FACULTY OF ENGINEERING

DEGREE OF
BACHELOR OF TECHNOLOGY
IN
FOOD TECHNOLOGY

DEPARTMENT OF FOOD TECHNOLOGY

CURRICULUM

(2022 - 2023)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

KARPAGAM ACADEMY OF HIGHER EDUCATION
Deemed to be University
(Established Under Section 3 of UGC Act, 1956)
(Accredited with A+ Grade by NAAC in the Second Cycle)
Pollachi Main Road, Eachanari Post, Coimbatore - 641 021, Tamil Nadu, India.
Phone: 0422 – 2980011 – 14 | Email: info@kahedu.edu.in

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FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY (B. E. /B. Tech.)

REGULATIONS
(2022)

CHOICE BASED CREDIT SYSTEM

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FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY

REGULAR PROGRAMME
REGULATIONS 2022
CHOICE BASED CREDIT SYSTEM

These regulations are effective from the academic year 2022 – 2023 and applicable tothe candidates admitted to B. E. / B. Tech. during 2022 - 2023 and onwards.

1. ADMISSION

1.1 Candidates seeking admission to the first semester of the eight semesters B. E./B.Tech. Degree Programme:

Should have passed the Higher Secondary Examination (10+2) prescribed by the State Government
/ Central Government with Mathematics/ Physics/ Chemistry/ Computer Science/ Electronics/ Information Technology/ Biology/ Informatics Practices/ Biotechnology/ Technical Vocational subject/ Agriculture/ Engineering Graphics/ Business Studies/ Entrepreneurship. (Any of the above three subjects) or any similar Examination of any other institution/ University or authority accepted by the Karpagam Academy of Higher Education as equivalent thereto).

Should obtained at least 45% marks (40% marks in case of candidates belonging to reserved category) in the above subjects taken together.

(OR)

Passed min. 3 years Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) subject to vacancies in the First Year, in case the vacancies at lateral entry are exhausted. (The Universities will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

1.2 Lateral Entry Admission

Candidates who possess Diploma in Engineering / Technology (10+3 or 10+2+2) awarded by the Directorate of Technical Education with passed minimum THREE

years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology are eligible to apply for admission to the third semester of B. E./B. Tech. Such candidates shall undergo two additional engineering subjects in the 3rd and 4th semester as prescribed by the University.

OR

Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.

OR

Passed D.Voc. Stream in the same or allied sector.

(The Universities will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme).

Eligibility criteria for admission in the third semester is given in the table below.

S. No.	Programme	Eligibility criteria
1.	B.E Bio Medical Engineering	Passed Minimum THREE years /TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology. **OR** Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2examination with Mathematics as a subject. **OR** Passed D.Voc. Stream in the same or allied sector. (The Universities will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)
2	B. E. Civil Engineering	
3.	B. E. Computer Science and Design	
4.	B. E. Computer Science and Engineering	
5.	B. E. Electrical and Electronics Engineering	
6.	B. E. Electronics and Communications Engineering	
7.	B. E. Mechanical Engineering	
8.	B. Tech. Artificial Intelligence and Data Science	
9.	B. Tech. Bio - Technology	
10.	B. Tech. Food Technology	

1.3 Migration from other University

Candidates who have completed their first to sixth semesters of B. E./B. Tech. study in any University are eligible to apply for admission to their next semester of B. E./B. Tech. in the branch corresponding to their branch of study. The student will be exempted from appearing for Examination of the equivalent courses passed in the earlier programme and will have to appear for courses whichhe/she has not done during the period of his/her earlier programme. Along withthe request letter and mark sheets, he/she has to submit a copy of syllabus of the programme duly attested by the Registrar, Competent authority, he/she has undergone. Equivalence Certificate shall be provided by the "Students" Affairs Committee" of Karpagam Academy of Higher Education.

Students" Affairs Committee comprises all the Heads of the Departments and Dean of the Faculty of Engineering and a nominee of the Registrar.

2. PROGRAMMES OFFERED

A candidate may undergo a programme in any one of the branches of study approved by the University as given below.

List of B. E. and B. Tech. Degree Programmes

1. B.E Bio Medical Engineering
2. B. E. Civil Engineering
3. B. E. Computer Science and Design
4. B. E. Computer Science and Engineering
5. B. E. Electrical and Electronics Engineering
6. B. E. Electronics and Communications Engineering
7. B. E. Mechanical Engineering
8. B.Tech. Artificial Intelligence and Data Science
9. B. Tech. Bio-Technology
10. B. Tech. Food Technology

3. MODE OF STUDY

3.1 Full-Time:

In this mode of study, the candidates are required to attend classes regularly on the specified working days of the University.

3.2 Conversion from full time mode of study to part time is not permitted.

3.3 Change from one programme to another is not permitted.

4. STRUCTURE OF PROGRAMMES

4.1 Every programme will have a curriculum with syllabus consisting of theory and practical courses such as:

(i) General core courses comprising Mathematics, Basic Sciences, Engineering Sciences and Humanities.

(ii) Core courses of Engineering/Technology.

(iii) Elective courses for specialization in related fields.

(iv) Workshop practice, computer practice, engineering graphics, laboratory work, in-plant training, seminar presentation, project work, industrial visits,camps, etc.

Every student is encouraged to participate in at least any one of the following programmes

- NSS / Sports/Physical exercise/NCC/YRC/Red Ribbon club/Environment club and Energy club
- Other Co-Curricular and Extra Curricular activities

(V) Choice Based Credit System

CBCS is introduced for students admitted in the academic year 2017-18. As per AICTE guidelines, CBCS is an approach in which students opt for courses of their choice. CBCS provides greater flexibility with multiple courses and enable students to undergo additional courses. CBCS is applicable to Full Time Undergraduate & Post Graduate Programmes of study. It provides a choice for students to select from the prescribed courses (Professional soft core, Professional Hard core, Professional Electives, Open Electives, Value added courses, Humanity Sciences, Basic sciences & Engineering sciences). A course designated as hard core for a particular programme of study must invariably be completed by the student to receive the degree in the programme. The Hardcore courses cannot be substituted by another courses. Students can exercise their choice among a set of Soft-core courses from the list of Soft-core courses specified for each Programme of study. The student should meet the criteria for prerequisites to become eligible to register for that course. The student should request for the course for every semester within the first week of semester. Maximum no of students to be registered in each course shall depend on availablility of physical facilities, classroom availability and lab capacity. Registration of already requested courses by students in previous semester is not allowed.

4.2 Each course is normally assigned certain number of credits.

No. of credits per lecture period per week	1
No. of credits per tutorial period per week	1
No. of credits for 3 periods of laboratory course per week	2
No. of credits for 3 periods of project work per week	2
No. of credits for 2 periods of Value-added course per week	1
No. of credits for 3 weeks of in-plant training during semester vacations	1

4.3 In every semester, the curriculum shall normally have a blend of theory courses not exceeding6and practical courses not exceeding 3. However, the total number of courses per semester shall not exceed 8.

4.4 The prescribed credits required for the award of the degree shall be within the limits specified below.

PROGRAMME	PRESCRIBED CREDIT RANGE
B. E./B. Tech.	160– 165

4.5 The medium of instruction for all Courses, Examinations, Seminar presentations and Project/Thesis reports is English.

4.6 Value Added Course

Besides core courses and elective courses, value added course is introduced. The blend of different courses is so designed that the student would be trained notonly in his / her relevant professional field but also as a socially conscious human being.

4.7 Evaluation in the courses comprises two parts, one is the Continuous Internal Assessment (CIA) and the other one is the End Semester Examination (ESE). Evaluation in few courses may be by Internal Assessment only.

5. DURATION OF THE PROGRAMME

5.1 The prescribed duration of the programme shall be

Programme	Min. No. of semesters	Max. No. of semesters
B. E./B. Tech. (H. Sc. Candidates)	8	14
B. E./B. Tech. (Lateral Entry Candidates)	6	12

5.2 Each semester shall normally consist of 90 working days or 540 hours.

5.3 Additional classes for improvement, conduct of model test, etc., over and above the specified periods shall be arranged, if required. But for the purpose of calculation of attendance requirement for eligibility to appear for the end semester Examinations (as per Clause 11) by the students, 540 hours conducted within the specified academic schedule alone shall be taken into account and the overall percentage of attendance shall be calculated accordingly.

6. REQUIREMENTS FOR COMPLETION OF THE SEMESTER

6.1 Ideally every student is expected to attend all classes and secure 100% attendance. However, in order to allow for certain unavoidable circumstances, the student is expected to attend at least 75% of the classes and the conduct of the candidate has been satisfactory during the course.

6.2 A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization / Accident / Specific Illness) or due to participation in University / District / State / National / International level sports or due to participation in Seminar / Conference / Workshop / Training Programme / Voluntary Service / Extension activities or similar programmes with prior permission from the Registrar shall be given exemption from prescribed attendance requirements and shall be permitted to appear for the Examination on the recommendation of the Head of the Department concerned and Dean to condone the lack of attendance. The Head of the Department has to verify and certify the genuineness of the case before recommending to the Dean. However, the candidate has to pay prescribed condonation fees.

6.3 Candidates who are not recommended for condonation and those who have less than 65% attendance will not be permitted to proceed to the next semester and have to redo the course. However, they are permitted to write the arrear Examinations, if any.

7. CLASS ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a teacher of the Department who shall function as Class Advisor for those students throughout them period of study.

Such Class Advisors shall advise the students and monitor the courses undergone by the students, check the attendance and progress of the students and counsel them periodically. If necessary, the Class Advisor may display the cumulative attendance particulars in the Department notice boardand also discuss with or inform the Parents/Guardian about the progress of the students. Each student shall be provided with course plan for each course at the beginning of each semester.

8. CLASS COMMITTEE

8.1. Every class shall have a class committee consisting of teachers of the class concerned, Maximum of six student representatives [boys and girls] and the concerned Head of the Department. It is like the „Quality Circle" with the overall goal of improving the teaching-learning process. The functions of the class committee include

- Clarifying the regulations of the degree programme and the details of rules therein particularly Clause 4 and 5 which should be displayed on Department Notice-Board.
- Informing the student representatives, the details of Regulations regarding weight age used for each assessment. In the case of practical courses (laboratory / drawing / project work / seminar, etc.) the breakup of marks for each experiment / exercise /module of work, should be clearly discussed in the class committee meeting and informed to the students.
- Solving problems experienced by students in the class room and in the laboratories.
- Informing the student representatives, the academic schedule, including the dates of assessments and the syllabus coverage for each assessment.
- Analyzing the performance of the students of the class after each test and finding the ways and means of solving problems, if any.
- Identifying the weak students, if any and requesting the teachers concerned to provide some additional academic support.

8.2 The class committee for a class under a particular branch is normally constituted by the Head of the Department. However, if the students of different

branches are mixed in a class (like the first semester which is generally common to all branches), the class committee is to be constituted by the Dean.

8.3 The class committee shall be constituted within the first week of each semester.

8.4 The Chairperson of the Class Committee may convene the meeting of the class committee.

8.5 The Dean may participate in any Class Committee of the Faculty.

8.6 The Chairperson is required to prepare the minutes of every meeting, submit the same to Dean through the HOD within two days of the meeting and arrange to circulate it among the students and teachers concerned. If there aresome points in the minutes requiring action by the Management, the same shall be brought to the notice of the Registrar by the HOD through Dean.

8.7 The first meeting of the Class Committee shall be held within one week from the date of commencement of the semester, in order to inform the students about the nature and weightage of assessments within the framework of the regulations. Two subsequent meetings may be held in a semester at suitable intervals. During these meetings the student members representing the entire class, shall meaningfully interact and express their opinions and suggestions of the other students of the class in order to improve the effectiveness of the teaching-learning process.

9. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or group, shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as Course Coordinator. The nomination of the Course Coordinator shall be made by the Dean depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The „Course Committee‟ shall meet to arrive at a common scheme of evaluation for the test and shall ensure a uniform evaluation of the tests. Where ever feasible, the Course Committee may also prepare a common question paper for the Internal Assessment test(s).

10. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

10.1 Every teacher is required to maintain an 'ATTENDANCE AND ASSESSMENT RECORD' (Log book) which consists of attendance marked in each theory or practical or project work class, the test marks and the record of class work (topic covered), separately for each course.

10.2 Continuous Internal Assessment (CIA): The performance of students in each subject will be continuously assessed by the respective teachers as per the guidelines given below:

THEORY COURSES:

S. No.	CATEGORY	MAXIMUM MARKS
1.	Assignment	5
2.	Seminar *	5
3.	Attendance	5
4.	Test – I	8
5.	Test – II	8
6.	Test – III	9
Continuous Internal Assessment: TOTAL		40

*Evaluation shall be made by a committee.

PATTERN OF TEST QUESTION PAPER (Test I & II)

INSTRUCTION	REMARKS
Maximum Marks	60
Duration	2 Hours
Part- A	1 to 9 Two Mark Questions, uniformly covering the two units of the syllabus. All the 9 Questions are to be answered. (**9 x 2 =18Marks)**.
Part- B	Question 10 to 12 will be of either-or type, covering two units of the syllabus. Each Question may have subdivision. (**3 x 14 =42 Marks)**.

