	2
CO3	3	1				1							2	2
CO4	3	2				1							3	3
CO5	3	1				1							3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	60	20				100
ESE	20	60	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO07 - WIRELESS INSTRUMENTATION
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	To impart knowledge on wireless technology for instrumentation, wireless components and its applications. To provide adequate technical information on power sources, wireless protocols and network implementation

Unit – I	**Wireless Instrumentation Technology:**	**9**

Introduction – Instruments and Instrumentation: Measurement systems – Multiplexing structures – Wireless instruments and communication protocols – RF interfaces and examples – Networks of wireless instruments – Sensor node components: Computing subsystem – Communication subsystem – Power subsystems – Sensing subsystems.

Unit – II	**Powering Autonomous sensors:**	**9**

Autonomous sensors – Ambient energy sources and transducers – Energy storage units – Power considerations of wireless instruments – Energy harvesting: Solar and wind energy harvesting, RF energy harvesting, Energy harvesting from vibration, Thermal energy harvesting – Energy management techniques – Calculation for battery selection – Understanding RSSI and LQI values.

Unit – III	**Wireless Systems/Standards for Automation:**	**9**

Wireless HART: Protocol stack – Network components – Addressing control – Coexistence techniques. ISA100.11a: Introduction – Scope – Working group of ISA 100 – Features – Sensor classes – System configuration and architecture of ISA 100.11a – Comparison between ISA100.11a and WHART protocol stacks.

Unit – IV	**Design of Wireless Devices and LoRa:**	**9**

Wireless sensor and instrument network design – Wireless integrated network sensors – Plug-and-play sensors and networks – Industrial wireless networks and automation.
Introduction – Communication Methods – Difference between LoRa and LoRaWAN – LoRaWAN architecture – LoRaWAN classes.

Unit – V	**Wireless Sensor and Instrument Applications:**	**9**

Application specific wireless sensors and instruments – Commercial wireless sensors and instruments – Industrial wireless sensor and instrument networks – Wireless human health monitoring and environmental applications – Radio frequency identification – Consumer products and other applications – Applications in Transportation and Agriculture.

Total:45

TEXT BOOK:

1. John G. Webster, Halit Eren, "Measurement, Instrumentation, and Sensors Handbook", 2nd Edition, CRC Press - Taylor & Francis Group, LLC, Boca Raton, Florida, 2017

REFERENCES:

1. Subhas Chandra Mukhopadhyay, "Smart Sensors, Measurement and Instrumentation", 2nd Edition , Springer Science & Business Media, Heidelberg, Germany, 2013
2. Sunit Kumar Sen, "Fieldbus and Networking in Process Automation", 1st Edition, Taylor & Francis Group, LLC, London, 2017
3. Halit Eren, "Wireless Sensors and Instruments: Networks, Design, and Applications", 1st Edition, CRC Press, 2006

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	identify different instrumentation systems and fundamentals of wireless technology	Understanding (K2)
CO2	indicate the power sources and energy storage units used for autonomous sensors	Understanding (K2)
CO3	recognize the different wireless protocols and network standards for wireless instruments	Understanding (K2)
CO4	illustrate design concepts and procedure for wireless devices and LoRA	Understanding (K2)
CO5	explore the various applications of wireless sensor and instrument systems and networks	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	2										
CO2	3	2	2									3	
CO3	3	3	2	2	3							3	2
CO4	3	3	3	2	3							3	3
CO5	3	3	3	3	3							3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85					100
CAT2	15	85					100
CAT3	15	85					100
ESE	10	90					100

* ±3% may be varied (CAT 1, 2 & 3 – 60 marks & ESE – 100 marks)

22EIO08 - INSTRUMENTATION TECHNIQUES IN AGRICULTURE
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Transducers Engineering	7	OE	3	0	0	3

Preamble	To discuss the sensing and automation technology associated with agriculture.	
Unit – I	**Necessity of Instrumentation:**	**9**
Necessity of instrumentation & control for agriculture and food processing requirement, World Agriculture Scenario, Indian Agriculture sector – A synoptic Review- Areas of Concern. Information, Interpretation and Instruction Systems – Agri Instrumentation. Introduction to Transducers – Characteristics.		
Unit – II	**Agri Transducers**	**9**
Technology Trend – Conventional and Silicon transducers, Capacitive gauges, Silicon Displacement transducer, Silicon Temperature transducer, Silicon Pressure Transducer. Grain Moisture transducers, soil moisture transducers, Humidity transducers, pH transducers, Gas transducers, Intelligent Sensors.		
Unit – III	**Automation in Agriculture**	**9**
Microprocessor based Grain moisture measurement- Introduction, Sensing Mechanism, I/O requirement analysis. Microprocessor based Soil Nutrient Estimation Systems- Soil nutrients and their role, collection of samples, soil nutrient estimation, sensing mechanism. Preparation of soil extract for estimation of N,P,K and S, I/O requirement Analysis. SCADA Based system for Agriculture process monitoring. Case Study : Interfacing of agri sensors with Microcontroller.		
Unit – IV	**Drip Irrigation and Precision Agriculture**	**9**
Introduction-Sensors, Hardware block Schematic, system operation, I/O Requirement Analysis, Hardware Systems. Precision: Introduction, need for precision agriculture. Subsystem and components- GPS, Agri sensors, DAS, Communication System. Precision agriculture status – Working Philosophy.		
Unit – V	**Green House cultivation:**	**9**
Designs and classification of greenhouse- Orientation of Greenhouse / Poly house- Components of green house- Plant growing structures/containers in green house production- Environmental factors influencing greenhouse cultivation- Media preparation and fumigation- Drip irrigation and fertigation systems greenhouse cultivation- Problem management in greenhouse cultivation.		
		Total:45

TEXT BOOK:

1.	Krishna Kant , "Microprocessor Based Agri Instrumentation", 1st Edition, PHI Private Limited, New Delhi, 2010.

REFERENCES:

1.	Suchismita Satapathy, Debesh Mishra, Arturo Realyvasquez, Arturo Realyvásquez Vargas, "Innovation in Agriculture with IoT and AI", Springer nature, Switzerland, 2021.
2.	Sidney Walter Reginald Cox, Filby D E , "Instrumentation in Agriculture", Lockwood Publishers, UK, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the necessity of instrumentation for agriculture	Understanding (K2)
CO2	familiarize with the Soil parameters and tranducers in agricultural instrumentation	Understanding (K2)
CO3	Illustrate the techniques of agriculture using Microprocessor and SCADA	Applying(K3)
CO4	Outline the fundamentals of Drip Irrigation and Precision Agriculture	Understanding (K2)
CO5	Utilize the concepts of instruments in Green house cultivation	Understanding (K2)

Mapping of COs with Pos and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											2	2
CO2	3	1											2	2
CO3	3	2											3	3

CO4	3	1										2	2
CO5	3	1										2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	40	60					100
ESE	20	60	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO09 - ENVIRONMENTAL SENSORS
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	All BE/BTech branches except Electronics and Instrumentation Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	Fundamental course on sensors, instruments, and real- time systems to monitor environmental systems.	
Unit – I	**Fibre Optic Sensors:**	**9**
The need for environmental monitoring and new technology-principles of fibre optic chemical sensors: Fluorescence sensors-Raman sensors-Evanescent field sensors - fibre optic sensors for environmental applications: Air pollutants, Seawater monitoring, Ground and drinking water contamination and Soil contamination.		
Unit – II	**Integrated Optic Sensors:**	**9**
Introduction to integrated optics- Fabrication of integrated optic devices- Sensor techniques in integrated optics: Evanescent waves, Spectroscopy, Ellipsometry, Surface plasmon resonance, Light scattering - Applications of integrated optic devices for environmental sensing: An integrated optic biosensor- An integrated optic gas sensor.		
Unit – III	**Piezoelectric Sensors and Gas Analysers:**	**9**
Piezoelectric crystal theory, Instrumentation, Gas analysis, Piezoelectric aerosol sensors, Piezoelectric crystal liquid sensors, PZ sensor coatings operating in liquids. Gas analysers: Principles of operation, Differential optical absorption spectroscopy, Fourier transform IR spectroscopy, Differential absorption LIDAR, Laser-induced fluorescence, Chemiluminescent techniques.		
Unit – IV	**Monitoring of Land Pollution:**	**9**
Common contaminant types and environmental behavior: Contaminants and site use, Commonly occurring contaminant types, Factors affecting contaminant behavior - Monitoring equipment and instrumentation: Discrete monitoring: indirect determination of subsurface conditions, Discrete monitoring: direct determination of subsurface conditions, Field testing kits, Continuous and automatic monitoring.		
Unit – V	**Monitoring of Water Pollution and Air Pollution:**	**9**
Water Pollution: Continuous monitoring - Physical variables: Temperature, Conductivity, salinity and total dissolved solids, Turbidity and suspended solids, Colour. Chemical variables: Dissolved oxygen, Acidity, alkalinity and pH, Anions, Cations. Biological variables: Biochemical oxygen demand- Total organic carbon, Chemical oxygen demand. Air Pollution: Air quality standards - Characterisation of atmospheric pollutants – Air pollution sampling - Monitoring modes.		
		Total:45

TEXT BOOK:

1.	Miguel F. Acevedo, "Real-Time Environmental Monitoring Sensors and Systems**",** 1st Edition, CRC Press, United States, 2015.

REFERENCES:

1.	Janick Artiola, Ian L. Pepper, Mark L. Brusseau, "Environmental Monitoring and Characterization", 1st Edition, Elsevier, 2004
2.	Acevedo M.F., "Data Analysis and Statistics for Geography, Environmental Science, and Engineering", 1st Edition, CRC press, 2013

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the role of fibre optic sensors for environmental monitoring	Understanding (K2)
CO2	apply the integrated optic sensors for environmental sensing	Applying (K3)
CO3	apply the piezoelectric sensors and gas analyzers for Environmental Monitoring	Applying (K3)
CO4	identify the cases and concept of land pollution	Understanding (K2)
CO5	explain the concept of Water pollution and Air pollution	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3	3			3						3	2
CO2		3	3				3						3	2
CO3		3	3				3						2	2

CO4		3	3				3						3	2
CO5			3				3						2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	40	60					100
ESE	30	50	20				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22EIO10 - POLLUTION CONTROL AND MANAGEMENT
(Offered by Department of Electronics and Instrumentation Engineering)

Programme & Branch	**All BE/BTech branches except Electronics and Instrumentation Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course will cover various aspects of pollution control, including the causes and effects of pollution, regulatory frameworks, and management strategies. Students will gain an understanding of the various types of pollutants, their sources, and the impact they have on the environment and human health.	
Unit – I	**Introduction to Pollution Control Management:**	**9**
Introduction to Pollution Control Management - Professional Codes of Ethics - Environmental Ethics - Environmental Systems Overview: Water Resource Management System - Wastewater Disposal Subsystem - Air Resource Management System.		
Unit – II	**Water Pollution:**	**9**
Water Pollutants And Their Sources - Water Pollution In Rivers - Water Pollution In Lakes - Water Pollution In Estuaries - Groundwater Pollution – Applications.		
Unit – III	**Wastewater Treatment:**	**9**
Characteristics of Wastewater - Wastewater Treatment Standards - Municipal Wastewater Treatment Systems - Land Treatment For Sustainability - Sludge Treatment - Alternative Sludge Disposal Techniques.		
Unit – IV	**Air Pollution:**	**9**
Air Pollution Perspective - Effects of Air Pollutants - Origin and Fate of Air Pollutants - Micro and Macro Air Pollution - Air Pollution Meteorology - Air Pollution Control of Stationary Sources - Air Pollution Control of Mobile Sources.		
Unit – V	**Solid Waste Management:**	**9**
Characteristics of Solid Waste - Solid waste management decision alternatives - Integrated Solid Waste Management - Collection Methods - Disposal by Municipal Solid Waste Landfill - Waste to Energy – Case study.		
		Total:45

TEXT BOOK:

1.	Mackenzie L. Davis & David A. Cornwell, "Introduction To Environmental Engineering", 5th Edition, The McGraw -Hill Series, 2013.

REFERENCES:

1.	Gilbert M. Masters Wendell P. Ela , "Introduction to Environmental Engineering and Science" 3rd Edition, Pearson Education Limited, 2014.
2.	J.Jeffrey Peirce, P.Aarne Vesilind, Ruth F.Weiner, "Environmental Pollution and Control", 4th Edition, Elsevier Science & Technology Books, 1997.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the fundamentals of pollution control and management	Understanding (K2)
CO2	interpret the concepts of water pollution and control methods	Understanding (K2)
CO3	summarize the methods of wastewater treatment and waste disposal	Understanding (K2)
CO4	apply suitable method for air pollution management techniques	Applying (K3)
CO5	identify various method for solid waste management techniques	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CSX01- FUNDAMENTALS OF DATABASES							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches except**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the learners to know the fundamentals of database and SQL language to create and manipulate the database	
Unit – I	**Introduction to Database Management:**	**9**
Introduction – Database System – Example – Characteristics – Importance of Databases – File System Vs Database System – DBMS Users – Data abstraction – Levels of abstraction – Data Independence – Database System Architecture – Database administrator – Choosing a DBMS – Enterprise Database: Advantages, Concerns, Designing.		
Unit – II	**Data Models:**	**9**
Introduction – Benefits of Data Modelling – Types Modelling – Phases of Data Modelling – ER model – Generalization, Specialization and Aggregation – Database Design Process – Strength and Weakness of ER Model – Case study of Building an ER Model. Relational Model – Data Structure – Mapping the ER Model to Relational Model – Data Manipulation – Data Integrity – Advantages of Relational Model.		
Unit – III	**SQL:**	**9**
SQL – Data Definition: CREATE, ALTER and DROP commands– Keys and Constraints – Data Manipulation: SQL Data Retrieval– Views: Creating views from single and multiple relations – DML operations on views – Embedded and Dynamic SQL.		
Unit – IV	**Functional Dependency and Normalization:**	**9**
Undesirable Properties and Schema refinement – Decomposition using functional dependencies: 1NF, 2NF, 3NF, BCNF – Desirable properties of Decomposition – Multi valued Dependencies.		
Unit – V	**Indexing and Hashing:**	**9**
Types of Memories – Secondary Storage – Buffer Management. File Structure – Heap file – Sequential file. Index – Types of Index – Indexed sequential file – B+ tree. Static hashing – External hashing – Dynamic Hashing.		

LIST OF EXPERIMENTS / EXERCISES:	
1.	Write the queries using Data definition language.
2.	Implement the Integrity Constraints on Database.
3.	Write the queries using Data manipulation language.
4.	Implement various Aggregate functions on Database
5.	Write queries using Set operations on various Relations.
6.	Write nested and sub queries on Database
7.	Implement the various Join operations using SQL
8.	Write the queries using DCL and TCL commands
9.	Create Views and perform SQL operations in it
10.	Perform SQL operations using index

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	G K Gupta, “Database Management Systems”, Tata Mc Graw Hill, 1st Edition, 2018.
REFERENCES/ MANUAL / SOFTWARE:	
1.	Silberschatz. Abraham, Korth, Henry F. and Sudarshan S., “Database System Concepts”, 7th Edition, McGraw Hill, New York, 2021.
2.	Back End : ORACLE / SQL SERVER / MYSQL

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the features, architecture and applications of database system and choose an appropriate database	Applying (K3) Precision (S3)
CO2	design a relational database using ER model	Applying (K3) Precision (S3)
CO3	manipulate the relational database with SQL statements	Applying (K3) Precision (S3)
CO4	design relational database using normalization methods	Applying (K3) Precision (S3)
CO5	apply indexing and hashing techniques in the design of relational database	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	50	40	-	-	-	100
CAT2	10	35	55	-	-	-	100
CAT3	10	30	60	-	-	-	100
ESE	5	35	60	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSX02 - DATA SCIENCE FOR ENGINEERS							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches except CSE & IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course introduces data science and the essentials of applied statistics required in the context of data science and its applications.	
Unit – I	**Introduction**	**9**
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – Building the model– presenting findings and building applications.		
Unit – II	**Descriptive Statistics**	**9**
Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores.		
Unit – III	**Predictive Analytics**	**9**
Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations – regression towards the mean.		
Unit – IV	**Python Libraries for Data Wrangling**	**9**
Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping.		
Unit – V	**Data Visualization**	**9**
Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.
2.	Working with Numpy arrays
3.	Working with Pandas data frames
4.	Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics .
5.	Perform the following Predictive Analytics a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis. b. Bivariate analysis: Linear and logistic regression modeling c. Multiple Regression analysis d. Also compare the results of the above analysis for the two data sets.
6.	Implement the following using Regression model a. Import a data from web storage. Name the dataset and now do Logistic Regression to find out the relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. b. Apply multiple regressions, if data have a continuous Independent variable. Apply on the above dataset. Apply regression Model techniques to predict the data on the above dataset. U3
7.	Apply and explore various plotting functions on the given data sets. a. Normal curves b. Density and contour plots c. Correlation and scatter plots d. Histograms e. Three-dimensional plotting
8.	Visualizing Geographic Data with Basemap
9.	Develop a Data Science project using Python code to build a recommendation system that recommends movies to users.
10.	Develop a Data Science project using Python to determine whether the consumer's attitude towards a particular product or topic is positive, negative, or neutral.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Davy Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. (Unit I)
2.	Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017. (Units II and III)
3.	Jake VanderPlas, “Python Data Science Handbook Essential Tool for Working with Data ”, O’Reilly, 2016. (Units IV and V)

REFERENCES/ MANUAL / SOFTWARE:

1.	Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green TeaPress, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	utilize the skills of data science processes such as data inspecting and cleansing	Applying (K3)
CO2	perform the different types of descriptive analytics for the data science process	Applying (K3)
CO3	perform the correlation and regression analytics on standard data sets for the data science	Applying (K3)
CO4	use the Python Libraries for Data Wrangling in data science	Applying (K3)
CO5	apply visualization techniques to interpret and explore data	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSX03 ENTERPRISE APPLICATION DEVELOPMENT USING JAVA
(Offerd by department of CSE)

Prog. & Branch	ALL BE/BTech Branches	Sem.	Category	L	T	P	Credit
Pre requisite	**Java Programming**	**5**	**OE**	**3**	**0**	**2**	**4**
Preamble	This course offers good knowledge on how to develop an enterprise oriented applications using java technologies and hosting with application server.						

UNIT – I	**Network Programming and RMI**	**9**

Network Programming - Basics - Classes and Interfaces - InetAddress - Factory methods - Instance Methods - Inet4Address and Inet6Address - TCP/IP Client Sockets - URL - URLConnection - HttpURLConnection -URI Class - Cookies - TCP/IP Server sockets - Datagrams - RMI architecture - Developing Simple RMI applications.

UNIT – II	**Servlets and JSP**	**9**

Introduction - HTTP Servlet Basics: Servlet API - Page Generation - Web Applications. Servlet Life Cycle: Servlet Alternatives - Reloading - init and destroy - Single Thread Model - Background Processing - Load on Startup - Client-Side Caching - Server-Side Caching - Retrieving information - Sending HTML information - Java Server Pages : Basics - Expression and Declaration - Directives - Includes and Forwards - Custom Tag libraries - Simple JSP program.

UNIT – III	**J2EE, Application Server and Software Architectures**	**9**

J2EE architecture - EJB - Session, Entity and Message driven beans - Model View Control (MVC) architecture – Case study: Application server - Apache Tomcat - Introduction - Installation - services - Hosting Java Apps with server. Types of software architectures - SOA and Monolith Architecture - Micro Services - Micro Service Architecture - Application Layer - Business Layer - Enterprise Layer - Infra Layer - REST API - Advantages with Micro Services

UNIT – IV	**Configuration of Spring Framework**	**9**

Basics of Spring framework - Annotation - Built annotations - Dependency injection - Starters : Web Starter - Data JPA Starter - DevTools for rapid application development : Run JAR - Application Properties - Automatic Restart - Live Reload - Server Port Number

UNIT – V	**SpringBoot Framework and Database connectivity**	**9**

Spring Boot: Introduction to Spring vs. Spring Boot vs. Spring MVC - Architecture - Initializr Modules – Interface - Database - Working with JPA - POJO classes - MYSQL - Working with Hibernate - Data JPA with CRUD Repositories - Data JPA with custom methods - Data JPA with custom queries

Lecture:45, Practical : 15 Total: 60

List of Exercises:

1. Develop chat application using TCP and UDP
2. Develop a RMI application
3. Develop servlet based Login application for session tracking
4. Develop a simple application using JSP
5. Create web application using Servlets, JDBC and JSP
6. Develop an EJB application that demonstrates Entity Bean
7. Implement an EJB application that demonstrates Session Bean
8. Develop an application and hosting with tomcat server
9. Develop a simple application using Spring with database connectivity
10. Deploy simple database application using SpringBoot

TEXT BOOKS:

1. Schildt, Herbert, “Java: The Complete Reference”, 9th Edition, Tata McGraw-Hill, New Delhi, 2014.
2. Mark Heckler, “Spring Boot: Up and Running: Building Cloud Native Java and Kotlin Applications”, 1st Edition, O'Reilly Media Inc., USA, 2021.

REFERENCES:

1. Asbury, Stephen and Weiner, Scott R.,”Developing Java Enterprise Applications”, 2nd Edition, Wiley Publications, 2001.
2. Claudio Eduardo de Oliveira, Greg L. Turnquist, Alex Antonov, “Developing Java Applications with Spring and Spring Boot”, Packt publishing, Mumbai, 2018
3. Craig Walls, “Spring in Action”, 5th Edition, Manning Publications, Dream Tech Press, New Delhi, 2018
4. https://www.javatpoint.com

COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**

CO1:	construct network with socket programming concepts and RMI architecture	Applying (K3)
CO2:	interpret server side programming using JSP and Servlets	Applying (K3) Precision (S3)
CO3:	make use of EJB, application server and microservice architecture and its concepts	Applying (K3)
CO4:	experiment with annotations, dev tools in Spring framework	Applying (K3) Precision (S3)
CO5:	utilize JPA/Hibernate for Spring Boot database connectivity	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

ASSESSMENT PATTERN

Test/Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1	40	40	20				100
CAT 2	40	30	30				100
CAT 3	40	30	30				100
ESE	30	40	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSO01 - COMPUTATIONAL SCIENCE FOR ENGINEERS							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches except CSE & IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course focuses on applications of computer simulation and modeling to real world simple and complex problems.	
Unit – I	**Modeling Process**	**9+3**
Model Classifications – Steps of the Modeling Process – System Dynamics: Unconstrained Growth and Decay – Rate of Change – Differential Equation – Difference Equation – Simulation Program – Analytical Solution – Further Refinement – Unconstrained Decay – Reports – Constrained Growth: Carrying Capacity – Revised Model – Equilibrium and Stability – Drug Dosage: Onecompartment Model of Single Dose and Repeated Doses – Mathematics of Repeated Doses – Sum of Finite Geometric Series – Two-compartment Model.		
Unit – II	**Force and Motion**	**9+3**
Modeling Falling and Skydiving: Acceleration, Velocity and Position – Physics Background – Friction during Fall – Modeling a Skydive – Assessment of the Skydive Model – Bungee Jumping: Physics Background – Vertical Springs – Modeling a Bungee Jump – The Pendulum Clock: Simple Pendulum – Linear Damping – Pendulum Clock – Rocket motion: Physics Background – System Dynamics Model.		
Unit – III	**System Dynamics Models**	**9+3**
Competition: Community Relations – Introduction to Competition – Modeling – Predator-Prey Model: Lotka-Volterra Model – Particular Situations – Modeling the spread of SARS: SIR Model – SARS Model – Reproductive Number – Enzyme Kinetics: Enzymatic Reactions – Differential Equations – Model – Moles vs. Molar – Results – Michaelis-Menten Equation – Modeling Inhibition.		
Unit – IV	**Data Driven Models**	**9+3**
Functions: Linear – Quadratic – Polynomial – Square Root – Exponential – Logarithmic – Logistic – Trigonometric – Empirical Models: Linear Empirical Model – Predictions – Linear Regression – Non-Linear One-term Model – Multi-term Models – Advanced Fitting with Computational Tools – Simulating with Randomness: Simulations: Disadvantages of Computational Simulations – Element of Chance – Measure of Quality – Simulation Development – Different Range of Random Numbers – Random numbers from various distributions – Rejection Method – Random Walk.		
Unit – V	**Matrix Models**	**9+3**
Matrices for Population Studies: Population Matrices and High-Performance Computing – Vectors – Vector Addition – Multiplication by Scalar – Dot Product – Matrices – Scalar Multiplication and Matrix Sums – Matrix Multiplication – Square Matrices – Matrices and Systems of Equations – Time after Time: The Problem – Age-structured Model – Leslie Matrices – Age Distribution over Time – Projected –population Growth Rate – Stage-structured Model – Algorithms – Sensitivity Analysis for Age and Stage Structured Model – Applicability of Leslie and Lefkovitch Matrices – Need for High-Performance Computing – Modeling with Markov Chains – The next Flu Pandemic.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Angela B. Shiflet, George W. Shiflet, “Introduction to Computational Science: Modeling and Simulation for the Sciences”, 2nd Edition, Princeton University Press, 2014.

REFERENCES:

1.	Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, “Discrete-Event System Simulation: Pearson New International Edition”, 5th Edition, Pearson Education Limited, 2013.
2.	R. Panneerselvam, P. Senthilkumar, System Simulation, Modelling and Languages, PHI learning Pvt.Ltd. 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	model system dynamics with and without constraints	Applying (K3)
CO2	determine system dynamics involved in force and motion	Applying (K3)
CO3	construct models for systems with interactions	Applying (K3)
CO4	make use of randomness and data for modeling	Applying (K3)
CO5	apply matrix theory in problem solving	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	10	45	45				100
CAT3	25	45	30				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSO02 - FORMAL LANGUAGES AND AUTOMATA THEORY							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course helps the learners to know the models of computation, along with their variants in the context of formal languages and their recognizers and to familiarize students with the foundations and principles of computer science. This can be applied in designing compilers and pattern recognition system.	
Unit – I	**Formal proof and Automata**	**9+3**
Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Conversion of NFA into DFA – Equivalence and minimization of automata.		
Unit – II	**Regular Expressions and Languages**	**9+3**
Regular expression – Equivalence of finite automata and regular expressions – Proving languages not to be regular (Pumping Lemma) – Closure properties of regular languages.		
Unit – III	**Context Free Grammar and Languages**	**9+3**
Context-Free Grammar (CFG) – Parse trees – Ambiguity in grammars and languages – Definition of the pushdown automata (PDA) – Languages of pushdown automata – Equivalence of pushdown automata and CFG-CFG to PDA-PDA to CFG – Deterministic Pushdown Automata.		
Unit – IV	**Context Free Languages and Turing Machines**	**9+3**
Normal forms for CFG – Chomsky Normal Form and Greibach Normal Form – Pumping lemma for CFL – Closure properties of Context Free Languages – Turing machines: Basic model – definition and representation – Instantaneous Description – Language acceptance by TM – Variants of Turing Machine – TM as Computer of Integer functions – Programming techniques for Turing machines (subroutines).		
Unit – V	**Undecidability**	**9+3**
language that is not Recursively Enumerable (RE) – An undecidable problem that is RE –Undecidable problems about Turing machine – Post„s correspondence problem – The classes P and NP –Kruskal„s algorithm – Traveling Salesman Problem.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, New Delhi, 2008.

REFERENCES:

1.	Martin J., “Introduction to Languages and the Theory of Computation”, 4th Edition, Tata McGraw-Hill, New Delhi, 2010.
2.	Linz P., "Introduction to Formal Language and Computation", 4th Edition, Narosa Publishing, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply induction and contradiction methods for theorem proving.	Applying (K3)
CO2	design finite automata and regular expression for regular languages.	Applying (K3)
CO3	develop and normalize context free grammar for context free languages and demonstrate the recognition of context free languages using push down automata.	Applying (K3)
CO4	construct Turing Machine to accomplish specific task and argue formally about its correctness.	Applying (K3)
CO5	make use of Turing machines to distinguish decidable / undecidable problems and compare different classes of problems.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSX04 – FOUNDATIONS OF MACHINE LEARNING							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches except CSE & IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	The course focuses on the methodology of how to translate a data driven business problem into an effective solution by using Machine Learning paradigm.	
Unit – I	**Introduction**	**9**
Introduction- Resurgence of ML, Relation with Artificial Intelligence (AI), Machine Learning Problems. Mathematical needs – Basics of Matrices, Numerical Methods, Probability and Statistics, Linear Algebra and Differential Calculus towards Machine Learning.		
Unit – II	**Machine Learning Categories and Tool Box**	**9**
Supervised Learning – Unsupervised Learning – Reinforcement Learning – ML Toolbox: Data – Infrastructure - Algorithms. Advanced Toolbox: Big data – Infrastructure – Advanced Algorithms. Machine Learning tool kit in MATLAB.		
Unit – III	**Data Scrubbing and Setting up your Data**	**9**
Data Scrubbing: Feature Selection – Row Comparison – One hot Encoding – Binning – Handling Missing Data – Calculation of Mean, Variance and Standard Deviation. Setting up your Data: Generalization of Data – Train and Test segments – Deciding of total quantity of data needed – Cross Validation.		
Unit – IV	**Basics of Regression, Clustering and Error Measurements**	**9**
Linear Regression – Multi linear Regression - Logistic Regression – Support Vector Machine - Clustering: K-Nearest Neighbors – K Means – Setting K. Bias and Variance. Error calculation: Mean Absolute Error (MAE) - Root Mean Squared Error (RMSE) - Relative Squared Error (RSE) - Relative Absolute Error (RAE) - Coefficient of Determination (R2 or R-squared).		
Unit – V	**Advanced Learning**	**9**
Reinforcement Learning – Neural Networks – Building a Neural Network – Ensemble Modeling- Decision Tree – Building a Decision Tree- Bootstrap Aggregation – Boosting - Random Forests – Deep Learning.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Implementation of Python basic Libraries such as Math, Numpy and Scipy.
2.	Implementation of Python Libraries for ML application such as Pandas and Matplotlib.
3.	Write a python program to compute Mean, Median, Mode, Variance and Standard Deviation using Datasets.
4.	Implement Naïve Bayes theorem to classify the English text.
5.	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions
6.	Write a program to compute reshaping the data, filtering the data, merging the data and handling the missing values in data sets.
7.	Write a program to implement SVM classification.
8.	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
9.	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Oliver Theobald, “Machine Learning for Absolute Beginners”, Scatterplot Press, Third Edition, 2020.

REFERENCES/ MANUAL / SOFTWARE:

1.	RajendraAkerkar, “Introduction to Artificial Intelligence”, PHI Learning Pvt Ltd, Second Edition August,2014.
2.	GopinathRebala, Ajay Ravi, Sanjay Churiwala, “An Introduction to Machine Learning”, Springer Nature,Switzerland, 1st edition, 2019.
3.	Windows,Python.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	relate machine learning basics and the importance of mathematics towards machine learning technologies.	Applying (K3) Precision (S3)
CO2	use toolbox for basic methods for different applications with the basic concepts of Python through examples	Applying (K3) Precision (S3)
CO3	perform pre-processing on data to be used in machine learning models and algorithms	Applying (K3) Precision (S3)
CO4	formulate own learning model for a specified application.	Applying (K3) Precision (S3)
CO5	apply decision tree and neural networks for solving a given problem.	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSX05 - WEB ENGINEERING							
(Offered by Department of CSE)							
Programme& Branch	**All BE/BTech Branches except CSE & IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course aims to equip the students with the necessary skills to design and develop web applications.