PATTERN OF TEST QUESTION PAPER (Test III)

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part - A	Part A will be online Examination. 20 Objective type Questions, Covering all the 5 units. **(20 x 1= 20 Marks) (Online Examination).**

Part- B	21 to 25 Two Mark Questions, uniformly covering the Five units of the syllabus. All the 5 Questions are to be answered. **(5 x 2= 10Marks)**.
Part- C	Question 26 to 30 will be of either-or type, covering Five units of the syllabus. Each Question may have subdivision. **(5 x 14=70 Marks).**

PRACTICAL COURSES:

S. No	CATEGORY	MAXIMUM MARKS
1.	Attendance	5
2.	Observation work	5
3.	Record work	5
4.	Model Examination	15
5.	Viva – Voce [Comprehensive]	10
Continuous Internal Assessment: TOTAL		40

Every practical exercise / experiment shall be evaluated based on the conduct of exercise/ experiment and records maintained.

INTEGRATED THEORY AND PRACTICAL COURSES:

The Continous Internal Assessment for Integrated Theory Course is awarded for 40 Marks with mark split up similar to regular theory course.
The external evaluation of integrated practical component from End semester Examination by internal mode is awarded for 50 Marks and later scaled down to 15 Marks and similarly the external evaluation for integrated theory from End semester Examination is awarded for 100 Marks and later scaled down to 45 Marks. Hence the external assessment for Integrated theory and practical components contribute to 60 Marks.

10.3 ATTENDANCE

Attendance carries a maximum of 5 marks and the distribution is as under:

S. No.	Attendance %	Marks
1	91 and above	5.0
2	81-90	4.0
3	76-80	3.0

10.4 PROJECT WORK/ INTERNSHIPS:

Final year project work will be always in-house. However, as a special case, if a student is able to get a project from a government organization or private or public sector company, the student may be permitted to do his/her project work in reputed institution/research organization/industry. Hence final year students may have commencement of eighth semester classes for 30 days in fast track mode andcomplete their final semester and are made eligible for undergoing Internships in Industry and also interested students are permitted for doing projects in Industries.

10.5 CERTIFICATION COURSES:

Students have to undergo a minimum of one value added course beyond curriculum as a certified course per semester for duration not less than 30 hours**.**

11. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION (ESE)

A candidate shall normally be permitted to appear for the ESE of any semester commencing from I semester if he/she has satisfied the semester completion requirements (Subject to Clause 5) and has registered for Examination in all courses of the semester. Registration is mandatory for Semester Examinations as well as arrear Examinations failing which the candidate will not be permitted to attend the next semester. A candidate already appeared for a subject in a semester and passed the Examination is not entitled to reappear in the same subject of the semester for improvement of grade.

12. END SEMESTER EXAMINATION

ESE will be held at the end of each semester for each subject, for 100 marks, later scaled down to 60 marks.

PATTERN OF ESE QUESTION PAPER:

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part - A	Part A will be online Examination. 20 Objective type Questions. Covering all the 5 units. **20*1= 20 Marks (Online Examination)**
Part- B	21 to 25 Two Mark Questions, uniformly covering the Five units of the syllabus. All the5 Questions are to be answered. **(5 *2= 10Marks)**.
Part- C	Question 26 to 30 will be of either-or type, covering Five units of the syllabus. Each Question may have subdivision. **(5*14=70 Marks)**

13. PASSING REQUIREMENTS

13.1 Passing minimum: The passing minimum for CIA is 20 (i.e. out of 40 marks). The passing minimum for ESE is 30 (i.e. out of 60 marks). The overall passing minimum for theory/laboratory course is 50 (Sum of his/her score in CIAand ESE) out of 100 marks.

13.1.1 The passing minimum for value added course is 50 marks out of 100marks. There will be two tests, the first covering 50% of syllabus for 50 marks and the other for 50 marks.

13.2 If the candidate fails to secure a pass in a particular course ESE, itis mandatory that candidate shall register and reappear for the Examination in that course during the subsequent semester when Examination is conducted in that course. Further the candidate should continue to register and reappear for the Examination till a pass is secured in such supplementary Examination within the stipulated maximum duration of the programme (Clause 5.1).

The CIA marks obtained by the candidate in his/her first or subsequent appearance where he/she secures a pass shall be retained by the office of the Controller of Examinations and considered valid for all remaining attempts till the candidate secures a pass in his/her ESE.

13.3 If the candidate fails to secure a pass in a particular course in CIA, it is mandatory that candidate shall register and reappear for the CIA in that course during the subsequent semester when CIA is conducted in that course by the faculty member assigned for that particular course during that semester by the concerned

HOD. Further, the candidate should continue to register and reappear for the CIA till a pass is secured in such subsequent Examination within the stipulated maximum duration of the programme (Clause 5.1).

13.3.1 If a candidate fails to secure a pass in value added course, he/she has to appear for the tests when course is conducted subsequently.

13.4 ONLINE COURSE (MOOC) COORDINATOR

To help students in planning their online courses and for general advice on online courses, the HOD shall nominate a MOOC coordinator for the online courses. The Online course MOOC coordinator shall identify the courses which students can select for their programme from the available online courses offered by the different agencies periodically and inform the same to the students. Further, the coordinator shall advice the students regarding the online courses and monitor their course.

13.4.1 Student Shall study atleast one online course from Sawayam/NPTEL in anyone of the first seven semesters for which examination shall be conducted at the end of the course by the respective organization body. The student can register to the course which are approved by the department. The student shall produce a pass certificate from the respective body before the end of the seventh semester.

14. AWARD OF LETTER GRADES

14.1 All assessments of a course will be done on absolute mark basis. However, for the purpose of reporting the performance of a candidate letter grades, eachcarrying certain number of points will be awarded as per the range of total marks (out of 100) obtained by the candidate in each subject as detailed below:

Letter grade	Marks Range	Grade Point	Description
O	91 - 100	10	OUTSTANDING
A+	81- 90	9	EXCELLENT
A	71-80	8	VERY GOOD
B+	66- 70	7	GOOD
B	61 – 65	6	ABOVE AVERAGE
C	55 - 60	5	AVERAGE
D	50 - 54	4	PASS
RA	<50	-	REAPPEARANCE
AB		0	ABSENT

14.2 GRADE SHEET

After results are declared, Grade sheet will be issued to each student which will contain the following details:

i. The list of courses enrolled during the semester and the grade scored,

ii. The Grade Point Average (**GPA**) for the semester and

iii. The Cumulative Grade Point Average (**CGPA**) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of Credits (**C**) of courses enrolled and the Grade Points (**GP**) corresponding to the grades scored in those courses, taken for all the courses to the sum of the number of credits of all the courses in the semester.

$$GPA = \frac{Sum\ of\ [C \times GP]}{Sum\ of\ C}$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from First semester. **RA** grade and value-added course will be excluded for calculating **GPA** and **CGPA**.

14.3 REVALUATION

Revaluation and Re-totaling are allowed on representation. A candidate can apply for revaluation of his/her semester Examination answer paper in a theory course, within 2 weeks from the declaration of results, on payment of a prescribed fee through proper application to the Controller of Examinations through the Head of the Department and Dean. A candidate can apply for revaluation of answer scripts fornot exceeding 5 subjects at a time. The Controller of Examinations will arrange for the revaluation and the results will be intimated to the candidate through the Head of the Department and Dean. Revaluation is not permitted for Supplementary Examinations, Practical Examinations, Technical Seminars, In-plant Training and Project Work.

14.4 TRANSPARENCY AND GRIEVANCE COMMITTEE

A student may get the Photostat copy of the answer script on payment of prescribed fee, if he/she wishes. The students can represent the grievance, if any, to the Grievance Committee, which consists of Dean of the Faculty, (if Dean is HOD, the Dean of another Faculty nominated by the University), HOD of the Department concerned, the faculty of the course and Dean from other discipline nominated bythe University and the COE. If the Committee feels that the grievance is genuine, thescript may be sent for external valuation; the marks awarded by the External Examiner will be final. The student has to pay prescribed fee for the same.

15. ELIGIBILITY FOR AWARD OF DEGREE

A student shall be declared to be eligible for award of Degree if he/she has

- Successfully gained the required number of total credits as specified in the curriculum corresponding to his/her programme within the stipulated time.
- No disciplinary action is pending against him/her.

The award of the degree must be approved by the Board of Management of Karpagam Academy of Higher Education.

16. CLASSIFICATION OF THE DEGREE AWARDED

16.1 A candidate who qualifies for the award of the Degree (vide Clause 15) having passed the Examination in all the courses in his/her first appearance within the specified minimum number of semesters (vide Clause 5.1) securing a CGPA of not less than **8** shall be declared to have passed the Examination in First Class with Distinction.

16.2 A regular candidate or a lateral entrant is eligible to register for B.E. (Honors), B. Tech (Honors). If, he / she has passed all the courses in the first appearance and holds / maintains a CGPA of 7.5 at VI Semester. He / she has to take an additional 20 credits by studying online courses through Swayam/NPTEL. Such a candidate is eligible for the award of BE (Honor), B.Tech (Honor). However, is he / she fails in securing 20 additional credits but maintains CGPA of 7.5 and above is not eligible for Honors degree but eligible for First class with Distinction.

16.3 A candidate who qualifies for the award of the Degree (vide Clause 15) having passed the Examination in all the courses within the specified minimum number of semesters (vide Clause 5.1) plus one year (two semesters), securingCGPA of not less than **6.5** shall be declared to have passed the Examination in First Class.

16.4 All other candidates (not covered in Clauses 17.1 and 17.2) who qualify for the award of the degree (vide Clause 15) shall be declared to have passed the Examination in Second Class.

17. PROVISION FOR WITHDRAWAL FROM END-SEMESTER EXAMINATION

17.1 A candidate may for valid reasons and on prior application, be granted permission to Withdraw from appearing for the examination of any one course or consecutive examinationsof more than one course in a semester examination.

17.2 Such withdrawal shall be permitted only once during the entire duration of

the degree programme. Withdrawal application shall be valid only if the candidate is otherwise eligible towrite the Examination.

17.3 Withdrawal application is valid only if it is made within 10 days prior to the commencement of the Examination in that course or courses and recommended by the Head of the Department, Dean and approved by the Registrar.

17.3.1 Not withstanding the requirement of mandatory TEN days notice, applications for withdrawal for special cases under extraordinary conditions may be consideredon the merit of the case.

17.4 Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction. This provision is not applicable to those who seek withdrawal during IIIsemester.

17.5 Withdrawal from the ESE is NOT applicable to arrear Examinations.

17.6 The candidate shall reappear for the withdrawn courses during the Examination conducted inthe subsequent semester.

18. PROVISION FOR AUTHORISED BREAK OF STUDY

18.1 Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for break of study. If a candidate intends to temporarily discontinue the programme in the middle of the semester for valid reasons and to rejoin the programme in a subsequent year, permission may be granted based on the merits of the case provided he/she applies tothe Registrar, through the Head of the Department and Dean stating reasons thereof and the probable date of rejoining the programme.

18.2 The total number of semesters for completion of the programme from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum no. of semesters specified in Clause 5.1 irrespective of the period of break of study (vide Clause 18) in order that he/she may be eligible for the award of the degree (vide Clause 15). The candidate thus permitted to rejoin the programme at the commencement of the semester after the break shall be governed by the curriculum and regulations in force at the time of rejoining. Such candidates may have to do additional courses as per the curriculum and regulations in force at that period of time.

18.3 The authorized break of study (for a maximum of one year) will not be counted for the duration specified for passing all the courses for the purpose of classification (vide Clause17). However, additional break of study granted will be counted for the purpose of classification.

18.4 The total period for completion of the programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in Clause 5.1 irrespective of the period of break of study (vide Clause 18.3) in order that he/she may be eligible for the award ofthe degree.

18.5 If any student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted „Withdrawal‟ or „Break of Study‟ (Clause18 and 18 respectively).

19. SUPPLEMENTARY ESE: After the publication of VIII semester results, if a student has **ONE** arrear in any theory course of the entire programme, he/she will be permitted to apply within 15 days of the publication of results, and appear for supplementary Examination.

20. INDUSTRIAL VISIT

Every student is required to undergo one industrial visit for every semester, starting from the third semester of the programme.

21. DISCIPLINE

Every student is required to observe discipline and decorous behavior both inside and outside the University and not to indulge in any activity which will tend to bring down the prestige of the University. The erring student will be referred to the Disciplinary Committee constituted by the University, to enquire into acts of indiscipline and recommend to the University about the disciplinary action to be taken.

If a student indulges in malpractice in any of the ESE/CIA he/she shall be liable for punitive action as prescribed by the University from time to time.

22. REVISION OF REGULATION AND CURRICULUM

The University may from time to time revise, amend or change the Regulations, Scheme of Examinations and syllabi, if found necessary on the recommendations of Board of Studies, Academic Council and Board of Management of Karpagam Academy of Higher Education.

DEPARTMENT OF FOOD TECHNOLOGY

B. TECH. FOOD TECHNOLOGY

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To prepare the graduates with strong knowledge and practical skills in their professional career.
2. To prepare the graduates to find out the workable solutions to troubleshoot the challenges involved in the food processing and its related sectors.
3. To prepare the graduates with ethical attitude, leadership, interdisciplinary skills, adapt to current trends through lifelong learning and to serve the society.

PROGRAM OUTCOME (PO)

The graduates of Food Technology (B. Tech.) will be able to:

a. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
d. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
e. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
f. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
g. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

At the end of the B.Tech. Biotechnology program, the graduates will be able to

1. Demonstrate the knowledge in fundamental sciences and engineering that are essential to understand food processing and preservation technology.
2. Demonstrate a working knowledge to apply for advanced food sciences and technologies.