Unit – I	**UI Design:**	**9**

HTML 5 – Basic Tags – Input Tags – Page Structure Elements – Cascading Style Sheet: Inline Styles – Embedded Style Sheets – Conflicting Styles – Linking External Style Sheets – Positioning Elements – Background – Element Dimensions – Box Model and Text Flow – Media types and Media queries – Drop – Down Menus

Unit – II	**Client Side Scripting – Part 1:**	**9**

Introduction – Control Statements – Functions: Function Definition – Random Number Generation: Scaling and Shifting Random Number – Displaying Random Images – Scope Rules – Global Functions – Recursion – Recursion vs Iterations. – Arrays: Declaring and Allocating Arrays – Random Image Generator using Array – Sorting and Searching Array

Unit – III	**Client Side Scripting – Part 2:**	**9**

Java Script Objects: Introduction – Math Object – String Object – Date Object – Boolean and Number Objects – Document Objects – Document Object Model: DOM Nodes and Trees – DOM Collections – Dynamic Style – Dynamic Styles to Create Animated Effects - Events – Event Handling: Load Event – Mousemove – Mouseover and Mouseout - Form Processing Events

Unit – IV	**Web Server and Database with MySQL:**	**9**

Relational Database Concepts – Basic SQL – SELECT – INSERT – UPDATA – DELETE – MySQL – Setting Up a MySQL User Account – Creating Databases in MySQL – Web Servers – Introduction – HTTP Transactions – Multitier Application Architecture – Client-Side Scripting versus Server-Side Scripting Accessing Web Servers – XAMPP Installation – Running the Examples Using Apache HTTP Server

Unit – V	**Server Side Scripting using PHP:**	**9**

Introduction – Data Type Conversion – Operators – Arrays – Strings Comparisons – String Processing: Searching for Expressions – Representing Patterns – Finding Matches – Character Classes – Finding Multiple Instance of a Pattern – Regular Expressions – Form Processing – Database Connectivity – Session Tracking.

LIST OF EXPERIMENTS / EXERCISES:

1.	Create a GitHub repository and explore the its features
2.	Design a static web page using HTML tags and host it in github repository.
3.	Apply CSS3 Text, Background, and Border properties to design an attractive web page
4.	Design a web page with navigation bar using appropriate CSS3 properties
5.	Design an online Registration Form and perform form validation using JavaScript
6.	Develop a simple dynamic web application to retrieve the user details from a Web Form and display the same on a web page using PHP
7.	Create a database with necessary tables and execute SQL queries using phpMyAdmin and MySQL
8.	Develop any real-time web application using PHP and MySQL
9.	Apply Session Tracking in PHP to manage users' session in a website

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Paul Deitel, Harvey M.Deitel and Abbey Deitel, "Internet and World Wide Web - How To Program", 5th Edition, Prentice Hall, 2012. (Unit I - V)

REFERENCES/ MANUAL / SOFTWARE:

1.	1. Xavier C, "World Wide Web Design with HTML", Tata McGraw Hill, New Delhi, 2017.

2.	Luke Welling and Laura Thomson, PHP and MySQL Web Development", 5th Edition, Pearson Education, 2016.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Design static web pages using HTML5 and CSS3	Applying (K3), Precision (S3)
CO2	Design interactive web pages using the basic programming constructs of JavaScript	Applying (K3), Precision (S3)
CO3	Make use of DOM and Event handling in JavaScript to validate an online registration form	Applying (K3), Precision (S3)
CO4	Create and manipulate relational databases using MySQL	Applying (K3), Precision (S3)
CO5	Develop a real-time dynamic web application using PHP and MySQL	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	30	55				100
CAT2	15	40	45				100
CAT3	15	40	45				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSO03- NATURE INSPIRED OPTIMIZATION TECHNIQUES							
(**Offered by Department of CSE**)							
Programme & Branch	**All BE/BTech Branches except CSE & IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides an introduction to nature inspired techniques and applications.	
Introduction		**9**
Philosophy of Natural Computing-Three Branches: A Brief Overview-Conceptualization-Individuals-Entitiesndagents-Parallelism and Distributivity-Interactivity–Adaptation-Feedback-Self-Organization-Complexity-Emergence and Reductionism-Bottom-up Vs Top-Down-Determination-Chaos and Fractals.		
Unit – II	**Computing Inspired By Nature**	**9**
Evolutionary Computing-Hill Climbing and Simulated Annealing-Evolutionary biology-Darwin's Dangerous Idea-Genetics Principles-Standard Evolutionary Algorithm-Genetic Algorithms-Selection-Crossover-Mutation-Neurocomputing-Artificial neurons-network architectures-learning approaches-Hebbian learning-Single layer perceptron-Multi-layer perceptron-Self organization maps- discrete Hopfield network.		
Unit – III	**Swarm Intelligence**	**9**
Introduction - Ant Colonies- Ant Foraging Behavior- Ant Colony Optimization- Simple ACO and scope of ACO algorithms – Ant Clustering Algorithm (ACA)- Swarm Robotics- Foraging for food- Social Adaptation of Knowledge - Particle Swarm Optimization(PSO)-Scope of PSO-social systems to particle swarm.		
Unit – IV	**Immuno Computing**	**9**
Introduction-Immune System-Physiology and main components-Pattern Recognition and Binding-adaptive immune response-Self/Non-self discrimination- Immune Network Theory-Danger Theory-artificial immune systems-Evaluating Interaction- Immune Algorithms-Bone Marrow Models-Negative selection algorithms-Clonal selection and affinity maturation-Artificial Immune Networks.		
Unit – V	**Computing With New Natura Materials**	**9**
DNA Computing - Basic concepts - DNA Molecule - Filtering models- Adleman's experiment - Test tube programming language-FormalmodelsUniversalDNAComputers-ScopeofDNAComputing-FromClassicaltoDNAComputing-Quantumcomputing-Introduction-basic concepts from quantum theory-principles from quantum mechanics.		
		Total:45

TEXT BOOK:

1.	Leandro Nunesde Castro,"Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/CRC, Taylor and Francis Group, 1stEdition, 2007.

REFERENCES:

1.	FloreanoD. and Mattiussi C.,"Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MITPress, Cambridge, 1stEdition, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Apply fundamental concepts in Nature Inspired Systems to solve computational problems.	Applying(K3)
CO2	Manipulate the evolutionary and neuro Computing techniques inspired by nature.	Applying(K3)
CO3	Implement collective intelligence of biological systems to computing.	Applying(K3)
CO4	Develop immune systems behavior to computing and optimization.	Applying(K3)
CO5	Make use of the characteristics of DNA computing and Quantum Computing.	Applying(K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	45	35				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSO04 - MACHINE TRANSLATION							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course helps the learners to know the basic concepts of neural networks and design of machine translation models with the core aspects of training and decoding. This helps in building a state of the - art model in machine translation.	
Unit – I	**Introduction**	**9**
The Translation Problem: Goals of Translation – Ambiguity – Linguistic view – Data view. Uses of Machine Translation: Information Access – Aiding Human Values – Communication – NLP Pipelines - Multimodal Translation. History: Neural Networks – Machine Translation. Evaluation: Task based Evaluation – Human Assessments – Automatic Metrics – Metrics Research.		
Unit – II	**Neural Network Based Machine Translation models**	**9**
Neural Networks: Linear models – Multiple Layers – Nonlinearity – Inference – Back-Propagation Training – Exploiting Parallel Processing. Computation Graphics: Neural Network as Computation Graphs – Gradient Computations. Neural Language Models: Feed-Forward Language Models – Word Embeddings – Noise Contrastive Estimation –Recurrent Neural Language Models – LSTM Models – Gate Recurrent Units.		
Unit – III	**Encoding and Decoding of Translation Model**	**9**
Translation: Encoder-Decoder Approach – Adding an Alignment Model – Training. Decoding: Beam Search – Ensemble Decoding – Reranking – Optimizing Decoding – Directing Decoding		
Unit – IV	**Refining Machine Translation Model**	**9**
Machine Learning Tricks: Failures – Ensuring Randomness – Adjusting Learning Rate – Avoiding Local Optima – Addressing Vanishing and Exploding Gradients – Sentence Level Optimization. Alternate Architecture: Components of NN – Attention Models-Convolutional Machine Translation and Neural Networks with Attention – Self-Attention: Transformer. Revisiting Words: Word Embeddings – Large Vocabularies-Character Based Models.		
Unit – V	**Adaptation and Linguistic Structure**	**9**
Adaptation: Domains – Mixture Models – Sub Sampling – Fine-Tuning -Using Monolingual Data – Multiple Language Pairs – Training on Related Tasks. Linguistic Structure: Guided Alignment Training – Modeling Coverage- Adding Linguistic Annotation		
		Total:45

TEXT BOOK:

1. Philipp Koehn, “Neural Machine Translation”, Cambridge University Press, 2020

REFERENCES:

1. Gloria Corpas Pastor, Johanna Monti, Ruslan Mitkov, Violeta Seretan, “Multiword Units in Machine Translation and Translation Technology “,John Benjamins Publishing Company , 2018.
2. Bernard Scott , “Translation, Brains and the Computer A Neurolinguistic Solution to Ambiguity and Complexity in Machine Translation” Springer International Publishing, 2018

COURSE OUTCOMES: On completion of the course, the students will be able to,		BT Mapped (Highest Level)
CO1	summarize the basic concepts and techniques of Machine Translator.	Understand (K2)
CO2	apply Neural Network concepts to build Machine Translation models	Applying (K3)
CO3	make use of encoding and decoding approaches for building Machine Translation models	Applying (K3)
CO4	apply optimization techniques to refine the Machine Translation models	Applying (K3)
CO5	utilize adaptation techniques and linguistic approaches to finetune the machine translation model	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	25	50	25				100
ESE	35	45	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSO05 – FUNDAMENTALS OF BLOCKCHAIN							
(Offered by Department of CSE)							
Programme & Branch	**All BE/BTech Branches except CSE & IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides technical fundamentals of Blockchain, practical implications, and hands on development aspects of blockchain applications.	
Unit – I	**Introduction:**	**9**
History – Introduction to Blockchain – Centralized vs. Decentralized Systems – Layers of Blockchain – Importance of Blockchain – Blockchain Uses and Use Cases – Laying the Blockchain Foundation – Cryptography – Symmetric Key Cryptography – Cryptographic Hash functions – MAC and HMAC – Asymmetric Key cryptography – Diffie-Helman Key Exchange – Symmetric vs Asymmetric Key Cryptography.		
Unit – II	**Working of Blockchain:**	**9**
Game Theory: Prisoner's Dilemma – Byzantine Generals' Problem – Components of Computer Science Engineering: The Blockchain – Merkle Trees – Properties of Blockchain Solutions – Blockchain Transactions – Distributed Consensus Mechanisms – Blockchain Applications – Scaling Blockchain.		
Unit – III	**Bitcoin:**	**9**
The History of Money – Introduction to Bitcoin - Working with Bitcoins – The Bitcoin Blockchain: Block structure – The Genesis Block – The Bitcoin Network: Network Discovery for a New Node – Bitcoin Transactions – Consensus and Block Mining – Block Propagation – Bitcoin Scripts – Full Nodes vs. SPVs – Bitcoin Wallets.		
Unit – IV	**Ethereum and Introduction to Hyperledger:**	**9**
Bitcoin to Ethereum – Ethereum Blockchain – Ethereum Smart Contracts – Ethereum Virtual Machine and Code Execution – Ethereum Ecosystem – Swarm – Whisper – DApp – Development Components – Hyperledger - Introduction – Projects: Fabric – Sawtooth lake – Iroha – Blockchain Explorer – Fabric Chaintool – Fabric SDK Py – Corda.		
Unit – V	**Blockchain Application Development:**	**9**
Decentralized Applications – Blockchain Application Development – Interacting with Bitcoin Blockchain – Sending Transactions – Creating a Smart Contract – Executing Smart Contract Functions – Public vs. Private Blockchains – Decentralized Application Architecture – Building an Ethereum DApp.		
		Total:45

TEXT BOOK:

1. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, "Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions", APress, 1st Edition, 2018, for Units 1 to 5.

REFERENCES:

1. Brenn Hill, Samanyu Chopra, Paul Valencourt, "Blockchain Quick Reference: A guide to exploring decentralized blockchain application development", Packt publishing, 1st Edition, 2018.
2. Imran Bashir, "Mastering Blockchain Distributed ledgers, decentralization and smart contracts Explained", Packt Publishing, 1st Edition, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explore the history, background, and theoretical aspects of blockchain and apply in real case scenarios	Applying (K3)
CO2	demonstrate core components and working of blockchain	Applying (K3)
CO3	apply Bitcoin's technical concepts for real case scenarios	Applying (K3)
CO4	adapt Ethereum blockchain for different use cases	Applying (K3)
CO5	demonstrate the end-to-end development of a decentralized application	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	30	50	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ITO01 - ARTIFICIAL INTELLIGENCE							
Programme & Branch	**All Engineering and Technology Branches except IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course focuses on the methodology of how to translate a data driven business problem into an effective solution by using powerful AI technologies and Machine Learning paradigm.	
Unit - I	**Introduction to Artificial Intelligence**	**9+3**
Introduction– Definition, Symbolic and Non-Symbolic Representation, Research Focus of Artificial Intelligence. Artificial Intelligence: History, Applications, Objectives, Artificial Intelligence Programming and future of AI.		
Unit - II	**Machine Learning Definition and Basics**	**9+3**
Introduction- Resurgence of ML, Relation with Artificial Intelligence (AI), Machine Learning Problems. Mathematical needs – Basics of Matrices, Numerical Methods, Probability and Statistics, Linear Algebra and Differential Calculus towards Machine Learning.		
Unit - III	**Machine Learning Categories and Tool Box**	**9+3**
Supervised Learning – Unsupervised Learning – Reinforcement Learning – ML Toolbox: Data – Infrastructure - Algorithms. Advanced Toolbox: Big data – Infrastructure – Advanced Algorithms. Machine Learning tool kit in MATLAB.		
Unit - IV	**Data Scrubbing and Setting up your Data**	**9+3**
Data Scrubbing: Feature Selection – Row Comparison – One hot Encoding – Binning – Handling Missing Data – Calculation of Mean, Variance and Standard Deviation. Setting up your Data: Generalization of Data – Train and Test segments – Deciding of total quantity of data needed – Cross Validation.		
Unit - V	**Basics of Regression, Clustering and Error Measurements**	**9+3**
Linear Regression – Multilinear Regression - Logistic Regression – Clustering: K-Nearest Neighbors – K Means – Setting K. Bias and Variance. Error calculation: Mean Absolute Error (MAE) - Root Mean Squared Error (RMSE) - Relative Squared Error (RSE) - Relative Absolute Error (RAE) - Coefficient of Determination (R2 or R-squared)		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Oliver Theobald, “Machine Learning for Absolute Beginners”, Independently Published, 2nd Edition, 2017.

REFERENCES:

1.	Rajendra Akerkar, “Introduction to Artificial Intelligence”, PHI Learning Pvt Ltd, 2nd Edition, 2014.
2.	Gopinath Rebala, Ajay Ravi, Sanjay Churiwala, “An Introduction to Machine Learning”, Springer,1st Edition, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate AI-based problems, and identify its key competitive advantages and issues.	Applying (K3)
CO2	plan to relate machine learning basics and the importance of mathematics towards machine learning technologies.	Applying (K3)
CO3	use toolbox for basic methods for different AI-based applications	Applying (K3)
CO4	organize pre-processing on data to be used in machine learning models	Applying (K3)
CO5	formulate own learning model for a specified AI application.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22ITX01 - NEXT GENERATION DATABASES

Programme & Branch	All Engineering and Technology Branches except IT	Sem.	Category	L	T	P	Credit
Prerequisites	18CST52- WEB TECHNOLOGY	5	OE	3	0	2	4

Preamble	This course provides an understanding of how to use Django framework to create a complete static and dynamic website from scratch very easily. The course also covers the integration of databases with Django in order to get a complete application. In addition, the course also introduces NoSQL and HDFS databases.

Unit - I	**Introduction to Django, Templates and Models**	**9 +3**

Installing Django , Starting a project, Views and URLconfs : generating static and dynamic contents –URLConfs and loose coupling – Dynamic URLs, Templates : Template System basic – using Template System – Basic template tags and Filters – Limitations – Using templates in views – template loading - Inheritance, Models : MTV Development pattern – Configuring database – defining Models in Python – Installing the Model – Data Access - Adding Model String Representations - Inserting and Updating Data - Selecting Objects - Deleting Objects .

Unit - II	**Forms, Advanced Templates and Models in Django**	**9 +3**

The Django Admin Site : Activating the Admin Interface - Using the Admin Site - Adding Your Models to the Admin Site - Customizing Field Labels - Custom ModelAdmin classes - Users, Groups, and Permissions, Forms : Simple validation - Making a Contact Form - Tying Form Objects Into Views – Working with form fields, Advanced Views and URLconf, Advanced Templates : RequestContext and Context Processors - Automatic HTML Escaping -Extending the Template - Writing Custom Template Loaders - Configuring the Template System in Standalone Mode, Advanced Models

Unit – III	**Session Management, caching and Database integration**	**9 +3**

Generic Views : Generic Views of Objects - Extending Generic Views, Deploying Django : Django with Apache, mod_python and FastCGI, Generating Non-HTML content : views and MIME-types - Producing CSV and PDFs - Syndication Feed Framework, Sessions, users and registration: Framework – Authentication – Permission – Groups – Messages, Caching : Setting Up the Cache - The Per-Site Cache -The Per-View Cache - Template Fragment Caching, Integrating with databases.

Unit – IV	**NoSQL Databases**	**9 +3**

Introduction to MongoDB – Term used in RDBMS and MongoDB – Data Types in MongoDB – MongoDB Query Language – Introduction to Apache Cassandra – CRUD operations –Collections – Using a counter – Time to Live – Alter Commands – Import and Export – Querying System Tables.

Unit - V	**Big Data Storage Systems**	**9 +3**

Introduction to Hive – Hive Architecture – Hive Data Types – Hive File Format – Hive Query Language – DDL – DML – Starting Hive Shell – Database – Tables – Partitions – Bucketing – Views – Subquery – Joins – Aggregation – Group by and Having –RCFile Implementation – User Defined Function.

LIST OF EXPERIMENTS / EXERCISES:

1.	Create a simple Django application with static and dynamic content
2.	Develop a Django application using templates and models
3.	Implement form processing in Django
4.	Develop a Django Admin site
5.	Create RSS and Atom feeds using Syndication Feed Framework
6.	Session management in Django
7.	Implement CRUD operations in MongoDB
8.	Create and use collections in MongoDB
9.	Implement DML and DDL in Hive
10.	Implement joins, Aggregation and GroupBy/Having in Hive

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	Adrian Holovaty, Jacob Kaplan Moss, “The Django Book Release 2.0”, A press, 2013. (For Units I,II,III)
2.	Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", 1st Edition, Wiley India Pvt. Ltd, 2015. (For Units IV, V)
REFERENCES/ MANUAL / SOFTWARE:	
1.	Andrew Pinkham, “Django unleashed”, Sams Publishing, 1st Edition, 2015
2.	Beau Curtin, “Django Cookbook: Web Development with Django Step by Step Guide”, 2nd Edition, 2016

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop static and dynamic web content using Django templates with models	Applying (K3)
CO2	create Django user models, templates and forms and develop simple web applications	Applying (K3)
CO3	build Django applications using sessions and databases	Applying (K3)
CO4	identify the significant features of NOSQL Databases	Applying (K3)
CO5	apply the bigdata storage concepts using Hive	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	60				100
CAT2	20	20	60				100
CAT3	10	20	70				100
ESE	15	25	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ITX02 - ADVANCED JAVA ROGRAMMING							
Programme & Branch	**All BE/BTech branches except Information Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course enables the students to develop, test, and deploy applications ready for production and how to establish them as cloud-based applications using Spring Boot.	
Unit - I	**Spring Boot**	**9+3**
Introduction – Features - Advantages, Microservices, System Requirements, Setting up the environment, 12-factor app, Spring Initializr, Build Tools – Maven and Gradle, pom.xml and build.gradle, Building application using Maven and Gradle, entry point class, Bootstrap Application Context , Spring Boot Starter Dependencies - Auto-Configuration		
Unit - II	**Spring Annotations and Data**	**9+3**
Spring Boot Annotations: Java annotations – Existence of Spring Annotations - Spring and Spring Boot Annotations. Working with Spring Data JPA and Caching: Accessing relational data using JdbcTemplate and Spring Data JPA with the in-memory database and MySQL - Query methods in Spring Data JPA - Caching.		
Unit - III	**Learning RESTFul API**	**9+3**
Building RESTFul Microservices: Creating and Consuming RESTFul APIs- Spring Boot Actuators – Custom health check indicators – Exception handling -Service discovery – RestTemplate - Routing a request – Spring Cloud Gateway. Securing a Web Application: Authentication and Authorization concepts – Spring security filters – Enabling and Disabling security – Oauth security – Accessing REST secured APIs –REST services		
Unit - IV	**Implementing Resilience4J and Swagger**	**9+3**
Building Resilient System: Client-side load balancing – Circuit breaker – Implementing Resilience4J. Logging: Logging Data – Logback – Spring Cloud Sleuth and Zipkin – ELK. Working with the Swagger API Management Tool: API documentation – Implementing Swagger - Swagger UI – Swagger documentation – Swagger Codegen.		
Unit - V	**Testing and Deploying**	**9+3**
Introduction – Data Type Conversion – Operators – Arrays – Strings Comparisons – String Processing: Searching for Expressions – Representing Patterns – Finding Matches – Character Classes – Finding Multiple Instance of a Pattern – Regular Expressions – Form Processing – Database Connectivity – Session Tracking.		

Lecture:45, Tutorial:15, Total:60

LIST OF EXPERIMENTS / EXERCISES:

1.	Build simple micro services using Java
2.	Develop a simple web application Maven and Gradle
3.	Utilize Bootstrap Application Context and Spring Boot Starter Dependencies to configure a web application
4.	Develop a simple web application to access relational data using JdbcTemplate in SpringBoot
5.	Implement advanced search operations in a relational data from your web application using Query methods in Spring Data JPA
6.	Create a RESTFul API using SpringBoot and consume it in your web application
7.	Create a secured web application using various security features in SpringBoot
8.	Implementation of fault tolerance and load balancing in your microservices using Resilience4J
9.	Testing your web application and RestFul Web Serives
10.	Deploying your web application using Docker and Containerization

TEXT BOOK:

1.	Shagun Bakliwal, “Hands-on Application Development using Spring Boot: Building Modern Cloud Native Applications by Learning RESTFul API, Microservices, CRUD Operations, Unit Testing, and Deployment”, BPB Publications, 1st Edition, 2021.

REFERENCES:

1.	Rajput, D. “Mastering Spring Boot 2.0: Build modern, cloud-native, and distributed systems using Spring Boot”, Packt Publishing Ltd, 2018.
2.	Claudio and Greg, “Developing Java Applications with Spring and Spring Boot”, Packt Publishing Ltd, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Apply the Spring Boot and all its capabilities.	Applying (K3)
CO2	Demonstrate thecommon annotations of the Spring Data and Spring Data JPA	Applying (K3)
CO3	Build RESTFul Microservices and Secured Web Application	Applying (K3)
CO4	Implement Resilience4J and Swagger API and host the apps on Cloud.	Applying (K3)
CO5	Learn to demonstrate Testing and Deploying a Spring Boot Application	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	5	20	75				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ITO02 - INTERNET OF THINGS							
Programme & Branch	**All Engineering and Technology Branches except IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Computer Networks**	**6**	**ES**	**3**	**1**	**0**	**4**

Preamble	This course provides an introduction to Internet of Things and its technologies that enable the students to develop real world applications using it.	
Unit - I	**Introduction to Internet of Things**	**9+3**
Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT Communication Models - IoT Communication APIs – IoT enabled Technologies – Wireless Sensor Networks - Cloud Computing – Big data analytics – Communication Protocols- Embedded Systems – IoT Levels and Templates.		
Unit - II	**Design Methodology and Endpoints**	**9+3**
M2M – Difference between M2M &IoT – Software defined networks – Network function Virtualization – IoT Platform design Methodologies – Domain Specific IoT – Home Automation – Smart Agriculture.**Endpoints:** Introduction to Raspberry PI – Interfaces: serial- SPI- 12C- Programming –Interfacing with external gadgets – controlling output – reading input from pins – Modern IoT controllers.		
Unit - III	**IoT Protocols**	**9+3**
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4,802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, ConstrainedNodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing overLow Power and Lossy Networks – Application Transport Methods: Supervisory Control and DataAcquisition – Application Layer Protocols: CoAP and MQTT.		
Unit - IV	**Data Analytics and Supporting Services**	**9+3**
Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning –No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analyticsand Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django –AWS for IoT – System Management with NETCONF-YANG.		
Unit - V	**IoT Seurity and Case Studies**	**9+3**
Attacks and Countermeasures – Authentication and Authorization at IoT Layers – Other security features and related issues – Middleware – Cross Layer security – Privacy and Risk Mitigations – Blockchain – 5G – Fog and Edge Computing. **IoT USECASES**: Asset Management The Smart Grid Commercial Building Automation Smart Cities.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Arshdeep Bahga and Vijay Madisetti, "Internet of Things – A Hands-on Approach", 1st Edition, University Press, 2015. (For Units I, II, V)
2.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, Cisco Press, 2017. (For Units III, IV)

REFERENCES:

1.	Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", 1st Edition, CRC Press, 2012
2.	Madhusanka Liyanage, An Braeken, Pradeep Kumar, Mika Ylianttila, “IoT Security: Advances in Authentication”, Wiley Publications, 2020. (For Unit V)
3.	https://aws.amazon.com/

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of IoT architecture, infrastructure and constraints of Internet of Things	Applying (K3)
CO2	utilize the design methodologies for IoT applications and experiment with simple applications using Raspberry Pi	Applying (K3)
CO3	apply the IoT protocols for local and global connectivity	Applying (K3)
CO4	develop IoT products with the use of data analytics and supporting services	Applying (K3)
CO5	identify the security challenges and opportunities in the different domains of Internet of Things	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	30	40	30				100
ESE	25	45	30				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22ITO03 - FUNDAMENTALS OF SOFTWARE DEVELOPMENT

(Common to All Engineering and Technology Branches)

Programme & Branch	All Engineering and Technology Branches except IT	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	This course provides knowledge on basic concepts of software construction, Quality of code and Effective coding in software development	
Unit - I	**Foundation on Software Construction**	**9+3**
Software Construction – Metaphors – Upstream Prerequisites: Importance of Prerequisites-Determining the kind of Software, Problem-Definition, Requirement, Architecture Prerequisites-Amount of time to spend on Upstream Prerequisites – Key Construction Decisions: Choice of Programming Language - Programming Conventions - Selection of Major Construction Practices.		
Unit - II	**Creating High–Quality Code**	**9+3**
Design in Construction: Design Challenges and Concepts - Design Building Blocks and Practices - Working Classes: Class Foundation – Interfaces - Design and Implementation Issues - Reason for Class Creation - High-Quality Routines- Defensive Programming: Assertion - Error-Handling Techniques - Exceptions.		
Unit - III	**Variables**	**9+3**
General Issues in using Variables -The Power of Variable Names - Fundamental Data Types - Unusual Data Types – Statements: Organizing Straight-Line Code - Using Conditionals - Controlling Loops - Unusual Control Structures- General Control Issues: Boolean Expressions - Compound and null Statements.		
Unit - IV	**Code Improvements**	**9+3**
The Software-Quality Landscape: Characteristics - Techniques for improvement - Relative Effectiveness of Quality Techniques - Quality Assurance - Collaborative Construction – Developer Testing – Debugging – Introduction to Refactoring – Code tuning Strategies and Techniques.		
Unit - V	**System Considerations**	**9+3**
Program size Vs Construction – Managing Construction – Integration – Programming Tools.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Steve McConnell, “Code Complete - A practical handbook of software construction”, 2nd edition, Microsoft press, 2006.

REFERENCES:

1.	Ali Bahrami, "Object Oriented Systems Development", 1st Edition, Tata McGraw-Hill, New Delhi, 2008.
2.	Infosys spring board contents provided by Infosys at https://infyspringboard.onwingspan.com/web/en/page/home

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	plan for software construction prerequisites and key construction decisions	Applying (K3)
CO2	develop the ability to create high-quality code that adheres to best practices and standards in software development	Applying (K3)
CO3	acquire a comprehensive understanding of variables, data types, statements, and control structures to write efficient, organized, and error-free code for solving complex problems	Applying (K3)
CO4	gain a comprehensive understanding of software quality and effective techniques for improving it, including quality assurance, collaborative construction, testing, debugging, refactoring, and code tuning	Applying (K3)
CO5	develop skills in managing program size and construction, integrating software components, and using programming tools to develop efficient and scalable software solutions.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	50				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	40	50				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22ITO04 - MOBILE APPLICATION DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All Engineering and Technology Branches except IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Java Programming**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on developing mobile applications using Android.	
Unit – I	**Introduction to Android**	**9+3**
Introduction – Android Architecture – Environmental setup – Develop simple Hello World application – App Folder structure - Android virtual device - Application Components –Toast message - Activity – Activity Life cycle – Log messages.		
Unit – II	**Layout and UI**	**9+3**
Intent –types - Intent filters - Views – Layouts - UI components: Text View, Edit Text, Button, Toggle Button, Radio Group, Check Box, AutoComplete Text View, Progress Bar, Rating Bar – Event Listeners and Handlers.		
Unit – III	**Resources and Alerts**	**9+3**
Resources overview – Styles and Themes - Menu: Option menu, Context menu – Notification – Broadcast receivers – Web View - Phone call.		
Unit – IV	**Storage**	**9+3**
Introduction to Storages - Bundle - SQL Lite: CRUD operations - Content providers – Shared preferences - JSON parsing		
Unit – V	**Services and Sensors**	**9+3**
Services –Sending SMS – Sensors: Motion and Position - Accessing geo location – Basic Animations: rotate, fade, zoom, slide and move.		