PEO-PO mapping

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
PEO 1	✓	✓	✓	✓	✓					✓		
PEO 2		✓	✓	✓		✓	✓	✓				
PEO 3				✓					✓		✓	✓

PEO-PSO mapping

	PSO1	PSO2
PEO1	✓	✓
PEO2	✓	✓
PEO3		✓

KARPAGAM ACADEMY OF HIGHER EDUCATION
Deemed to be University
(Established Under Section 3 of UGC Act, 1956)
(Accredited with A+ Grade by NAAC in the Second Cycle)
Pollachi Main Road, Eachanari Post, Coimbatore - 641 021,
Tamil Nadu, India.

B. TECH. – FOOD TECHNOLOGY

COLLEGE OF STUDY AND SCHEME OF EXAMINATION
(2022 BATCH ONWARDS)

SEMESTER I											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTCC101	English	2,3	h,i,k,l	2	0	2	3	40	60	100	1
22BTCC102	Mathematics-I	2,3	a,b,e, h,i	3	1	0	4	40	60	100	3
22BTFT141	Engineering Chemistry	2,3	a,b,c, d, e, f, i, k	4	0	2	5	40	60	100	5
22BTFT142	Basic Electrical and Electronics Engineering	2,3	a,b,c, e,i,k	3	1	2	5	40	60	100	8
22BTCC143	Python Programming	1	a,b,d	2	0	2	3	40	60	100	11
SEMESTER TOTAL				**13**	**3**	**8**	**20**	**200**	**300**	**500**	
SEMESTER – II											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTCC201	Communicative English	1,2, 3	h,i,k,l	2	0	2	3	40	60	100	14
22BTCC202	Mathematics-II	2, 3	a,b, e,h,i	3	1	0	4	40	60	100	16
22BTCC203	Environmental Studies	1, 3	f,g,h,l	3	0	0	3	40	60	100	19
22BTFT204	Fundamentals of Food Science and Technology	1, 2	a, b, g, l	3	0	0	3	40	60	100	22
22BTFT241	Engineering Physics	2,3	a,b,c,e, h,i,k	3	1	2	5	40	60	100	24
22BTFT211	Workshop Practices	2, 3	a,c,d,g, i,l	0	0	4	2	40	60	100	27
22BTFT212	Engineering Graphics	1	a,d,e	1	0	4	3	40	60	100	29
SEMESTER TOTAL				**15**	**1**	**14**	**23**	**280**	**420**	**700**	
PROGRAM TOTAL (I YEAR)				**28**	**4**	**23**	**43**	**480**	**720**	**1200**	

SEMESTER III											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTFT301	Mathematics III	1,2	a,b,c,d	3	1	0	4	40	60	100	31
22BTFT302	Engineering Properties of Food Materials	1,2,3	a,f,g, k,l	3	0	0	3	40	60	100	33
22BTFT303	Post-Harvest Technology	1,2	a,b,c,d, e,f,g,l	3	0	0	3	40	60	100	35
22BTFT304	Food Process Calculations	1,2	a,b,c, d,l	2	1	0	3	40	60	100	37
22BTFT305	Thermodynamics	1,2	a,b,c,d	2	1	0	3	40	60	100	39
22BTFT341	Food Microbiology	1,2,3	a,b,c,f, g,i,l	3	0	2	4	40	60	100	41
22BTFT342	Food Chemistry	1,2,3	a,b,c,d, f,i,l	3	0	2	4	40	60	100	44
SEMESTER TOTAL				**19**	**3**	**4**	**24**	**280**	**420**	**700**	
SEMESTER – IV											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTFT401	Mathematics IV (Probability and Statistics)	2	a,b,c, d,l	4	0	0	4	40	60	100	47
22BTFT402	Fluid Mechanics	2,3	a,b,c,d	3	0	0	3	40	60	100	49
22BTFT403	Plantation Products and Spice Processing Technology	2,3	a,b, d,l	3	0	0	3	40	60	100	51
22BTFT441	Heat and Mass Transfer	2,3	a,b,c,d	2	1	2	4	40	60	100	53
22BTFT442	Unit Operations in Food Processing	1,2,3	a,b,c, d,f	3	0	2	4	40	60	100	56
22BTFT443	Food Biochemistry and Nutrition	1,2,3	a,c,f, g,l	3	0	2	4	40	60	100	59
SEMESTER TOTAL				**18**	**1**	**6**	**19**	**240**	**360**	**600**	
PROGRAM TOTAL (I YEAR)				**37**	**4**	**10**	**43**	**520**	**780**	**1300**	

SEMESTER V											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTFT501	Refrigeration, Air conditioning and Cold Storage for Perishable Foods	1,2	a,g,i	2	1	0	3	40	60	100	63
22BTFT502	Livestock and Marine Technology	1,2,3	a,c,f,g,l	3	0	0	3	40	60	100	65
22BTFT541	Dairy Technology	1,2,3	a,b,c,i,l	3	0	2	4	40	60	100	68
22BTFT542	Fruits and Vegetables Processing Technology	1,2,3	a,b,c,d, f,g,l	3	0	2	4	40	60	100	71
22BTFT543	Food Analysis	2,3	a,b,c d,l	3	0	2	4	40	60	100	74
55BTFT5E	Professional Elective - I	-	-	3	0	0	3	40	60	100	-
SEMESTER TOTAL				**17**	**1**	**6**	**21**	**240**	**360**	**600**	
SEMESTER – VI											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTFT601	Food Safety Regulations	3	a,c,l	3	0	0	3	40	60	100	77
22BTFT602	Beverage Processing Technology	2,3	a,b, d,f,g	3	0	0	3	40	60	100	79
22BTFT603	Design of Food Process Equipment	1,2 ,3	a,b,c,d, e,g,l	2	1	0	3	40	60	100	81
22BTFT641	Bakery & Confectionary Technology	1,2,3	a,b,c,f, g,i,l	3	0	2	4	40	60	100	83
22BTFT642	Food Additives	1,2,3	a,b,c,f, g,h,l	3	0	2	4	40	60	100	86
22BTFT6OE	Open Elective – I	-	-	3	0	0	3	40	60	100	-
22BTFT6E	Professional Elective – II	-	-	3	0	0	3	40	60	100	-
SEMESTER TOTAL				**20**	**1**	**4**	**23**	**280**	**420**	**700**	
PROGRAM TOTAL (I YEAR)				**37**	**2**	**10**	**44**	**520**	**780**	**1300**	

SEMESTER VII												
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTCC701	Professional Ethics and Entrepreneurship Development	3	a,h,i, j,l	3	0	0	3	40	60	100	89
22BTFT702	Process Economics and Plant Layout Design	2,3	a,b,c	3	0	0	3	40	60	100	91
22BTFT703	Waste Management in Food Industries	1,2,3	a,c,f, g,l	3	0	0	3	40	60	100	93
22BTFT741	Food Packaging Technology	1,2,3	a,b,c, e,j,l	3	0	2	4	40	60	100	95
22BTFT7E	Professional Elective III	-	-	3	0	0	3	40	60	100	-
22BTFT7OE	Open Elective – II	-	-	3	0	0	3	40	60	100	-
22BTFT791	Project Work Phase – I	1,2,3	i,j,k,l	0	0	2	1	40	60	100	98
22BTFT792	Internship	1,2,3	i,j,k,l	0	0	0	4	100	0	100	-
SEMESTER TOTAL				**18**	**0**	**4**	**24**	**380**	**420**	**800**	
SEMESTER – VIII											
Course code	**Course Title**	**Objectives & outcomes**		**Instruction hours / week**			**Credits**	**Maximum Marks**			**Page No**
								CIA	**ESE**	**Total**	
		PEOs	**POs**	**L**	**T**	**P**		**40**	**60**	**100**	
22BTFT801	Food Fermentation Technology	1,3	a,b,d,g	3	0	0	3	40	60	100	99
22BTFT8E	Professional Elective IV	-	-	3	0	0	3	40	60	100	-
22BTFT891	Project Work Phase II	1,2,3	i,j,k,l	0	0	12	6	120	180	300	101
SEMESTER TOTAL				**6**	**0**	**12**	**12**	**200**	**300**	**500**	
PROGRAM TOTAL (I YEAR)				**24**	**0**	**16**	**36**	**580**	**720**	**1300**	

Professional Elective - I

Course code	Course Title	Objectives & out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER – V											
22BTFT5E01	Lipid Processing Technology	1,2, 3	a,c,d,l	3	0	0	3	40	60	100	102
22BTFT5E02	Nonthermal Techniques in Food Processing	1,2	a,c,d,l	3	0	0	3	40	60	100	104
22BTFT5E03	Process Control for Food Engineers	1,2	a,b,d, e	3	0	0	3	40	60	100	106
22BTFT5E04	Cereals and Pulses Technology	1,2, 3	a,c,f, g,l	3	0	0	3	40	60	100	108

Professional Elective – II

Course code	Course Title	Objectives & out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER – VI											
22BTFT6E01	Milling Technology	2,3	a,c,e f, l	3	0	0	3	40	60	100	110
22BTFT6E02	Technology of Oilseeds Processing	1,3	a,b,c, d,l	3	0	0	3	40	60	100	112
22BTFT6E03	Design and Formulation of Foods	1	a,b, c,e	3	0	0	3	40	60	100	114
22BTFT6E04	Functional Foods and Nutraceuticals	1,2	a,b,d, f,l	3	0	0	3	40	60	100	116

Professional Elective – III

Course code	Course Title	Objectives & outcomes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER – VII											
22BTFT7E01	Analytical Methods for Food Products	1,3	a,b, c,d,l	3	0	0	3	40	60	100	118
22BTFT7E02	Traditional and Organic Foods	1,3	a,b, d,g, i	3	0	0	3	40	60	100	121
22BTFT7E03	New Product Development and Sensory Science	2	a,b, d,f,l	3	0	0	3	40	60	100	123
22BTFT7E04	Marketing Management and International Trade	1,2, 3	b,h,i, j,l	3	0	0	3	40	60	100	125
22BTFT7E05	Food Colorants and Flavorants	1	a,g,l	3	0	0	3	40	60	100	127
22BTFT7E06	Novel Food Processing Technologies	1	a,e,g	3	0	0	3	40	60	100	129

Professional Elective – IV

Course code	Course Title	Objectives & out comes		Instruction hours / week			Credits	Maximum Marks			Page No
		PEOs	POs	L	T	P		CIA	ESE	Total	
								40	60	100	
SEMESTER – VIII											
22BTFT8E01	Food Biotechnology	1,3	a,b, e,f	3	0	0	3	40	60	100	131
22BTFT8E02	Supply Chain Management	2,3	a,h, i,k	3	0	0	3	40	60	100	133
22BTFT8E03	Drying Technology for Foods	1,3	a,b,c, e,l	3	0	0	3	40	60	100	135
22BTFT8E04	Extrusion Technology	1,2	a,c,e, f,l	3	0	0	3	40	60	100	137
22BTFT8E05	Food Allergy and Toxicology	2	a,b, f,g	3	0	0	3	40	60	100	139
22BTFT8E06	Total Quality Management	2,3	a,b,d, g,f,i,l	3	0	0	3	40	60	100	141

Open Electives I & II

(offered by Food Technology)

Course code	Course Title	Instruction hours / week			Credits	Maximum Marks			Page No
		L	T	P		CIA	ESE	Total	
						40	60	100	
22BTFTOE01	Processing of Food Materials	3	0	0	3	40	60	100	143
22BTFTOE02	Nutrition and Dietetics	3	0	0	3	40	60	100	145
22BTFTOE03	Ready to Eat Foods	3	0	0	3	40	60	100	147
22BTFTOE04	Agricultural Waste and Byproducts Utilization	3	0	0	3	40	60	100	149
22BTFTOE05	Design of Food Process Equipment	3	0	0	3	40	60	100	151

Open Electives I & II

(preferred by Food Technology)

Course code	Course Title	Instruction hours / week			Credits	Maximum Marks			Page No
		L	T	P		CIA	ESE	Total	
						40	60	100	
COMPUTER SCIENCE AND ENGINEERING									
22BECSOE01	Internet of Things	3	0	0	3	40	60	100	153
22BECSOE03	Block Chain Technologies	3	0	0	3	40	60	100	155
MECHANICAL ENGINEERING									
22BEMEOE01	Computer Aided Design	3	0	0	3	40	60	100	157
BIOTECHNOLOGY									
22BTBTOE04	Fundamentals of Nanobiotechnology	3	0	0	3	40	60	100	159

SEMESTER I

B. Tech. – Food Technology **2022 -2023**

22BTCC101 **Semester - I**

ENGLISH

4H -3C

Instruction Hours/week: L:2 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Enable students to attain fluency and accuracy to inculcate proficiency in professional communication to meet the growing demand in the field of Global communication.
- Help students acquire their ability to speak effectively in real life situations.
- Inculcate the habit of reading and to develop their effective reading skills.
- Ensure that students use dictionary to improve their active and passive vocabulary.
- Enable students to improve their lexical, grammatical and communicative competence.
- Enrich the knowledge of official document writing such as Note taking, Precise writing etc.,

Course Outcomes

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

- Use English language for communication: verbal & non–verbal.
- Enrich comprehension and acquisition of speaking & writing ability.
- Gain confidence in using English language in real life situations.
- Improve word power: lexical, grammatical and communication competence.
- Guide the students to write business letters and other forms of technical writing.
- Enable students to prepare for oral communication in formal contexts.