Lecture:45, Tutorial:15,Total:60

TEXT BOOK:

1.	https://developer.android.com

REFERENCES:

1.	John Horton, “Android Programming for Beginners”, 3rd Edition, Packt Publishing, 2021.
2.	Bill Phillips, Chris Stewart and Kristin Marsicano, “Android Programming”, 3rd Edition, BigNerd Ranch Guides, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Illustrate the steps to create android application and discuss its activity life cycle	Applying (K3)
CO2	develop an Android application using Layouts, UI components with event handling	Applying (K3)
CO3	design styles, themes and menu	Applying (K3)
CO4	plan to execute CRUD operations on SQLite	Applying (K3)
CO5	build applications using services, animations and sensors	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40				100
CAT2	20	40	40				100
CAT2	20	40	40				100
ESE	25	35	40				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22ITO05 - FUNDAMENTALS OF CLOUD COMPUTING							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All Engineering and Technology Branches except IT**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides a basic introduction to cloud computing and utility computing. It also deals with analyzing a few case studies to appreciate the emergence of the cloud as the next-generation computing paradigm.	
Unit – I	**Introduction**	**9**
Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.		
Unit – II	**Virtualization**	**9**
Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices – Virtualization Support and Disaster Recovery.		
Unit – III	**Cloud Architecture, Services And Storage**	**9**
NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage.		
Unit – IV	**Resource Management and Security In Cloud**	**9**
InterCloud Resource Management – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Data Security –Application Security – Virtual Machine Security.		
Unit – V	**Case Studies**	**9**
Google App Engine (GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services (AWS) – Microsoft Azure – Cloud Software Environments – Eucalyptus – Open Nebula – Open Stack.		
		Total:45

TEXT BOOK:

1.	Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", 1st Edition, John Wiley & Sons, 2011. (For Unit I)
2.	Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2017. (For Units II,III,IV,V)

REFERENCES:

1.	Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press, 2017.
2.	Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013
3.	Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", Tata McGraw Hill, 2009

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	summarize the main concepts, key technologies, strengths, and limitations of cloud computing and identify suitable scenarios for moving to the cloud platform.	Applying (K3)
CO2	interpret the role of virtualization as the key enabling technology that helped in the development of the cloud platform	Applying (K3)
CO3	develop the ability to understand and use the architecture of compute cloud and storage cloud services and delivery models	Applying (K3)
CO4	examine the core issues of cloud computing architecture namely resource management and security.	Applying (K3)
CO5	experiment with several public cloud offerings and cloud development tools to choose the appropriate service provider for one's requirements.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	30	40	30				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22ITO06 - INTRODUCTION TO ETHICAL HACKING

Programme & Branch	All Engineering and Technology Branches except IT	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	This course provides basic knowledge about different kinds of hacking methods and their countermeasures.	
Unit- I	**Introduction to Hacking**	**9**
Ethical Hacking Overview - Role of Security and Penetration Testers .- Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing - Numbering Systems. - Network and Computer Attacks - Malware - Protecting Against Malware Attacks.- Intruder Attacks - Addressing Physical Security		
Unit- II	**Foot printing & Scanning**	**9**
What is foot printing? - Internet Foot printing- Scanning – Determining if the system is alive – Determining which services are running or Listening – Detecting the operating system – Processing and storing scan data.		
Unit- III	**Enumeration**	**9**
Enumeration - basic banner grabbing- Enumerating Common Network services and its countermeasures. Hacking Windows – Unauthenticated attacks – authenticated attacks – windows security features.		
Unit- IV	**Hardware & Wireless Hacking**	**9**
Hacking Hardware – Physical access – Hacking Devices – Default Configurations – Reverse Engineering Hardware. VPN Hacking. Wireless Equipment – Discovery and monitoring - Denial of Service Attacks – Common DoS Attack Techniques – DoS- Countermeasures - Encryption attacks –Authentication attack.		
Unit- V	**Application hacking & Countermeasures**	**9**
Web and Database Hacking – Web Server Hacking - Web application Hacking - Common web application Vulnerabilities – Database Hacking. Mobile Hacking – Hacking android – iOS.		
		Total:45

TEXT BOOK:

1.	Stuart McClure, Joel Scambray, Goerge Kurtz, “Hacking Exposed 7: Network Security Secrets and Solutions”, 7th Edition, Tata McGraw Hill Publishers, 2012.
2.	Michael T. Simpson, Kent Backman, and James E. Corley, “Hands-on Ethical Hacking and Network Defense, Course Technology”, Delmar Cengage Learning, 2010

REFERENCES:

1.	Patrick Engebretson, “The Basics of Hacking and Penetration Testing”, SYNGRESS, Elsevier, 2013.
2.	Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2014.
3.	Kevin Beaver, “Ethical Hacking for Dummies”, 6th Edition, Wiley, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Organize a computer and network against a variety of attacks	Applying (K3)
CO2	Identify and explain the basic vulnerabilities in any computing system	Applying (K3)
CO3	Enumerate the Computer network services and determine the possible security attacks in Windows machine.	Applying (K3)
CO4	Identify and assess the vulnerabilities in hardware and wireless environment.	Applying (K3)
CO5	formulate research problems in the computer security applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22ITO07 - BUSINESS CONTINUITY PLANNING

(Common to All Engineering and Technology Branches)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course introduces the concept of Business Continuity Process and Recovery from a natural or manmade disaster. It also discusses various aspects like risk evaluation, strategies, awareness and training programmes on business continuity.

Unit - I	**Introduction:**	**9**

Introduction: Vulnerability of today's business organizations-Disaster - Classification of Disasters-Direct impact: unavailability and loss of information-Alternative Business operations –Loss of information-Indirect impact-rippling effects of business operations-Long Term Impact –Image-Market Position-Growth or decline -Risk management – Building Continuity- Rebuilding the Infrastructure-Resumption of Business activities-Business Continuity planning Strategy

Unit - II	**Multilateral Continuity Planning:**	**9**

Multilateral Continuity Planning: Multilateral continuity planning-MCP approach-Project success factors-Benefits of multilateral continuity planning-Marketing protection: a justification for funding of total asset protection programme-Total asset protection-Brand value-Operational risk management-Senior management arrangements, systems and controls- Understanding the organization's business-Business strategy and business continuity planning-BCP within a business strategic context

Unit - III	**Business Continuity Planning:**	**9**

Business Continuity Planning: The business continuity planning methodology - The business continuity management lifecycle-BCM programme management-Understanding the organization - A practical approach-Risk evaluation and control:practical guidelines for risk assessment-Risk evaluation and control-Business impact analysis-A walk through a comprehensive BIA-Developing business continuity strategies for the business or work areas-Business/work area recovery-Types of contingencies-Vital records and paper documentation issues-Salvage considerations

Unit - IV	**Developing Business Continuity Strategies:**	**9**

Developing Business Continuity Strategies Business continuity for telecommunications-Business continuity strategies- General strategies-Hardware strategies-Software strategies- Network service strategies-offsite storages and facility strategies-Call centre Strategies-Strategies for communications products and services -Understanding the business information flow-Vulnerability assessment-Business challenges-Marketplace trends-Planning to recover your data – Availability-Tape backup – Disk-to-disk-High availability-WAN availability-Virtualization

Unit - V	**Awareness and training:**	**9**

Awareness and training-Establish BC policy-Acquiring or developing training aids-Awareness through maintenance, review, audit and testing-BC plan testing – Overview – Testing – Maintenance-BC audit-Audit objective-Determining the maturity level of the organization-Defining the audit programme-Audit planning – Fieldwork-Analysis

Total:45

TEXT BOOK:

1. Andrew Hiles, "The Definitive Handbook of Business Continuity Management", 2nd Edition, John Wiley& Sons, 2007

REFERENCES:

1. Snedaker, Susan, "Business continuity & disaster recovery planning for IT professionals", 2nd Edition, Syngress, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	utilize the significance of Business Continuity Planning in the event of a disaster	Applying (K3)
CO2	illustrate multilateral continuity planning and describe organization's business process and Strategy	Applying (K3)
CO3	plan to carry out risk evaluation and control guidelines for risk assessment	Applying (K3)
CO4	choose appropriate Business continuity strategies for telecommunications and IT	Applying (K3)
CO5	make use of training, testing and auditing in Business continuity planning	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22CHO01 - INDUSTRIAL ENZYMOLOGY							
Programme& Branch		**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**V**	**OE**	**3**	**1**	**0**	**4**
Preamble	The course helps the students to understand the basic principles of enzyme and its structure, function and kinetics, mechanism of enzyme action and inhibitors and application of enzymes for various industrial processes						
Unit – I	**INTRODUCTION TO ENZYMOLOGY**						**9 + 3**
Classification of enzymes. Mechanisms of enzyme action; History of Industrial enzyme development; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory.							
Unit – II	**KINETICS OF ENZYME ACTION**						**9 + 3**
Kinetics of single substrate reactions; estimation of Michaelis – Menten parameters, enzyme inhibition multisubstrate reactions - mechanisms and kinetics for steady state; Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.							
Unit – III	**PURIFICATION AND PRODUCTION OF INDUSTRIAL ENZYMES**						**9 + 3**
Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes - microbial fermentation and downstream processing.							
Unit – IV	**INDUSTRIAL APPLICATION OF ENZYME**						**9 + 3**
Enzymes involved in production process of Brewing and Baking industry, dairy industry, meat processing, Fruit and Vegetable processing, pharmaceutical industries							
Unit – V	**ALTERING ENZYME PERFORMANCE AND STABILITY**						**9 + 3**
Modification of industrial enzyme function and stability by enzyme engineering approaches; immobilization of enzymes. Safety and regulatory aspects: ethics in the use of enzymes in food products, medical and dietary considerations, evaluation of enzyme safety, toxicity consideration in the use of enzymes							
Total:45 + 15 =60 hours							

TEXTBOOK:

1.	Trevor Palmer,"Enzymes",2nd Edition,Horwood Publishing Ltd, 2007.
2.	Robert J. Whitehurst & Maarten van Oort, "Enzymes in Food Technology", 2nd Edition, John Wiley & Sons, UK, 2009.

REFERENCES:

1.	Ed Godfrey and West, Industrial Enzymology- Macmillan Press Ltd 2nd edition, 1996.
2.	MuthusamyChandrasekaran, "Enzymes in Food and Beverage Processing", 1st Edition, CRC Press, USA, 2016.
3.	N Gray, M Calvin, Enzymes Biotechnology SC Bhatia CBS Publishers and Distributors Pvt Limited Edition, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the fundamental concepts of economics and forecasting in food processing	Understanding (K2)
CO2	analyze the cost economics in food industry	Analysing (K4)
CO3	make use of market equilibrium and interpret national income calculation and inflation issues	Applying (K3)
CO4	apply the management principles in food processing	Applying (K3)
CO5	outline the organizational structure and its types.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	20	20			100
CAT2	20	20	40	20			100
CAT3	20	40	40				100
ESE	20	40	30	10			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO02 - WASTE TO ENERGY CONVERSION							
Programme& Branch		**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**V**	**OE**	**3**	**1**	**0**	**4**
Preamble	This course focuses on Waste to Energy Conversion, covering the principles, technologies, and applications of various conversion processes. Students will learn how to design, optimize, and evaluate the environmental and economic impacts of waste-to-energy systems.						
Unit - I	**Introduction to Waste Management and Energy Conversion**						**9 + 3**
Overview of waste management and the importance of waste-to-energy conversion; Types of wastes and their characteristics; Overview of energy conversion technologies and their applications in waste-to-energy.							
Unit - II	**Waste Characterization and Analysis**						**9 + 3**
Methods for waste characterization and analysis; Techniques for determining waste composition and energy content; Principles of waste reduction, reuse, and recycling; Collection and transport systems for solid, liquid, and gaseous wastes; Waste storage, handling techniques and hazards associated.							
Unit - III	**Thermal and Biological Conversion Technologies**						**9 + 3**
Incineration and pyrolysis processes; Gasification and plasma arc gasification; Anaerobic digestion and biogas production; Composting and vermiculture - Operation, and optimization of thermal and biological conversion systems							
Unit - IV	**Chemical Conversion Technologies**						**9 + 3**
Hydrogen production from waste; Synthesis of fuels and chemicals from waste streams -Operation, and optimization of chemical conversion systems							
Unit - V	**Environmental impact, case studies and applications**						**9 + 3**
Environmental impact of waste-to-energy conversion; Life cycle assessment and sustainability analysis; Economic and policy considerations for waste-to-energy systems; Case studies of successful waste-to-energy projects; Applications of waste-to-energy technologies in various industries							
Total:45 + 15 =60 hours							

TEXTBOOK:

1.	Marc J. Rogoff, Francois Screve, "Waste-to-Energy: Technologies and Project Implementation" 2nd Edition, Elsevier Science, UK, 2011.

REFERENCES:

1.	George Tchobanoglous, Frank Kreith, "Handbook of Solid Waste Management" 2nd Edition, McGraw Hill Professional, 2002.
2.	Naomi B Klinghoffer, Marco J Castaldi, "Waste to Energy Conversion Technology" Woodhead Publishing Limited, UK, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the importance of waste-to-energy conversion and its role in sustainable development	Understanding (K2)
CO2	understand methods for waste characterization and analysis to determine waste composition and energy content	Understanding (K2)
CO3	describe the basic principles of incineration, pyrolysis, gasification,plasma arc gasification, anaerobic digestion, biogas production, composting, and vermiculture processes	Understanding (K2)
CO4	summarize the principles of hydrogen production and synthesis of fuels and chemicals from waste streams	Understanding (K2)
CO5	express the basic concepts of life cycle assessment and sustainability analysis for evaluating the environmental impact of waste-to-energy conversion technologies	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2												
CO2	2	2												
CO3	2	2												
CO4	2	2												
CO5	2	2												
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	70					100
CAT2	20	70					100
CAT3	20	70					100
ESE	20	70					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22CHO03 - APPLIED NANOTECHNOLOGY

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**V**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will able to help students to gain knowledge in preparation and application of nanomaterials	
Unit - I	**Overview of Nanomaterials**	**9 + 3**
Introduction and Classification, Nanostructure induced effects on properties. Introduction to Fabrication and preparation techniques		
Unit - II	**Characterization of Nanomaterials**	**9 + 3**
General classification of characterization techniques, Usage of Microscopy – SEM, TEM, STM & AFM, Usage of Crystallography – XRD & XRF. Spectroscopy – IR, NMR and Raman Spectroscopy.		
Unit - III	**Key nanostructures and applications**	**9 + 3**
Nano – Semiconductors, Nanomagnetic Materials, Carbon based Nanomaterials – Bucky ball, CNT, Graphite and Graphene. Templated Nanostructures, Nano catalysts, Biological Nanomaterials – Polypeptides, DNA		
Unit - IV	**Introduction to Composite materials**	**9 + 3**
Definition of composite materials, Fibers and Matrices, Key properties of composites. Manufacturing processes – Molding, Forming, 3D assembly and Tape laying, Sandwich composites		
Unit - V	**Applied composites**	**9 + 3**
Application of Composite materials – Aerospace construction, Automotives, Wind turbines, Ship building, Ski, Bicycles, Other applications – Pressure gas bottle, Bogie Frame, Offshore installations, Biomechanical applications, Cable car, Applications of Nanocomposites		

Total:45 + 15 =60 hours

TEXTBOOK:

1. Robert Kelsall, Ian W Hamley and Mark Geoghegan, “Nanoscale Science and Technology”, 1st Edition, Wiley, UK, 2005.(Units I, II & III)
2. Daniel Gay, “Composite Materials – Design and applications”, CRC Press, Boca Raton, USA, 2014. (Units IV & V)

REFERENCES:

1. William A. Goddard, "Hand book of Nanoscience, Engineering and Technology ", 1st Edition, CRC Press, United State of America, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the phenomena of nanosize and the general synthesis techniques	Understanding (K2)
CO2	explain the techniques available for characterization of nanomaterials	Understanding (K2)
CO3	discuss the synthesis characterization and applications of various nanomaterials	Understanding (K2)
CO4	Explain the key features of composites and their manufacturing techniques	Understanding (K2)
CO5	illustrate the important applications of composite and nano composite materials in various sectors	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	30	70					100
CAT3	20	80					100
ESE	20	80					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22CHO04 - AIR POLLUTION MONITORING AND CONTROL

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**VI**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will enable the students to have a comprehensive understanding of powder technology and its fundamentals	
Unit - I	**Introduction to Air Pollution**	**9+3**
Air pollutants – History, air quality standards, monitoring and measurement, sampling and analysis- classifications of pollutants– sources andeffects. Regulatory system: Framework in India- clean air act – provisions for recent development		
Unit - II	**Gaseous pollutants and Particulates**	**9+3**
Chemical and physical properties of gaseous pollutants- Stack Plumes- models, general characteristics and types. Particulates: Collection mechanism- particle size distribution- collection efficiency		
Unit - III	**Ambient Air Quality Monitoring**	**9+3**
Air-Quality Sampling Program, Reference Methods and Continuous Monitoring, Environmental Surveillance and Control System, Typical Air Sampling Train, Integrated Sampling Devices for Suspended Particulate Matter		
Unit - IV	**Air Pollution Controlling Equipment**	**9+3**
Incinerators, Absorbers, Thermal oxidizers, Gravity settling chambers –classifications, operation, typical applications and suggestions for improvement		
Unit - V	**Hybrid systems and Air Pollution Survey**	**9+3**
Hybrid systems –Wet electrostatic precipitators, Dry scrubbers, Electrostatically augmented fabric filters. Air pollution surveying guidelines		

Total:45 + 15 =60 hours

TEXTBOOK:

1.	Louis Theodore, Anthony J. Buonicore, "Air Pollution Control Equipment Calculations",1stEdition, Wiley, USA, 2008
2.	Karl B. Schnelle, Jr., Russell F. Dunn, Mary Ellen Ternes "Air Pollution Control Technology Handbook" 2ndEdition, CRC Press, 2017

REFERENCES:

1.	Rao M.N. and Rao H.V.N, "Air Pollution", 1stEdition, McGraw Hill International edition, India, 2001
2.	C. S. Rao, "EnvironmentalPollution ControlEngineering", Revised second Edition, New Age International, 2007

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the evolution procedure in analyzing the air pollutants based on air quality standards	Understanding (K2)
CO2	explain the characteristics of gaseous pollutants and particulates	Understanding (K2)
CO3	demonstrate the air quality monitoring techniques	Understanding (K2)
CO4	execute the operations, applications ofair pollution control equipment	Applying (K3)
CO5	explain the concepts involved in hybrid systems and air pollution survey	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	20	60	20				100
ESE	20	60	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO05 - PAINTS AND COATINGS

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**VI**	**OE**	**3**	**1**	**0**	**4**

Preamble	To gain knowledge on surface engineering, chemical conversion, surface coating, electro-deposition coating methods and design guidelines for surface coating

Unit - I	**Surface Engineering**:	**9+3**

Introduction to surface engineering, scope of surface engineering, surface engineering to combat corrosion and wear, Surface preparation– selective surface hardening, laser melting, shot peening, shot blasting, sand blasting, vapor phase degreasing and hydro-blasting.

Unit - II	**Chemical Conversion Coating:**	**9+3**

Phosphate and chromate chemical conversion coating – types and applications. Aluminium, chromic, sulfuric and hard coat anodizing. Oxidation treatments, Diffusion heat treatment coatings and pack-cementation diffusion coatings.

Unit - III	**Surface coating methods**:	**9+3**

Organic coating - paints, Ceramic coating and Linings – Glass lining, porcelain enamels, concrete and cementations coating and lining, high performance ceramic coating and lining, Hot dipping – Batch and continuous process, coating microstructure, galvanized aluminium and terne coatings.

Unit - IV	**Electro-deposition coating methods**	**9+3**

Electrochemical deposition – aqueous solution electroplating, continuous electro deposition, fused-salt electroplating, precious metal plating, electroless plating, and composite coatings. Weld-overlay coatings, Thermal spray coatings, Chemical and physical vapor deposition coatings.

Unit - V	**Design guidelines for surface coating:**	**9+3**

Pre-processing and Post processing Heat Treatment, Coating Thickness, Case Depth, and Component Distortion Considerations, Surface Roughness and Finishing, Design guidelines for surface preparation, organic and inorganic coating and other important considerations.

Total:45 + 15 =60 hours

TEXTBOOK:

1. J.R. Davis and Associates, “Surface Engineering for corrosion and wear resistance”, ASM internationals and IOM communications, 2001.

REFERENCES:

1. Rudolf Strauss, “Surface Mount Technology”, Butterworth-Heinemann Publisher, 1994
2. Brian Griffiths, “Manufacturing Surface Technology: Surface Integrity and Functional Performance (Manufacturing Processes Modular S.) (Manufacturing Processes Modular)”, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basics of surface engineering and surface preparation methods.	Understanding (K2)
CO2	describe the principles and applications of different chemical conversion coating methods.	Understanding (K2)
CO3	illustrate the principles and applications of different surface coating methods.	Understanding (K2)
CO4	explain the principles and applications of various surface laying methods.	Understanding (K2)
CO5	demonstrate the design guidelines and surface preparation methodologies for various surfaces.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1				1							
CO2	3	2	1				1							
CO3	3	2	1				1							

CO4	3	2	1				1							
CO5	3	2	3				1							

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	50	50					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO06 - POWDER TECHNOLOGY

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**VI**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will enable the students to have a comprehensive understanding of powder technology and its fundamentals	
Unit - I	**Particle size Characterization and Measurement**	**9**
Particle Size , Particle Size Distribution, Average Particle Size, Size Measurement, Particle Size Analysis Methods and Instrumentation: Visual methods, Separation methods, Stream scanning methods, Field scanning methods, Sedimentation, Surface methods.		
Unit - II	**Particle shape Characterization and Measurement**	**9**
Particle Shape Characterization. Introduction, Representative Size, Geometrical Shape Descriptors, Dynamic Equivalent Shape, Particle Density, Measurement Method for Particle Density, Hardness, Stiffness and Toughness of Particles- Indentation Hardness, Measurement of Hardness, Measurement of Stiffness, Measurement of Toughness.		
Unit - III	**Fundamental Properties of Particles**	**9**
Diffusion of Particles, Optical Properties: Light Scattering, Light Extinction, Dynamic Light Scattering, Photophoresis, Particle Sedimentation, Settling of Two Spherical Particles, Rate of Sedimentation in Concentrated Suspension, Particle Electrification and Electrophoresis, Particle Deposition and Reentrainment, Agglomeration, Particle Impact Breakage, Sintering, Ignition and Combustion Reaction, Solubility and Dissolution Rate		
Unit - IV	**Particle Generation and Fundamentals**	**9**
Aerosol Particle Generation, Generation of Particles by Reaction, Crystallization, Design and Formation of Composite Particles, Surface Modification, methods, Microencapsulation and Nanocoating, Polymerization and Precipitation In Situ, Mechanical Routes, Characterization of Coated Particles, Recent developments		
Unit - V	**Particle Hazards and protective devices**	**9**
Health Effects Due to Particle Matter, Respiratory System, Penetration and Deposition of Particles in the Respiratory Tract, Fate of Deposited Particles, Health Effects of Inhaled Particles, Threshold Limit Value, Respiratory Protective Devices for Particulate Matter, Types of Respirators, Air-Purifying Respirators, Atmosphere-Supplying Respirators, Protection Factor, Spontaneous Ignition and Dust Explosion Mechanism and Prevention, Applications to industrial processes and equipment.		
		Total:45

TEXTBOOK:

1.	Hiroaki Masuda, KoHigashitani, Hideto Yoshida, Powder Technology Hand book, 3rd edition, CRC Press, Taylor Francis Group, 2006.

REFERENCES:

1.	Agba D. Salman, Michael Hounslow, Jonathan P.K. Seville, Hand book of powder technology, Vol 11, Granulation, Elsevier, 2006.
2.	Muhammad E. Fayed, Lambert Otten, Hand book of powder science & Technology, 2nd edition, International Thomson Publishing, Chapman & Hall , 1997

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe various particle size characteristics and its measurement techniques	Understanding (K2)
CO2	explain different particle shape characteristics and its measurement methods	Understanding (K2)
CO3	summarize various fundamental properties of particles	Understanding (K2)
CO4	explain the fundamentals of techniques available for particle generation	Understanding (K2)
CO5	describe health hazards of powders, its health effects and protective techniques	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													

CO3	3													
CO4	3	2				2						1		
CO5	3	1	3			3	3					2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														
ASSESSMENT PATTERN - THEORY														
Test / Bloom's Category*	**Remembering (K1) %**		**Understanding (K2) %**		**Applying (K3) %**		**Analyzing (K4) %**		**Evaluating (K5) %**		**Creating (K6) %**		**Total %**	
CAT1	30		70										100	
CAT2	30		70										100	
CAT3	30		70										100	
ESE	30		70										100	
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)														

22CHO07– HYDROGEN ENERGY

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge on fundamentals of hydrogen energy as energy systems, production processes, storage, utilization, and safety.	
Unit - I	**Introduction of Hydrogen Energy Systems**	**9**
Hydrogen pathway's introduction – current uses, General introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and Hydrogen production power plants		
Unit - II	**Hydrogen Production Processes**	**9**
Thermal-Steam Reformation, Thermo chemical Water Splitting, Gasification, Pyrolysis, Nuclear thermo catalytic and partial oxidation methods; Electrochemical, Electrolysis, Photo electro chemical; Biological, Photo Biological; Anaerobic Digestion, Fermentative Microorganisms		
Unit - III	**Hydrogen Storage**	**9**
Physical and chemical properties, General storage methods, compressed storage, Composite cylinders, Glass micro sphere storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage.		
Unit - IV	**Hydrogen Utilization**	**9**
Overview of Hydrogen utilization: I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic and marine applications. Hydrogen fuel quality, performance, COV, emission and combustion characteristics of Spark Ignition engines for hydrogen, back firing, knocking, volumetric efficiency, hydrogen manifold and direct injection, fumigation,		
Unit - V	**Hydrogen Safety**	**9**
Safety barrier diagram, risk analysis, safety in handling and refueling station, safety in vehicular and stationary applications, fire detecting system, safety management, and simulation of crash tests.		

Total:45

TEXT BOOK:

1. Michael Ball and Martin Wietschel, "The Hydrogen Economy Opportunities and Challenges", Cambridge University Press, 2009

REFERENCES:

1. Bent Sorensen, Giuseppe Spazzafumo; "Hydrogen and Fuel Cells", 3rdEdition, Elsevier, 2018
2. Bockris. J.O.M, "Energy options: real economics and the solar hydrogen system", Halsted Press and London publisher, 1980

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basics of hydrogen pathways	Understanding (K2)
CO2	describe the different production processes	Understanding (K2)
CO3	illustrate the chemical and physical properties which are required for storage of Hydrogen	Understanding (K2)
CO4	discuss major utilization of hydrogen energy in various sectors	Understanding (K2)
CO5	explain various risk analysis and safety protocols	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22CHO08– RUBBER TECHNOLOGY

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**VII**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course aims to introduce elementary concepts on basics, compounding, vulcanization, components of rubber manufacturing, testing methods involved and manufacturing process in specific rubber and their applications.	
Unit – I	**Rubber – Basics**	**9**
Polymers and Monomers, Synthesis of Macromolecules – addition polymerization and condensation polymerization, Physical behavior of polymers - Interatomic and Intermolecular Forces, Structure and Behavior of Macromolecular Chains, Classification of Rubber – Natural and Synthetic, Elastomers and their characteristics		
Unit - II	**Compounding and Vulcanization**	**9**
Compounding Recipes – Components, Processing Methods, Finishing Steps; Equipment for Compounding – Types of Mills and Banbury Mixers for rubber processing, Mixing Cycles and Mixing Steps, Vulcanization – Sulfur and Sufurless, Vulcanization Conditions, Vulcanization Techniques, Special Types – Continuous, Cold, High Energy Radiation and Microwave		
Unit - III	**Fillers for Rubber & Their Roles**	**9**
Manufacture and Grades, Processing, Vulcanization and Compounding with four Fillers - Carbon Black, Calcium Carbonate, Clays, Silicas and their applications		
Unit - IV	**Processing, Vulcanization, Properties Tests**	**9**
Processability Tests – Plasticity, Compression, Rotary Shear, Mixing, Extrusion, Relaxation, Scorch; Vulcanization Tests – Cruing, Effect of Temperature; Stress-Strain Tests – Tensile, Hardness, Crystallization, Low temperature stiffness, Low temperature Brittleness; Dynamic Mechanical Tests – Rebound, Free vibration, Flex resistance, Crack initiation and growth; Aging Tests – Oxygen aging, Heat aging, Water Resistance, Tear Test		
Unit - V	**Manufacturing Process of Specific Rubbers**	**9**
Styrene-Butadiene rubber, Polybutadiene and polyisoprene rubber, Ethylene-propylene rubber, Butyl and Halobutyl rubber, Nitrile rubber, Polyacrilic rubber, Neoprene, Silicone rubber, Fluorocarbon elastomer, Polyurethane elastomer		
		Total:45

TEXT BOOK:

1.	Maurice Morton, “Rubber Technology”, 3rd Edition, Springer Science+ Business Media Dordrecht, 1999.

REFERENCES:

1.	Martin.J.M and Smith.W.K, Handbook of Rubber Technology, Vol.2, CBS Publishers & Distributors, New Delhi, 2004.
2.	White.J.L., Rubber Processing Technology Materials, Principles, Hanser Publication,New York, 1995
3.	Blow.C.M. and Hepburn.C. Rubber Technology and Manufacture, Butterworths, 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the polymer science behind rubber technology	Understanding (K2)
CO2	describe the processes of compounding and vulcanization	Understanding (K2)
CO3	illustrate the properties of fillers and additives	Understanding (K2)
CO4	discuss major testing methods and processes involved in rubber manufacture	Understanding (K2)
CO5	Explain the manufacturing process of specialty rubbers	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										1		
CO2	3	3										1		

CO3	3	2										1		
CO4	3	2										1		
CO5	3	2										1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO09 - INDUSTRIAL ACCIDENT PREVENTION AND MANAGEMENT							
Programme& Branch		**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**VIII**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamentals of electrochemical engineering and its applications.	
Unit – I	**Introduction**	**9**
Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, UnsafeCondition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safetyorganization- objectives, types, functions, Role of management, supervisors, workmen, unions,government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.		
Unit – II	**Personal protection in work environment**	**9**
Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring SafetyPerformance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping:Responsibility of management and employees. Advantages of good housekeeping. 5 s ofhousekeeping. Work permit system- objectives, hot work and cold work permits. Typicalindustrial models and methodology. Entry into confined spaces.		
Unit - III	**Safety issues in construction**	**9**
Introduction to construction industry and safety issues in construction Safety in variousconstruction operations – Excavation and filling – Under-water works – Under-pinning &Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space –Temporary Structures. Familiarization with relevant Indian Standards and the National BuildingCode provisions on construction safety. Relevance of ergonomics in construction safety.Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders		
Unit – IV	**Safety hazards in machines**	**9**
Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards anddevices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas5welding and Arc Welding. Material Handling-Classification-safety consideration-manual andmechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenanceof common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program inProduction industries		
Unit - V	**Hazard identification and analysis**	**9**
Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fireexplosion and toxic gas release, Structure of hazard identification and risk assessment.Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants- The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard andOperability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up.Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets		
		Total:45

TEXTBOOK:

1.	Paul S V, Safety management System and Documentation training ProgrammeHandbook, CBS Publication, 2000.

REFERENCES:

1.	AIChE/CCPS, Guidelines for Hazard Evaluation Procedures. (Second edition).Centre for Chemical Process Safety, American Institute of Chemical Engineers, NewYork, 1992.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Describe the theories of accident causation and preventive measures of industrial accidents.	Understanding (K2)
CO2	Explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping.	Understanding (K2)
CO3	Explain different issues in construction industries	Understanding (K2)

CO4	Describe various hazards associated with different machines and mechanicalmaterial handling.	Understanding (K2)
CO5	Utilize different hazard identification tools in different industries with theknowledge of different types of chemical hazards	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	70	10				100
CAT2	20	70	10				100
CAT3	20	70	10				100
ESE	20	70	10				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO010 - ELECTROCHEMICAL ENGINEERING

Programme& Branch		Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**VIII**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamentals of electrochemical engineering and its applications.	
Unit - I	**Basics of Electrochemistry:**	**9**

Importance of electrochemical systems: Faraday's law - Current density - Potential and Ohm's law. Cell potential. Electrochemical kinetics: Double layer - Butler–Volmer Kinetic Expression - Influence of Mass Transfer on the Reaction Rate - Current efficiency.		
Unit - II	**Transport phenomena and Electrodes**	**9**
Mobility of electrons in cells, Concentration over potential, Current distribution and membrane transport. Electrode configuration – Porous electrodes, characterization, current distribution, Three phase electrodes, Electrodes with flow		
Unit - III	**Batteries and Fuel cells**	**9**
Components of a cell - Classification of batteries and cell - Theoretical capacity and state of charge - Cell characteristics and electrochemical performance - Heat efficiency of secondary cells- Charge retention and self-discharge - capacity fade in secondary cells. Fuel cell fundamentals: Types of fuel cells- Current–voltage characteristics and polarizations - Electrode structure - Proton-Exchange Membrane (PEM) fuel cells - Solid Oxide Fuel cells.		
Unit – IV	**Electrochemistry for e-vehicles**	**9**
Introduction to fuel cell stack and super capacitors. Electric and Hybrid vehicles - Objectives, power demand determination, regenerative braking, Battery electric vehicle, Hybrid electric vehicle, Start-Stop hybrid, Fuel Cell Hybrid systems		
Unit - V	**Electro-deposition and Corrosion**	**9**
Electro-deposition: Fundamentals – Nucleation - Deposit morphology – Additives - Impact of side reactions and resistive substrates. Corrosion: Fundamentals - Thermodynamics of corrosion systems - Localized corrosion - Corrosion protection.		
		Total:45

TEXTBOOK:

1.	Thomas F.Fuller and John N.Harb, "Electrochemical Engineering", 1st Edition, John Wiley & Sons, USA, 2018.

REFERENCES:

1.	Allen J.Bard and Larry R. Faulkner, "Electrochemical Methods, Fundamentals and Applications", 2nd Edition, John Wiley & Sons Inc, United State of America, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basics of electrochemical systems and electrochemical kinetics.	Understanding (K2)
CO2	describe the transport properties of electrochemical systems and electro analytical techniques.	Understanding (K2)
CO3	explain the fundamental properties and classification of batteries and fuel cells.	Understanding (K2)
CO4	describe the technology of electrochemical systems for electric vehicles	Understanding (K2)
CO5	illustrate the concepts of electro-deposition and corrosion prevention.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO011 -SMART AND FUNCTIONAL MATERIALS							
Programme& Branch		**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**VIII**	**OE**	**3**	**0**	**0**	**3**
Preamble	To acquire knowledge on smart and intelligent materials, their synthesis method and their applications in various fields						
Unit – I	Smart Materials and Structures						**9**
Introduction, System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems							
Unit - II	Ferroelectric Materials						**9**
Introduction, Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs.							
Unit - III	Shape Memory Materials						**9**
Introduction, Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs							
Unit – IV	Smart Hydrogels						**9**
Introduction, Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics							
Unit – V	Smart systems for space applications						**9**
Introduction, Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines							
							Total:45

TEXT BOOK:

1.	Schwartz. M, “New Materials, Processes, and Methods Technology”, CRC Press, 2006.
2.	D.J. Leo. D.J, “Engineering Analysis of Smart Material Systems”, Wiley 2007.