UNIT: I - BASIC WRITING SKILLS

Sentence Structures - Use of phrases and clauses in sentences - Importance of proper punctuation - Creating coherence- Organizing principles of paragraphs in documents - Techniques for writing precisely.

UNIT: II - VOCABULARY BUILDING

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance, with prefixes and suffixes from foreign languages in English to form derivatives. - Synonyms, antonyms, and standard abbreviations.

UNIT: III – GRAMMAR AND USAGE

Subject-verb agreement - Noun-pronoun agreement - Misplaced modifiers – Articles – Prepositions – Redundancies – Clichés.

UNIT: IV - LISTENING AND READING SKILLS

Note taking- viewing model interviews – listening to informal conversations – improving listening / reading comprehension – reading model prose / poems – reading exercise

UNIT: V -WRITING PRACTICES

Comprehension - Précis writing - essay writing listening comprehension - common everyday situations: conversations and dialogues - communication at workplace – interviews - formal presentations.

Note: Students shall have hands on training in improving listening skill in the language laboratory @ 2 periods per each unit.

Suggested Readings:

1. Sangeeta Sharma , Meenakshi Raman, (2015),Technical Communication: Principles And Practice, 2nd Edition, OUP, New Delhi.
2. Sanjay Kumar and PushpLata, (2011), Communication Skills, Oxford University Press.
3. Liz Hamp - Lyons and Ben Heasly, (2006), Study Writing, Cambridge University Press
4. F.T. Wood., (2007), Remedial English Grammar, Macmillan.
5. Michael Swan, (1995). Practical English Usage, OUP.

MATHEMATICS I

4H -4C

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course Objectives

The goal of this course is for the students to

- Develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- Understand geometrical aspects of curvature and elegant application of differential calculus which are needed in Engineering applications.
- Make the student acquire sound knowledge of techniques in solving ordinary differential equations that model Engineering problems.
- Familiarize the student with functions of several variables which is the foundation for many branches of Engineering.
- Introduce sequence and series which is central to many applications in Engineering.
- Apply differentiation to solve maxima and minima problems which is a foundation course which mainly deals with a single variable.

Course Outcomes

Upon completion of this course the students will be able to

- Find the rank, Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices and the students will be able to use matrix algebra techniques for practical applications.
- Equip the students to have basic knowledge and understanding of differential calculus in the field of Engineering.
- Solve simple standard examples using the ideas of differential equations.
- Apply various techniques to solve Partial Differential Equations.
- Develop the tool of power series for learning advanced Engineering Mathematics.
- Apply the knowledge acquired to solve various Engineering problems.

UNIT I - MATRICES

Introduction - Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction to canonical form through orthogonal reduction. Simple problems using Scilab.

UNIT II – DIFFERENTIAL CALCULUS

Overview of Derivatives - Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes- Evolutes as Envelope of normal

UNIT III - DIFFERENTIAL EQUATIONS

Linear Differential equations of second and higher order with constant coefficients – Homogeneous equation of Euler's and Legendre's type – Method of variation parameters.

UNIT IV – FUNCTIONS OF SEVERAL VARIABLES

Partial derivatives- Homogeneous functions and Euler's theorem - Total derivative - Differentiation of implicit functions - Jacobians -Partial differentiation of implicit functions-Taylor's series for functions of two variables- Errors and approximations - Maxima and minima of functions of two variables- Lagrange's method of undetermined multipliers.

UNIT V - SEQUENCES AND SERIES

Sequences: Definition and examples – **Series:** Types and Convergence – Series of positive terms – Tests of convergence: Comparision test, Integral test and D'Alembert's ratio test – Alternating series – Leibnitz's test – Series of positive and negative terms – Absolute and conditional convergence.

Suggested Readings:

1. Grewal B.S., (2014), Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi.
2. Erwin Kreyszig, (2016), Advanced Engineering Mathematics, 10th Edition, John Wiley, India.
3. BaliN.P. and Manish Goyal, (2014), A text book of Engineering Mathematics, Laxmi Publications, New Delhi, India.
4. Veerarajan T**,** (2008), Engineering Mathematics for first year,Tata McGraw-Hill, New Delhi,.
5. Ramana B.V**,** (2010), Higher Engineering Mathematics, 11th Reprint, Tata McGraw Hill New Delhi.
6. Hemamalini. P.T**,** (2014), Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
7. ThomasG.B and. FinneyR.L**,** (2002), Calculus and Analytic geometry, 9th Edition,Pearson**,**.
8. Michale D. Greenberg, (2011),Advanced Engineering Mathematics, 2nd Edition, Books Pearson Education, First Indian reprint.
9. Peter V. O'Neil,(2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning.
10. Gilbert Strang, (2009), Introduction to Linear Algebra, 4th Edition, Wellesley-Cambridge Press.

Websites:

1. www.efunda.com
2. www.mathcentre.ac.uk
3. www.intmath.com/matrices-determinants
4. www. Intmath.com/calculus/calculus-intro.php

22BTFT141 **Semester - I**

ENGINEERING CHEMISTRY
(Theory & Lab)

6H -5C

Instruction Hours/week: L:4 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students to,

- To learn the basics of Periodic properties, Intermolecular forces.
- To infer the terminologies of electrochemistry and to analyze about energy storage devices.
- To build the concept of corrosion and its prevention.
- To summarize the basic water technology and its purification.
- To analyze about spectroscopic technique.
- To develop an understanding of the range and uses of analytical methods in chemistry.

Course Outcomes

Upon completion of this course, students will be able to,

1. Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
2. Analyse the mechanism of different energy storage devices.
3. Rationalise different types of corrosion and its prevention.
4. List the various methods in the purification of water.
5. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
6. Integrate the chemical principles in the projects undertaken in field of engineering and technology.

UNIT I – PERIODIC PROPERTIES, INTERMOLECULAR FORCES

Introduction to Periodic Properties- atomic and ionic sizes, ionization energies, electron affinity and electronegativity, effective nuclear charge. Penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations. Polarizability, oxidation states, coordination numbers. Ionic, dipolar and van Der Waals interactions

UNIT II – WATER TECHNOLOGY

Sources-Characteristics – Specification for drinking water, BIS &WHO-Alkalinity – Types of alkalinity and determination – Hardness – Types and estimation by EDTA method - Domestic water treatment – Disinfection methods (Chlorination, Ozonation. UV treatment) – Boiler feed water – Requirements – Disadvantages of using hard water in boilers – Internal conditioning (Phosphate, Calgon and Carbonate conditioning

methods) – External conditioning – Demineralization process – Desalination - Reverse osmosis.

UNIT III – ORGANIC REACTIONS AND GREEN CHEMISTRY

Introduction to organic reactions and its mechanism involving substitution, addition, elimination, oxidation, reduction, cyclization and ring opening, Greening of chemistry and industry, Waste minimization and atom economy, Reduction of material use, energy requirement, risk and hazard, Sustainable use of chemical feedstock's, water and energy.

UNIT IV – STEREOCHEMISTRY

Introduction nomenclature stereo descriptors R, S, D and L, Meso nomenclature, Stereoisomerism, Classification, Enantiomers – Optical isomerism, Diastereomers, Optical activity – causes, specific rotation, phenomenon of chirality, Racemization and resolution of enantiomers, Biological importance of chirality – taste, odor, chiral foodstuffs, agrochemicals, pharmaceuticals, stereochemical specificity.

UNIT V - POLYMER CHEMISTRY

Introduction functionality degree of polymerization, Classification of polymers, Natural and synthetic, Thermoplastic and thermosetting, Types and mechanism of polymerization addition (free radical, cationic, anionic and living), Condensation and copolymerization, Properties of polymers Tg, tacticity, molecular weight-weight average, number average and polydispersity index, Techniques of polymerization bulk, emulsion, solution and suspension, Structure, properties and uses of PE, PVC, PC, PTFE, PP, Nylon 6, Nylon 66, Bakelite, Epoxy conducting polymers – polyaniline and polypyrole.

Suggested Readings:

1. P C Jain & Monica Jain, (2015). Engineering Chemistry, Dhanpat Rai Publishing Company
2. B. H. Mahan, (2010). University chemistry, Pearson Education,
3. M. J. Sienko and R. A. Plane, Chemistry: Principles and Applications.
4. C. N. Banwell, (2001) Fundamentals of Molecular Spectroscopy, McGraw-Hill. B. L. Tembe, Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web- book)
5. P. W. Atkins, (2009). Physical Chemistry, Oxford University Press,
6. K. P. C. Volhardt and N. E. Schore, (2014).5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman.

(ii) Laboratory

Course Objectives

The goal of this course is for students to

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

Course Outcomes

Upon completion of the course the students will be able to

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:
- Estimate rate constants of reactions from concentration of reactants/products as a function of time
- Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.

Choice of 10 experiments from the following:

1. Determination of surface tension and viscosity.
2. Determination of Sodium Carbonate and Sodium Hydrogen Carbonate in a mixture using volumetric titration.
3. Determination of Ca / Mg using complexometric titration.
4. Thin layer chromatography.
5. Determination of chloride content of water.
6. Determination of the rate constant of a reaction.
7. Conductometry - Determination of cell constant and conductance of solutions.
8. pH Metry – Determination of Acid / Base.
9. Potentiometry - determination of redox potentials and emfs.
10. Saponification/acid value of an oil.
11. Determination of the partition coefficient of a substance between two immiscible liquids.
12. Adsorption of acetic acid by charcoal.
13. Use of the capillary viscosimeters to demonstrate the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING
(Theory & Lab)

6H -5C

Instruction Hours/week: L:3 T:1 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam: 3 Hours

(i) Theory

Course Objectives

- To impart the basic knowledge about the Electric circuits.
- To understand the concept of Electrical Machines and Transformers.
- To understand the working of Semiconductor devices and Digital Circuits.
- To impart the basic knowledge of Measuring Instruments and Electrical Installation.
- Know the fundamentals of Electrical Engineering and practical.
- Practical implementation of fundamental theory concepts.

Course Outcomes

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

1. Select the electric circuits with DC and AC excitation by applying various circuit laws.
2. Use the Measuring Instruments in Electrical Installation.
3. Interpret the various digital circuits in real time applications.
4. Develop basic applications using various semiconductor devices.
5. Interpret the working operation of the transformer.
6. Understand the working operation of electrical machines.

UNIT I - DC CIRCUITS

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin's and Norton Theorems.

UNIT II - AC CIRCUITS

Representation of sinusoidal waveforms, peak and rms values, Phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III - ELECTRICAL MACHINES AND TRANSFORMER

Construction and working of a three-phase and Single-phase induction motor. Construction, working and speed control of DC motor. Magnetic materials, BH characteristics, Construction and working principle of ideal and practical transformer.

UNIT IV- SEMICONDUCTOR DEVICES AND DIGITAL ELECTRONICS

Bipolar Junction Transistor – Characteristics. Introduction to operational Amplifier – Model–Applications. Number systems – binary codes - logic gates - Boolean algebra, laws & theorems.

UNIT V- MEASURING INSTRUMENTS AND ELECTRICAL INSTALLATION

Principle, construction, and operation of moving coil and moving iron meters-Measurement of Power. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, RCCB, MCCB. Earthing. Types of Batteries and its application in Electric Vehicle, Important Characteristics for Batteries. Elementary calculations for energy consumption and battery backup.

Suggested Books

1. S.K.Bhattacharya, "Basic Electrical Engineering", Pearson, 2019.
2. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010
4. VN Mittle and Arvind Mittal, (2006), Basic Electrical Engineering, McGraw Hill.
5. A.Sudhaka and Shyammohan S Palli, (2013), Circuits and Networks, McGraw Hill.
6. R. Muthusubramanian and S.Salivahanan, (2014), Basic Electrical and Electronics Engineering, McGraw Hill.

Web Links

1. www. nptel.ac.in.
2. encyclopedia-magnetica.com/doku.php/co energy.
3. https://en.wikibooks.org/wiki/electronics/measuring instruments.

(ii) Laboratory

Course Objective

- To impart the basic knowledge about the AC circuits.
- To impart the basic knowledge about the DC circuits.
- To understand the working of Energy Meter.
- To understand the working of DC Machines.
- To impart the knowledge of Logical digital circuits and their differences.
- Know the fundamentals of Electrical Engineering and practical.

Course Outcomes (Cos)

At the end of this course, students will be able

1. Summarize the basics of electric circuits.
2. Analyze the concept of magnetic circuit.
3. Study different meters and instruments for measurement of electrical quantities.

4. Interpret the working principles of DC Machines.
5. Analyze the working principles of Energy Meter.
6. Define the truth table of Logic Gates.

List of Experiments

1. Experimental verification of electrical circuit problems using Ohms law
2. Experimental verification of electrical circuit problems using Kirchoff's Voltage law.
3. Experimental verification of electrical circuit problems using Kirchoff's Current law.
4. Measurement of electrical quantities – voltage, current, power & power factor in R load.
5. Measurement of energy using single phase energy meter.
6. Speed control of DC Shunt Motor.
7. Verification of truth table of Logic Gates.

PYTHON PROGRAMMING
(Theory & Lab)

4H -3C

Instruction Hours/week: L:3 T:1 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam: 3 Hours

(i) Theory

Course Objectives

Students undergoing this course are exposed to:

- Describe the core syntax and semantics of Python programming language.
- Discover the need for working with the strings and functions.
- Illustrate the process of structuring the data using lists, dictionaries, tuples and sets.
- Indicate the use of regular expressions and built-in functions to navigate the file system.
- Infer the Object-oriented Programming concepts in Python.
- Students will solve problems, explore real-world software development challenges, and create practical and contemporary applications.