REFERENCES:

1.	Yui. N, Mrsny. R.J, “Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems”, CRC Press, 2004.

2.	Ball. P, ”Made to Measure: Materials for the 21stCentury”, Princeton University Press, 1997.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	recall the classification and applications of smart materials	Understanding (K2)
CO2	describe the various ferroelectric materials and its applications	Understanding (K2)
CO3	explain the significance of shape memory materials and its functional properties	Understanding (K2)
CO4	elaborate the synthesis of smart hydrogels and their applications in various fields	Understanding (K2)
CO5	enumerate the role of smart systems in space applications	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CDO01 - FUNDAMENTALS OF USER EXPERIENCE DESIGN							
(Computer Science and Design)							
Programme & Branch	**BE - Computer Science and Design**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This subject will teach how to create amazing user experiences for products from scratch, user personas and also understand the importance of a good UX design and the role of a UX designer. It deals different stages of designing a UX and the application of various principles of psychology in UX design. Also learn how to conduct user research and market research, which is crucial to creating a great UX.

Unit – I	**UX Design Process:**	9+3

What is UX? – UX Design Vs UI Design – Why is UX so Important – Full Stack Design – UX Design Process – Discovery and Planning – The UX Strategy – UX Research: Discover – Explore – Test – Listen – UX Analysis – Design – Production.

Unit – II	**User Research:**	9+3

User Behavior Basics – The Gestalt Theory – Psychology in UX – User Research – Market Research Vs User Research – Benefits of User Research – Getting to Know Your Users – Grouping Customer Information – How to Conduct User Interviews?.

Unit – III	**User Personas and Affinity Diagram:**	9+3

User Personas: What are User Personas? – Creating a Persona – Four Different Perspectives on Personas – Benefits of Personas – Affinity Diagrams: Affinity Diagram – Work Activity Affinity Diagram – Capture, Grouping and Labeling.

Unit – IV	**Information Architecture and Visual Design Principles:**	9+3

Information Architecture: Navigation – Task Flow – Content Strategy – Site Map – Gestures – Basics of Visual Design – Lines – Shapes – Colors – Font/Typography – Textures – Forms – Design Principles – Alignment – Hierarchy – Contrast – Repetition – Proximity – Balance – Space – Visual Design Tools.

Unit – V	**Wireframes and Prototyping**	9+3

What is Wireframe? – How to Create Wireframes? – Types of Wireframes – Wireframing Tools: Sketch Wireframes – Stenciling and Paper cutouts – Wireframing Software – What is Prototyping – Prototyping Methods – Paper Prototypes – Digital Prototypes – Coding Prototypes – The process of Creating Prototypes – Prototyping Tools.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Elvis Canziba “Hands-On UX Design for Developers: Design, Prototype, and Implement Compelling User Experiences from Scratch”, First Edition, Packet Publishing, 2018 for units I - V
2.	Rex Hartson, Pardha S. Pyla, “The UX Book Process and Guidelines for Ensuring a Quality User Experience”, 1st Edition, Morgan Kaufmann Publisher, Elsevier, 2012 2018 for unit 2

REFERENCES:

1.	https://www.netsolutions.com/insights/information-architecture/ 2018 for unit 3
2.	https://boldist.co/design/gesture-based-interfaces/ for unit 3
3.	https://www.usertesting.com/blog/affinity-mapping for unit 3

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Utilize the UX design process on product or service.	Applying (K3)
CO2	Apply principles and procedures to conduct user research.	Applying (K3)
CO3	Create user persona and construct affinity diagram for the product or service	Applying (K3)
CO4	Design information architecture based on various visual design principles.	Applying (K3)
CO5	Create wireframes and prototypes for the product or service by using various tools and software.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	60	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	15	20	65	-	-	-	100
ESE	15	20	65	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CDX01 - FUNDAMENTALS OF USER INTERACTIVE DESIGN							
(Computer Science and Design)							
Programme & Branch	**BE - Computer Science and Design**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course gives perfect introduction to user interface design and explains how to design intuitive user interfaces by focusing on effective human communication.	
Unit - I	**Introduction**	9
UI Is Communication Concept - Communication Design Principles- UI Design Situation - Core Principles of UI Is Communication - Effective Communication - Intuitive UI- Necessary And Unnecessary Consistency - Unintuitive UI- Inductive UI- Deductive UI		
Unit - II	**Interaction and Visual Design**	9
Interactions -Controls - Commands - Labels And Instructions – Feedback - Task Steps and Navigation - Surfaces - Errors And Notifications - Dynamic Elements - Importance of Visual Design - Graphic Designers – Layout -- Typography And Text – Color - Affordances - Icons And Glyphs- Animations And Transitions - Demanding Attention.		
Unit - III	**Communication Design Process**	9
Communicating to People - Emotional Connection – Personality - Attributes - Good Tone -Motivating Users - Minimizing Effort - Forgiveness - Building Trustworthiness - Courageous Design - communication-driven design process- Basic design process – Mistakes - Planning phase - Design phase -Refinement phase.		
Unit - IV	**Material Design and Components**	9
Material Design: Introduction, Principles. Material Environment: Surfaces. Elevation. Light and Shadows. Basic Components: App bars Bottom and Top, Bottom Navigation, Buttons, Cards, Text Fields, Navigation Drawer.		
Unit - V	**Advanced Components**	9
Advanced Components: Backdrop, Checkboxes, Chips, Date Pickers, Dialogs, Dividers, Image List, Lists, Menus, Progress Indicators, Radio Buttons, Sheets – Bottom and Side, Sliders, Snackbars, Switches, Tabs, Tool Tips, Time Pickers.		

Lecture: 45, Practical:30, Total:75

TEXT BOOK:

1.	McKay, Everett N. UI is communication: How to design intuitive, user centered interfaces by focusing on effective communication. Newnes, 2013.

List of Exercises / Experiments:

1.	Explore Figma Interface in Various tools in toolbar Layers, Assets, Pages Design Panel
2.	Apply design constraints to objects in your workflow
3.	Create Frames and grids and add it in Figma
4.	Apply Auto Layout to either frames or components in Figma
5.	Create and use Figma components in Your Design
6.	Create a style guide for your mobile and web application.
7.	Create a mockup mobile UI screens for any mobile app.
8.	Create a mockup web UI screens for any web application.
9.	Create Prototyping in Figma Prototype Panel Inspect Panel
10.	Create a Prototype for your mockup mobile and web application.
11.	Create a micro interaction in Figma
12.	Create a portfolio for your mockup mobile and web project.

REFERENCES:	
1.	https://material.io/components

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Establish the baseline principles of UI design as a form of effective human communication	Applying (K3)
CO2	Make use of practical communication-based guide to interaction and visual design	Applying (K3)
CO3	Integrate the concepts of Communication-based design process from interaction to visual design	Applying (K3)
CO4	Apply the material design principles and its components used to create a user interface	Applying (K3)
CO5	Design a simple user interface by applying the advanced material components	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	5	20	75	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CDO02 - INTRODUCTION TO MOBILE GAME DESIGN							
(Computer Science and Design)							
Programme & Branch	**BE - Computer Science and Design**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course helps the students to provide the basic knowledge and practical guide to develop mobile games without prior knowledge or skills that are required to understand its contents.	
Unit - I	**Mobile Game Design Process**	**9**
Introduction – Mobile operating system – Mobile Indie Team: Roles – Basic Game Design Process – Do's and Don'ts of Game Design – Hardware Limitations – Design Constraints – Business models		
Unit - II	**User Interface Design for Mobile Games**	**9**
Roles of UI – UI in video games – Designing the UI: Aesthetics, vectors and rasters, Designing icons – UI Design Practices: Screen Flow, Wireframes, Button Size, Main Screen, Screen rotation, challenges – Mobile Game Engines.		
Unit - III	**Graphics and Audio for Mobile**	**9**
Graphics : Pixels and Vectors – Graphic file formats – 2D & 3D Graphic Assets – Character Designing – Colors for mobile – Audio: Digital Sound Technology – Recording and Playback – Types of Game sounds – Designing Audio – Practices for audio design.		
Unit - IV	**Mobile Game Controls and Coding**	**9**
Mobile Game controls: Input Technology – Touchscreens – Keypads – Touchscreen Gestures – Input Interfaces – Built-in devices – Future technologies – Coding Games: Programming language features – Game programming: C++, Java, HTML5, Xcode – Structure of Game program.		
Unit - V	**Prototyping**	**9**
Prototyping process: Defining – Building – Testing – Fixing – Styles: Horizontal and Vertical – Prototyping Types: Disposable code – Imagination – Pencil and Paper – Visual prototypes – Interactive prototypes – Tools for prototyping – Pitching a mobile game: Game Mechanics – Control scheme and Interface – Game Flow.		
		Total: 45

TEXT BOOK:

1.	Dr. Claudio Scolastici, David Nolte, "Mobile Game Design Essentials", Packt Publishing Ltd, 2013
2.	Manning, J., & Buttfield-Addison, P. (2017). "Mobile Game Development with Unity: Build Once, Deploy Anywhere". O'Reilly Media, Inc.

REFERENCES:

1.	https://techbeacon.com/app-dev-testing/4-fundamentals-mobile-game-design

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the most important design process to develop game	Applying (K3)
CO2	built user interface design for mobile games	Applying (K3)
CO3	focus on the basic structure of game program and its controls along with the creation of user interface	Applying (K3)
CO4	Develop and design controls in mobile games using game programming .	Applying (K3)
CO5	model visual prototype for mobile gaming.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	25	60				100
CAT2	10	35	55				100
CAT3	15	25	60				100
ESE	20	25	55				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CDO03 - INTRODUCTION TO GRAPHICS DESIGN							
(Computer Science and Design)							
Programme & Branch	**BE - Computer Science and Design**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge of principles of design and how they apply to various graphic designs and provides in- depth knowledge of major design formats and disciplines such as typography, interactive design, motion graphics and package design. This course will benefit the students to apply these design concepts and techniques in upcoming real world scenarios.

Unit - I	**Fundamentals of Graphic Design**	**9**

Introduction – Graphic design, discipline, career competencies and expectations, importance of design. Basics – Formal elements of design, typographic shapes, HAUS, Laws of perceptual organization. Typography – Elements, Type Classifications, Designing with Type, Spacing, Web Type basics, Expressive typography. Design Process – Design Thinking, Five phase model of design process, Craftsmanship.

Unit - II	**Concept Generation**	**9**

Concept Generation and Creativity – Design concept, concept generation process, Tools that stimulate creative thinking. Visualization, icons and color – Image classifications and depictions, signs and symbols, Icon design, Media, methods and visualization, Creating, selecting and manipulating images, Basics of visualizing form, drawing, using color. Composition.

Unit - III	**Proportional systems, Formats and Disciplines**	**9**

Proportional Systems, the grid and Brochure design – Mathematical ratios and proportional systems, Grid. Posters - Purpose of posters, Social Commentary. Book covers – purpose of cover design, designing a cover, designing for a series.

Unit - IV	**Branding and Advertising**	**9**

Branding and visual identity – Branding, purpose and process of branding, visual identity - purpose and designing, logo - purpose and designing, fundamentals of letterhead design. Advertising - .purpose, who creates advertising? , Role of storytelling and story building, designing ads, The Ad Campaign, Responsible advertising and being proactive.

Unit - V	**Web, Mobile, Motion Design and Package Design**	**9**

Web, Mobile and Motion design – expectations from interactive experiences, Websites, Website Development, Conceptual development and visual design, Engaging content, Mobile design, Motion design, and Visual basics for screen based media. Package Design – purpose, considerations, Audio CD package design.

Total:45

TEXT BOOK:

1.	Robin Landa, Graphic Design Solutions, 6thEdition, Cencage Learning,2019
2.	Katherine A. Hughes, Graphic Design- Learn It, Do It, 1stEdition, CRC Press, 2019

REFERENCES:

1.	Valerie Colston, Graphic Design: A Practical Guide for Librarians, 1stEdition, Rowman & Littlefield Publishers, 2019

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Understand the formal elements, design principles and process.	Understand (K2)
CO2	Apply the concept generation process and creative thinking for real world design scenarios.	Apply (K3)
CO3	Utilize the formats, disciplines and proportional systems.	Apply (K3)
CO4	Apply branding and logos and identity to products and advertising.	Apply (K3)
CO5	Develop visual language in various projects and media channels including web, mobile and motion design and understand package design.	Apply (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	60	25				100
CAT2	15	65	20				100
CAT3	15	65	20				100
ESE	10	70	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CDX02 - Virtual Reality and Augmented Reality							
(Computer Science and Design)							
Programme & Branch	**BE - Computer Science and Design**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**PC**	**2**	**0**	**2**	**3**

Preamble	This course introduces the fundamentals of the Virtual Reality and Augmented Reality to efficiently incorporate user experience, identifying and resolving conflicts in real life. It aims to analyze the application of AR and VR in architecture, gaming, entertainment etc.

Unit - I	**Design ,Art Across Digital Realities and eXtended Reality**	**9**

How Humans Interact with Computers-Modalities Through the Ages-Types of Common HCI Modalities -The Current State of Modalities for Spatial Computing Devices - Current Controllers for Immersive Computing Systems-A Note on Hand Tracking and Hand Pose Recognition-Designing for Our Senses, Not Our Devices-Sensory Design-Five Sensory Principles.Virtual Reality for Art-3D Art Optimization-Introduction-Draw Calls- Using VR Tools for Creating 3D Art -Acquiring 3D Models Versus Making Them from Scratch.

Unit - II	**Hardware, SLAM, Tracking**	**9**

How the Computer Vision That Makes Augmented Reality Possible Works-A Brief History of AR- Select an AR Platform-Mapping-Platforms- Apple's ARKit- Other Development Considerations –Lighting-The AR Cloud- The Dawn of the AR Cloud-The Bigger Picture—Privacy and AR Cloud Data.

Unit - III	**Creating Cross-Platform Augmented Reality and Virtual Reality**	**9**

Virtual Reality and Augmented Reality: Cross-Platform Theory-The Role of Game Engines-Understanding 3D Graphics-Portability Lessons from Video Game Design-Simplifying the Controller Input-Virtual Reality Toolkit: Open Source Framework for the Community-Three Virtual Reality and Augmented Reality Development Best Practices.

Unit - IV	**Enhancing Data Representation:Data Visualization and Artificial Intelligence in Spatial Computing**	**9**

Data and Machine Learning Visualization Design and Development in Spatial Computing-Introduction-Understanding Data Visualization-Principles for Data and Machine Learning Visualization-2D Data Visualizations versus 3D Data Visualization-Animation-Data Representations, Infographics, and Interactions-3D Reconstruction and Direct Manipulation of Real-World Data.

Unit - V	**Character AI ,Behaviors and Use Cases in Embodied Reality**	**9**

Introduction - Behaviors -Current Practice: Reactive AI-More Intelligence in the System: Deliberative AI-The Virtual and Augmented Reality Health Technology Ecosystem-VR/AR Health Technology Application Design - Standard UX Isn't Intuitive-The Fan Experience: SportsXR.

List of Exercises / Experiments :

1.	Setup an Input system for marker-less AR system.
2.	Setup an Interaction for marker-less AR system.
3.	Optimize, debug and build marker-less AR application
4.	Setup an Input system for marker AR system.
5.	Setup an Interaction for marker AR system.
6.	Optimize, debug and build marker AR application
7.	Setup 3D model for VR Environment
8.	Setup VR Input System
9.	Setup VR interaction system
10.	optimize, debug and built VR education application

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1. Creating Augmented and Virtual Realities by Erin Pangilinan, Steve Lukas, Vasanth Mohan Released March 2019,Publisher(s): O'Reilly Media, Inc.,ISBN: 9781492044147

REFERENCES:

1. Paul Mealy,Virtual & Augmented Reality For Dummies,ISBN: 978-1-119-48134-8 July 2018

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understanding the fundamentals of Design ,Art Across Digital Realities and extended Reality	Applying (K3), Precision(S3)
CO2	explore the components of Hardware, SLAM, and Tracking	Applying (K3), Precision(S3)
CO3	apply the concept by creating Cross-Platform Augmented Reality and Virtual Reality	Applying (K3), Precision(S3)
CO4	Demonstrate the enhancing Data Representation of Data Visualization and Artificial Intelligence in Spatial Computing	Applying (K3), Precision(S3)
CO5	Demonstrate the character of AI ,behaviors and Use Cases in Embodied Reality	Applying (K3), Precision(S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	35	30	35				100
CAT2	25	30	45				100
CAT3	25	30	45				100
ESE	20	50	30				100

±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ADO01 - DATA WAREHOUSING AND DATA MINING							
(Offered by Artificial Intelligence and Data Science)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides a comprehensive knowledge about building a data warehouse and performing data mining operations.	
Unit – I	**Introduction:**	**9+3**
Data Mining – Steps in Knowledge Discovery Process – Kinds of Data and Patterns – Technologies used – Targeted applications – Major issues in Data Mining – Data objects and attribute types – Statistical descriptions of data – Measuring data similarity and dissimilarity.		
Unit – II	**Data Preprocessing:**	**9+3**
Major tasks in data preprocessing - Data Cleaning – Data Integration – Data Reduction – Data Transformation – Data Discretization and Concept hierarchy generation.		
Unit – III	**Data Warehousing:**	**9+3**
Data warehouse architecture – Data warehouse modeling – Data cube – OLAP operations – Data warehouse design and usage – Data warehouse implementation – Data generalization by attribute oriented induction.		
Unit – IV	**Frequent Pattern Mining:**	**9+3**
Basic concepts – Frequent itemset mining methods: Apriori algorithm – A pattern growth approach for mining frequent itemsets – Pattern evaluation methods – Multilevel – Multi dimensional frequent pattern mining.		
Unit – V	**Data Mining Applications:**	**9+3**
Mining complex data types – Other methodologies of data mining – Data mining applications – Data mining and Society – Data mining trends		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Han Jiawei, and Kamber Micheline, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers, 2012.

REFERENCES:

1.	Berson Alex, and Smith Stephen J, "Data Warehousing, Data Mining and OLAP", 1st Edition, Tata McGraw- Hill, New Delhi, 2004.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the concepts of data mining and perform statistical analysis of data	Applying (K3)
CO2	apply various preprocessing techniques	Applying (K3)
CO3	perform OLAP operations by constructing data warehouse	Applying (K3)
CO4	apply association rule mining methods to solve the problem	Applying (K3)
CO5	discuss about data mining applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2											
CO2	3	2	2											
CO3	3	2	2											
CO4	3	2	2											
CO5	3	2	2											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22ADX01 – DATA VISUALIZATION							
(Offered by Artificial Intelligence and Data Science)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides practical exposure to Python Programming frameworks required for visualizing data.	
Unit – I	**Introduction to NumPy:**	**9**
Understanding Data Types in Python – NumPy Arrays Basics: Array Attributes – Array Indexing – Array Slicing – Array Reshaping – Concatenation and Splitting – NumPy Arrays Computation: Universal Functions – Loops Slowness – UFuncs Introduction – UFuncs Exploring – Features – Aggregations		
Unit – II	**Computation on Arrays:**	**9**
Computation on Arrays: Broadcasting – Introduction – Rules – Comparisons, Masks, and Boolean Logic – ufuncs Comparison Operators – Boolean Arrays – Masks Boolean Arrays – Fancy Indexing – Sorting Arrays – Fast Sorting in NumPy – Partial Sorts – Example – Structured Data: NumPy's Structured Arrays		
Unit – III	**Data Manipulation with Pandas:**	**9**
Pandas Objects Introduction – Data Indexing and Selection – Data Operation: Index Preservation – Index Alignment – Operations between DataFrame and Series – Handling missing data – Hierarchical Indexing: Creating, Indexing, Slicing, Rearranging and Data Aggregations		
Unit – IV	**Advanced Operations with Pandas:**	**9**
Combining Datasets: Concat and Append – Combining Datasets: Merge and Join – Aggregation and Grouping – Pivot Tables – Vectorized String Operations: Pandas String Operations Introduction – Pandas String Methods		
Unit – V	**Visualization with Matplotlib:**	**9**
General Matplotlib – Line Plots – Scatter Plots – Visualizing errors – Density and Contour Plots – Histograms, Binnings and Density – Customizing Plot Legends – Customizing Colorbars – Multiple Subplots		

LIST OF EXPERIMENTS / EXERCISES:

1.	Perform operations on arrays using Numpy.
2.	Perform Data Manipulation using Pandas.
3.	Combine datasets using concat, append, merge and join functions
4.	Perform aggregation and grouping using Pandas
5.	Explore Pivot Tables and vectorized String Operations
6.	Visualize data using line, scatter, density and contour plots.
7.	Visualize the Customizing Plot Legends
8.	Implement Customizing Colorbars and Multiple Subplots

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	VanderPlas, J. "Python data science handbook: Essential tools for working with data", 1st Edition, O'Reilly Media, Inc.", 2016.

REFERENCES/ MANUAL / SOFTWARE:

1.	Dr. Ossama Embarak, " Data Analysis and Visualization using Python ", APress, 2018
2.	Wes McKinney, "Python for Data Analysis", 2nd Edition, Or'reilly, 2018.
3.	Operating System : Linux / Windows
4.	Software : Python / Keras / Tensorflow / OpenCV
5.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	perform array operations using Numpy	Applying (K3) Precision (S3)
CO2	manipulate the dense data arrays in python	Applying (K3) Precision (S3)
CO3	manipulate data using Pandas	Applying (K3) Precision (S3)
CO4	apply data transformations such as aggregation and grouping using Pandas	Applying (K3) Precision (S3)
CO5	use Matplotlib for visualizing the data in python	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	5	45	50				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22ADO02 – NEURAL NETWORKS AND DEEP LEARNING							
(Offered by Artificial Intelligence and Data Science)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course is designed to impart the skills required to build different deep neural network architectures.	
Unit – I	**Neural Networks:**	**9**
Introduction – Basic Architecture of Neural Networks – Training Neural Network with Back propagation – Practical Issues in Neural Network Training - Power of Function Composition – Common Neural Architectures – Neural Architectures : Binary Classification Models – Multiclass Models.		
Unit – II	**Training Deep Neural Networks:**	**9**
Introduction – Back propagation- Setup and Initialization Issues – Vanishing and Exploding Gradient Problems – Gradient Descent Strategies – Batch Normalization - Practical Tricks for Acceleration and Compression – Bias-Variance Trade-Off.		
Unit – III	**Radial Basis Function Networks and Boltzmann Machines:**	**9**
Radial Basis Function : Introduction - Training an RBF Network – Hopfield Network – The Boltzman Machine – Restricted Boltzman Machine – Applications of Restricted Boltzman Machines		
Unit – IV	**Recurrent Neural Networks:**	**9**
Introduction – Architecture of Recurrent Neural Networks – Challenges of training Recurrent Networks – Echo-State Networks – Long Short-Term Memory (LSTM) – Gated Recurrent Units (GRUs) – Applications of Recurrent Neural Networks		
Unit – V	**Convolution Neural Networks:**	**9**
Introduction – Basic Structure of Convolutional Network – Training a Convolutional Network – Case Studies of Convolutional Architectures – Applications of Convolutional Networks.		
		Total:45

TEXT BOOK:

1.	Aggarwal, Charu C, “Neural Networks and Deep learning”, 1st Edition, Springer, 2018.

REFERENCES:

1.	Ian Goodfellow, YoshuaBengio, and Aaron Courvill, “Deep Learning”, MIT Press, USA, 2016
2.	Josh Patterson and Adam Gibson, “Deep Learning – A Practitioner’s Approach”, 1st Edition, O’Reilly Series, August 2017.
3.	Indra den Bakker, “Python Deep Learning Cookbook”, 1st Edition, Packt Publishing, October 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use Artificial Neural Network .concepts to solve real world problems	Applying (K3)
CO2	solve simple real world problems using deep neural networks.	Applying (K3)
CO3	use the concepts of RBF and Boltzman machines to solve real world problems	Applying (K3)
CO4	explicate the concepts of RNN models and apply it for solving Natural Language problems.	Applying (K3)
CO5	exemplify the concepts of CNN models and apply it for solving computer vision related problems.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**3**	**2**	**3**	**2**										
CO2	**3**	**2**	**3**	**2**										
CO3	**3**	**2**	**3**	**2**										
CO4	**3**	**2**	**3**	**2**										
CO5	**3**	**2**	**3**	**2**										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	45	45				100
CAT2	10	45	45				100
CAT3	10	45	45				100
ESE	5	45	45				100
*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**							

22ADO03 - BUSINESS ANALYTICS							
(Offered by Artificial Intelligence and Data Science)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Python Programming**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge on various analytical methods for achieving Business Intelligence.	
Unit – I	**Foundations of Business Analytics:**	**9**
Business Analytics - Evaluation of Business analytics – scope of business analytics - Data for Business Analytics: Data set and Database - Big data-Metrics and Data classification - Data reliability and validity - Models in business analytics - problem solving with analytics		
Unit – II	**Business Analytics on spreadsheet and Visualization:**	**9**
Basic excel skills - Excel function - using excel lookup function for specific application - using excel lookup functions for database queries - spreadsheet Add-ins for business analytics - Data Visualization: Tools and Software - Creating Charts in Microsoft Excel - Excel Data Visualization Tools		
Unit – III	**Descriptive Statistics:**	**9**
Populations and samples - Measures of location - Measures of dispersion - Measures of shape - Excel descriptive statistic tool-Descriptive statistic for grouped data - Descriptive statistic for Categorical data-Measures of association-outliers-statistical thinking in business decisions		
Unit – IV	**Statistical Inference and Regression models**:	**9**
Statistical Inference: Hypothesis Testing - Hypothesis-Testing Procedure- One-Sample Hypothesis Tests. Trendlines and Regression Analysis: Modeling Relationships and Trends in Data - Simple Linear Regression : Finding the Best-Fitting Regression Line – Multiple linera regression		
Unit – V	**Forecasting Techniques:**	**9**
Qualitative and judgemental Forecasting-statistical forecasting model - forecasting models for stationary timeseries-forecasting models for time series with linear trend – forecasting time series with seasonality -selecting appropriate time series based forecasting models-regression forecasting with causal varialbles		
		Total:45

TEXT BOOK:

1.	James R. Evans. Business Analytics, **2nd** Edition, Pearson, 2017.

REFERENCES:

1.	U Dinesh Kumar. Business Analytics: The Science of Data - Driven Decision Making, 1st Edition, Wiley, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform the business data modelling and its analytics	Applying (K3)
CO2	perform the analytics on spreadsheet and tools and methods for data Visualization	Applying (K3)
CO3	summarize data using descriptive Statistics	Applying (K3)
CO4	interpret and making inference on results and use regression models for prediction	Applying (K3)
CO5	apply various Forecasting Techniques on time series data	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1										
CO2	3	2	2	1										
CO3	3	2	2	1										

CO4	3	2	2	1										
CO5	3	2	2	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	50	35				100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	5	50	45				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22ALO01- BUSINESS INTELLIGENCE							
(Offered by Artificial Intelligence and Machine Learning)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course focuses on learners to apply the business intelligence concepts and techniques to various applications for making better decisions.	
Unit – I	**Business View of Information Technology Applications:**	**9+3**
Core Business Processes – Baldrige Business Excellence Framework – Purpose of using IT in Business – Characteristics of Internet-ready IT Applications – Enterprise Applications – Information users and their requirements. Case Study: GoodLife HealthCare Group, Good Food Restaurants Inc, Ten To Ten Retail Stores. Types of Digital Data: Introduction – Structured Data – Unstructured Data – Semi-Structured Data – Difference between semi-structured and structured data.		
Unit – II	**Business Intelligence and Data Integration:**	**9+3**
Business Intelligence: Definition – Evolution – Need for BI – BI Value Chain – Business Analytics –BI Framework – BI Users – BI Applications – BI Roles and Responsibilities – Data Integration : Need for Data Warehouse – Definition of Data Warehouse – Data mart – Ralph Kimbal's Approach vs. W.H.Inmon's Approach – Goals of Data Warehouse –ETL Process		
Unit – III	**OLTP, OLAP and Multidimensional Data Modeling:**	**9+3**
OLTP – OLAP – OLAP Architectures – Data Models – Role of OLAP Tools in BI –OLAP Operations –Basics of Data Modeling – Types of Data Model – Data Modeling Techniques –Fact Table –Dimension Table –Dimensional Models –Dimensional Modeling Life Cycle –Designing the Dimensional Model.		
Unit – IV	**Performance Management and Enterprise Reporting:**	**9+3**
Understanding Measures and Performance – Measurement System – Role of metrics –KPIs – Enterprise Reporting: Reporting Perspectives – Report Standardization and Presentation Practices – Enterprise Reporting Characteristics – Balanced Scorecard – Dashboards –Creating Dashboards – Scorecards vs. Dashboards – Analysis.		
Unit – V	**Role of Statistics in Analytics and BI Applications:**	**9+3**
Understanding Statistics - Role of Statistics in Analytics –Data Description and Summarization – Statistical Test – Understanding Hypothesis and t-Test - Correlation Analysis – Regression – ANOVA -The F-Test - Time Series Analysis - BI Applications: BI and Mobility – BI and Cloud Computing –Business Intelligence for ERP systems – Social CRM and Business Intelligence.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Prasad R.N. and SeemaAcharya, "Fundamentals of Business Analytics", 2nd Edition, Wiley-India Publication, 2016.

REFERENCES:

1.	Ramesh Sharda, DursunDelen and Efraim Turban, "Business Intelligence, Analytics, and Data Science: A Managerial Perspective", 4th Edition, Pearson Education, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the enterprise view of IT applications and identify the different types of digital data	Applying (K3)
CO2	make use of BI concepts and techniques to experiment ETL process	Applying (K3)
CO3	compare OLTP with OLAP systems and design dimensional model	Applying (K3)
CO4	apply different performance evaluation metrics for a given problem	Applying (K3)
CO5	Perform statistical analysis and apply BI to mobile, cloud, ERP and social CRM systems	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**3**	**2**	**1**											
CO2	**3**	**2**	**1**											
CO3	**3**	**2**	**1**											
CO4	**3**	**2**	**1**											
CO5	**3**	**2**	**1**											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	10	50	40				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22ALX01 - DATA EXPLORATION AND VISUALIZATION TECHNIQUES							
(Offered by Artificial Intelligence and Machine Learning)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Python Programming**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	To provide practical exposure to Python Programming frameworks required for visualizing various types of data	
Unit – I	**Data visualization in business intelligence:**	**9**
Introduction to data visualization – need for data visualization – visualization in business decision making – Data visualization techniques and libraries – Data gathering and cleaning: cleaning data – reading – merging and integrating data – reading data from JSON		
Unit – II	**Data Exploring and Analysis:**	**9**
Data collection structures: series – data frames – panels - Series data structures – Data frame data structure – data analysis: Statistical Analysis – Data grouping – Iterating through groups – Aggregations – Transformations – Filtration.		
Unit – III	**Data visualization techniques:**	**9**
Direct plotting: line plot – bar plot – pie chart – box plot – histogram plot – scatter plot – seaborn plotting system:strip plot – box plot – swarm plot – joint plot – Matplotlib plot: Line plot – bar chart - histogram plot – scatter plot – stack plot – pie chart.		
Unit – IV	**Time series analysis:**	**9**
Date and time data types and tools – time conversion - time series basics – date ranges, frequencies and shifting – time zone handling - periods and period arithmetic – Resampling and frequency conversion – Moving Window functions.		
Unit – V	**Categorical Data Analysis and Modeling Libraries:**	**9**
Categorical data – advanced groupby – Techniques for method chaining – Interfacing between pandas and model code – Creating model descriptions with Patsy – statsmodel.		