Course Outcomes

Upon Completion of this course, the student will be able to:

1. Explain various operators used in python.
2. Apply the string handling functions to solve the given problem.
3. Describe Object oriented concepts with python.
4. Use image processing techniques in python programming to solve a given problem.
5. Discuss the functions of networking in python.
6. Solve a given analogy.

UNIT I - INTRODUCTION

Installing Python; basic syntax, interactive shell, editing, saving, and running a script variable, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages.

UNIT II - CONDITIONAL STATEMENT & STRING HANDLING

Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation – Manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab- separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers.

UNIT III - OBJECT ORIENTED PROGRAMMING WITH PYTHON

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects – OOP, continued: inheritance, polymorphism, operator overloading; abstract classes; exception handling, try block

UNIT IV - IMAGE PROCESSING WITH PYTHON

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Program structure and design. Recursive functions Simple Graphics and Image Processing: "turtle" module; simple 2d drawing – colors, shapes; digital images, image file formats, image processing Simple image manipulations with 'image' module (convert to b/w, ray scale, blur, etc).

UNIT V - NETWORKING WITH PYTHON

Multithreading, Networks, and Client/Server Programming; introduction to HTML, interacting with remote HTML server, running html-based queries, downloading pages; CGI programming, programming a simple CGI form.

Text Book:

1. Shroff,"Learning Python: Powerful Object-Oriented Programming: 5th Edition, Fifthedition(24 July 2013).
2. Timothy A. Budd 'Exploring Python' – TATA McGRAW-HILL Edition – 2011.
3. Vamsi Kurama, "Python Programming: A Modern Approach", Pearson Education, 2018.

Reference Book:

1. "Python Essential Reference". Addison-Wesley Professional; 4 edition (July 19, 2009) byDavid M. Baezly.
2. "Python Cookbook" O'Reilly Media; 3rd edition (June 1, 2013) by David M. Baezly.
3. Guido Van Rossum, Fred. L. Drake 'Introduction to Python' – Network Theory Limited –March 2011.
4. Alex Martelli 'Python in a Nutshell' - O'Reilly - 2nd Edition, 2006.

Websites:

1. https://www.codecademy.com/learn/python
2. www.learnpython.org/

(ii) Laboratory

Course Objectives

Students undergoing this course are exposed to:

- Compile, test, and debug simple Python programs.
- Evaluate Python programs with conditionals and loops.
- Utilize functions for structuring Python programs.

- Outline compound data using Python lists, tuples, and dictionaries.
- Apply data from/to files in Python.

Course Outcomes

Upon completion of the course, students will be able to:

- Compile, test, and debug simple Python programs.
- Illustrate Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Utilize Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

LIST OF EXPERIMENTS:

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method).
3. Exponentiation (power of a number).
4. Find the maximum of a list of numbers.
5. Linear search and Binary search.
6. Selection sort, Insertion sort.
7. Merge sort.
8. First n prime numbers.
9. Multiply matrices.
10. Programs that take command line arguments (word count).
11. Find the most frequent words in a text read from a file.
12. Simulate elliptical orbits in Pygame.
13. Simulate bouncing ball in Pygame.

SEMESTER II

B. Tech. – Food Technology **2022 -2023**

22BTCC201 **Semester - II**

COMMUNICATIVE ENGLISH

4H -3C

Instruction Hours/week: L:2 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to

- Acquire their ability to speak effectively in real life situations.
- Enable students to communicate in effective way without any barriers.
- Inculcate the habit of listening and to develop their effective listening skills.
- Ensure that students use different aids in order to attain effective communication.
- Realize the barriers of communication and overcome the barriers.
- Enable students to improve their group behavior and presentation skill.

Course Outcomes

Students undergoing this course will be able to

- Enrich comprehension and acquisition of listening, speaking & writing ability.
- Gain confidence in using English language and develop leadership qualities.
- To guide the students to effectively manage the team as a team player.
- To develop the students Interpersonal and Interview skills.
- Use English language for communication: verbal & non –verbal.
- To enable students to prepare for oral communication in formal contexts.

UNIT I - COMMUNICATION SKILLS

Communication Skills: Introduction, Definition, The Importance of Communication - The Communication Process – Source, Message, Encoding, Channel, Decoding Receiver, Feedback, Context - Barriers to Communication: Physiological Barriers, Physical Barriers, Cultural Barriers, Language Barriers, Gender Barriers, Interpersonal Barriers, Psychological Barriers, Emotional Barriers - Perspectives in Communication: Introduction, Visual Perception, Language, Other factors affecting our perspective-Past Experiences, Prejudices, Feelings, Environment

UNIT 1I - ELEMENTS OF COMMUNICATION

Introduction, Face to Face Communication- Tone of Voice, Body Language (Non-verbal communication), Verbal Communication, Physical Communication. Communication Styles: Introduction, The Communication Styles Matrix with example for each -Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style.

UNIT III - BASIC LISTENING SKILLS

Introduction, Self-Awareness, Active Listening, Becoming an Active Listener, Listening in Difficult Situations. Effective Written Communication: Introduction,When and When Not to Use Written Communication-Complexity of the Topic, Amountof Discussion's Required, Shades of Meaning, Formal Communication. Writing Effectively: Subject Lines, Put the Main Point First, Know Your Audience Organization of the Message.

UNIT IV - INTERVIEW SKILLS AND GIVING PRESENTATIONS

Purpose of an interview, Do's and Don'ts of an interview- Dealing with Fears, planning your Presentation, Structuring Your Presentation, Delivering Your Presentation, Techniques of Delivery.

UNIT V - WRITING PRACTICES

Group Discussion: Introduction, Communication skills in group discussion, Do's and Don'ts of group discussion.

Note: Students shall have hands on training in improving Speaking skill in the language laboratory @ 2 periods per each unit.

Suggested Readings

1. Sanjay Kumar, Pushpalata, (2011), Communication skills,1st Edition Oxford Press.
2. Konarnira, (2011), Communication Skills forprofessionals,2nd Edition New arrivals.
3. JohnAdair,4th Edition, (2009), Effective communication, 1stEdition Cengage Learning
4. India pvt.ltd
5. Butter Field, (2011), Soft skill for everyone, Macmillan.
6. Stephen.P.Robbins, (2013).Communication skills, Oxford Press.

MATHEMATICS II

4H -4C

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to:

- Determine mathematical tools needed in evaluating multiple integrals and their usage.
- Calculate and establish identities connecting the vector quantities, to Evaluate line, surface and volume integrals in simple coordinate systems.
- Utilize Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.
- Apply the knowledge of Mathematics in various Engineering fields by making them to identify the functions in engineering problems as analytic function and their analyze as a function of a complex variables.
- Develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, to specify some difficult integration that appear in applications can be solved by complex integration in application areas such as fluid dynamics and flow of the electric current.
- Utilize Laplace transforms efficiently for solving the problems that occur in various branches of Engineering disciplines.

Course outcomes

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

1. Apply integration to compute multiple integrals, area, volume, integrals in polar and Cartesian coordinates, in addition to change of order and vector integration.
2. Acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
3. Find the Analytic functions using the Cauchy Riemann equations and they will learn mapping properties of elementary functions and mapping properties of some special transcendental functions.
4. Understand relations between conformal mappings and quadratic differentials and how geometric structures are changing under conformal mappings.
5. Evaluate complex integrals using the Cauchy integral formula and the residue theorem and to appreciate how complex methods can be used to prove some important theoretical results.
6. Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

UNIT-I MULTIPLE INTEGRALS

Double integral – Cartesian coordinates – Polar coordinates – Change of order of integration – Triple integration in Cartesian co-ordinates – Area as double integrals.

UNIT-II VECTOR CALCULUS

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem, Gauss divergence theorem and Stoke's theorems (Statement Only)- Surfaces: hemisphere and rectangular parallelopipeds.

UNIT-III ANALYTIC FUNCTIONS

Analytic functions - Cauchy-Riemann equations in Cartesian and polar forms – Sufficient condition for an analytic function (Statement Only) - Properties of analytic functions – Constructions of an analytic function - Conformal mapping: w = z+a, az, 1/z and bilinear transformation.

UNIT-IV COMPLEX INTEGRATION

Complex Integration - Cauchy's integral theorem and integral formula (Statement Only) – Taylor series and Laurent series - Residues – Cauchy's residue theorem (Statement Only) - Applications of Residue theorem to evaluate real integralsaround unit circle and semi-circle (excluding poles on the real axis).

UNIT-V LAPLACE TRANSFORM

Transforms of elementary functions – Basic properties – Transforms ofderivatives and integrals – Initial and final value theorems. Inverse Laplace transforms – Convolution theorem (statement only) – Solution of Ordinary Differential Equations with constant coefficients using Laplace transforms – Transform of periodic functions.

Suggested Readings:

1. Grewal, B.S., (2014), Higher Engineering Mathematics Khanna Publishers, New Delhi, 43rd Edition.
2. Kreyszig Erwin, (2016), Advanced Engineering Mathematics, John Wiley and Sons, 10th Edition, New Delhi.
3. Bali N. P and Manish Goyal, (2011), A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd.
4. Ramana B.V, (2008), Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, New Delhi.
5. Kandasamy. P, Thilagavathy. K, Gunavathy. K., (2008), Engineering Mathematics, S Chand & Co. Ltd, New Delhi.
6. Hemamalini. P.T**,** (2014), Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
7. Venkataraman, M. K., (2005), Engineering Mathematics, The National Publishing Company, Chennai.
8. Dass, H.K., and Er. Rajnish Verma, (2011), Higher Engineering Mathematics, S.Chand Private Ltd.

9. Glyn James, (2012), Advanced Modern Engineering Mathematics, 3rd Edition, Pearson Education.
10. Peter V. O'Neil, (2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning.
11. Sastry.S.S,(2014), Engineering Mathematics''. Vol.I&II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi.
12. Wylie, R.C. and Barrett. L.C., (2012), Advanced Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi.
13. Narayanan. S, Manicavachagampillay.T.K and Ramaniah, (2002),Advanced Mathematics for Engineering Students, Viswanathan S.(Printers and Publishers) Pvt. Ltd. Chennai.

Websites:

1. www.intmath.com
2. www.efunda.com
3. www.mathcentre.ac.uk
4. www.sosmath.com/diffeq/laplace/basic/basic.html

22BTCC203 **Semester - II**

ENVIRONMENTAL STUDIES

3H - 3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to:

- Create the awareness about environmental problems among people.
- Develop an attitude of concern for the environment.
- Motivate public to participate in environment protection and improvement.
- To gain a variety of experiences and acquire a basic understanding of environment and its associated problems.
- To help the individuals in acquiring skills for identifying and solving environmental problems.
- Relate critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

Course Outcomes

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

1. Demonstrate core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Identify concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Distinguish the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Analyze the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Prioritize and analyses the social issues.
6. Integrate the environmental principles in the projects undertaken in field of engineering and technology.

UNIT I – INTRODUCTION - ENVIRONMENTAL STUDIES & ECOSYSTEMS

Environment Definition, Scope and importance; Ecosystem, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Classification of ecosystem. Forest ecosystem, Grass and Ecosystem, Desertecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

UNIT II - NATURAL RESOURCES - RENEWABLE AND NON-RENEWABLE RESOURCES

Natural resources - Renewable and Non – Renewable resources. Land resources and land use change, Land degradation, soil erosion and desertification. Forest resources - Deforestation: Causes and impacts due to mining, dam building on environment,

forests, biodiversity and tribal populations. Water resources- Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water. Use of alternate energy sources, growing energy needs, case studies. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNIT III - BIODIVERSITY AND ITS CONSERVATION

Levels of biological diversity - genetic, species and ecosystem diversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Bio- geographical classification of India. Biodiversity patterns (global, National and local levels). Hot- spots of biodiversity. India as a mega-diversity nation. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT IV - ENVIRONMENTAL POLLUTION

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution. Nuclear hazards and human health risks. Solid waste management and control measures of urban, industrial and e-wastes. Role of an individual in prevention of pollution. Case studies.

UNIT V - SOCIAL ISSUES AND THE ENVIRONMENT

Concept of sustainability and sustainable development. Water conservation -Rain water harvesting, watershed management. Climate change, global warming, ozone layer depletion, acid rain and its impacts on human communities and agriculture. Environment Laws (Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act). International agreements (Montreal and Kyoto protocols). Resettlement and rehabilitation of project affected persons. Disaster management (floods, earthquake, cyclones and landslides). Environmental Movements (Chipko, Silent valley, Bishnois of Rajasthan). Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). Human population growth: Impacts on environment, human health and welfare.

Suggested Readings:

1. Anubha Kaushik., and Kaushik, C.P. 2004. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, New Delhi.
2. Erach Bharucha. 2004. A text book for Environmental Studies, University Grants Commission and Bharat Vidypeeth Institute of Environmental EducationResearch, New Delhi.
3. Rajagopalan, R. 2016. Environmental Studies: From Crisis to Cure, Oxford University Press.
4. Sing, J.S., Sing. S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Publishing Company, New Delhi.

5. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S. Chand& Company Pvt. Ltd., New Delhi.
6. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.
7. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.
8. Tripathy. S.N., and Sunakar Panda. (2004). Fundamentals of Environmental Studies (2nd ed.). Vrianda Publications Private Ltd, New Delhi.
9. Verma, P.S., and Agarwal V.K. 2001. Environmental Biology (Principles of Ecology). S. Chand and Company Ltd, New Delhi.
10. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, New Delhi.

22BTCC204 **Semester - II**

FUNDAMENTALS OF FOOD SCIENCE AND TECHNOLOGY

3H - 3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Understand the history and evolution of food processing.
- Acquire knowledge on the structure and composition of foods.
- Discuss the nutritional quality and post-harvest changes of various plant foods.
- Study the structure and composition of various animal foods.
- Understand the functions of food.

Course Outcomes

Upon successful completion of the course, students will be able to,

1. Understand the history, development and present status of Food Science and Technology.
2. Explain the significance and basic concepts of the Food technology.
   be aware of the skills required to be a professional food technologist
3. Know the scope for self-employment as small, medium or large-scale entrepreneurs.
4. Acquire knowledge on the principles of food preservation.
5. Assess novel processed foods.

UNIT I - INTRODUCTION

Historical evolution of food processing technology. Basic concepts of food science, food processing, Food technology and food manufacturing, Development of Food Processing and Technology, Importance of Food Processing and Preservation,

UNIT II – FOOD GROUPS

Compositional, Nutritional and Technological aspects of Plant foods; Cereals and Millets, Pulses, Fats and Oils, Fruits and Vegetables - Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fibre. Compositional, Nutritional and Technological aspects of Animal foods; Flesh Foods - Meat, Fish, Poultry and egg.

UNIT III - METHODS OF FOOD HANDLING AND STORAGE

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

UNIT IV - FOOD PRESERVATION

Preservation of food by salt, sugar, high temperature, Preservation by use of low

temperature – Chilling, freezing and cold storage - Principle, methods and equipment - Preservation by drying, dehydration and concentration - Principle, methods and equipment. Irradiation and fermentation.

UNIT V - PROCESSED FOODS

Classification of processed food on the basis of extent and type of processing; Minimally processed foods, Preserved foods, Manufactured foods, Formulated foods, Food derivatives, Pharmaceuticals and Functional foods.

Suggested Readings:

1. Srilakshmi, B. 2005. Food Science, 3rd edition. New Age International (P) Ltd. Publishers, New Delhi.
2. Manay N.S and Shadaksharaswamy, M.(2001). Foods facts and principles. Wiley Eastern Ltd. New Delhi, Bangalore, Bombay, Calcutta , Hyderabad.
3. R.P. Srivastava and Sanjeev Kumar. 2002. Fruit and Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi.
4. Potter, N. N., & Hotchkiss, J. H. (2012). Food science. Springer Science & Business Media.

ENGINEERING PHYSICS
(Theory & Lab)

6H -5C

Instruction Hours/week: L:3 T:1 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives

The Goal of this course is for students to

- Inculcate the basics of properties of matter, sound and its applications.
- Understand the basics of laser and optical fiber with appropriate applications.
- Disseminate the fundamentals of thermal physics and their applications.
- Introduce the concepts of quantum mechanics for diverse applications.
- Impart the basic knowledge of crystal and its various crystal structures.

Course Outcomes

Upon completion of this course, the students will be able to

1. Understand the elastic nature of materials.
2. Infer the characteristics of laser for various engineering applications.
3. Extend the knowledge on optical fiber for communication purposes.
4. Illustrate the thermal properties of materials through various methods.
5. Develop the idea of quantum mechanics through applications.
6. Identify the different atomic arrangements of crystals and its defects.

UNIT I – PROPERTIES OF MATTER AND SOUND

Elasticity – stress - strain diagram - factors affecting elastic modulus - tensile strength – Poisson's ratio – Twisting couple - Torsion pendulum- bending of beams – bending moment – young's modulus – uniform and non-uniform bending – I- shaped girders. Basics of sound - Sabine's formula – acoustic quality - Ultrasound– Production, Industrial and medical applications.

UNIT II – LASER AND FIBER OPTICS

Light: Introduction – various phenomena – LASER - characteristics - Einstein's co-efficients derivation. Nd:YAG, CO_2, Semiconductor LASER- Applications of LASER in industry and medicine. Fiber optics - principle– modes of propagation of light in optical fibers – numerical aperture and acceptance angle – Attenuation - types of optical fibers (Material, refractive index and mode) – fiber optical communication system (block diagram) - Fiber optic sensors

UNIT III – THERMAL PHYSICS

Laws of thermodynamics - thermal expansions – bimetallic strips – Mode of heat transfer - thermal conductivity, Forbe's and Lee's disc method: theory and experiment – heat conduction through compound media (series and parallel) – Joule Thomson's

effect – porous plug experiment – refrigerating mechanisms – Air conditioning mechanisms - microwave oven and solar water heater.

UNIT IV – QUANTUM PHYSICS

Black body radiation - Photo electric effect – Compton effect –De Broglie hypothesis - uncertainty principle – super position principle - wave function and wave packets – Phase and group velocities - Schrödinger's wave equations – probability of fining a particle in one dimensional box- physical significance of wave function – Expectation values – Degeneracy.

UNIT V – CRYSTAL PHYSICS

Crystalline and amorphous solids – crystal structure - unit cell, primitive cell - crystal systems, Bravais lattices, Miller indices – inter-planar distances - Coordination number and packing factor for SC, BCC, FCC, HCP structures – ZnS and diamond structure – quasi crystal and liquid crystal – defects in crystal.

Suggested Readings:

1. Bhattacharya D.K. & Poonam T., Engineering Physics, Oxford University Press, 2015.
2. Gaur R.K. and Gupta S.L, Engineering Physics, Dhanpat Rai Publications, 2012.
3. Pandey. B.K. & Chaturvedi.S, Engineering Physics, Cengage Learning India, 2012.
4. Halliday.D., Resnick R. & Walker. J, Principles of Physics, Wiley, 2015.
5. Charles Kittel, Kittel's Introduction to Solid State Physics, Wiley India Edition, 2019.
6. P.M. Mathews, K.Venkatesan, A text book of Quantum Mechanics, 2/e, Mc Graw Hill Education, 2017.
7. Laser Fundamentals, William T Silfvast, Cambridge Univ Press. 2012.
8. Fiber Optics and Optoelectronics, R P Khare, Oxford, 2012.
9. Daniel V.Schroeder, An Introduction to Thermal Physics, Pearson, 2014.
10. D.S. Mathur, Elements of properties of matter, S.Chand, 2010.

Journals:

1. Nature Physics.
2. Journal of Applied Mechanics (ASME).
3. Ultrasonics and sonochemistry (Elsevier).
4. Journal of Light wave Technology (IEEE).
5. Optics and Laser Technology (Elsevier).
6. Applied Thermal Engineering (Elsevier).
7. Physical Review B (American Physical Society).

Weblinks:

1. https://nptel.ac.in/courses/122/103/122103011/
2. https://nptel.ac.in/courses/113/104/113104081/
3. http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/lascon.html

(ii) Laboratory

Course Objective

- To learn the basic concepts in physics relevant to different branches of Engineering and Technology.

Course Outcome

- To familiarize the properties of material and basic concepts in physics.

LIST OF EXPERIMENTS – PHYSICS (Any 8 Experiments)

1. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of disc.
2. Uniform bending (or) Non-uniform Bending – Determination of young's modulus.
3. Viscosity of liquids-Determination of co-efficient of viscosity of a liquid by Poiseuille's flow.
4. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.
5. Laser- Determination of the wave length of the laser using grating, Acceptance angle of optical fiber.
6. Spectrometer- Determination of wavelength using grating.
7. Air wedge – Determination of thickness of a thin sheet/wire.
8. Lee's disc – Determination of thermal conductivity.
9. Determination of Band gap of a semiconductor.
10. Characteristics of photo diode.

22BTFT211 **Semester - II**

WORKSHOP PRACTICES

3H - 2C

Instruction Hours/week: L:1 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- To prepare the students to gain the knowledge about various manufacturing methods.
- To impart knowledge on the operations in CNC machining.
- To prepare the students to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- To provide practical knowledge on the use of Basic Electrical Components.
- To provide practical knowledge on the use of Electronic components.
- To provide practical knowledge on carpentry and domestic wiring circuits.

Course Outcomes

Upon completion of this course, the students will:

1. Understand different manufacturing processes which are commonly employed in the industry.
2. Fabricate components using different methods.
3. Apply knowledge on fabrication of various components.
4. Create study models in interdisciplinary domain.
5. Able to understand concepts of basic in hand practices.
6. Assemble different components and produce small devices of their interest.

(i) LECTURES & VIDEOS:

Detailed contents

1. Study on various manufacturing methods- Casting, Forming, Machining and Welding.
2. Study on CNC machine operation.
3. Study on Fitting operations and power tools.
4. Study on Soldering process, Motor coil winding and Solar PV Cells.
5. Study on P-N Junction Diode Characteristics.
6. Study on Carpentry.
7. Study on Domestic wiring circuits.

(ii) WORKSHOP PRACTICE:

1. Machine shop.
2. Fitting shop.
3. Welding shop.
4. Casting.
5. Plumbing Exercises.

Suggested Readings:

1. Gowri S, Jeyapoovan, T.Engineering Practices Lab Manual, 5th edition, Vikas Publishing House Pvt. Ltd,Chennai. 2017.
2. Bawa, H.S, Workshop Practice, 2nd edition, Tata McGraw – Hill Publishing Company Limited, New Delhi,2009.
3. Choudhry S K, Elements of workshop technology, Vol 2, 13th edition, Indian book distributing company,Kolkatta, 2010.
4. D K Singh, Manufacturing Technology, 2nd edition, Pearson Education, 2008.
5. Kalpakjian S., Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, PearsonEducation India Edition, 2001.
6. Roy A. Lindberg, Processes and Materials of Manufacture, 4th edition, Prentice Hall India, 1997.
7. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, 4th edition, Tata McGraw Hill House, 2018.

ENGINEERING GRAPHICS

4H - 3C

Instruction Hours/week: L:2 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

1. To enhance visualization skills, which will facilitate the understanding of engineering systems.
2. To prepare the students to design the components with realistic constraints.
3. To make the students to consider economic, environmental, ethical, health and safety when they design.
4. To make the students to design the components with considering manufacturability, and sustainability
5. To communicate effectively through drawings.
6. To make the students to understand to use necessary for engineering practice.

Course Outcomes

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

1. Know the engineering design and its place in society.
2. Understand the visual aspects of engineering design and engineering graphics standards.
3. Make the engineering communication effectively.
4. Prepare the 2D free hand sketching.
5. Acquire the knowledge of projections of points, lines and plane surfaces.
6. Understand the basic concept of projection of solids.

UNIT I - INTRODUCTION

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Bureau of Indian Standards (BIS), Layout of drawing sheets, sizes of drawing sheets, different types of lines used in drawing practice geometric constructions, principles of dimensioning– linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension. Reducing Scale, Enlarging Scale, Plain Scale, Diagonal Scale and Vernier Scale. Conic sections including the Ellipse, Parabola and Hyperbola (eccentricity method only); Cycloid, Epicycloid, Hypocycloid and Involute.

UNIT II - FREE HAND SKETCHING

Representation of Three-Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects.

UNIT III - INTRODUCTION TO COMPUTER GRAPHICS – 2D

Overview of Computer Graphics, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software, Consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Annotations, layering& other functions. Sketching of 2D simple geometries, editing and dimensioning of 2D geometries.

UNIT IV - PROJECTION OF POINTS AND LINES

Projection of points and straight lines located in the first quadrant inclined to both planes– Determination of true lengths and true inclinations (By using CAD software).

UNIT V - PROJECTION OF PLANE SURFACES

Projection of polygonal surface and circular lamina inclined to both reference planes (By using CAD software).

Suggested Readings:

1. Venugopal K and Prabhu Raja V, (2021), Engineering Graphics, New Age International Publishers.
2. C M Agrawal and Basant Agrawal, (2019), Engineering Graphics, Tata McGraw Hill, New Delhi.
3. James D. Bethune, (2020), Engineering Graphics with AutoCAD, Macromedia Press.
4. Narayana, K.L. & P Kannaiah, (2010), Text book on Engineering Drawing, Scitech Publishers.
5. Shah, M.B. & Rana B.C., (2017), Engineering Drawing and Computer Graphics, Pearson Education.
6. Bhatt N.D., Panchal V.M. & Ingle P.R, (2019), Engineering Drawing, Charotar Publishing House.

SEMESTER - III

B. Tech. – Food Technology **2022 - 2023**

22BTFT301 **Semester-III**

MATHEMATICS - III

TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATION

4H-4C

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier, transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

Course outcomes

Upon successful completion of the course, students should be able to:

1. Solve the given standard partial differential equations.
2. Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
3. Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
4. Apply the mathematical principles of transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
5. Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.
6. The learners can equip themselves in the transform techniques and solve partial differential equations.

UNIT I - PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II - FOURIER SERIES

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT III - APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of PDE – Method of separation of variables - Fourier Series Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction.

UNIT IV - FOURIER TRANSFORMS

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V - Z TRANSFORMS AND DIFFERENCE EQUATIONS

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

Suggested Readings:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
3. Vasishtha A.K , Gupta R K, Integral Transforms, Krishna Prakashan Media, 2016.
4. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
5. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
6. James, G., "Advanced Modern Engineering Mathematics", 5th Edition, Pearson Education, 2012.
7. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
8. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
9. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 2007.
10. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.