LIST OF EXPERIMENTS / EXERCISES:	
1.	Load data in different formats and apply preprocessing
2.	Perform grouping aggregating and transforming operations on data
3.	Design different types of using direct plotting methods
4.	Create different types of plots using Matplolib
5.	Design different types of plot using Seaborn
6.	Demonstrate time series operations
7.	Visualize categorical data and perform operations on it
8.	Apply data transformations using Patsy

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	Dr. Ossama Embarak, " Data Analysis and Visualization using Python ", 1st Edition, APress, 2018 for Units 1, 2 and 3
2.	Wes McKinney, "Python for Data Analysis", 3rd Edition, Or'reilly, 2022 for Units 4 and 5.
REFERENCES:	
1.	Daniel Nelson. Data Visualization in Python, 1st Edition, StackAbuse, 2020.
2.	Jake Vander Plas, "Python Data Science Handbook Essential Tools for Working with Data", 1st Edition, O'Reilly Media, 2016.
REFERENCES/ MANUAL / SOFTWARE:	
1.	Python, Matplotlib, Seaborn, Plotly
2.	Linux / Windows
3.	Lab manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explore the concepts of data visualization and decision making using different formats	Applying (K3)

CO2	make use of the features of data frames, panels and series data structure to analyze data	Applying (K3)
CO3	apply the plotting techniques for efficient data visualization	Applying (K3)
CO4	perform time series data analysis using appropriate methods	Applying (K3)
CO5	implement suitable techniques to analyze categorical data and use libraries for modeling the data	Applying (K3)
CO6	perform data preprocessing and transformation operations	Applying (K3) Precision (S3)
CO7	explore various plotting to interpret various visualizations	Applying (K3) Precision (S3)
CO8	demonstrate the use of Patsy for modeling and analyze categorical data.	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	5	45	50				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22ALO02 - INDUSTRIAL MACHINE LEARNING							
(Offered by Artificial Intelligence and Machine Learning)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course helps the students to understand and apply various machine learning algorithms in industrial applications.	
Unit – I	**Introduction:**	**9**
The Fourth Industrial Revolution: Introduction – Industry Summarization – Machine Learning Challenges and Opportunities within Smart Industries – Applications: Energy Sector – Basic Materials Sector – Industrials Sector – Customer Services Sector – Healthcare Sector – Customer Goods Sector – Telecommunications Sector – Utilities Sector – Financial services Sector – Information Technology Sector		
Unit – II	**Component-Level Case Study:**	**9**
Introduction – Ball Bearing Prognostics: Data - Driven Techniques – PRONOSTIA Testbed – Feature Extraction from Vibration Signals – Hidden Markov Model-Based RUL Estimation: Hidden Markov Model Construction – RUL Results – Interpretation of the Degradation model		
Unit – III	**Machine-Level Case Study:**	**9**
Introduction – Performance of Industrial Motors as a Fingerprint: Improving Reliability Models with Fingerprints – Industrial Internet Consortium Testbed – Testbed Dataset Description – Clustering Algorithms for Fingerprint Development: Agglomerative Hierarchical Clustering – K-means Clustering – Spectral Clustering – Affinity Propagation – Gaussian Mixture Model Clustering – Implementation Details		
Unit – IV	**Production-Level Case Study:**	**9**
Introduction – Laser Surface Heat Treatment: Image Acquisition – Response Time Requirement – Anomaly Detection-Based AVI System: Anomaly Detection Algorithms in Image Processing – Proposed Methodology – Performance of the AVI System – Interpretation of the Normality Model		
Unit – V	**Distribution-Level Case Study:**	**9**
Introduction – Air Freight Process: Data Preprocessing – Supervised Classification Algorithms for Forecasting: k-Nearest Neighbors – Classification Trees – Rule Induction – Artificial Neural Networks – Support Vector Machines – Logistic Regression – Bayesian Network Classifiers –.Meta classifiers – Implementation		
		Total:45

TEXT BOOK:

1.	Pedro Larranaga, David Atienza,Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza, "Industrial Applications of Machine Learning", 1st Edition, CRC Press, 2019 .

REFERENCES:

1.	Andreas François Vermeulen," Industrial Machine Learning: Using Artificial Intelligence as a Transformational Disruptor", 1st Edition, Apress, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Understand and apply machine learning concepts in various industry applications	Applying (K3)
CO2	Use Hidden Markov models for handling industrial data	Applying (K3)
CO3	Apply various clustering techniques in solving industry problems	Applying (K3)
CO4	Make use of anomaly prediction algorithms in industrial image processing	Applying (K3)
CO5	Apply classification algorithms for industrial forecasting	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**3**	**2**	**2**											
CO2	**3**	**2**	**2**											
CO3	**3**	**2**	**2**											
CO4	**3**	**2**	**2**											
CO5	**3**	**2**	**2**											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	40	50				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22ALO03 - MACHINE LEARNING FOR SMART CITIES							
(Offered by Artificial Intelligence and Machine Learning)							
Programme & Branch	**All BE/BTech Branches except AIDS and AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides working principles of Sensors, UAV's, Geriatric Design and IoT Enabled Homes and applying machine learning for Smart Cities.	
Unit – I	**Machine Learning for Sustainable and Resilient Buildings**	**9**
Introduction – Sustainability and Resiliency Conditions – Paradigm and challenges of Sustainability and Resilience – Sustainability and Resilience of Engineered System – Structure Engineering Dilemmas and Resilient Epcot – Smart Building Appliances – Intelligent Tools (SRB) – Component of Smart Buildings – Machine Learning Tasks – ML Tools and Services – Big Data Application in SB		
Unit – II	**Sensors and UAV's**	**9**
Introduction – Sensors – Unmanned Aerial Vehicle – Bluetooth – Problem Description – Univariate Time series – Multivariate Time Series – Hidden Markov Model – Fuzzy Logic		
Unit – III	**Data Fusion Approaches**	**9**
Introduction to Data Fusion – Types of Data Fusion Architecture – Centralized Architecture – Decentralized Architecture – Distributed Architecture – Hierarchical Architecture – Case Study –Smart City Infrastructure – IoT Deployments – Smart City Control and Management Centers – Theory of Unified City Modeling – Smart City Operational Model- Theories and Models – Case Study – Web Browsing History Analysis – Data Model for Group Construction in Student's Industrial Placement.		
Unit – IV	**Geriatric Design and IoT Enabled Smart Homes**	**9**
Introduction to Geriatric Design – Background – Development of Smart Homes – Development of Smart Homes for Elderly – Indian Scenario –Geriatric Smart Home Requirements – Design – Framework for Smart homes –Architectural Interventions – Case Study: Schematic Design for a Nesting Home – IoT Based Real Time Automation – Technical Components of Smart Home		
Unit – V	**Impact of IoT Enabled Smart Cities**	**9**
Recent Development in IoT Application for Modern City – Classification of IoT based Smart Cities – Impact of 5G Technology – IoT Five Layer Architecture – IoT Computing Paradigm – Research Advancement and Drawbacks – Integration of Cloud Computing - integration of Applications – System Security – Research Challenges and Guidelines		
		Total:45

TEXT BOOK:

1.	Adarsh Kumar, Anand Nayyar, Arun Solanki, "Digital Cities Road map IoT-Based Architecture and Sustainable Buildings", 1st Edition, Wiley, 2021.

REFERENCES:

1.	J. Joshua Thomas, Vasiliki Geropanta, Anna Karagianni, Vladimir Panchenko "Smart Cities and Machine Learning in Urban Health", IGIGlobal, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the machine learning concepts for sustainable and resilient buildings	Applying (K3)
CO2	demonstrate the concept of sensors and time series data	Applying (K3)
CO3	explore data fusion approach	Applying (K3)
CO4	develop Geriatric design on IoT enabled homes	Applying (K3)
CO5	study the impact of IoT enabled smart cities	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**3**	**2**	**2**	**2**										
CO2	**3**	**2**	**2**	**2**										
CO3	**3**	**2**	**2**	**2**										
CO4	**3**	**2**	**2**	**2**										
CO5	**3**	**2**	**2**	**2**										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	50				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22MAO01 - MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING

Programme & Branch	All Engineering and Technology branches except AIDS & AIML	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To impart the basic knowledge in linear algebra, decomposition of matrices, continuous optimization, linear regression and support vector machines which provide the foundations for machine learning and deep learning.	
Unit - I	**Vector Spaces:**	**9+3**
Real Vector spaces – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - II	**Linear Transformations:**	**9+3**
Introduction – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection.		
Unit - IV	**Matrix Decomposition and Continuous Optimization:**	**9+3**
Matrix Decomposition: Cholesky decomposition – Singular Value Decomposition. Continuous Optimization: Introduction – Unconstrained Optimization – Gradient Descent method – Constrained Optimization – Lagrange Multipliers method – Convex Optimization.		
Unit - V	**Linear regression and Support vector machines:**	**9+3**
Linear Regression: Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression. Support Vector Machines: Introduction – Linear and Non-linear Support vector machine – Margin and support vectors – Hard and Soft margins in Support vector machines – Kernels – Primal support vector machine – Dual support vector machine.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Howard Anton and Chris Rorres, “Elementary Linear Algebra”, 11th Edition, John Wiley & Sons, New Delhi, 2014.**(Units I,II,III)**
2.	M. P. Deisenroth, A. A. Faisal, and C. S. Ong, “Mathematics for Machine Learning”, 1st Edition Cambridge University Press, 2019.**(Units IV, V)**

REFERENCES:

1.	David C. Lay, Steven R. Lay, Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2.	Ethem Alpaydin, “Introduction to Machine Learning(Adaptive Computation and Machine Learning series)”, 4th Edition, MIT Press,USA,2020.
3.	R. O. Duda, E. Hart, and D.G. Stork, "Pattern classification", 2nd Edition, John Wiley & Sons, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concepts of vector spaces.	Understanding (K2)
CO2	apply the concepts of linear mappings in machine learning.	Applying (K3)
CO3	apply the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	apply the knowledge of factorisation of matrices and optimization techniques in clustering and classification of data.	Applying (K3)

CO5	describe the concepts of parameter estimation and support vector machine.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	30	60				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22MAO02 - NUMERICAL COMPUTING

Programme & Branch	Common to CSE, CSD, IT, AIDS, AIML, ECE, EEE and EIE Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations, finding eigen values and solve linear system of equations, ordinary differential equations.	
Unit - I	**Solution to Algebraic and Transcendental Equations and Eigen value problems:**	**9+3**
Solution to Algebraic and Transcendental Equations**:** Bisection method **-** Iteration method – Method of false position – Newton-Raphson method Iterative method for Eigen values: Power method – Jacobi's method.		
Unit - II	**Solution of Simultaneous Linear Algebraic equations:**	**9+3**
Introduction - Direct methods: Gauss elimination method – Gauss - Jordan method – LU decomposition method – Crout's method –Iterative methods: Gauss Jacobi and Gauss – Seidel methods – Inverse of a matrix by Gauss Elimination method.		
Unit - III	**Interpolation:**	**9+3**
Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.		
Unit - IV	**Numerical Differentiation and Integration:**	**9+3**
Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule – Simpsons 3/8th rule – Double integrals using Trapezoidal and Simpson's rules.		
Unit - V	**Numerical Solution of First order Ordinary Differential Equations::**	**9+3**
Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Veerarajan T, Ramachandran T., "Numerical Methods", 1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.

REFERENCES:

1.	Kandasamy, P., Thilakavathy, K. and Gunavathy, K., "Numerical Methods", Reprint Edition, S.Chand & Co, New Delhi, 2016.
2.	Sankara Rao. K., "Numerical Methods for Scientists and Engineers", 3rd Edition, Prentice Hall of India Pvt. Ltd, , New Delhi, 2007.
3.	Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
4.	Sastry, S.S, "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)

CO2	solve simultaneous linear equations by numerical methods.	Applying (K3)
CO3	compute intermediate values of given evenly (or) unevenly spaced data.	Applying (K3)
CO4	apply the concepts of numerical differentiation and integration in real time applications.	Applying (K3)
CO5	obtain the solution of first ordinary differential equations by numerical methods.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	75	-	-	-	100
CAT2	10	15	75	-	-	-	100
CAT3	10	15	75	-	-	-	100
ESE	10	15	75	-	-	-	100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22MAO03 STOCHASTIC PROCESSES AND QUEUING THEORY

Programme & Branch	Common to CSE, IT, CSD, AIDS, AIML, EEE, EIE and MTS Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To provide an in-depth knowledge in random variables, random process, correlation and promote the ability to apply suitable queuing models to real time applications.	
Unit - I	**Random Variables:**	**9+3**
Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit - II	**Random processes:**	**9+3**
General concepts and definitions – Classification – Stationary process – Markov chains – Transition probabilities – Poisson process.		
Unit - III	**Correlation and Spectral densities:**	**9+3**
Auto Correlation – Cross Correlation – Properties (Without Proof) – Power spectral density – Cross spectral density – Properties (Without Proof) – Wiener- Khintchine relation – Relationship between cross power spectrum and cross correlation function.		
Unit - IV	**Queuing Theory:**	**9+3**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO).		
Unit - V	**Non-Markovian Queues and Queue Networks:**	**9+3**
Introduction to Non-Markovian queues – M/G/1 queue – Pollaczek-Khintchine formula – Series queues – Open and Closed queuing networks.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Veerarajan, T, "Probability and Statistics, Random Processes and Queuing Theory", 1st edition, McGraw-Hill Education, Chennai, 2019.

REFERENCES:

1.	Athanasios Papoulis, S. Unnikrishna Pillai., "Probability, Random Variables and Stochastic Processes", 4th edition, McGraw Hill, New Delhi, 2017.
2.	Allen A.O., "Probability, Statistics and Queuing Theory", 2nd Edition, Academic Press, New Delhi, 1990.
3.	Roy D. Yates and David J. Goodman, "Probability and Stochastic Processes - A friendly Introduction for Electrical and Computer Engineers", 3rd edition, John Wiley & Sons, 2014.
4.	John F. Shortle, James M. Thompson, Donald Gross and Carl M. Harris, "Fundamentals of Queuing Theory", 5th edition, John Wiley and Sons, New York, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	classify random variables and apply suitably in practical problems.	Applying (K3)
CO2	apply the concept of random process in communication problems.	Applying (K3)
CO3	understand the concepts and properties of Spectral Density Function and Cross Correlation function.	Understanding (K2)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)

CO5	identify the real time queue in computer networks and take decision accordingly.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22MAO04 STATISTICS FOR ENGINEERS AND DATA SCIENTISTS

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	To impart the basic knowledge in presentation of data, descriptive statistical measures and provide skills to apply correlation, suitable non- parametric tests and control charts to control the variations in real time applications.	
Unit - I	**Organization and Presentation of Data:**	**9+3**
Introduction to Statistics – Collection of data – Classification and tabulation of data – Types of data: primary, secondary, quantitative and qualitative data – Types of Measurements: nominal, ordinal, discrete and continuous data – Presentation of data – Diagrammatic and Graphical Representation: Histogram - Frequency curve - Frequency polygon - Cumulative frequency distributions – Ogive curves – Stem and leaf chart.		
Unit - II	**Descriptive Statistics:**	**9+3**
Measures of location or central tendency: Arithmetic mean – Median – Mode – Geometric mean – Harmonic mean – Partition values: Quartiles – Deciles and percentiles – Measures of dispersion: Mean deviation – Quartile deviation – Standard deviation – Coefficient of variation – Measures of skewness – Kurtosis.		
Unit - III	**Correlation and Regression:**	**9+3**
Correlation and Regression: Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation - Regression Coefficients – Fitting of Regression Lines. **Multiple Correlation and Regression:** Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order coefficient..		
Unit - IV	**Non-parametric tests:**	**9+3**
Introduction – Sign test: One sample sign test – Sign test for paired samples – Signed rank test – Rank Sum test: Mann Whitney U test – Kruskal-Wallis test – One sample run test – Tests of randomness.		
Unit - V	**Statistical Quality Control:**	**9+3**
Introduction to Statistical quality control – Control charts – Control chart for variables: $\bar{X}$-chart – R-chart – s-chart – Charts for attributes: np-chart – p-chart – c-chart.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	S.P.Gupta, "Statistical Methods", 44th Revised Edition, Sultan Chand & Sons, New Delhi, 2011 (Units I,II, V)
2.	S.C.Gupta, V.K.Kapoor, "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand & Sons, New Delhi, 2022. (Units III, IV)

REFERENCES:

1.	Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.
2.	G.C.Beri, "Business Statistics", 3rd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
3.	Johnson. R.A., Miller. I and Freund. J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, India, 2018.
4.	Anthony Hayter, "Probability and Statistics for Engineers and Scientists", 4th Edition, Cengage Learning, USA, 2012.
5.	J. K. Sharma, "Business Statistics", 5th Edition, Vikas Publishing House Pvt Ltd, Noida, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the classification of data and present the data in various forms.	Understanding (K2)
CO2	compute and interpret descriptive statistical measures using numerical and graphical techniques.	Applying (K3)
CO3	apply statistical methods like correlation, regression analysis in analysing and interpreting experimental data.	Applying (K3)
CO4	use appropriate non-parametric test to analyze experimental data.	Applying (K3)
CO5	identify suitable control charts for monitoring processes..	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2												
CO2	3	2												
CO3	3	3	2											
CO4	3	3	1											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22MAO05 - GRAPH THEORY AND ITS APPLICATIONS

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.	
Unit - I	**Graphs:**	**9+3**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph – Representations of graphs: Adjacency matrix – Incidence matrix.		
Unit - II	**Trees:**	**9+3**
Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – Construction of spanning tree: BFS algorithm – DFS algorithm – Finding all spanning trees of a graph – Fundamental circuits.		
Unit - III	**Graph Coloring:**	**9+3**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit - IV	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Transport networks –Residual capacity and Residual network – Ford-Fulkerson Algorithm – Edmonds-Karp Algorithm – Maximal Flow Applications: Multiple sources and sinks – Maximum Bipartite matching.		
Unit - V	**Graph Theoretic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Kruskal's algorithm.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", 1st Edition, Dover Publications, New York, 2016.(Units I,II,III)
2.	S. Saha Ray, "Graph Theory with Algorithms and Its Applications in Applied Science and Technology", 1st Edition, Springer, London, 2013.(Units IV,V)

REFERENCES:

1.	Douglas B West, "Introduction to Graph Theory", 2nd Edition, Pearson Education, New Delhi, 2002.
2.	Jonathan L. Gross and Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.
3.	J.A.Bondy and U.S.R. Murty ,Graph Theory and Applications , 5th Edition, Elsevier Science Publishing Co., Inc., New York,1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand basic graph theoretic concepts.	Understanding (K2)
CO2	intrepret the concepts the concepts of tress and its types.	Applying (K3)
CO3	compute the Chromatic partition, Chromatic polynomial and Matching of a given graph.	Applying (K3)
CO4	identify the maximal flow in network by means of algorithms.	Applying (K3)

CO5	apply various graph theoretic algorithms to communication and network problems.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22MAX01 - DATA ANALYTICS USING R PROGRAMMING

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	2	4

Preamble	To impart the basic knowledge in R and develop skills to apply the knowledge of R programming to statistical measures, data handling, probability, testing of hypothesis and design of experiments.	
Unit - I	**Introduction to R:**	**9+3**
Overview of R programming – Need for R – Installing R – Environment setup with R Studio – Packages: Installing packages – Running and manipulating packages – Basic objects: Vectors – Matrix – Array – Lists – Factors – Data frames.		
Unit - II	**R Programming Structures and Functions:**	**9+3**
Basic expressions: Arithmetic expressions – Control Statements: if and if-else statements –— switch statement – Loops: for loop – while loop – Function: Creating a function – calling a function – Default value for function arguments – Logical functions – Math functions – Statistical functions – Apply-family functions – Getting started with strings – Formatting data and time.		
Unit - III	**Descriptive Statistics:**	**9+3**
Summary command – Summarizing samples – cumulative statistics – summary statistics for data frames – summary tables – Linear Modeling: Simple linear regression – Multiple regression – Curvilinear regression – Plotting linear models and curve fitting.		
Unit - IV	**Working with data:**	**9+3**
Reading and writing data: Text-format in a file – Excel worksheets – Native data files – built-in datasets. Visualizing data: Scatter plots – line plots – bar charts – pie charts – Cleveland dot charts –Histogram and density plots – Box-whisker plots.		
Unit - V	**Probability Distributions, Testing of hypothesis and ANOVA:**	**9+3**
Probability Distributions: Binomial Distribution – Poisson Distribution – Normal Distribution. Testing of Hypothesis and ANOVA: Student's t-test – Non-Parametric tests: Wilcoxon U-test – Paired t and U-tests – Correlation and covariance – Tests for association – Analysis of variance: One-way ANOVA – Two-way ANOVA.		

List of Exercises / Experiments:

1.	Implementation of operations of data objects such as vector, list and matrix.
2.	Implementation and use of array, factors and data frames in R.
3.	Programs using decision making statements and looping structures.
4.	Programs to demonstrate programming concepts using functions (Using built-in and user-defined functions)
5.	Performing various basic statistical measures for the given data.
6.	Calculate the regression coefficient and obtain the lines of regression for the given data.
7.	Creating and reading various types of data files.
8.	Create different charts for visualization of given set of data.
9.	Computation of probability using Binomial, Poisson and Normal distributions.
10.	Perform the t-test for testing significance of mean.
11.	Perform various non-parametric tests for the given sample data.
12.	Perform One way and two way ANOVA.

Lecture: 45, Practical: 15, Total: 60

TEXT BOOK:

1.	Kun Ren, “Learning R Programming”, 1st Edition, Packt Publishing Ltd, UK, 2016. **(Units I, II)**
2.	Mark Gardener, “Beginning R-The Statistical Programming Language”,1st Edition, John Wiley & Sons,Inc, USA, 2012.**(Units III,IV, V)**

REFERENCES:

1.	Seema Acharya, “Data Analytics using R”, 1st Edition, McGraw Hill Education, Chennai, 2018.
2.	Norman Matloff, “The Art of R Programming”, 1st Edition, No Starch Press, San Francisco, 2011.
3.	Paul Teetor, “R Cookbook”, 1st Edition, O'Reilly Media, USA, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basics of fundamentals of R.	Understanding (K2)
CO2	apply the concepts of decision, looping structures and functions in real time problems.	Applying (K3)
CO3	apply R programming to descriptive statistics.	Applying (K3)
CO4	apply the libraries for data manipulation and data visualization in R.	Applying (K3)
CO5	use R studio to identify the probability and test statistical hypothesis.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	1											
CO2	3	1	1		2									
CO3	3	2	2	2	2									
CO4	3	3	2	3	2									
CO5	3	2	2	3	2									
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22MAO06 OPERATIONS RESEARCH

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	To provide the skills for solving the real time engineering problems involving linear objective functions, transportation models and also impart knowledge in finding optimal solutions to problems involving limited resources, project management techniques and game theoretic concepts.	
Unit - I	**Linear Programming:**	**9+3**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit - II	**Transportation and Assignment Problems:**	**9+3**
Transportation Problem: Introduction – Mathematical formulation – Solution of transportation problem: Initial basic feasible solution: North-West Corner Rule – Vogel's Approximation Method – Optimal Solution: MODI method. **Assignment Problems**: Introduction – Mathematical Formulation – Hungarian Algorithm.		
Unit - III	**Games Theory:**	**9+3**
Theory of Games: Introduction – Basic Terminology – Two-Person zero sum games – Pure strategies (Games with saddle point) – Mixed Strategies (Games without saddle points) – Rule of Dominance – Solution of Mixed Strategy games: Algebraic method – Arithmetic method – Graphical method.		
Unit - IV	**Sequencing models:**	**9+3**
Sequencing problems: Introduction – Johnson's algorithm – Processing of n jobs through two machines – Processing of n jobs through three machines – Processing of 'n' jobs through 'm' machines - Processing of two jobs through 'm' machines.		
Unit - V	**Network and Project Management:**	**9+3**
Introduction – Basic terminology **–** Rules of Network construction – Fulkerson's Rule for numbering of events – Construction of network – Critical Path Method (CPM) – Programme Evaluation and Review Technique (PERT).		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1. Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2. Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3. Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4. Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5. Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	apply transportation and assignment algorithms in engineering problems.	Applying (K3)
CO3	use game theory concepts in practical situations.	Applying (K3)
CO4	identify the minimum processing times for sequencing problems	Applying (K3)
CO5	apply the concepts of CPM and PERT in scheduling the project networks.	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	3	2	3											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22MAO07 - NUMBER THEORY AND CRYPTOGRAPHY

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	To provide the skills for applying various number theoretic algorithms, congruences, primality tests in cryptography and network security and impart knowledge of basic cryptographic techniques.	
Unit - I	**Divisibility Theory:**	**9+3**
Division algorithm – Base-b representations – Number patterns – Prime and composite numbers – Fibonacci and Lucas numbers – Fermat numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit - II	**Theory of Congruences:**	**9+3**
Basic concepts – Properties of congruences – Linear congruences – Solution of linear congruences – Fermat's Little theorem – Chinese remainder theorem.		
Unit - III	**Number Theoretic Functions:**	**9+3**
Introduction – Functions τ and σ – Mobius function – Greatest integer function – Euler's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit - IV	**Primality testing and Factorization:**	**9+3**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Miller-Rabin test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit - V	**Classical Cryptographic Techniques:**	**9+3**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Thomas Koshy, "Elementary Number Theory with Applications", 2nd Edition, Academic Press, Elsevier, USA, 2007.(Units I,II,III)
2.	William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson Education, New Delhi, 2019.(Units IV,V)

REFERENCES:

1.	Ivan Niven, Herbert S. Zukerman, Hugh L. Montgomery, "An Introduction to the Theory of Numbers", Reprint Edition, John Wiley & Sons, New Delhi, 2008.
2.	Bernard Menezes, "Cryptography and Network Security", Cengage Learning India, 1st Edition, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain the knowledge in theory of congruences and solution of linear congruences.	Understanding (K2)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	apply the suitable cryptographic techniques to handle real time security issues.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2												
CO2	3	1												
CO3	3	1												
CO4	3	2	1		2									
CO5	3	2	1		2									
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22MAO08 NON-LINEAR OPTIMIZATION

Preamble	The course focuses on the basic concepts, various techniques and applications of engineering optimization.	
Unit - I	**Classical Optimization Techniques:**	**9**
Introduction to Optimization – Statement of an Optimization problem – Mathematical formulation – Multi variable optimization with equality constraints – Lagrange multipliers method – Multi variable optimization with inequality constraint – Kuhn Tucker conditions.		
Unit - II	**Non-Linear Programming: One-Dimensional Minimization Method:**	**9**
Introduction – Unimodal function – Elimination Methods: Unrestricted search – Exhaustive search – Dichotomous search – Interval halving method – Fibonacci method – Golden section method – Direct root methods: Newton method – Secant method.		
Unit - III	**Non-Linear Programming: Unconstrained Optimization Techniques:**	**9**
Introduction to Unconstrained optimization – Direct Search Methods: Grid search method – Univariate method – Hookes and Jeeve's method – Powell's method.		
Unit - IV	**Unconstrained Optimization Techniques (Indirect Methods):**	**9**
Gradient of a Function – Indirect Search Methods: Steepest descent method – Fletcher-Reeves method – Newton's method – Marquardt method.		
Unit - V	**Non-Linear Programming: Constrained Optimization Techniques:**	**9**
Introduction – Characteristics of a Constrained Problem – Direct Methods: Random search method – Sequential linear programming – Indirect methods: Transformation techniques – Exterior penalty function method – Interior penalty function method.		

Total: 45

TEXT BOOK:

1.	S.S.Rao, Engineering Optimization Theory and Practice, 1st Edition, John Wiley & Sons Ltd, USA, 2020.

REFERENCES:

1.	David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 4th edition, Springer-Verlag, 2015
2.	A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Engineering Optimization: Methods and applications, 2nd Edition, Wiley India Pvt. Ltd., 2006.
3.	Yang, Xin-She. Optimization Techniques and Applications with Examples. 1st Edition, John Wiley & Sons, United Kingdom, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve problems with equality and inequality constraints.	Applying (K3)
CO2	solve nonlinear programming problems of functions of single variable.	Applying (K3)
CO3	use methods of unconstrained optimization to solve non linear problems	Applying (K3)
CO4	solve nonlinear optimization problems in the presence of inequality and equality constraints.	Applying (K3)
CO5	apply several modern methods of optimization for solving engineering problems	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2											
CO2	3	2												
CO3	3	3	1											
CO4	3	3	3											
CO5	3	2	3											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	10	10	80				100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22MAO09 OPTIMIZATION FOR ENGINEERS

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	To provide the skills for solving the real time engineering problems involving linear and non-linear objective functions and also impart knowledge in finding optimal solutions to problems involving multi-level decision making and analyzing queuing models.	
Unit - I	**Linear Programming:**	**9**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit - II	**Integer Programming:**	**9**
Introduction – Types of Integer Programming Problems – Solution of Integer programming problems – Gomory's all integer cutting plane method - Gomory's Mixed-Integer Cutting Plane Method – Branch and Bound method.		
Unit - III	**Dynamic programming:**	**9**
Introduction – Characteristics – Formulation of Dynamic programming problems –Dynamic programming Algorithm – Solution of Discrete Dynamic programming problem – Solution of LPP by Dynamic programming.		
Unit - IV	**Queueing Theory:**	**9**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO)..		
Unit - V	**Non-Linear Programming:**	**9**
Introduction – Mathematical formulation of Non-linear programing problems – Non-linear programing problem with equality constraints – Lagrange multipliers method – Non-linear programing problem with inequality constraint – Kuhn Tucker conditions.		