Websites:

1. www.sosmath.com
2. http://mathworld.wolfram.com/FourierSeries.html
3. http://www.math.umn.edu/~olver/pdn.html
4. http://www.facstaff.bucknell.edu/mastascu/econtrolhtml/sampled/sampled.html

ENGINEERING PROPERTIES OF FOOD MATERIALS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Describe the physical properties of food materials.
- Explain the rheology of food and use of viscometer and texture analyzer in food industry.
- Develop knowledge on thermal properties of food commodities.
- Outline the aerodynamic and hydrodynamic properties of foods.
- Define the electrical properties of food and its applications in food engineering.

Course Outcomes

Upon successful completion of the course, students will be able to,

1. Estimate the physical properties of food materials.
2. Report the frictional properties and storage of agricultural crops.
3. Compare and contrast the Newtonian and non-Newtonian fluids.
4. Express the overall thermal properties of food materials.
5. Measure the aero- and hydrodynamic characteristics and the application of frictional properties in grain handling, processing and conveying.
6. Demonstrate the dielectric and radiation heating properties of foods.

UNIT I - PHYSICAL PROPERTIES OF FOODS

Mass, Area, Volume, Methods of estimation of Shape, Size, volume, density, porosity and surface area, sphericity, roundness specific gravity. Particle size distribution Frictional properties- coefficient of friction, Storage and flow pattern of agricultural crops, Acoustic properties of food materials.

UNIT II - RHEOLOGICAL PROPERTIES OF FOODS

Stress, Strain, Elasticity, Tensile strength, Plasticity, Deformation of food materials. Newton's law of viscosity – momentum-diffusivity- kinematic viscosity – viscous fluids – Newtonian and Non-Newtonian fluids- Viscosity Measurements-Viscometers of different types and their applications- Mechanical hysteresis, Viscoelasticity, Food Textural attributes, Texture measuring instruments.

UNIT III - THERMAL PROPERTIES OF FOODS

Definitions of Heat capacity, specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient, Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity, DTA, TGA, DSC, Steady state and Transient heat flow.

UNIT IV - AERODYNAMIC AND HYDRODYNAMIC PROPERTIES OF FOODS

Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials. Reynold's Number Water activity- measurement-vapor pressure method –freezing point depression method- Effect of temperature, and pressure on water activity-moisture sorption isotherms- models-Henderson, PET and GAB models, Criteria of Equilibrium, Raoult's & Henry's law.

UNIT V – ELECTRO-MAGNETICAND OPTICAL PROPERTIES OF FOODS

Dielectric properties-dielectric constants, Dielectric measurements- Ionic Interaction-Dipolar rotation. Effect of moisture, temperature and pressure on dielectric properties. Colour, Reflectance, Diffraction, Absorption, Radiation, Colour measurement – Lightness, Hue, Saturation. CIE & LAB Colour systems.

Suggested Readings:

1. Serpil Sahin and Servet Gulum Sumnu. Physical Properties of Foods. Springer. USA, 2007.
2. Nuri N. Mohsenin. Thermal Properties of Food & Agricultural materials", Gordon and Reach sciencepublishers, 1990.
3. Rao, M.A and S.S.H. Rizvi. Engineering Properties of Foods. Mercel Dekker Inc. New York 4th Edition, 2014.
4. Lewis M.J. Physical properties of foods and food processing systems. Wood head publishing Cambridge, UK, 2006.
5. Shafiur Rehman. Food Properties Hand book. CRC press inc. New York, 2nd Edition, 2009.
6. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company inc, Westport USA, 1983
7. Kachru R.P.and R.K. Gupta, "Physico – Chemical Constituents and Engineering Properties of Food crops", Scientific publishers, Jodhpur.

22BTFT303 **Semester- III**

POST HARVEST TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Discuss the basics of postharvest storage practices.
- Outline the postharvest losses of different food grains.
- Understand the proper separation and storage practices.
- Discuss various constraints of milling and their economy.
- Explain different methods used for material handling systems.

Course Outcomes

Upon completion of this course, students will able to,

1. Apply their knowledge of post-harvest storage practices.
2. Acquire knowledge on reduction of post-harvest losses.
3. Develop new methods for the storage of food grains.
4. Analyze the different methods of milling and their economic importance.
5. Interpret the methods of material handling systems.
6. Extrapolate the post-harvest technology practices.

UNIT I - OVERVIEW OF POST-HARVEST TECHNOLOGY

Concept and science, Introduction to different agricultural crops, their cropping pattern, production, harvesting and post-harvest losses- Transpiration, water loss and deterioration in quality. Respiration, maturation, ripening, senescence and biochemical changes affecting quality and marketability. Ethylene effect – application and control. Temperature effect – heat, chilling and freezing injury, reasons for losses, importance of loss reduction, Post- Harvest Handling operations.

UNIT II - CLEANING SORTING AND GRADING

Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance. Kinetics of quality changes: physical, chemical, sensory and nutritional changes during handling for processing

UNIT III - SEPARATION, DECORTICATING AND SHELLING

Magnetic separator, destoners, electrostatic separators, pneumatic separator Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.

UNIT IV - MILLING AND MATERIALS HANDLING

Milling, polishing, grinding, milling equipment, de huskers, polishers(abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement Introduction to different conveying equipment used for handling of grains, fruits and vegetables; Post harvest treatment to increase shelf life i.e. freezing, chilling, dehydration, canning, thermal processing. Scope and importance of material handling devices

UNIT V - STUDY OF DIFFERENT MATERIAL HANDLING SYSTEMS

Classification, principles of operation, conveyor system selection/design Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper Chain conveyor: Principle of operation, advantages, disadvantages, capacity andspeed, conveying chain screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors Bucket elevator:Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge,buckets types, power requirement Pneumatic conveying system: types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Suggested Readings:

1. Amalendu Chakraverty and R. Paul Singh. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
2. Chakraverty. 2008. Post- Harvest Technology of Cereals, Pulses and Oilseeds, 3rdEd. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw- Hill Co., Inc., NY, USA.
4. James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.
5. K.M. Sahay and K.K. singh. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.

22BTFT304 **Semester-III**

FOOD PROCESS CALCULATIONS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Describe the basic units, dimensions and basic related functions involved in food process engineering.
- Recognize the various law governing the gases and vapors
- Explain the material balance and law of conservation of energy.
- Solve problems in Energy balance in heat exchangers.
- Define the types, properties and agitation processes in fluids.

Course Outcomes

Upon successful completion of the course students will be able to:

1. Enumerate the units and dimensions of various physical quantities.
2. Explain the laws and theory of gases and vapors.
3. Calculate the material balance in food processing units.
4. Verify the energy balance involved in food processing operations.
5. Describe the types and properties of fluid flow.
6. Demonstrate the processes of agitation in fluids.

UNIT I - DIMENSIONS AND UNIT

Fundamental -derived units. Definitions of some basic physical quantities – Force, momentum, pressure, work and energy, power, heat and enthalpy. Dimensional analysis. Mole - atomical molar mass. Moisture content. -water activity. Conversions and calculations of RPM- RCF, normality, molality, molarity, PPM and PPB, Fundamental Calculations and Humidity: Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity.

UNIT II - STOICHIOMETRY

Basic Principles of Stoichiometry - Importance of material balance and energybalance in a process Industry-Dimensions, Units, conversion factors and their use – Data sources, Humidity and applications. Material Balance: Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallization, drying, extraction, Leaching

UNIT III - MATERIAL BALANCE

Law of Conservation of mass- Process flow diagram-system boundaries - overall mass balance – component mass balance –basis and tie material- Continuous vs. Batch-Recycle and by pass-unsteady state -mass balance problems on

concentration, dehydration, evaporation, crystallization, mixing –solvent extraction – multi stage process.

UNIT IV - ENERGY BALANCE

Heat capacity – gases – solids – liquids -Latent heat – sensible heat -energy balance for a closed system and open system -total energy balances. Energy balance problems in heat exchangers –Drying. Use of mean heat capacity in heat calculations,problems involving sensible heat and latent heats, evaluation of enthalpy.

UNIT V - FLUID MECHANICS AND AGITATION OF FLOW THROUGH PACKINGS

Fluid – properties – compressible, incompressible fluids, Newtonian and Non-Newtonian Fluids, Fluid statics for compressible & incompressible. Agitation – power requirement, Flow in packed columns, flow in fluidization columns, settling phenomena, Flow measurement, pumping of liquids and gases – equipments.

Suggested Readings:

1. Romeo T. Toleda. (2000). “Fundamentals of Food Process Engineering “, Chapman & Hall, USA, CBS publications, New Delhi.
2. Smith, PG. (2004). “Introduction to Food Process Engineering “, Springer.
3. Paul Singh R and Dennis R. Heldman (2004) “Introduction to Food Engineering”. Academic Press – Elsevier India Private Ltd. New Delhi.
4. Bhatt, B.L and Vora, S.M., "Stoichiometry", Third Edition, McGraw-Hill, New York, 2004.
5. Venkataramani, V. and Anantharaman, N., "Process Calculations”, Prentice Hall of India, New Delhi, 2011.

22BTFT305 **Semester-III**

THERMODYNAMICS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- State the fundamentals and calculations involved in zeroth law of thermodynamics.
- Discuss the applications of first law of thermodynamics.
- Illustrate the knowledge on second law of thermodynamics and entropy.
- Describe thermodynamic properties of pure substances, its phase change processes and to study the working principle of steam boilers.
- Explain the working principle of carnot, vapor compression, vapor absorption and air refrigeration systems.

Course Outcomes

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

1. Understand the laws, concepts and principles of thermodynamics.
2. Apply first law of thermodynamics to closed and open systems.
3. Solve problems related to cycles and cyclic devices using second law of thermodynamics.
4. Calculate the thermodynamic properties of pure substances and phase change processes
5. Discuss the classification, working and accessories of steam boilers
6. Understand the working of carnot, vapour compression, vapor absorption and air refrigeration systems.

UNIT I - BASIC CONCEPTS AND FIRST LAW

Thermodynamics, Terminologies, systems – classification – properties and state of a system. Thermodynamic process, cycle and equilibrium. Zeroth law of thermodynamics. Law of conservation of energy. Heat – specific heat – thermal capacity and water equivalent. Mechanical equivalent of heat, work – power - universal gas constant. Internal energy, enthalpy and molar specific heat of a gas. First law of thermodynamics – Limitations of first law of thermodynamics

UNIT II - APPLICATION OF FIRST LAW OF THERMODYNAMICS TO NON-FLOW AND FLOW PROCESSES

Work done during a non-flow process - Work done for constant volume, constant pressure, constant temperature, adiabatic and polytropic process. Application of first law of thermodynamics to a steady flow system - boiler, condenser, evaporator, nozzle, turbine, rotary and reciprocating compressor.

UNIT III - SECOND LAW OF THERMODYNAMICS

Kelvin planck and Clausius statements. Heat engine, heat pump and refrigeration. Relation between heat and entropy – Importance and units of entropy – Clausius inequality - available and unavailable heat energy.

UNIT IV - STEAM PROPERTIES AND BOILERS

Formation of steam at a constant pressure – Temperature vs total heat during steam formation. Wet, dry saturated and super-heated steam – Dryness fraction of wet steam – Enthalpy and specific volume of steam – uses of steam tables. Boilers: Classification of steam boilers, Vertical and Cross tube Cradley boiler, Cochran, Lancashire, Locomotive and Babcock-Wilcox boilers. Boiler mountings and accessories.

UNIT V - REFRIGERATION SYSTEMS AND COMPONENTS

Principles of refrigeration, choice of refrigerants, components of refrigeration cycle. Types of refrigeration: Carnot refrigeration, vapor compression cycle, air refrigeration cycle, absorption refrigeration cycle.

Suggested Readings:

1. Narayanan, K.V. (2013). A Text book of chemical engineering thermodynamics. 2nd Edition. PHI Learning Private Limited.
2. Rajput, R.K. (2009). Engineering Thermodynamics. 3rd Edition. Laxmi Publication. New Delhi.
3. Nag, P.K. (2017). Engineering Thermodynamics. 6th Edition. McGraw Hill Education (India) Private Limited.

FOOD MICROBIOLOGY
(Theory and Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students to,

- Describe the basic concepts and factors affecting the growth of microorganisms.
- Define the preservation of foods using temperature as a parameter.
- Analyze the role of drying, additives and radiation in the food preservation.
- Identify the microorganisms associated with the food fermentation processes.
- Explain about the food borne illness and sanitation in food industries.

Course Outcomes

Upon successful completion of the course students will be able to,

1. Recognize the general concepts and factors affecting the growth of microorganisms.
2. Infer the different temperature range as control agent for food preservation.
3. Outline the methods include drying, additives and radiation to prevent microbial spoilage.
4. Select the microbial cultures for preparing various fermented food products.
5. Evaluate the pathogenesis of food borne pathogens and food poisoning.
6. Enumerate the bacteriology of water and sanitation measures in food industries.

UNIT I - FOOD AND MICROORGANISMS

General concepts about molds, bacteria and yeasts. Gram Positive and Gram-Negative bacteria Factors affecting growth of microorganisms – pH, water activity, oxidation – reduction potential, nutrient content, inhibitory substances and biological structure – combined effects of factors affecting growth. Microbial spoilage of food, Detection and enumeration of microorganisms, control of microbial growth.