Total: 45

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- conceptsand cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**

CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	solve Integer Programming problems that exist in real time applications.	Applying (K3)
CO3	demonstrate the theoretical workings of dynamic programming method to find shortest path for given network.	Applying (K3)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	apply the concept of non-linear programming for solving the problems involving non-linear constraints and objectives.	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	3											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO01 - THIN FILM TECHNOLOGY							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the essential knowledge on deposition, characterization and application of thin films in various engineering fields, and also provides motivation towards innovations.	
Unit – I	**Theories and models of thin film growth:**	**9+3**
Introduction – Theories of thin film nucleation: Impingement, Adsorption and Thermal accommodation – The capillarity model – The atomistic models – Structural consequences of thin film nucleation – The four stages of film Growth – The incorporation of defects during growth.		
Unit – II	**Vacuum technology:**	**9+3**
Principle and working of vacuum pumps: Roots vacuum pump, Rotary pump, Diffusion pump, Turbo molecular pump, Cryogenic pump, Ion pump, Ti-sublimation pump – Measurement of Pressure: Bayet-Albert gauge, Pirani and Penning gauge – Cold cathode and hot cathode ionization gauges – Pressure controlling system (qualitative).		
Unit – III	**Deposition of thin films - Physical methods:**	**9+3**
Thermal evaporation – Electron beam evaporation – Pulsed laser deposition – Ion plating – DC sputtering – RF sputtering – Magnetron sputtering – Reactive sputtering – Molecular beam epitaxy - Demonstration of deposition of thin films by RF sputtering.		
Unit – IV	**Deposition of thin films – Chemical methods:**	**9+3**
Chemical vapor deposition – Sol-gel method – Chemical bath deposition – Hydro thermal methods – Electroplating deposition – Electroless deposition – Spray Pyrolysis - Spin coating.		
Unit – V	**Characterization and Applications of thin films:**	**9+3**
Characterization: X-ray diffraction, Energy dispersive X-ray analysis, Atomic probe microscopy, Scanning Tunneling Microscope, X-ray Photoemission Spectroscopy, UV-vis spectroscopy and Four probe resistivity – Applications (qualitative): Thin film solar cells, Thin film gas sensors, Thin films for information storage and Optical coatings.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Maissel L.I. and Glang R, Hand book of Thin Film Technology, Reprint, McGraw Hill Inc., New York, 1970, (Unit I – IV)
2.	Sam Zhang, Lin Li and Ashok Kumar, Materials Characterization Techniques, 1st edition, CRC Press, Boca Raton, 2008 (Unit V)

REFERENCES:

1.	Ohring M, Material Science of Thin Films, 2nd Edition, Academic Press, New Jersey, 2001
2.	Goswami A, Thin Film Fundamentals, Reprint, New Age International (P) Ltd, New Delhi, 2003
3.	Chopra K. L, Thin Film Phenomena, Illustrated, McGraw Hill Inc., New York, 1969

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	utilize the appropriate theory and models to comprehend the thin film growth process.	Applying (K3)
CO2	apply the principle of vacuum pump to explain select methods to create vacuum and to make use of the principle of vacuum gauge to explain the measurement of vacuum by select methods.	Applying (K3)
CO3	describe the deposition of thin films by select physical methods using the principle of working of respective methods.	Applying (K3)
CO4	explain the deposition of thin films by select chemical methods using the principle of working of respective methods.	Applying (K3)
CO5	make use of select characterization techniques to comprehend the properties of thin films and also to illustrate the various device applications of thin films.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO02- HIGH ENERGY STORAGE DEVICES							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**
Preamble	This course aims to impart the essential knowledge on the fundamental principles and application areas of proven technologies and materials for energy storage solutions, together with an overview of development trends in this engineering field.						
Unit – I	**Introduction to Energy Storage:**						**9+3**
An overview of energy storage systems (qualitative): Thermal energy storage, mechanical energy storage, chemical energy storage, electrical energy storage, electrochemical energy storage, electrostatic energy storage, magnetic energy storage and optical energy storage – General criteria of energy storage systems – Conventional batteries: fundamentals and applications – Grid connected and off grid energy storage systems and requirements.							
Unit – II	**Thermal storage and Mechanical Storage:**						**9+3**
Thermal storage: Thermal properties of materials, principle of operations, efficiency factors, large scale and medium scale operations – Merits and demerits of thermal storage system – Recent development in thermal storage systems. Mechanical Storage: Types of mechanical storage systems, principle of operations, emerging advances and technologies in mechanical storage systems – Flywheel.							
Unit – III	**Magnetic storage, Electro-optic, Optical and Chemical Storage:**						**9+3**
Magnetic storage: Principle of operation, emerging challenges and a review on devices and technology. Electro-optic and optical storage: Emerging devices and upcoming technologies (qualitative). Chemical storage: Power to gas – Hydrogen and Methane. Power to liquid – Bio fuels – Aluminum-Boron, silicon, and zinc.							
Unit – IV	**Electrochemical Storage:**						**9+3**
Materials, Principle of operation, positive electrode materials, negative electrode materials, electrolytes. Li-ion batteries: Principle of operation, battery components, design of electrodes, cell and battery fabrications – Building block cells – Battery modules and packs – Li-polymer batteries – Applications – Future developments: Sodium-battery, magnesium battery, aluminum battery and silicon battery.							
Unit – V	**Fuel Cells, Hydrogen storage and Super capacitors:**						**9+3**
Fuel Cells: Introduction to fuel cells, PEM (polymer electrolyte membrane), Hydrogen PEM fuel cell, direct methanol fuel cell, alkaline fuel cells and solid oxide fuel cells. Hydrogen storage systems: Solid state hydrogen storage tanks, gas phase hydrogen storage tanks, cryogenic hydrogen storage tanks and liquid phase hydrogen storage tanks. Super capacitors: Features of super capacitors, basic principle of operation, performance and technologies of super capacitors.							
Lecture: 45, Tutorial: 15, Total: 60							
TEXT BOOK:							
1.	Robert A. Huggins, Energy Storage, Springer, 2010, (Unit I – V)						
2.	Ehsani, Y. Gao, S. Gay, A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, New York, 2005 (Unit I - V)						
REFERENCES:							
1.	Yuping Wu, Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion), CRC Press, United Kingdom, 2015						
2.	Trevor M. Letcher, Storing Energy: with Special Reference to Renewable Energy Sources, 2nd edition, Elsevier, 2022						
3.	D. Linden and T. S. Reddy, Handbook of Batteries, 4th edition, McGraw Hill, Newyork, 2011						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	utilize the appropriate concepts and models to comprehend the basics of energy storage systems.	Applying (K3)
CO2	apply the principle of thermal and mechanical storage systems to explain the working and the recent advancements in thermal and mechanical storage systems.	Applying (K3)
CO3	ultilize the principle of operation of magnetic storage systems, electro-optic, optical and chemical storage systems to illustrate the respective process under gone in these techniques.	Applying (K3)
CO4	explain the principle of operation of electrochemical storage device and materials used and to elucidate the construction and working of various types of high energy storage batteries.	Applying (K3)
CO5	make use of various techniques to construct different types of fuel cells and to explain the advanced techniques involved in hydrogen storage systems and also to explain the principle and working of super capacitors.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO03- STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**
Preamble	This course aims to impart the essential knowledge on the characterization of materials using X-ray diffraction, Raman spectroscopy, UV-visible spectroscopy, Electron microscopy and Scanning tunneling microscopy and their application in various engineering fields, and also provides motivation towards innovations.						
Unit – I	**Introduction to Characterization Techniques and X-Ray Diffraction:**						**9+3**
Importance of materials characterization – Classification of characterization techniques – Crystalline materials – Reciprocal lattice – Theory of X-ray diffraction – Powder and Single crystal X-ray diffraction: Instrumentation (qualitative), XRD pattern, systematic procedure for structure determination (qualitative), crystallite size determination (Scherrer equation), strain calculation – Applications.							
Unit – II	**Electron Microscopy:**						**9+3**
Need of electron microscopy – Electron specimen interaction: Emission of secondary electrons, backscattered electrons, characteristic X-rays, transmitted electrons, specimen interaction volume – Resolution – Scanning electron microscope and transmission electron microscope: Schematic diagram and working – Different types of filaments – Field emission scanning electron microscope –Wavelength dispersive X-ray analysis – Three parameter equation for quantitative composition analysis.							
Unit – III	**Scanning Tunneling Microscopy:**						**9+3**
Introduction to quantum mechanical tunneling – Basic principles of scanning tunneling microscopy – Two modes of scanning: constant height mode and constant voltage mode – Instrumentation and working – Applications.							
Unit – IV	**Raman Spectroscopy:**						**9+3**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation and working – Near-Infra-Red Raman Spectroscopy – Applications.							
Unit – V	**Ultra Violet &Visible Spectroscopy:**						**9+3**
Regions of UV-Visible radiation – Colour and light absorption – Chromophore concept – Beer's and Lambert's laws – Theory of electronic transition – Frank-Condon principle – Instrumentation and working – Applications.							
Lecture: 45, Tutorial: 15, Total: 60							

TEXT BOOK:

1.	Cullity B. D. and Stock S. R, Elements of X-ray diffraction, 3rd Edition, Pearson Education, India, 2003 (Unit I)
2.	Banwell C. N, McCash E. M, Choudhury H. K, Fundamentals of Molecular Spectroscopy, 5th Edition, Tata McGraw-Hill Publ., New Delhi, 2013 (Unit II-V)

REFERENCES:

1.	Holt D. B. and Joy D. C, SEM micro characterization of semiconductors, 1st Edition, Academic Press, New Delhi, 1989
2.	Willard H. H., Merritt L. L., John A Dean, and Settle Jr. F. A, Instrumental methods of Analysis 7th Edition, Wadsworth Publishing Company, United States, 1988
3.	Elton N. Kaufman, Characterization of Materials (Volume1 & 2), 2nd, Wiley-Interscience, New Jersey, 2012

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concept of X-ray diffraction to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO2	determine the micro-structural parameters of materials and to perform surface analysis of materials using the concept of matter waves and electron microscopy.	Applying (K3)
CO3	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image recorded at atomic level using scanning tunneling microscopy.	Applying (K3)
CO4	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO5	apply the theory of UV-Vis spectroscopy to comprehend the working of UV-Vis spectrophotometer.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	25	35	40				100
CAT3	30	30	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO04 – SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL APPLICATIONS OF NANOMATERIALS							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**
Preamble	This course aims to impart the knowledge on the fundamentals of nanomaterials, synthesis of nanomaterials, analysis of nanomaterials, carbon tubes and biological applications of nanomaterials.						
Unit – I	**Introduction to nanomaterials**						**9+3**
Nanoscience and nanotechnology – Scientific revolution – Nanoscale – Nanosized effects – Surface-to-volume ratio – Quantum confinement effect – Classification of nanomaterials based on dimension – Properties of nanomaterials – Metal nanoparticles – Ceramic nanoparticles – Semiconductor nanoparticles – Polymer nanomaterials.							
Unit – II	**Synthesis of nanomaterials**						**9+3**
Physical, chemical and mechanical methods of preparation – Top down approaches and bottom up approaches – Physical Vapor Deposition method – Colloidal precipitation method – Sol-Gel method – Chemical precipitation method – Green synthesis method of nanomaterials.							
Unit – III	**Characterization of nanomaterials**						**9+3**
X-ray diffraction analysis – Grain size calculation – Lattice parameters - Cell volume – Photoluminescence analysis – Emission peak analysis – UV visible spectroscopy analysis – Bandgap estimation – HRTEM & AFM analysis (qualitative) – particle size analysis – BET (qualitative).							
Unit – IV	**Carbon nanotubes**						**9+3**
Allotropes of carbon – Diamond – Graphite – Graphene – Fullerenes – Carbon nanotubes – Properties – SWCNT – MWCNT – Structure of Carbon nanotubes – Preparation: Laser ablation method – CVD – Applications.							
Unit – V	**Biological applications**						**9+3**
Antibacterial activity – Mechanism – Antifungal activity – Microorganism – Gram positive bacteria – Gram negative bacteria – Disc diffusion method – Antioxidant activity – DPPH method – Anticancer activity – Cytotoxity – MTT method –Toxicity of nanoparticles.							
Lecture: 45, Tutorial: 15, Total: 60							
TEXT BOOK:							
1.	Charles P Poole Jr., and Frank J. Ownes ,. “Introduction to Nanotechnology”, John Wiley Sons, Inc., 2003 (Unit I – V).						
REFERENCES:							
1.	C. Kittel., “Introduction to Solid State Physics”, Wiley Eastern Ltd., (2005).						
2.	Tamilarasan K. and Prabu K., “Materials Science”, 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the properties of nanomaterials using concepts such as surface to volume ratio and quantum confinement and also able to classify nanomaterials.	Applying (K3)
CO2	explain the synthesis of nanomaterials using select physical and chemical methods.	Applying (K3)
CO3	explain the characterization of nanomaterials using XRD, UV-vis, HRTEM & AFM and BET.	Applying (K3)
CO4	Illustrate the preparation of CNT and their applications.	Applying (K3)
CO5	explore the biological applications of nanomaterials such as antibacterial activity, antifungal activity, antioxidant activity and anticancer activity.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO05 - TECHNIQUES OF CRYSTAL GROWTH							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the knowledge on crystals, physics of crystal growth and crystal growth methods.	
Unit – I	**Introduction to Crystals**	**9+3**
Classification of solids – Crystalline and amorphous – Single and polycrystalline materials – Space lattice – Bravais lattice – Lattice planes – Miller indices – Indices of crystal direction – Symmetry – Symmetry elements in cubic crystal – Physical properties.		
Unit – II	**Theories of Crystal Growth**	**9+3**
Phase rule – Phase diagrams – Binary phase diagrams – Alloy and compounds – Binary system with complete solid solution and no solid solution (eutectic) – Invariant reactions – Eutectic, peritectic and peritectoid (qualitative) – Nucleation concept – Homogeneous, heterogeneous nucleation – Classical theory – Energy of formation of nucleus – Kinetic theory of nucleation (qualitative) – Atmospheric nucleation.		
Unit – III	**Melt growth**	**9+3**
Bulk crystal growth methods – Melt growth methods – Bridgman (vertical and horizontal) and Czochralski methods – Liquid encapsulated technique (LEC) for semiconductors – Vermeil growth technique for growing gem crystals – Zone melting.		
Unit – IV	**Solution growth**	**9+3**
Low temperature solution growth – High temperature solution growth – Electro crystallization – Crystal growth in gel – Growth of biological crystals – Hydrothermal technique.		
Unit – V	**Vapour growth**	**9+3**
Physical vapour transport – chemical vapour transport. Epitaxial growth techniques – Liquid phase epitaxy – Vapour phase epitaxy: chloride, hydride, metalorganic – Molecular beam epitaxy – Chemical beam epitaxy.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Boardman A. D., O'Conner D. E. and Young D. A., Symmetry and its Applications in Science, London McGraw Hill, 1973. (Unit I – V)
2.	Introduction to Crystallography Philips, Read Books (9 June 2011), India. (Unit I – V)

REFERENCES:

1.	B. D. Cullity Addison, Elements of X-ray diffraction, Wesley Publishers, 1977.
2.	Santhana Raghavan and Dr. P. Ramasamy, Crystal growth processes and methods, KRU publications, 1999.
3.	Leonid V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company.
4.	C. Kittel Wiley, Introduction to Solid State Physics, Eastern University Edition.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the physical properties of crystals using the concepts of crystalline materials, amorphous material, space lattice, unit cell, Miller indices and crystal symmetry.	Applying (K3)
CO2	explain nucleation in crystal growth using the concepts of phase diagrams and formation energy.	Applying (K3)
CO3	demonstrate the growth of bulk crystals using melt growth techniques.	Applying (K3)
CO4	demonstrate the growth of crystals using solution growth techniques.	Applying (K3)
CO5	comprehend the growth of epitaxy crystal using vapour growth techniques.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22CYO01 - INSTRUMENTAL METHODS OF ANALYSIS

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	Instrumental methods of analysis aim to prepare the students to have all-encompassing knowledge of spectral methods in order to identify the molecules and reaction mechanism for the process to enhance application towards the industries.

Unit – I	**Absorption and Emission Spectroscopy**	**9+3**

Basic concepts of Absorption and Emission Spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of Atomic Absorption, Atomic Fluorescence and Atomic Emission Spectroscopy.

Unit – II	**IR, Raman and NMR Spectroscopy**	**9+3**

Infrared Spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis.
Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis.
Nuclear Magnetic resonance Spectroscopy – basic principles – pulsed Fourier transform NMR spectrometer – Structural elucidation using NMR spectra and quantitative analysis.

Unit – III	**Surface Studies**	**9+3**

Surface Study – X-Ray Emission Spectroscopy (XES), X- Ray Photo Electron Spectroscopy (XPS) - Auger Electron Spectroscopy (AES) - Transmission Electron Microscopy (TEM) - Scanning Electron Microscopy (SEM) - Surface Tunneling Microscopy (STEM) - Atomic Force Microscopy (AFM).

Unit – IV	**Mass Spectroscopy**	**9+3**

Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems - correlation of molecular spectra with molecular structure - Instrumentation design and application of Fourier Transform Mass Spectroscopy (FT-MS) and Ion Microprobe Mass Analyzer (IMMA).

Unit - V	**Thermal Analysis**	**9+3**

Thermal Analysis: principles and instrumentations and applications of Thermogravimetry (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, Thermo Mechanical Analysis and Thermometric Titration.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Chatwal. G. R., Anand, Sham K., “Instrumental Methods of Chemical Analysis” 5th Edition, Himalaya Publishing House, 2019.

REFERENCES:

1.	B.K. Sharma, Instrumental Method of Chemical Analysis, Krishna Prakashan Media (P) Ltd. 2019.
2.	Willard,H.H, Merritt,L.L, Dean,J.A, and Settle, F.A, “Instrumental methods of analysis” CBS Publishers & Distributors, 7 Ed, 2004.
3.	Kaur. H, “Instrumental Methods of Chemical Analysis”, XII Edition, Pragati prakashan, Meerat, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the basics of spectroscopy to understand the instrumentation of various spectral techniques.	Understanding (K2)
CO2	apply the IR, Raman and NMR for quantitative analysis of the sample.	Applying (K3)
CO3	apply the various techniques for the better understanding of surface morphology.	Applying (K3)
CO4	explain the principle, instrumentation of mass spectroscopy for the analysis of organic sample.	Understanding (K2)
CO5	illustrate the thermal analysis for the identification of thermal stability of the compounds.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO02 - CHEMISTRY CONCEPTS FOR COMPETITIVE EXAMINATIONS

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims to refresh the knowledge of chemistry required for competitive examinations and equip the students with a capacity to solve the problems in chemistry while participating various competitive examinations including TNFUSRC-FORESTER (paper-II: General science-chemistry), UPSC-IAS (prelims: General science-chemistry), GATE (thermodynamics concept for chemical & mechanical engineering).

Unit – I	**Periodic Classification of Elements**	**9+3**

Mendeleev's periodic table-Law and classification of elements- Modern periodic law-Modern periodic table and its characteristics - Periodic properties – important aspects of s, p & d block elements -Reactivity series and Uses - Alloys-Uses of Alloys- Properties of nano metals and oxides.

Unit – II	**Chemical Equations and Bonding**	**9+3**

Chemical Equations: Types of ions and radicals- oxidation and reduction-redox reactions - balancing ionic equations.
Chemical Bonding: Octet rule -types of chemical bond -formation of ionic and covalent bond- common properties of ionic and covalent compounds- differences between ionic and covalent compounds-Coordinate covalent bond- Coordination compounds – nomenclature and isomerism - application in analytical chemistry.

Unit – III	**Acids, Bases, Salts and Metallurgy**	**9+3**

Acid- base theory – Bronsted- Lowry theory- conjugate acid-base- Lewis concept- HSAB- applications- pH scale- Importance of pH in everyday life-salts-classification of salts-uses of salts.
Metallurgy: introduction-terminologies in metallurgy-differences between minerals and ores-occurrence of metals- metallurgy of aluminum, copper and iron.

Unit – IV	**Carbon and its Compounds**	**9+3**

Introduction-compounds of carbon-modern definition of organic chemistry- bonding in carbon and its compounds-allotropy-physical nature of carbon and its compounds-chemical properties of carbon compounds-homologous series-hydrocarbons and their types-functional groups- classification of organic compounds based on functional group-ethanol-ethanoic acid.

Unit – V	**Thermodynamics**	**9+3**

Introduction- some important terms in thermodynamics-thermodynamic system, process, properties and energy- first law of thermodynamics: mathematical expression and interpretation- applications of first law of thermodynamics-molar heat capacity-reversible isothermal expansion/compression of an ideal gas-adiabatic expansion of an ideal gas-isobaric and isochoric processes in ideal gases- second laws of thermodynamics: entropy- entropy change for isolated system (system and surroundings)- entropy change for system only (ideal gas)- entropy change for mixing of ideal gases-entropy of physical changes- entropy of chemical changes-Maxwell relations.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Steven S. Zumdahl, Susan A. Zumdahl and Donald J. DeCoste , "Chemistry", 10th Edition, Cengage Learning, 2018., for Units-I, II, III, IV.
2.	Wiley editorial board. "Wiley Engineering Chemistry". 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019, for Units-I, II, III, V.

REFERENCES:

1.	B.R. Puri, L.R. Sharma, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., 2020.
2.	Paula Bruise, "Organic Chemistry", 8th Edition, Pearson Education, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the basic concept of periodic classification of elements to explain the periodic properties and reactivity series of s, p & d block elements.	Applying (K3)
CO2	utilize the concepts of chemical equation and bonding to solve the problems in balancing ionic equation and differentiate ionic and covalent compounds.	Applying (K3)
CO3	apply the concept of acid, base, salts and metallurgy to explain HSAB concepts, Importance of pH in everyday life, classification of salts and metallurgy of Al, Cu & Fe.	Applying (K3)
CO4	make use of the concept of carbon and its compounds to explain bonding and classification of carbon compounds.	Applying (K3)
CO5	utilize the important terms and concepts of thermodynamics to explain the first law and second law of thermodynamics with examples.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100
* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)							

22CYO03 – ORGANIC CHEMISTRY FOR INDUSTRY							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Organic Chemistry for Industry aims to equip the students to have wide-range knowledge on organic chemistry in order to meet the industrial needs.

Unit – I	**Basic aspects of Organic Chemistry**	**9+3**

Organic intermediates: carbocations, carbanions, free radicals, carbenes and nitrenes, their method of formation, stability and synthetic applications- Nucleophilic uni- and bimolecular reactions (SN1 and SN2)- Elimination reactions (E1 & E2; Hoffman & Saytzeff's rule).

Unit – II	**Molecular Rearrangements**	**9+3**

Reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements - Migration of carbon: Wagner-Meerwein, Pinacol-pinacolone, benzyl-benzilic acid rearrangement – Migration of nitrogen: Beckmann rearrangement, Hofmann, Curtius, Lossen rearrangements- Migration of oxygen: Bayer-Villiger oxidation.

Unit – III	**Synthetic Reagents & Applications**	**9+3**

Lithium aluminium hydride- sodium borohydride- selenium-di-oxide- osmium tetroxide- phenyl isothiocyanate- N-bromosuccinamide (NBS)- lead tetraacetate - dicyclohexylcarbodiimide (DCC) – pyridinium chlorochromate (PCC) – Swern oxidation –p-toluenesulphonyl chloride – trifluoroacetic acid- lithium diisopropylamide (LDA) – 1,3- dithiane (reactive umpolung) - crown ethers- Trimethyl silyl iodide - dichlorodicyanobenzoquinone (DDQ) – Gilman reagent– phase transfer catalysts- Wilkinson's catalysts.

Unit – IV	**Unit Operations**	**9+3**

Extraction: Liquid equilibria-extraction with reflux-extraction with agitation-counter current extraction. **Filtration:** Theory of filtration- pressure and vacuum filtration-centrifugal filtration.
Distillation: Azeotropic and steam distillation. **Evaporation**: Types of evaporators-factors affecting evaporation. **Crystallization:** Crystallization from aqueous-non- aqueous solutions factors affecting crystallization-nucleation.

Unit – V	**Unit Processes**	**9+3**

Nitration: Nitrating agents-aromatic nitration-kinetics and mechanism of aromatic nitration- process equipment for technical nitration-mixed acid for nitration.
Halogenation: Kinetics of halogenations-types of halogenations-catalytic halogenations-Case study on industrial halogenation process.
Fermentation: Aerobic and anaerobic fermentation. Production of Antibiotics: Penicillin and Streptomycin-Production of Vitamins: B2 and B12.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	P.S.Kalsi," Organic Reactions and their Mechanisms", 5th Edition, New Age International publishers, 2020, for Unit-I, II, III, V.
2.	Arun Bahl, B.S.Bahl, "Advanced Organic Chemistry", 6th Edition, S Chand, 2022, for Unit-IV, V.

REFERENCES:

1.	V.K.Ahluwalia, Rakesh Parashar, "Organic Reaction Mechanisms" Fourth Edition, 2011
2.	Jonathan Clayden, Nick Greeves, Stuart Warren, "Organic Chemistry", 2nd Edition, Oxford University Press, 2014.
3.	Paula Yurkanis Bruice, "Organic Chemistry",8th Edition, Pearson, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the basic concept of organic intermediates to explain the SN1, SN2, E1 and E2 reactions.	Understanding (K2)
CO2	utilize the concepts of molecular rearrangement to explain reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements.	Applying (K3)
CO3	select the suitable synthetic regents for various functional group conversions in organic synthesis.	Applying (K3)
CO4	make use of the concept of extraction, filtration, distillation, evaporation, crystallization for the purification of organic compounds.	Applying (K3)
CO5	apply the concept of nitration, halogenations and fermentation to explain the industrial unit process.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO04 - CORROSION SCIENCE AND ENGINEERING							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	Corrosion science and engineering aims to equip the students to have a wide-range of knowledge on corrosion and prevention methods in order to meet the industrial needs.	
Unit – I	**Corrosion and its Units**	**9+3**
Introduction- electro chemical mechanism Vs chemical mechanism - emf series and Galvanic series – galvanic corrosion – area effect in anodic and cathodic metal coatings – prediction using emf series and galvanic series - Pilling Bedworth's ratio and it consequences (Problems) – units of corrosion rate: mdd (milligrams per square decimeter per day), mmpy (millie miles per year) and mpy (mils per year) –- importance of corrosion prevention in various industries: direct and indirect effects of determining corrosion rates - weight loss method, weight gain method and chemical analysis of solution.		
Unit – II	**Thermodynamics of Corrosion**	**9+3**
Electrode potentials, Electrical double layer, Gouy−Chapman model, Stern model, Bockris – Devanathan−Müller model - free energy and oxidation potential - criterion of corrosion (Problems) - basis of Pourbaix Diagrams - Pourbaix diagrams of water, magnesium, aluminium and Iron - limitations.		
Unit – III	**Kinetics of Corrosion**	**9+3**
Electrochemical polarization – Evan's diagram – activation polarization – concentration polarization - mixed potential theory(Wagner and Traud) – application of mixed potential theory – effect of metal in acid solution – cathodic protection of iron in acid solution – effect of cathodic reaction – effect of cathodic area – passivity – Flade potential – theories of passivity - adsorption theory – oxide film theory – film sequence theory.		
Unit – IV	**Types of Corrosion**	**9+3**
Introduction - (i) Crevice - differential aeration corrosion (ii) pitting – mechanism and factors (iii) intergranular- chromium depletion theory, weld decay and knife line attack (iv) stress - SCC mechanism and fatique- Cavitation damage – fretting damage (v) stray current corrosion - causes and its control.		
Unit - V	**Prevention of Corrosion**	**9+3**
Inhibitors – types of inhibitors, chemisorption of inhibitors, effect of concentration, effect of molecular structure, vapour phase inhibitors – prevention of corrosion at the design stage and in service conditions – control of catastrophic oxidation and hydrogen disease – Langelier saturation index and its uses - corrosion prevention by surface coatings – phosphating and its uses -principles and procedures of cathodic protection: sacrificial anodes and external cathodic current impression- painting, vitreous enamels, plastic lining.		
Lecture: 45, Tutorial: 15, Total: 60		

TEXT BOOK:

1. E. McCafferty, Introduction to Corrosion Science, 2nd Edition, Springer, 2017.

REFERENCES:

1. R. Winston, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, Revised 4th Edition, Wiley publisher, 2008.
2. Fontanna, "Corrosion Engineering", (Materials Science and Metallurgy series), McGraw Hill international Ed., 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the mechanism, expression of rate of corrosion and importance of corrosion studies to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the thermodynamics and kinetics of different models of corrosion with respect to the environment.	Applying (K3)
CO3	utilize the theories of corrosion to interpret with the real time applications.	Applying (K3)
CO4	organize the various types of corrosion to understand the corrosion problems.	Applying (K3)
CO5	summarize the corrosion prevention methods to avoid corrosion related issues.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO05 - CHEMISTRY OF COSMETICS IN DAILY LIFE							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to provide knowledge on chemistry of cosmetics for engineering students.

Unit 1	**Formulation of Cosmetic Product**	**9+3**

Introduction - basic sciences of cleansing – surfactant and adsorption, surfactant micelles, surfactants and cleansing, surfactants and foam (foam formation, stability, drainage, rupture and collapse and defoaming) - basics of dispersions - electrical charges associated with surfaces and barriers – basics of emulsion (stability, Ostwald ripening, prevention of creaming and sedimentation).

Unit 2	**Structuring Materials and Regulation for Cosmetics**	**9+3**

Introduction - water/hydrophilic base materials, oleaginous/hydrophobic base materials and amphiphilic substances - adding functions and effects - materials that add or improve functional value, emotional value and materials for quality control – cosmetic and personal care product safety – potential contaminants in cosmetics – regulations related to cosmetics – cosmetic regulation in india - future challenges in cosmetics material development.

Unit 3	**Polymers in Cosmetic Products**	**9+3**

Polymers in Cosmetics - polymer solubility and compatibility, polymer conformation - polymers that modify surfaces - film-forming polymers in cosmetics and personal care products - hair-conditioning polymers - polymers for the treatment of skin - polymers as controlled release matrices - dendritic polymers - polymeric antimicrobials and bacteriostats.

Unit 4	**Natural Products and Fragrance in Cosmetics**	**9+3**

Introduction – natural products – extraction methods - encapsulation and controlled release - allergens in cosmetics – testing for allergens - aroma chemicals - fragrance creation and duplication - fragrance applications -– malodor – fragrance allergies and sensitivities.

Unit 5	**Preparation of Cosmetics**	**9+3**

Cosmetics in day to day life – characteristics, types, formulation, preparation and evaluation methods of lipstick, shampoo, powder, nail lacquer, creams, toothpaste and hair dye.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Kazutami Sakamoto, Robert Y. Lochhead, Howard I. Maibach, Yuji Yamashita, Cosmetic Science and Technology: Theoretical Principles and Applications, Elsevier, 2017 , for Units- I, II, III, IV, V.
2.	Gaurav Kumar Sharma, Jayesh Gadiya, Meenakshi Dhanawat A text book of cosmetic formulation, 2018, for Unit-V.

REFERENCES:

1.	R.K. Nema, K.S. Rathore , B.K. Dubey, Textbook of Cosmetics, CBS Publishers and Distributors, 2017.
2.	Bruno Burlando, Elisa Bottini-Massa, LuisellaVerotta, Laura Cornara, Herbal Principles in Cosmetics: Properties and Mechanisms of Action, CRC Press, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the formulation of cosmetics products.	Understanding (K2)
CO2	identify the structuring materials and regulation involved in cosmetics development.	Applying (K3)
CO3	interpret the polymers and its role in cosmetics.	Understanding (K2)
CO4	develop knowledge about natural products and Fragrance in Cosmetics.	Applying (K3)
CO5	apply the knowledge of cosmetics to explain the characteristics, formulation, preparation and quality control of different cosmetic products used in day to day life.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO06 – NANOCOMPOSITE MATERIALS							
Programme& Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**
Preamble	This course aims to equip the students to have knowledge on processing, characterization, properties, features and applications of nanocomposites.						
Unit – I	**Introduction of nanocomposites**						**9+3**
Introduction – nanocomposites – nanocomposites past and present – nomenclature – composite materials: introduction to solids - atomic and molecular solids – role of statistics in materials – primary, secondary and tertiary structure – transitions.							
Unit - II	**Properties and features of nanocomposites**						**9+3**
Properties: physics of modulus – continuum measurements – yield – fracture – rubbery elasticity and viscoelasticity – composites and nanocomposites – surface mechanical properties –diffusion and permeability – features of nanocomposites: basics of polymer nanocomposites - nano reinforcements – matrix materials – hazards of particles.							
Unit - III	**Processing of nanocomposites**						**9+3**
Viscosity: types of flow, experimental viscosity, non-newtonian flow -low-viscosity processing: solvent processing, particle behavior, in situ polymerization, post-forming, hazards of solvent processing - melt, high shear and direct processing: melting and softening, melt processes with small shears or low-shear rates flow, meltprocesses with large deformations or high-shear rates, thermo-kinetic processes.							
Unit - IV	**Characterization of nanocomposites**						**9+3**
Introduction to characterization – experiment design – sample preparation – imaging –structural characterization – scales in nanocomposites – texture – electromagnetic energy –visualization – physicochemical analysis – characterization of physical properties.							
Unit - V	**Applications of nanocomposites**						**9+3**
Nanocomposites – optical, structural applications – nanoparticulate systems with organic matrices – applications – biodegradable protein nanocomposites – applications-polypropylene nanocomposites – application as exterior automatic components – hybrid nanocomposite materials – application for corrosion protection.							
Lecture: 45, Tutorial: 15, Total: 60							

TEXT BOOK:

1.	Thomas E. Twardowski, “Introduction to Nanocomposite Materials – Properties, Processing, Characterization”, DesTech Publications, April 2007, for Units-I, II, III, IV.
2.	Klaus Friedrich, Stoyko Fakivov, Zhony Shang, “Polymer Composites from Nano – to Macro – scale”, Springer USA, 2005, for Units-I, II, V.

REFERENCES:

1.	Pulickel M. A, Linda S. S, Paul V.B, “Nanocomposite Science and Technology”, Wiley-VCH, 2006.
2.	Vikas Mittal, Characterization techniques for polymer nonocomposites, Wiley-VCH, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the knowledge of nanocomposites and to explain its structure.	Applying (K3)
CO2	apply the knowledge on various properties and features of nanocomposites.	Applying (K3)
CO3	choose the various concepts involving in the processing of nanocomposites.	Applying (K3)
CO4	apply the acquired knowledge on characterization of nanocomposites.	Applying (K3)
CO5	organize the applications of nanocomposites in various fields.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO07 - WASTE AND HAZARDOUS WASTE MANAGEMENT							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range of knowledge on waste management.	
Unit – I	**Solid Waste Management**	**9**
Solid wastes: definition, sources, types, composition of solid waste- Solid waste management system: collection, separation, processing and transformation of solid waste – combustion, aerobic composting, vermicomposting, pyrolysis, landfill-classification, types, methods and control of leachate in landfills - recycling of material found in municipal solid waste- recycling of paper and cardboard, recycling of plastics, recycling of glass.		
Unit – II	**Hazardous Waste Management**	**9**
Hazardous wastes: definition, nature and sources of hazardous waste, classification and characteristics of hazardous waste- chemical class of hazardous waste, generation, segregation, treatment and disposal: waste reduction, waste minimization, recycling - chemical treatment: acid base neutralization, chemical precipitation, oxidation/reduction, hydrolysis, electrolysis, chemical extraction and leaching, ion exchange, photolytic reaction- thermal treatment methods: incineration – biodegradation of hazardous waste: aerobic, anaerobic, reductive dehalogenations - land treatment and composting.		
Unit – III	**E- Waste & Biomedical Waste Management**	**9**
E-Waste Management: definition, sources, classification, collection, segregation, treatment and disposal. **Biomedical Waste Management :** Introduction-definition –components of biomedical waste-waste generation –waste identification and waste control-waste storage-labeling and color coding-handling and transportation-waste treatment and disposal- autoclave, hydroclave , microwave treatments- chemical disinfection – sanitary and secure landfill.		
Unit – IV	**Pollution From Major Industries And Management**	**9**
Introduction- sources and characteristics - waste treatment flow sheets for selected industries such as textiles, tanneries, pharmaceuticals, sugar, petroleum refinery, fertilizer and dairy industries.		
Unit – V	**Solid Waste Management and Legislation**	**9**
Solid waste management plan - solid waste (management and handling) rules - biomedical waste (management and handling) rules- plastic waste management rules - e-waste management rules - hazardous and other wastes (management and transboundary movement) rules - construction and demolition waste management rules.		
		Total: 45

TEXT BOOK:

1. George Tchobanoglous, Hillary Theisen, Samuel a Vigil, Integrated solid waste management (Engineering principle and management issues) McGraw hill Education (India) Pvt. Ltd., 2015, for Unit-I, II, V.
2. SC Bhatia, Handbook of Industrial pollution and control (Volume-1), CBS Publisher and Distributers, New Delhi, 2002, for Unit-II, III, IV, V.

REFERENCES:

1. Manual on Municipal Solid Waste management, Central public Health and Environmental Engineering Organization (CPHEEO), Govt. of India, May 2000.
2. Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans, Hazardous waste management, MEDTEC, 2015.
3. Majeti Narasimha Vara Prasad, Meththika Vithanage, Anwesha Borthakur, “Handbook of Electronic Waste Management: International Best Practices and Case Studies” 1st Edition, Butterworth-Heinemann, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the technical points that are required to set up a solid waste management system.	Applying (K3)
CO2	explain the various disposal and treatment methods of hazardous wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical waste.	Applying (K3)
CO4	identify the hazards from various industries and apply the waste management techniques for its treatment.	Applying (K3)
CO5	relate the legal legislation to solid waste management.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO08 - CHEMISTRY IN EVERY DAY LIFE

Programme& Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	This course aims to prepare the students to have the knowledge on oils, fats, sugar, adulterants in food, creams, milk powder, soil, fertilizer, pesticides, insecticides, fungicides and herbicides in order to know its chemistry in our everyday activities.

Unit – I	**Oils, Fats and Sugar**	**9**

Distinction between oils and fats – properties – classification – edible oils – vegetable oils –animal oils – manufacture of oils by solvent extraction – refining of crude vegetable oils – processing of animal fats – manufacture of cane sugar – manufacture of sucrose from beet root.

Unit – II	**Adulterants in food**	**9**

Food Adulteration and prevention – common food adulterants – food additives – food colorants– preservatives – flavourants – food poisoning – analysis of adulterants in edible oils, coffee powder, chilli powder, turmeric powder, meat , fish, ghee and milk – harmful effects of food adulterants

Unit – III	**Creams and Milk powder**	**9**

Creams: Composition-chemistry of creaming process- Factors influencing cream separation (Mention the factors only) - Estimation of fat in cream - Milk powder: Need for making powder-drying process- spraying, drum drying, jet drying and foam drying-principles involved in each.

Unit – IV	**Soil and Fertilizers**	**9**

Soil analysis: Composition of soil - Organic and Inorganic constituents-Soil acidity - buffering capacity of soils -Liming of soil - Fertilizers: primary nutrients –role of Nitrogen, potassium and phosphorous on plant growth –Complex fertilizers and mixed fertilizers and its composition - Secondary nutrients – micronutrients and their functions in plants -optimal addition of Fertilizers to obtain estimated yield.

Unit – V	**Pesticides, Insecticides, Fungicides and Herbicides**	**9**

Pesticides – Classification – general methods of application and toxicity, Safety measures when using pesticides-Insecticides: Inorganic pesticides – borates - Organic pesticides – D.D.T. and BHC-Plant derivatives: pyrethrin and Nicotine - Synthetic organic pesticides: Endrin and Aldrin (Chemical name - Structure- functions and uses)-Fungicides: Inorganic (Bordeaux mixture) and organic (dithiocarbamate) fungicides - Industrial fungicides: Creosote fractions - Herbicides: Selective and non-selective - 2, 4-dicholorophenoxyacetic acid and 2,4,5-tricholorophenoxyaceticacid (structure and function).

Total: 45

TEXT BOOK:

1. Sharma B K , Industrial Chemistry, Goel publishing house, New Delhi, 2011, for Units- I, II, IV
2. Alex V Ramani, Food Chemistry, MJP Publishers, Chennai, 2009, for Units -II, III, V.

REFERENCES:

1. Dilip Kumar Das, Introductory Soil Science, 1st Edition, Kalyani Publishers, Reprint 2002.
2. K. Bagavathi Sundari– “Applied Chemistry”, MJP Publishers, Chennai, 2006.
3. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern limited, New Delhi, 1993.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the importance of oils, fats and sugar.	Understanding (K2)
CO2	identify the harmful effects of adulterants in food.	Applying (K3)
CO3	develop the knowledge on creams and milk powder.	Applying (K3)
CO4	interpret the nature and composition of soil and fertilizers.	Understanding (K2)
CO5	illustrate the difference of pesticides, insecticides, fungicides and herbicides.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO09 - CHEMISTRY OF NUTRITION FOR WOMEN HEALTH							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course aims to provide knowledge for engineering students on components of health, fitness and also the role of nutrition for women health.

Unit 1	**Nutrition**	**9**

Energy- functions, sources and concept of energy balance - recommended dietary allowances, dietary sources - effects of deficiency and/ or excess consumption on health of the following nutrients: carbohydrates and dietary fibre – lipids – proteins - fat soluble vitamins: A, D,E and K - water soluble vitamins: Thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C – minerals: calcium, iron, zinc and iodine.

Unit 2	**Women Health**	**9**

Disease pattern and reproductive health- menopause – hypothyroid- PCOD-diabetes - policies and programs for promoting maternal and child nutrition and health - concept of small family - methods of family planning - merits and demerits.

Unit 3	**Nutrition for Nursing Mother and Infants**	**9**

Physiology and psychology of lactation, hormonal control, composition of colostrums and breast milk, nutritional requirements of a nursing mother, advantages of breast feeding, food and nutritional requirements for infants, weaning and supplementary foods for infants and immunization.

Unit 4	**Nutrition for Physical Fitness**	**9**

Significance of physical fitness and nutrition in the prevention and management of weight control, obesity, diabetes mellitus, CV disorders, bone health and cancer - nutrition and exercise regimes for pre and postnatal fitness - nutritional and exercise regimes for management of obesity - critical review of various dietary regimes for weight and fat reduction - prevention of weight cycling.

Unit 5	**Role of Women in National Development**	**9**

Women in family and community: Demographic changes menarche, marriage, fertility, morbidity, mortality, life expectancy, sex ratio, aging, widowhood. Women in society: Women's role, their resources, and contribution to family, and effect of nutritional status.

Total: 45

TEXT BOOK:

1.	Srilakshmi, B., Nutrition Science, New Age International (P) Ltd., New Delhi, 2017, for Units- I, IV, V.
2.	Arpita Verma, Women's Health and Nutrition: Role of State and Voluntary Organizations, Rawat Publishers, 2017, for Units - II, III, IV.

REFERENCES:

1.	Shubhangini A Joshi , Nutrition and Dietetics, TataMacGraw Hill, 2010.
2.	Rujuta Diwekar, Women and The Weight Loss Tamasha, Westland ltd, 2010.
3.	Swaminathan, M., Advanced Textbook on Food and Nutrition, Vol. 1, Second Edition, Bangalore Printing and Publishing Co. Ltd., Bangalore, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the knowledge of dietary sources in day to day life.	Applying (K3)
CO2	explain the disease pattern and policies towards women health.	Understanding (K2)
CO3	develop knowledge about nutrition during lactation and for infants.	Applying (K3)
CO4	utilize the knowledge of physical fitness and nutrition towards good health.	Applying (K3)
CO5	interpret the various role of women in society.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22GEO01 - GERMAN LANGUAGE LEVEL 1							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course serves as an introduction to the German language and awareness towards German lifestyle and cultural aspects of Germany and German speaking countries. One can learn to introduce oneself and able to gain the basic day to day vocabulary. On keen learning one would be able to understand the sentence structure and be able to reciprocate to basic questions	
Unit – I	**Good Day (Guten Tag)**	**9**
Greetings, Self-introduction and introducing others, Numbers, Alphabets, Countries and languages spoken. Grammar – W questions, Simple sentences, Verb conjugation and personal pronoun.		
Unit – II	**Friends & Colleague (Freund und Kollegen):**	**9**
Hobbies, Profession, Week, Months, Season and Generate Profile. Grammar – Articles, Plural, Verbs – have and to be, Yes/No questions.		
Unit – III	**n the City (In der Stadt):**	**9**
Name of places/buildings in the city, asking for directions, Understanding means of transport. Grammar – definite and indefinite articles, Negation articles and Imperative		
Unit – IV	**Food and Appointment (Essen und Termin):**	**9**
Food, Shopping, initiate conversations to understand and do shopping. Grammar – Accusative case, Verbs with Accusative. Understanding time and reciprocating, Appointments, Asking excuse, Family. Grammar – Prepositions: *am, um, von...bis,* Possessive articles- *mein, dein*.., Modal verbs- *müssen, können, wollen*		
Unit – V	**Socializing (Zeit mit Freunden):**	**9**
Planning together, Birthday, Invitation, Restaurant, looking for specific information in texts. Grammar – Separable verbs, Prepositions with Accusative case, Past tense of have and to be, Personal pronoun with Accusative.		
		Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2.	https://www.dw.com/en/learn-german - Deutsche Welle, Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand structure of language and introducing each other	Remembering (K1)
CO2	understand vocabulary on seasons and basic verbs	Understanding (K2)
CO3	ask for directions in a new place and avail transport as required	Understanding (K2)
CO4	understand food habits of German and ask for appointments.	Understanding (K2)
CO5	learn to socialize in a German speaking country	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO02 - JAPANESE LANGUAGE LEVEL 1							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 55 Kanjis also enables one to greet, introduce oneself and other person and also provides the ability to understand basic day to day conversations	
Unit – I	**Introduction to Hiragana and Katakana:**	**9**
Chart 1, Chart 2, Chart 3, Annexures 1 and 2 and basic Japanese rules along with similar sounded vocabularies for each chart.		
Unit – II	**Introduction to Nouns, various particles and usages:**	**9**
Forming simple sentences, asking questions, positioning differentiation and owning fundamentals – new particles and usages		
Unit – III	**Introduction of Verbs, time and place markers:**	**9**
Usage of action words in sentences and framing them – place and time markers usages – giving and receiving – omission of certain particles in a sentence.		
Unit – IV	**Introduction of Adjectives, Adverbs and usages:**	**9**
Describing nouns and verbs and framing them to relate day to day conversations- positive and negative ending of the same – introduction of the likes and dislikes expressions		
Unit – V	**Introduction to Counters and Kanji:**	**9**
How to use numbers-How to use quantifiers-Present form of adjectives and Nouns-Other necessary particles-How to use numbers and quantifiers – 55 kanji characters		
		Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and understand typical expression in Hiragana and Katakana	Remembering (K1)
CO2	greet and introduce oneself and other	Understanding (K2)
CO3	communicate day to day conversations – basic level	Understanding (K2)
CO4	understand the Kanjis in Japanese Script	Understanding (K2)
CO5	comprehend concept of numbers, days, months, time and counters	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO03 - DESIGN THINKING FOR ENGINEERS							
Programme & Branch	**All BE/BTech Branches except CSE, CSD & AI**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Design Thinking is human-centered problem-solving tool which emphasize on empathy, collaboration, co-creation and stakeholder feedback to unlock creativity and innovation, to devises feasible and viable idea/solutions.	
Unit – I	**Design Thinking and Explore:**	**9+3**
Design Thinking: Key Principles and Mindset – Five Phases, Methods and Tools of Design Thinking – User Guide – Foundation Building for Design Thinking – **Explore:** Methods & Tools – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit – II	**Empathize:**	**9+3**
Empathize: Methods & Tools – Field Observation – Deep User Interview – Empathy Map – User Journey Map - Need Finding – User Insights - User Persona Development.		
Unit – III	**Experiment:**	**9+3**
Experiment: Methods & Tools – Ideation – SCAMPER – Analogous Inspiration – Deconstruct & Reconstruct – User Experience Journey – Prototyping– Idea Refinement.		
Unit – IV	**Engage:**	**9+3**
Engage: Methods & Tools – Story Telling – Art of Story Telling – Storyboarding – Co-Creation with Users – Collect Feedback from Users.		
Unit – V	**Evolve:**	**9+3**
Evolve: Methods & Tools – Concept Synthesis – Strategic Requirements –Evolved Activity Systems – Activity System Integration – Viability Analysis – Innovation Tools using User Needs, CAP, 4S – Change Management - Quick Wins.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017. (E-Book)

REFERENCES:

1.	Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.
2.	Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "The Designing for Growth FieldBook: A Step-by-Step Project Guide", Columbia University Press, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Construct design challenge and reframe the design challenge into design opportunity.	Applying (K3)
CO2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.	Applying (K3)
CO3	Develop ideas and prototypes by brain storming using the ideation tools.	Applying (K3)
CO4	Organize the user walkthrough experience using ideal user experience journey.	Applying (K3)
CO5	Develop smart strategies & implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9+3**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
Unit - II	**User Study and Contextual Enquiry:**	**9+3**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs –organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
Unit - III	**Product Design:**	**9+3**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
Unit - IV	**Business Model Canvas (BMC):**	**9+3**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
Unit - V	**IPR and Commercialization:**	**9+3**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Rishikesha T.Krishnan, “8 Steps To Innovation: Going From Jugaad To Excellence”, Collins India, 2013.

REFERENCES:

1. Peter Drucker, “Innovation and Entrepreneurship”, Routledge CRC Press, London, 2014.
2. Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 7th edition, McGraw-Hill Higher Education, 2020.
3. Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st edition, John Wiley and Sons; 2010
4. Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand innovation need and design thinking phases	Understanding (K2)
CO2	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)
CO3	develop and analyse the product concepts based on the customer needs and presents the overall architecture of the product.	Analysing (K4)
CO4	predict a structured business model for MVP	Applying (K3)
CO5	practice the procedures for protection of their ideas’ IPR	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	40	10			100
CAT2	20	30	40	20			100
CAT3	30	30	40				100
ESE	20	30	30	20			100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO05-GERMAN LANGUAGE LEVEL 2							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	German Language Level 1	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the learner to acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations	
Unit – I	**Contacts(Kontakte):**	**9**
Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.		
Unit – II	**Accomodation(Die Wohnung):**	**9**
Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with *sehr/zu*, Adjective with Accusative, prepositions with Dative		
Unit – III	**Are you Working?(Arbeiten Sie):**	**9**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – *und, oder, aber*		
Unit – IV	**Clothes and Style(Kleidung und mode):**	**9**
Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative		
Unit – V	**Health and Vacation(Gesundheit und Urlaub):**	**9**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nicht dürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: *man*, Question words – *Wer, Wen, Was, Wem*, Adverbs – *Zuerst, dann, Später, Zum Schl*		
		Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs", Goyal Publishers, Delhi, 2015.
2.	

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand letters and simple texts	Remembering (K1)
CO2	assimilate vocabulary on Accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understand how to do shopping in a German store	Understanding (K2)
CO5	understand body parts and how to plan personal travel	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		

CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO06-GERMAN LANGUAGE LEVEL 3							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	German Language Level 2	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations.
Unit – I	**All about food (Rund Ums Essen):** **9**
Understand information about person, Speak about food, Introduce self and others, Understand and explain a picture base story, To justify something, To speak about feelings, To express opinions, To answer questions on a text, To describe a restaurant. Grammar: Possessive Articles in Dative, Yes/No questions, Reflexive verbs, Sentence with 'weil'	
Unit – II	**School days (Nach der Schulzeit):** **9**
Understand School reports, Speak and write comments about schooldays, To speak about habits, Understand and provide City-Tipps, To Understand School types in Germany and speak about it. Grammar: Modal verbs in Past tense, Positional Verbs, Two-way prepositions in Dativ and Akkusativ.	
Unit – III	**Media in everyday life (Medien in Alltag):** **9**
To speak about advantages and disadvantages of Media, formulate comparisons, Express your own opinion, Talk about Movies, Understand and Write Movie reviews. Grammar: Comparative degree, Comparative Sentences with 'Als' and 'Wie', Subordinate clause with 'dass', Superlative degree.	
Unit – IV	**Feelings and expressions (Gefühle):** **9**
Express thanks and congratulations, Talk about feelings, To understand information about festivals and speak about it, To describe a city, Express joy and regrets, Understand and write Blog entries, Write appropriate heading. Grammar: Subordinate Clause with 'Wenn', Adjectives to be used along with definite articles.	
Unit – V	**Profession and Travel (Beruf und Reisen):** **9**
To have a conversation at ticket counter, To talk about leisure activities, To gather information from Texts, Introduce people, Express career preferences, Ideate the dream job, To prepare and make telephone calls, To understand text about Workplace. Ask for information, Express uncertainty, Understand and give directions, Understand a newspaper article, Say your own opinion, Talk about the way to work, Describe a statistic, Understand information about a trip, Talk about travel. Grammar: Adjective to be used along with indefinite articles, Prepositions, verb – 'werden', Subordinate clause – indirect questions, All units will include elements for reading, writing, speaking and listening.	
	Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs", Goyal Publishers, Delhi, 2015
2.	

REFERENCES:

1.	Rosa-Maria Dallapiazza , Eduard von Jan, Till Schonherr, "Tangram 2 (German)" , Goyal Publishers, Delhi, 2011.
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand German food style, restaurant and be able express oneself.	Remembering (K1)
CO2	understand German school system and discuss about habits and provide City-Tipps	Understanding (K2)
CO3	analyze and compare media in everyday life.	Understanding (K2)
CO4	express feelings, describe a city and write blog entries.	Understanding (K2)
CO5	seek and provide information in a professional setup, give directions to others and talk about travel	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO07-GERMAN LANGUAGE LEVEL 4							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**German Language Level 3**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge about interacting with external world, understanding various cultural aspects, behaviour and addressing relationships in personal and professional front. It helps one to understand reports from various media and at work. Enhance learner's grammatical exposure and cover the core basic grammatical concepts which would lay the foundation to have a better hold of the language. With focused learning one should be able to read and respond to reports, write simple formal and informal letters and text messages and be able to engage in simple conversations in known situations.

Unit – I	**Learning (Lernen):**	**9**
Understanding and describing learning problems, Understanding and giving advice, Giving reasons, Understanding reports about everyday work life, Talking about everyday working life, Understanding a radio report, Understanding and making a mini-presentation. Grammar: Conjunctions- denn,weil, Konjuntiv II: Sollte(suggestions), Genitive, Temporal prepositions – bis, über + Akkusativ,ab+dativ		
Unit – II	**Athletic (Sportlich):**	**9**
Expressing enthusiasm, hope, disappointment, Understanding and writing fan comments, Formulating follow-ups, Making suggestions and reacting, Making an appointment, Understanding a report about an excursion, Understanding difficult texts, Introducing a tourist attraction. Grammar: Conjunctions – deshalb, trotzdem, Verbs with Dativ and Akkusativ		
Unit – III	**Living Together (Zusammen Leben):**	**9**
To complain, apologize & give in, As for something, Understand experience reports, Report on the past, Talk about pets, Respond to information, Write and correct a story. Grammatik: Konjunctiv II- könnte, Subordinate clauses – als and Wenn.		
Unit – IV	**Good Entertainment (Gute Unterhaltung):**	**9**
Talk about music style, Buy concert tickets, Introduce a musician / band, Understand newspaper reports, Give more detailed information about a person, Understand information about painting, Understand description of a picture, Describe a picture. Grammatik: Interrogative Articles: Was fuer eine? , Pronouns – man/jemand/niemand and alles/etwas/nichts , Relative sentences in Nominativ		
Unit – V	**Passage of time and Culture (Zeitablauf & Kultur):**	**9**
Talk about wishes, Express wishes, Give Suggestions, Understand a conversation, Plan something together, To ask others something, Understand a text, Exchange information, Talk about proverbs, write a story. Understand information about other cultures, Discuss about behavior, Express intentions, Use the appropriate salutation, Understand tips in a text, Talk about forms of addressing others, Give more information, Discuss about clichés and write about them. All units will include elements for reading, writing, speaking and listening. Grammatik: Konjunctiv II (Wishes, Suggestions), Verbs with prepositions, W- questions with prepositions, Relative sentences in Akkusativ, Subordinate clauses with damit and Um…Zu.		
		Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch", Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	Rosa-Maria Dallapiazza, Eduard von Jan, Till Schonherr, "Tangram 2 (German)", Goyal Publishers, Delhi, 2011.
2.	https://www.dw.com/en/learn-german - Deutsche Welle, Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	leverage learning in Workplace, understanding reports and make presentation.	Remembering (K1)
CO2	reciprocate to different situations, make appointment and understand texts.	Understanding (K2)
CO3	handle relationships and respond appropriately to exchange information	Understanding (K2)
CO4	familiarize to various channels of entertainment	Understanding (K2)
CO5	know about various cultural aspects, usage of proverbs and cliches.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO08 - JAPANESE LANGUAGE LEVEL 2

(Common to All Engineering and Technology Branches)

Programme& Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 1	All	OE	4	0	0	4

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form	
Unit – I	**Introduction to groups of verbs:**	**9**
tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions		
Unit – II	**Introduction to Casual Form:**	**9**
nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style		
Unit – III	**Express opinions and thoughts:**	**9**
Introduction to new particle-Express someone one's thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications		
Unit – IV	**Introduction to If clause and remaining Kanjis:**	**9**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-50 Kanjis		
Unit – V	**Introduction to giving and receiving with te form and "when, even if" usages:**	**9**
Providing to and getting from differences - Understanding of situations and framing sentences using when and even if..etc.		

Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	differentiate groups of verbs and its forms	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script and If clause	Understanding (K2)
CO5	comprehend concept of "even if", "when" and job-related information	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO09 - JAPANESE LANGUAGE LEVEL 3							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Japanese Language Level 2**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	The intermediate level of Japanese which provides understanding of all forms ofverbs, adverbs, conjunctions, etc. which includes 150 Kanji's and provides the ability to comprehend conversations encountered in daily life	
Unit – I	**Introduction to Potential verbs:**	**9**
Causes and Reasons-Favouring Expressions-Expressing a State-Potential Verb Sentences-Simultaneous actions-Verb Groups-te Form-Customary Actions-Nouns-Basic Questions and Kanji's.		
Unit – II	**Introduction to Transitive and Intransitive verbs:**	**9**
Consequence of verbs- Embarrassment about Facts- Consequence of Verbs with an Intentions-Affirmative Sentences- Conjunctions-Basic Questions and kanji's.		
Unit – III	**Introduction to Volitional forms:**	**9**
Expressions of Speakers Intention-Expressing Suggestion or Advice-Usage of Adverbs and Quantifiers-Basic Questions and kanji's.		
Unit – IV	**Introduction to Imperative and Prohibitive verbs:**	**9**
Commanding person- Interrogatives-Expressions of Third Person-Actions and its Occurrence - Possibilities of an Action-Changing of States Basic Questions and Kanji's.		
Unit – V	**Introduction to Conditional form and Passive verbs:**	**9**
Description of Requirement and Speaker's Judgement, HabitualActions, Directions and suggestions-Passive forms of Verbs-Basic Questions and Kanji's.		
		Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.
2.	

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and understand BasicVocabularies.	Remembering (K1)
CO2	understand Conversations used in daily life.	Understanding (K2)
CO3	comprehend personal communication and express greetings.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Coherent conversations in everyday situations.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO10 -JAPANESE LANGUAGE LEVEL 4							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**JAPANESE LANGUAGE LEVEL 3**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	The intermediate level of Japanese provides understanding of expressions of verbs, its pattern, Relationships which also includes 150 Kanji's and also provides the ability to understand relationship among the people.	
Unit – I	**Introduction to Reasoning:**	**9**
Causes and Sequences-Causes and Effects-Interrogative Patterns-Adjective as a Noun -Basic Questions and Kanji's		
Unit – II	**Introduction to Exchanging of things:**	**9**
Expressions for Giving and Receiving of Things-Polite Expression of Request-Indicating a Purpose of Actions-Basic Quantifiers-Basic Questions and kanji's.		
Unit – III	**Introduction to States of an Action:**	**9**
Sentence Pattern to Indicate Appearance-Degree of Action and State-Adjectives as Adverbs- Convey information -Basic Questions and kanji's.		
Unit – IV	**Introduction to Causative Verbs:**	**9**
Causative Forms of Verbs-Asking Opportunity to do something-Hypothetical Questions-Judgement and Course of an actions-Basic Questions and Kanji's.		
Unit – V	**Introduction to Relationship in Social Status:**	**9**
Honorific expressions- Respectful expressions- Humble expressions-Polite expressions-Basic Questions and Kanji's.		
		Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.
2.	

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and Understand Relationship of a Person.	Remembering (K1)
CO2	understand Conversations Used in Everyday Activities.	Understanding (K2)
CO3	comprehend Contents at Near Natural Speed.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script..	Understanding (K2)
CO5	comprehend Orally Presented Materials.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO11 -FRENCH LANGUAGE LEVEL 1							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course provides a foundation of the French language as well as an understanding of the French culture and lifestyle of France and other French-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications	
Unit – I	**Introduction**	**9**
French and French culture, alphabets, pronunciation, accents, rules, and terms for pronunciation (mas-fem), Salutations, numbers.		
Unit – II	**Daily Life**	**9**
Subject Pronoun, Francophonie's, adjectives – colors, week, months, seasons.		
Unit – III	**Articles and Verbs**	**9**
Articles - Indefinite, definite, partitive, and contracted, (examples), introductions to verbs, 1st group of verb		
Unit – IV	**In the City**	**9**
2nd group of verbs, irregular verbs (avoir, etre, faire …..) present yourself & negative sentences. (faire and Jouer verb with the expressions)		
Unit – V	**Food and Culture**	**9**
Prepositions – preposition of places (country, cities and etc), Imperative mode, invitations, culture – food (wine, cheese ….) Future (recent future)		
		Total:45

TEXT BOOK:

1.	A1 – saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G, Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	Understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	Ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	Understand the food habits of France and ask for appointments	Understanding (K2)
CO5	Learn to socialize in French-speaking countries	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO12 -FRENCH LANGUAGE LEVEL 2							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**all**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course is designed to assist students in developing vocabulary in accordance with the Common European Framework of Reference for Languages at the A2 level. This course will aid in the integration of basic grammar structures as well as the acquisition of vocabulary necessary to comprehend and respond in everyday circumstances. The learner will be able to develop a thorough comprehension of French grammar and confidently express themselves in everyday circumstances.	
Unit – I	**French and You**	**9**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, about favorite films and Types of screens in the movie world, Verbs (Regulars and irregulars), Reflexive Verbs, Prepositions		
Unit – II	**Eat and Repeat**	**9**
Favorite foods, Recopies, Types of meals, Describing House and Kitchen, Presentation of the recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form		
Unit – III	**Vacation**	**9**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense		
Unit – IV	**Likes and Views**	**9**
Favorite persons & things, Giving advice, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative		
Unit – V	**Then and Now**	**9**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.		
		Total:45

TEXT BOOK:

1.	A2 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G .Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Understand the French language in deep and its usage	Remembering (K1)
CO2	Preparation of their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	Converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	Understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	Know the difference between Past and Present and Compare them.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %

CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO13- FRENCH LANGUAGE LEVEL 3							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course gives knowledge regarding a variety of personal and professional circumstances, as well as improving vocabulary and speaking abilities to reply to and seek information in those settings. It also gives you the ability to articulate yourself and arrange appointments. With perseverance, one can master all of the essential grammatical structures needed to respond confidently in everyday circumstances. It almost gives you an idea of how Natives communicate.	
Unit – I	**Start Over**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about the future (actions and situations), Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of the subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative**	**9**
Write a letter by describing the problem, talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct, and Indirect		
Unit – IV	**Travel and Communication**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on the telephone, Roleplay (Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, the use of superlatives, Exclamatory phrases, subjunctives.		
		Total:45

TEXT BOOK:

1.	B1 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Learn on Future tense.	Remembering (K1)
CO2	Understand Permissions and Prohibitions.	Understanding (K2)
CO3	Knowing about Letter writing, Creating Ads, Expressing Desires, and Instructing Others.	Understanding (K2)
CO4	Understanding rules for travel and Enhancing communications.	Understanding (K2)
CO5	Expressing the feelings and emotions using advanced grammar	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO14 – SPANISH LANGUAGE LEVEL 1 4-0-0-4

22GEO15 - SPANISH LANGUAGE LEVEL 2							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the Learner to acquire the vocabulary as per theframework of Spanish language A2 level competence. This course will help to assimilate the basicgrammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the Spanish grammar and confidently articulate in day today situations.
Unit – I	**Spanish and You (El Español y tú)** **9**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, About favorite films and Types of screens in the movie world, Verbs(Regulars and irregulars), Reflexive Verbs, Prepositions	
Unit – II	**Eat and Repeat (**Comer y repetir**)** **9**
Favorite foods, Recipies, Types of meals, Describing House and Kitchen, Presentation of recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form	
Unit – III	**Its Vacation Time (**Tiempo de vacaciones) **9**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense, Usage of Todavia or No	
Unit – IV	**Likes and Views (**Gustasyvistas) **9**
Favorite persons & things, Giving advices, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative	
Unit – V	**Then and Now(Antes y Ahora)** **9**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.	
	Total:45

TEXT BOOK:

1.	AULA INTERNACIONAL 2 (A2) Jaime Corpas, AgusinGarmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the Spanish language in deep and its usage	Remembering (K1)
CO2	prepare for their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	know the difference between Past and Present and Comparing them.	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO16 - SPANISH LANGUAGE LEVEL 3							
(Common to All Engineering and Technology Branches)							
Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations. It almost gives a basic idea on how Natives speak.	
Unit – I	**Start Over(Volver a Empezar)**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about future (actions and situations),Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More(Prohibiciones y mas)**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative (Seamoscreatives)**	**9**
Write a letter by describing the problem,talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct and Indirect.		
Unit – IV	**Travel and Communication (Viajar y comunicar)**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on telephone, Role play(Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk(Hablemos)**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, use of superlatives, Exclamatory phrases, subjunctive.		
		Total:45

TEXT BOOK:

1.	Aula International 3 (B1) [Paperback] Jaime Corpas, Agusin Garmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	learn on Future tense.	Remembering (K1)
CO2	understand about Permissions and Prohibitions.	Understanding (K2)
CO3	knowing about Letter writing, Creating Ads, Expressing Desires and Instructing Others.	Understanding (K2)
CO4	understanding rules for travel and Enhance communications.	Understanding (K2)
CO5	expressing the feelings and emotions using advanced grammar	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22GEO17 - ENTREPRENEURSHIP DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**22GET71 - Engineering Economics & Management**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	The purpose of this course to create entrepreneurial awareness among engineering students.	
Unit – I	**Entrepreneurship Concepts:**	**9**
Entrepreneurship & Entrepreneur- Role in Economic Development - Factors affecting Entrepreneurship- Creativity and Innovation - Entrepreneurship vs Intrapreneurship- Entrepreneurial Motivation factors – Types of Entrepreneurship & Entrepreneurs - Characteristics of Entrepreneurs - Entrepreneurship Development in India		
Unit – II	**Entrepreneurial Ventures and opportunity assessment:**	**9**
New venture creation – Bootstrapping, Minipreneurship, Start-ups, Acquiring, Franchising & Social venturing - Venture development stages - Models of market opportunity- Opportunity assessment: Critical Factors In Opportunity Assessment, Idea vs Opportunity, Evaluation process, Global opportunities for entrepreneurs.		
Unit – III	**Business Plan:**	**9**
Designing Business Model- Business Model Canvas- Objectives of a Business Plan - Business Planning Process – Structure of a Business Plan – Technical, Marketing, Financial Feasibility assessment - Competitive analysis - Common errors in Business Plan formulation - Presentation of the Business Plan: The 'Pitch'- case studies		
Unit – IV	**Financing and accounting:**	**9**
Forms of entrepreneurial capital – Sources of Financial capital: debt financing- Commercial banks and other sources, equity financing: Initial Public offering (IPO), Private placement - Venture capitalists - Angel investors-New forms of financing: Impact investors, Micro-financing, Peer-to-Peer Lending, Crowd funding - Natural capital. Preparing Financial Budget, Break even analysis, Taxation-Direct and indirect taxes, Insolvency and Bankruptcy- Case Study		
Unit – V	**Small Business Management:**	**9**
Definition of Small Scale Industries: Strengths and Weaknesses, Sickness in Small Enterprises: Symptoms -Causes and remedies- Indian Startup Ecosystem – Institutions supporting small business enterprises, Business Incubators – Government Policy for Small Scale Enterprises - Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger, FDI and Sub-Contracting		
		Total:45

TEXT BOOK:

1.	Donald F. Kuratko,"Entrepreneurship: Theory, Process, Practice", 11th Edition, Cengage Learning, Boston, 2020.

REFERENCES:

1.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Sabyasachi Sinha "Entrepreneurship", 11th Edition, McGraw Hill, Noida, 2020.
2.	Charantimath Poornima .M, "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
3.	Gordon E & Natarajan K, "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the importance of entrepreneurship and demonstrate the traits of an entrepreneur	Applying (K3)
CO2	identify suitable entrepreneurial ventures and business opportunity	Applying (K3)
CO3	assess the components of business plan	Analyzing (K4)
CO4	appraise the sources of finance and interpret accounting statements	Applying (K3)
CO5	interpret the causes of sickness of small scale enterprises and its remedies	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2	1	1		3	2		
CO2	1	2	2	2		2	2	1	1		3	2		
CO3	2	2	2	2	2	2	2	2	2	2	3	2		

CO4	1	1	2	1		2	1	1	1	2	3	2		
CO5	1	1	2	1		2	1	1	1	2	3	2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	30	30	20			100
CAT3	30	30	40				100
ESE	10	30	40	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEX01 - NCC Studies(Army Wing) – I
(Offered by Department of Electrical and Electronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5 / 6	OE	3	0	2	4

Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.	
Unit - I	**NCC Organisation and National Integration:**	**9**
NCC Organisation – History of NCC- NCC Organisation- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.		
Unit - II	**Basic physical Training and Drill:**	**9**
Basic physical Training – various exercises for fitness(with Demonstration)-Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION)		
Unit - III	**Weapon Training:**	**9**
Main Parts of a Rifle- Characteristics of 5.56mm INSAS rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing(WITH PRACTICE SESSION) - Characteristics of 7.62mm SLR- LMG- carbine machine gun.		
Unit - IV	**Social Awareness and Community Development:**	**9**
Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility		
Unit - V	**Specialized Subject (ARMY):**	**9**
Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading including practical.		

Lecture :45, Practical:30, Total:75

TEXT BOOK:

1.	"National Cadet Corps- A Concise handbook of NCC Cadets", Ramesh Publishing House, New Delhi,2014.

REFERENCES:

1.	"Cadets Handbook – Common Subjects SD/SW", published by DG NCC, New Delhi.
2.	"Cadets Handbook- Specialized Subjects SD/SW", published by DG NCC, New Delhi.
3.	"NCC OTA Precise", published by DG NCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders..	Applying (K3)
CO3	basic knowledge of weapons and their use and handling.	Applying (K3)
CO4	understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils	Applying (K3)
CO5	acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						3	3	3	3	3				
CO2					3									
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

22GEX02 - NCCSTUDIES (AIRWING)–I							
(Offered by Department of Information Technology)							
Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/ 6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, honing qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.	
Unit–I	**NCC Organization and National Integration**	**9 + 3**
NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training - NCC badges of Rank - Honors' and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF - Indo-Pak War-1971 - Operation Safed Sagar. National Integration - Unity in diversity - contribution of youth in nation building - national integration council - Images and Slogans on National Integration.		
Unit–II	**Drill and Weapon Training**	**9 + 3**
Drill- Words of commands - position and commands - sizing and forming - saluting - marching - turning on the march and wheeling - saluting on the march - side pace, pace forward and to the rear - marking time - Drill with arms - ceremonial drill - guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle - Characteristics of .22 rifle - loading and unloading – position and holding - safety precautions – range procedure - MPI and Elevation - Group and Snap shooting - Long/Short range firing (WITH PRACTICE SESSION).		
Unit–III	**Principles of Flight**	**9 + 3**
Laws of motion-Forces acting on aircraft – Bernoulli's theorem - Stalling - Primary control surfaces – secondary control surfaces - Aircraft recognition.		
Unit-IV	**Aero Engines**	**9 + 3**
Introduction of Aero engine -Types of engine - piston engine - jet engines - Turbo prop engines-Basic Flight Instruments - Modern trends.		
Unit–V	**Aero Modeling**	**9 + 3**
History of aeromodeling - Materials used in Aero-modeling - Types of Aero-models – Static Models - Gliders - Controlline models - Radio Control Models - Building and Flying of Aero-models.		

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1.	"National Cadet Corps - A Concise handbook of NCC Cadets", Ramesh Publishing House, NewDelhi, 2014.

REFERENCES/ MANUAL / SOFTWARE:

1.	"Cadets Handbook – Common Subjects SD/SW", DGNCC, New Delhi.
2.	"Cadets Handbook – Specialised Subjects SD/SW", DGNCC, New Delhi.
3.	"NCCOTA Precise", DGNCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	build sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling	Applying (K3)
CO3	illustrate various forces and moments acting on aircraft	Applying (K3)
CO4	outline the concepts of aircraft engine and rocket propulsion	Applying (K3)
CO5	design, build and fly chuck gliders/model air planes and display static models.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						3	3	3	3	3				
CO2					3									
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
CO6														
CO7														
CO8														
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

22MBO01 - Cost Accounting for Engineers							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites		**5**	**OE**	**4**	**0**	**0**	**4**

Preamble	To provide an In-depth study of the Cost Accounting principles and techniques for identification, analysis and classification of costs components to facilitate decision Making.	
Unit – I	**Introduction to Cost Accounting**	**12**
Introduction to Cost Accounting: Meaning - Scope, objectives and significance of Cost Accounting its relationship with financial accounting and management accounting– cost centres – cost units – Elements of cost – classification of cost – preparation of cost sheet.		
Unit – II	**Cost Ascertainment – Elements of cost**	**12**
Material Costs: Procurement of materials – Inventory management and control – scrap, spoilage, defectives and wastage **Labour Costs:** Time Keeping, Time booking and payroll – Labour turnover – principles and methods of remuneration and incentive schemes. **Overheads:** Collection, classification and apportionment and allocation of overheads.		
Unit – III	**Basic Costing Methods**	**12**
Operating Costing - Meaning - Preparation of Operating Cost Sheet - Transport Costing - Power Supply Costing - Hospital Costing.		
Unit – IV	**Advanced Costing Methods**	**12**
Features of Job Costing - Batch Costing - Preparation of Cost Sheet Under Job Costing, and Batch Costing - Process Costing - Process Loss - Normal and Abnormal Loss.		
Unit – V	**Cost Accounting Techniques**	**12**
Budget and Budgetary Control: Budgetary control as a management Tool – Installation of Budgetary control system classification of budgets – Fixed and Flexible Budgeting. **Standard Costing and Variance Analysis:** Budgetary control and standard costing – Suitability of standard costing – Standard costing as a management Tool – Cost variances – Direct material cost variances – Direct labour cost variances – Overhead variances – Sales variance.		
		Total:60

REFERENCES:

1.	JawaharLal, SeemaSrivastava, Manisha Singh, " Cost Accounting, Text, Problems and Cases", 6th Edition, McGraw Hill Education, New Delhi, 2020.
2.	William Lanen, Shannon Anderson and Michael Maher, "Fundamentals of cost Accounting",7th Edition, McGraw Hill Education, New Delhi, 2020.
3.	M.N.Arora and PriyankaKatyal, "Cost Accounting", 5th Edition, Vikas publishing House, New Delhi, 2023.
4.	Ravi M.Kishore, " Cost and Management Accounting", 6th Edition, Taxmann, New Delhi, 2021
5.	M.N.Arora, "Cost and Management Accounting",11th Edition, Vikas Publishing, New Delhi, 2021.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the conceptual frame work of cost accounting	Understanding (K2)
CO2	understand the basic concepts and process in determination of cost of product and services	Understanding (K2)
CO3	use the basic costing methods in different business situation	Applying (K3)
CO4	demonstrate the advanced costing methods in various decision making situation	Applying (K3)
CO5	prepare various types of budgets and determine variance in different situations.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1										2	3	1		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										2	3	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	35	65					100
CAT2	15	35	50				100
CAT 3	15	15	70				100
ESE	25	25	50				100
* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)							

22MBO02 - Economic Analysis for Decision Making							
Programme& Branch		**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basic understanding of differential calculus**	**6**	**OE**	**4**	**0**	**0**	**4**

Preamble	The course aims at introducing a few vital techniques required for carrying out economic analysis for making informed managerial decisions.	
Unit – I	**Economic Optimization**	**12**
Economic Optimization: Theory of firm – Business versus Economic profit – Revenue relations – Cost relations – Profit relations – Marginal versus incremental concept.		
Unit – II	**Forecasting**	**12**
Forecasting: Forecasting applications – Techniques –Naire method – Moving average – Exponential smoothing - Trend analysis – Linear Trend – Growth Trend – Sales, cost and revenue forecasting.		
Unit – III	**Production and Cost Analysis**	**12**
Production: Production function – Returns to scale and returns to factor – Total, managerial and average product – Law of diminishing returns – Optimal input usage – Production function estimation. **Cost Analysis:** Economic and Accounting costs – Time in cost analysis – Short run cost – Long run cost – cost relations – cost volume – profit analysis.		
Unit – IV	**Competitive Market Analysis**	**12**
Competitive Market Analysis: Characteristics of competitive markets – Profit maximisation – Marginal analysis in competition – competitive market supply curve – Equilibrium in competitive markets - Monopoly – Monopolistic competition.		
Unit – V	**Game theory and Competitive Strategy**	**12**
Game Theory Basics - Prisoner's Dilemma - Saddle Point - Two Person Zero Sum Game - Games without Saddle Points - Dominance Rule - Mixed Strategies.		
		Total:60

REFERENCES:

1.	Mark Hirschey, “Managerial Economics”, 12th Edition, Cengage Learning, New Delhi, 2022.
2.	Geetika, PiyaliGhosh, Purba Roy Choudhury, “Managerial Economics”, 3rd Edition, McGraw Hill Education, New Delhi, 2019.
3.	Gupta. G, “Managerial Economics”, 2nd Edition, McGraw Hill Education, New Delhi, 2019.
4.	Ahuja. H. L, “Principles of Microeconomics”, 22nd Edition, S. Chand Publishing, New Delhi, 2019.
5.	PanneerSelvam R, P. Sivasankaran, P. Senthilkumar., “Managerial Economics”, 1st Edition, Cengage Learning, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Understand revenue, cost and profit relations and apply techniques to find best course of action.	Applying (K3)
CO2	Apply appropriate forecasting techniques for estimating sales, cost and revenue.	Applying (K3)
CO3	Understand the relation between inputs and output of production system and perform cost – volume – profit analysis	Applying (K3)
CO4	Apply market equilibrium concepts in monopoly and monopolistically competitive markets.	Applying (K3)
CO5	Understand game theory and apply in different strategic decisions	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1					2					1	3			
CO2					2					1	3			
CO3					2					1	3			
CO4					2					1	3			
CO5					2					1	3			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	55	30				100
CAT2	15	45	40				100
CAT 3	15	45	40				100
ESE	5	40	55				100
* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)							

22MBO03 - MARKETING ANALYTICS

Programme& Branch	BE / B.Tech Programme	Sem	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	4	0	0	4

Preamble	Marketing analytics enables marketers to measure, manage and analyze marketing performance to maximize its effectiveness and optimize return on investment (ROI). This course exposes the students with the tools to measure customer value and apply analytic tools to various marketing decisions.	
Unit – I	**Market & Marketing Analytics**	**12**
Introduction - Introduction to marketing analytics, Models & Metrics **Market Insight** - Market sizing. **Market Segmentation** –Segmentation, Targeting & Positioning		
Unit – II	**Business & Competition**	**12**
Competitive Analysis - Competitor identification, analysis, and actions **Business Strategy** –Scenarios, Decision Model, Metrics **Business Operations** - Forecasting		
Unit – III	**Product and Price**	**12**
Product and Service Analytics - Conjoint analysis and product/service metrics **Price Analytics** - Pricing techniques and assessment		
Unit – IV	**Distribution & Promotion**	**12**
Distribution Analytics –Characteristics, Channel evaluation and selection, Multichannel distribution and metrics. **Promotion Analytics** - Promotion budget estimation and allocation, Metrics		
Unit – V	**Sales**	**12**
Sales Analytics - Metrics for sales, profitability, and support		

Total:60

REFERENCES:

1.	Stephen Sorger, "Marketing Analytics: Strategic Models and Metrics", 1st Edition, Admiral Press, UK, 2016.
2.	Wayne L. Winston, "Marketing Analytics: Data-Driven Techniques with Microsoft Excel", 1st Edition, Wiley, New Delhi, 2018.
3.	Tommy Blanchard, "Data Science for Marketing Analytics", 1st Edition, Packt Publishing, UK, 2019.
4.	Mike Grigsby, "Marketing Analytics", 2nd Edition, Kogan Page, UK, 2018.
5.	David A. Aaker, V. Kumar, Robert P. Leone, George S. Day., "Marketing Research", 1st Edition, Wiley, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	Understand the importance of Analytics in Marketing, size and segment the market	Understanding (K2)
CO2:	Understand the Business, competition and its related decisions.	Understanding (K2)
CO3:	Identify important features of a product and suitable pricing methods.	Applying (K3)
CO4:	Assess Channel performance and Promotion Metrics.	Applying (K3)
CO5:	Assess sales performance.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1										2	3	1		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										2	3	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	35	65					100
CAT2	15	35	50				100
CAT 3	15	15	70				100
ESE	25	25	50				100
* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)							

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE-638060
(AUTONOMOUS)
BOARD OF FOOD TECHNOLOGY

DEGREE & PROGRAMME: BTECH & FOOD TECHNOLOGY

HONOURS DEGREE TITLE: FOOD PROCESSING AND MANAGEMENT

The following courses are identified to earn additional 18 credits to get a Honours degree with specialization in **Food Processing and Management**

S.No	Course Code	Course Title	Credits	Prerequisites	Semester
1.	22FTH01	Food Supply Chain Management	4	Nil	5
2.	22FTH02	Entrepreneurship	3	Nil	5
3.	22FTH03	International Food Safety Regulations	4	Nil	6
4.	22FTH04	Project Management	3	Nil	6
5.	22FTH05	Food Safety Management System	4	Nil	7
		TOTAL	**18**		

22FTH01- FOOD SUPPLY CHAIN MANAGEMENT							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course addresses the theory and practices of supply chain management within the context of the food system.	
Unit – I	**Introduction and overview of Food Supply Chain Management**	**9+3**
Introduction and overview of Food Supply Chain Management, present status of Food Supply Chains in India and challenges thereof, Inbound and Out bound logistics, Supply Chain as a source of competitive advantage. Buyer-Vendor co-ordination, Procurement, Vendor development and evaluation, Reduced sourcing and supplier partnership - benefits, Risks and critical success factors, Multilevel supply control, Inventory control systems of stock replenishment, Cost elements, EOQ and its derivative models, Use of computers for materials function.		
Unit – II	**System view of logistics, Coordination and management of transportation**	**9+3**
System view of logistics, Coordination and management of transportation, Inter model transportation and third party transportation services, Characteristics of different transportation services, Carrier selection, contracting and evaluation methods, inventory order processing, Purchasing warehousing materials handling, Packaging and customer service standards, Physical distribution planning, Channel considerations, Inventory strategies and management, Transportation infrastructure and management, Facility location, Materials handling		
Unit – III	**Logistics/Supply Chain (SC) Strategy and Planning**	**9+3**
Corporate Strategy, Logistics/SC Strategy, Logistics/SC Planning, Levels of Planning, Major Planning Areas, Conceptualizing the Logistics/SC Planning Problems, Guidelines for Strategy Formulation, Selecting the Proper Channel Strategy, Measuring Strategy Performance. The Logistics/Supply Chain Product: Nature and Classification of Products, The Product Life Cycle, Product Characteristics, Weight-Bulk Ratio, Value-Weight Ratio, Substitutability, Risk Characteristics, Product Packaging, Product Pricing, Geographic Pricing Methods, Legal Concerns.		
Unit – IV	**Order Processing and Information Systems**	**9+3**
Defining Order Processing, Order Preparation, Order Transmittal, Order Entry, Order Filling, Order Status Reporting, Order-Processing Examples, Industrial Order Processing, Retail Order Processing, Customer Order Processing, Web-Based Channel Order Planning, Other Factors Affecting Order- processing Time, Processing Priorities, Parallel versus Sequential Processing, Order-Filling Accuracy, Order Batching.		
Unit – V	**Strategic considerations for supply chain**	**9+3**
Strategic considerations for supply chain, Porter's industry analysis and value-chain models, Concept of total cost of ownership, Supply stream strategies, Classification and development guidelines, Measuring effectiveness of supply management, Logistics engineering. Operations Research Models for operational and strategic issues in supply chain management, The Bullwhip Effect and supply-chain management game.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Chopra, S, and P. Meindl, "Supply Chain Management – Strategy, Planning and Operation", 6th edition, Pearson Education, 2016.

REFERENCES:

1.	Raghuram, G. and N. Rangaraj, "Logistics and Supply Chain Management: Cases and Concepts", First edition, Macmillan, New Delhi, 2000.
2.	Simchi-Levi, D., P. Kaminski and E. Simchi-Levi, "Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies", 2nd Edition, Irwin, McGraw-Hill, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline Food Supply Chain Management in India.	Understanding (K2)
CO2	classify the Coordination and management of transportation services.	Understanding (K2)
CO3	infer suitable Logistics/Supply Chain (SC) Strategy and Planning for products.	Understanding (K2)
CO4	utilize the Order Processing and factors affecting order processing.	Applying (K3)
CO5	Summarize the supply chain strategies	Understanding (K2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	30	50	20				100
ESE	30	50	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTH02 - ENTREPRENEURSHIP

Programme & Branch	B.Tech & Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5/6/7	HN	3	0	0	3

Preamble	This course provides a detailed overview of entrepreneurship as the foundation of business growth and value creation in the national economy.

Unit – I	Entrepreneurship Journey and Discovery	9

Introduction- Entrepreneurial Journey-Different types of entrepreneurs- Innovative, replicative, Opportunity, Necessity, entrepreneurial origins, entrepreneurial and start up firms, stages of start up journey at corporate and Product levels, Incubators and accelerators. Entrepreneurial Discovery- Triggers for entrepreneurial quest- case studies.

Unit – II	Ideathon and prototyping	9

Ideathon and Prototyping Difference between entrepreneurship and start up, risk of innovation, Product development for optimal business impact, Broad stages of product development, Stages from ideathon to commercialization, Theme thread -passion Cube of start up, Demand supply match, Design thinking as an Interconnected iterative process, Impact of design thinking on design, manufacture and delivery, Emotional drivers of design thinking, design thinking importance in entrepreneurship, stages of ideathon and prototyping in the entrepreneurial journey, Different ideathon approaches, Technology drivers for ideathon, Characteristics of ideathon , Prototype, Common prototyping problems and solutions.

Unit – III	Technological Innovation and Entrepreneurship	9

The technology pyramid, types of technological innovation, unique role of start ups, Technology driven Industries, Navigating the next Industrial Revolution, Pioneering Leadership Model, Technology Competence framework, Innovator Strategies, Model of five Technology forces, Elements of customised product design, Facets of Technological behaviour, Three steps of De-commoditisation, trends of technological development, framework of customised product design.

Unit – IV	Financial resources , Education and Entrepreneurship	9

Financial resources- Financing Staircase, Startup funding and investment trends, Startup canvas- Micro, Nano , small scale , medium scale entreprises, Financial strategy, role of finance management, Financial ratio analysis. Education and Entrepreneurship- India's development pathway-Innovation, efficiency, competitiveness and collaborative framework, global benchmarks in student educational proficiency ,role of India's science and technology, Education and Management, STEM at Industrial revolution, Beyond founders and founder families- Entrepreneurs and leaders, Co-founding as a powerful leader, Challenges of cofounders/management,Issues in founder, co-founders and family firms, Transition challenges for founders / family controlled firms

Unit – V	Entrepreneurial culture and Employment	9

India as a Start-up Nation, National Entrepreneurial Culture, Entrepreneurial Thermodynamics, Entrepreneurship and Employment, Start-up Case Studies.

Total:45

TEXT BOOK:

1. Donald F. Kuratko,"Entrepreneurship: Theory, Process, Practice", 11th Edition, Cengage Learning, Boston, 2020.

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Sabyasachi Sinha "Entrepreneurship", 11th Edition, McGraw Hill, Noida, 2020.
2. Charantimath Poornima .M, "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
3. Barringer and Ireland, "Entrepreneurship", 3rd Edition, Pearson Education, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	outline the importance of entrepreneurship journey and discovery	Understanding (K2)
CO2:	make use of ideathon and prototyping	Applying (K3)
CO3:	identify suitable technological innovation and entrepreneurship	Applying (K3)
CO4:	Infer the importance of financial resources and entrepreneurship	Understanding (K2)
CO5:	Utilize the entrepreneurial culture and employment	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTH03 - INTERNATIONAL FOOD SAFETY REGULATIONS							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course deals about international agencies and international food laws and regulations on food safety	
Unit – I	**Regulations on Food Import and Export**	**9+3**
Food categorization system, Product/Ingredient Approval, Export & Import Laws and Regulations, FTDR Act, 1992 and Foreign Trade Policy, Food Import Clearance System (FICS).		
Unit – II	**World Trade Organization (WTO)**	**9+3**
The Role of the WTO - The WTO Framework - Introduction to OIE and IPPC, other International Food Standards (e.g. European Commission, USFDA etc). Introduction to WTO agreement: SPS and TBT Agreement- Negotiation of the SPS Agreement - WTO Dispute Settlement - Functioning of the SPS Agreement		
Unit – III	**Codex Alimentarius Commission (CAC)**	**9+3**
The Work of Codex – development and use – Standard setting and Advisory mechanisms: JECFA, JEMRA, JMPR - Standards in effect - Implications on trade in light of SPS and TBT, Other International Standards Setting Bodies, Harmonisation Of India's Food Standards with Codex Standards and Other International Best Practices, Country Specific Standards - European Committee for Standardization (CEN), PAN American Standards Commission (COPANT), Euro-Asian Council for Standardization, FDA, EPA, EU, ASEAN, EFSA (European Food Safety Authority)		
Unit – IV	**Regulation of Food Additives, Contaminants And Pesticides**	**9+3**
Regulation Of Food Additives Contaminants And Pesticides In The United States: The Food Additive Approval Process - Regulation Of Contaminants And Pesticides European Community Legislation on Limits for Additives and Contaminants in Food: Scientific Advisory Committees - Pesticide Residues - Veterinary Drug Residues - Other Contaminants Development Of Australia New Zealand Standards: Food Regulation in New Zealand – WTO Obligations – The Regulation of Food Additives – The Regulation of Contaminants and Other Restricted Substances		
Unit – V	**Development Of The Codex Standard For Contaminants And Toxins In Food**	**9+3**
Development Of The GSCTF – Scope, Purpose and Principles of the General Standard on Contaminants and Toxins In Food - The Content of The General Standard Status and Future Codex Standards For Pesticide Residues: Need for International Standards For Pesticide Residues - Selection of Pesticides for Elaboration of Codex MRLS - Joint FAO/WHO Meeting on Pesticide Residues - Safety of Pesticide Residues - Good Agricultural Practice - Codex Extraneous Residue Limits - International Regulatory Practices Involving Pesticide Residues Development of Radiological Standards: Radioactivity And Radiation Protection - International Commission on Radiological Protection. Establishment of Codex Microbiological Criteria for Foods		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Naomi Rees., David Watson, "International standards for food safety", 1st Edition, Springer US, 2000.

REFERENCES:

1. Neal D. Fortin, "Food regulation: Law, Science, Policy, and Practice", 2nd Edition, Wiley Publishers, 2016.
2. Raymond O'Rourke, "European Food law", 3rd Edition, Thomson, Sweet & Maxwell, 2005.
3. Christine Boisrobert, Aleksandra Stjepanovic, Sangsuk Oh, Huub Lelieveld (eds), "Ensuring Global Food Safety", 1st Edition, Academic Press, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the regulations on Food Import and Export	Understanding (K2)
CO2	explain the role of World Trade Organization in food law and policies	Understanding (K2)
CO3	outline about codex and global perspectives on the challenges and opportunities in the international food trade, including the steps being taken towards international harmonization	Understanding (K2)
CO4	apply the Regulation of Food Additives, Contaminants and Pesticides in various countries while involving in international trade	Applying (K3)
CO5	make use of the Codex Standards for Contaminants and Toxin Evaluation in Food	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	30	40	30				100
ESE	40	50	10				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTH04 - PROJECT MANAGEMENT							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course deals about the general and advanced concepts of Project Management to meet the demand in the market from a variety of fields	
Unit – I	**Project Management Fundamentals**	**9**
Introduction to Project Management, Project success, Types of structure organizations, Project management office, stakeholders management.		
Unit – II	**Project Life cycle and selection methods**	**9**
Types of project and Project life cycle, Project life cycle phases and Project appraisal , Methods of project selection , market and demand analysis, Financial analysis, capital budgeting techniques.		
Unit – III	**Risk Management and technical analysis**	**9**
Risk Management , Stand alone risk analysis , Hillier model, simulation analysis ,Decision analysis, abandonment analysis, technical analysis, Product mix and Plant capacity analysis.		
Unit – IV	**Resources management and Probability models**	**9**
Project team building , Conflict and Negotiation, HRM Issues and time management, Project time management- PERT networks , CPM, Probability model in networks, simulation of networks, Slacks and floats, Crashing of networks		
Unit – V	**Cost management and procurement management**	**9**
Introduction to project cost management, Cost control-tools and techniques, cost estimation, Introduction to quality management- Source of variability, Six Sigma , Six sigma tools, Procurement Management and Project Termination.		
		Total:45

TEXT BOOK:

1.	Banga, T.R., Agarwal, N.K., Sharma, S.C., “Industrial Engineering and Management Science”, 5th Edition, Khanna Publishers, New Delhi 2007.

REFERENCES:

1.	C F Gray, E W Larson and G V Desai, “Project Management, The Managerial Process”, Tata McGraw Hill, 2010
2.	Jack R. Meredith and Samuel J. Mantel, Jr. – ‘Project Management- A Managerial Approach’ Eighth Edition – John Wiley & Sons Inc – 2012.
3.	Leender, Johnson, Flynn, Fearon, Purchasing Supply Chain Management, 14th Edition, McGraw-Hil, 2011

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	summarize the Project management fundamentals	Understanding (K2)
CO2:	identify the project life cycle and selection methods	Applying (K3)
CO3:	Identify the risk management and technical analysis	Applying (K3)
CO4:	Infer the role resources management and probability models	Understanding (K2)
CO5:	Make use of cost management technique and procurement management	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	40	60					100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22FTH05 - FOOD SAFETY MANAGEMENT SYSTEM							
Programme & Branch	**B.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course will provide students with an understanding of the principles and practices of food safety management systems	
Unit – I	**Introduction and PRP**	**9+3**
Introduction, Food safety, Food safety importance, History of food safety management system, Principles of food safety management system. Introduction to PRPs, The different types of PRPs, Implementing and maintaining PRPs, The importance of PRPs in a HACCP system, Challenges to PRPs .		
Unit – II	**GMP and HACCP**	**9+3**
Good Manufacturing Practices (GMPs), Principles of GMPs, Implementing GMPs in a food business. Introduction to HACCP, seven principles of HACCP, developing a HACCP plan, Implementing and maintaining a HACCP plan, Validating and verifying a HACCP plan, Challenges to HACCP.		
Unit – III	**ISO22000 and FSSC 22000**	**9+3**
ISO 22000, requirements of ISO 22000, Implementation of ISO 22000-compliant food safety management system, benefits of ISO22000 certification, Challenges to ISO 22000. FSSC 22000, requirements of FSSC 22000, Implementing and maintaining FSSC 22000, benefits of FSSC 22000 certification, Challenges to FSSC 22000 certification.		
Unit – IV	**BRCGS**	**9+3**
Introduction to BRCGS**,** The requirements of BRCGS, Implementing and maintaining BRCGS, The benefits of BRCGS certification, Challenges to BRCGS certification.		
Unit – V	**Training, Documentation, and Management Commitment**	**9+3**
The importance of training in food safety, different types of food safety training, Developing and maintaining food safety documentation, importance of management commitment to food safety, Challenges to food safety training, documentation, and management commitment		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	David A. Bell and David A. Barach, “Food Safety Management Systems: Principles and Practices”, Wiley, 2019

REFERENCES:

1.	“HARPC for Food Safety: A Risk-Based Approach to Food Safety Management” International Organization for Standardization (ISO, 2013
2.	David A. Bell and David A, “HACCP: A Practical Guide for Food and Beverage Manufacturers”, Wiley, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the basics of food safety importance and PRP	Understanding (K2)
CO2	apply the GMP and HACCP in the food industry	Applying (K3)
CO3	develop ISO22000 and FSSC 22000 in the food industry	Applying (K3)
CO4	make use of BRCGS in the food sector	Applying (K3)
CO5	Summarize the different types of food safety training	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	50	10				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)