UNIT II - MICROBIOLOGY OF PRESERVATION – HIGH AND LOW TEMPERATURES

Heat resistance of microorganisms and their spores, Determination of heat resistance Effect of high temperature on microbes – TDT, D value, Z value, 12D concept, F value**.** Pasteurization and canning Growth of microorganisms at low temperatures, temperatures employed in low temperature storage, freezing – preparation, freezing and changes occur in foods, response of microorganisms to freezing, Indicator Microorganisms, Tolerance of microorganisms to thermal processing.

UNIT III - MICROBIOLOGY OF PRESERVATION – DRYING, ADDITIVES AND RADIATION

Drying – Methods, factors in the control of drying, treatments before and after drying, microbiology of dried foods and specific dried foods, IMF. Additives – Antimicrobial preservatives, antibiotics and developed preservatives. Radiation – Ultraviolet radiation, factors influencing, ionizing radiations - effect on microorganisms and foods, Microwave processing. Tolerance of microorganisms to chemical processing.

UNIT IV - FOOD FERMENTATION

General principles of culture maintenance and preparation – Bacterial, Yeast and mold cultures. Manufacture, spoilage and defects of Bread, malt beverages – beer and related beverages, wines, distilled liquors, vinegar, fermented vegetables – sauerkraut and pickles, fermented dairy products – yogurt, kefir, kumiss, probiotics and prebiotics cheese, SCP, oriental fermented foods – soy sauce, tempeh, miso, ang-khak, idli, natto, soybean cheese, Minchin, fermented fish, preserved eggs, and poi.

UNIT V - FOOD BORNE ILLNESS AND SANITATION

Food borne diseases – Clostridium, E. coli, Listeria, Bacillus, Mycotoxins – Aflatoxin, Patulin and ochratoxin, seafood toxicants – shellfish poisoning, ciguatera, scombroid fish poisoning, Food borne viruses; Helminths, nematodes and protozoa, poisoning by chemicals, Bacteriology of water supplies – Sewage and waste treatment and disposal-Microbiology of the food product - Good Manufacturing Practices (GMP) – Hazard Analysis and Critical Control Points (HACCP).

Suggested Readings:

1. Adams M.R and Moss M.O, (2007). "Food Microbiology", 2nd Edition, Third reprint, Panima Publishing Corporation, New Delhi,
2. William C Frazier and Dennis C. Westoff, (2008). "Food Microbiology", Special Edition, Springer, The Mc Graw-Hill Companies.
3. Montville, Thomas J. and Karl R. Matthews "Food Microbiology: An Introduction". ASM Press, 2005.
4. Doyle, Michael P. "Food Microbiology: Fundamentals and Frontiers". 2nd Edition, ASM Press, 2001.
5. Pawsey, R. K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.

(ii) Laboratory

Course Objectives

The goal of this course is for students,

- To explain the working principle of microscopes and sterilization techniques.
- To outline the preparation of media for the cultivation of microorganisms.
- To identify the isolated strains using staining techniques and biochemical tests.
- To perform staining techniques and practice various staining methods.
- To apply various biochemical test to identify microorganisms in contaminated food.

Course Outcomes

Upon successful completion of the course students will be able to,

1. Perform aseptic technique to properly handle microorganisms to avoid contamination.
2. Use the knowledge to handle microscopes to observe stained microorganisms.
3. Enumerate the microorganisms to check the quality characteristics of food.
4. Isolate the pure culture from mixed population found in contaminated foods.
5. Identify the microorganisms using staining techniques.
6. Test the quality of water and milk.

LIST OF EXPERIMENTS

1. Microscopy: working and applications.
2. Sterilization techniques and applications.
3. Preparation of culture media, broth and slants.
4. Staining methods: simple and differential staining.
5. Demonstration of bacterial motility by hanging drop method.
6. Microbiological examination of water quality by MPN method.
7. Bacteriological testing of milk.
8. Enumeration of microbes in spoiled food.
9. Production of wine and estimation of alcohol content.
10. Demonstration of beer production.

FOOD CHEMISTRY
(Theory and Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives
The goal of this course is for students to,

- Explain the properties of biomolecules and its reactions involved.
- Identify the functional role of food components and their interaction in food products in terms of colour, flavour, texture and nutrient composition.
- Discuss and use effectively, food composition tables and databases.
- Compare the various physical and chemical properties of foods.
- Illustrate the analysis of proteins and lipids.

Course Outcomes
Upon successful completion of this course, students will be able to,

1. Summarize the structure of molecules, its reactions and interactions of food components in food products.
2. Recall the use of food composition tables and databases.
3. Categorize the physical and chemical properties of food.
4. Recognize the analysis test of proteins and lipids.
5. Assess the importance of minerals and vitamins in food.
6. Employ the use of color and other flavor compounds present in food.

UNIT I - CARBOHYDRATES

Simple Sugars: mono and disaccharides, Hygroscopcity & solubility, optical rotation, muta rotation; sensory properties-sweetness index, caramelization, Maillard reaction; Glucose syrup, high fructose corn syrup, Dextrose Equivalent, Degree of polymerisation; Sugar alcohols; Oligosaccharides: structure, nomenclature, occurrence, uses in foods. Polysaccharides: Starch- amylose and amylopectin- properties, thickening &gelatinization, modified starches, resistant starch, Dextrins anddextrans, Starch hydrolysates – Maltodextrins and dextrins; Pectins, gums & seaweeds- gel formation & viscosity. Fiber Cellulose & hemicellulose; Food sources, functional role and uses in foods.

UNIT II - PROTEINS

Proteins in foods -classification, structure and properties of amino acids; Essential amino & Non- Essential amino acids. Review of protein structure & conformation;

Chemical and Physical properties of Proteins. Reactions of proteins in food systems: Dissociation, optical activity, solubility, hydration, swelling, foam formation &stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Food enzymes- classification, kinetics, production and applications; Mechanism of enzyme action. Determination of proteins in food.

UNIT III - LIPIDS

Lipids in foods - occurrence, classification, structure of simple, compound and derived lipids. Nomenclature of fats. Non-glyceride components in fats& oils; Properties of fats & oils: crystal formation, polymorphism, melting points, plasticity, isomerization, unsaturation; Modification of fats: hydrogenation- cis and trans isomers, interesterification, acetylation, winterization; Hydrolytic rancidity & oxidative rancidity; radiolysis Shortening power of fats, tenderization, emulsification, frying – smoke point, autooxidation, polymerization; Fat replacements; Food sources, functional role and uses in foods.

UNIT IV - WATER, MINERALS AND VITAMINS

Water: Structure of water molecule, Chemical and physical properties of water, Types of water: free, bound & entrapped water, water activity. Drinking water, mineral water, water hardness, water quality for food process in. Minerals & vitamins: Mineral & vitamin content of foods- Food and Pharmaceutical grades; Recommended daily intake, toxicities, deficiencies, factors affecting bioavailability, stability &degradation during processing.

UNIT V – COLOR, FLAVORS AND OTHER COMPONENTS

Colour, flavour & aroma components: Naturally occurring colours, acids, other flavor & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; Synthetic colours and naturally similar /artificial flavours, Threshold values, off flavours & food taints. Naturally occurring toxic substances (trypsin inhibitors, phytins, tannins, oxalates, goitrogen, toxic amino acids, glucosinolates, aflatoxins), protease inhibitors, bioactive components: phytates, polyphenols, saponins, phytoestrogens etc. Processing and storage techniques of flavoring compounds. Changes (color, flavor and other components) during processing and storage.

Suggested Readings:

1. Belitz H.-D, Grosch W and Schieberle P. (2004), Food Chemistry, 3rd Revised Edition, Springer-Verlag.
2. Meyer, Lillian Hoagland (1987), Food Chemistry, CBS Publishers
3. Chopra, H.K. and P.S. Panesar, (2010), Food Chemistry, Narosa
4. Vaclavik, V. A. and Christian E. W., (2003), Essentials of Food Science - 2nd Edition, Kluwer Academic, Springer.
5. John W. Brady. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.

6. Thayumanavan, B, Krishnaveni, S and Parvathi, K. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN: 81-7515-459-4.

(ii) Laboratory

Course objectives

The goal of this course is for students,

- To compare the various physical and chemical properties of foods.
- To illustrate the analysis of proteins and lipids.
- To analyze rancidity property of fatty acids.
- To calculate the isoelectric effect of milk.
- To demonstrate browning effects in food.

Course outcomes

Upon successful completion of the course, students should be able to:

1. Categorize the physical and chemical properties of food.
2. Recognize the analysis test of proteins and lipids.
3. Discuss the rancidity of fats.
4. Evaluate gelling properties of starch and electrophoresis.
5. Test rennin on milk proteins and isoelectric effect.
6. Determine browning properties in food.

List of Experiments

1. Enzymatic Browning in foods.
2. Gelling properties of starch.
3. Study of gluten formation.
4. Foaming properties of proteins.
5. Iso-electric precipitation of casein.
6. Preparation of emulsions.
7. Estimation of free fatty acids.
8. Oxidative rancidity of fats.
9. Estimation of Carotenoids.
10. Rapid Detection of flavor Compounds.
11. Enzyme activity assay (protease / amylase).

Suggested Readings:

1. Weaver, C.M, and J.R. Daniel (2005), The Food Chemistry Laboratory – A Manual for Experimental Foods, Dietetics & Food Scientists - 2nd Edition, CRC Press.

SEMESTER - IV

B. Tech. - Food Technology **2022 - 2023**

22BTFT401 **Semester-IV**

MATHEMATICS-IV
(PROBABILITY AND STATISTICS)

4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two-dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

Course Outcomes

Upon successful completion of the course, students will be able to

1. Explain the fundamental concepts of probability and standard distributions which can describe real life phenomenon.
2. Explain the basic concepts of one- and two-dimensional random variables and their applications in engineering.
3. Apply the concept of testing of hypothesis for small and large samples in real life problems.
4. Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
5. Discuss the notion of sampling distributions and statistical techniques used in engineering and management problems.
6. Discuss about the techniques in quality control that model engineering problems.

UNIT I - PROBABILITY AND RANDOM VARIABLES

Probability – The axioms of probability – Conditional probability – Baye‘s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II - TWO - DIMENSIONAL RANDOM VARIABLES

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression using SPSS tool– Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III - TESTING OF HYPOTHESIS

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means - Tests based on t, Chisquare and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV - DESIGN OF EXPERIMENTS

One way and Two-way classifications - Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design using SPSS tool.

UNIT V - STATISTICAL QUALITY CONTROL

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

Suggested Readings:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund ‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
4. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
5. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
6. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum‘s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
7. Walpole. R.E., Myers. R.H., Myers.S.L. and Ye.K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.
8. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
9. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
10. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Websites:

1. www.cut-theknot.org/probability.shtml
2. www.mathworld. Wolfram.com
3. www.mathcentre.ac.uk

22BTFT402 **Semester-IV**

FLUID MECHANICS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students,

- To outline the concepts of fluid mechanics.
- To evaluate the pressure variations in fluids and measurement devices.
- To determine the fluid statics on variable surface conditions.
- To derive the equations of motion and kinetics of fluid flow.
- To analyze the flow of fluids in various geometries of pipes.

Course Outcomes

Upon successful completion of the course students will be able to,

1. Recognize the various properties of fluids.
2. Recall the pressure differences in fluids.
3. Categorize the different devices to measure the pressure of fluids.
4. Calculate the forces acting on bodies submerged in different positions in liquids.
5. Employ the basic design calculations for fluid flow in pipes
6. Summarize the flow behavior of fluids in pipes.

UNIT I - PROPERTIES OF FLUIDS

Introduction- units and Dimensions – Properties of fluids-Density – Specific weight - Specific Volume- Specific gravity- equation of state – perfect gas - Viscosity- Thermodynamic properties- Compressibility and Bulk modulus- Surface tension and capillarity -vapor pressure and cavitation.

UNIT II - PRESSURE AND ITS MEASUREMENT

Fluid pressure at a point- Pascal's law- Pressure variation in a fluid at rest-Absolute, Gauge, Atmospheric and vacuum pressures- Measurement of pressure Simple Manometers-Differential manometers, micro manometers, Mechanical gages – calibration

UNIT III - FLUID STATICS

Hydro static forces on surfaces- Total pressure and center of pressure- Vertical plane surface submerged in liquid- Horizontal plane surface submerged in liquid- Inclined plane surface submerged in liquid- curved surface submerged in liquid, Pressure diagram – total pressure on curved surface. Archimedes principles – buoyancy – meta centre – metacentric height.

UNIT IV - BASIC CONCEPTS OF FLUID FLOW AND MEASUREMENT

Kinematics of flow-Types of fluid flow-Rate of flow-continuity equation- continuity equation in three dimensions- velocity and acceleration velocity potential function and stream function- Dynamics of Fluid flow- Equations of motion- Euler's equation of motion- Bernoulli's equation- Practical applications of Bernoulli's equation – Venturimeter- Orifice meter Pitot tube. Rotameter, Flow measurement in channels – notches – rectangular, Cippollette and triangular – float method.

UNIT V - FLOW THROUGH PIPES

Reynolds Experiment, Darcy – Weisbach equation for friction head loss – Chezy's formula Laminar and turbulent flow- Loss of energy in pipes- Loss of energy due to friction- Minor energy Losses-Hydraulic gradient and Total Energy line- Flow through pipes in series- Equivalent pipe-Flow through parallel pipes- Flow through branched pipes-Power transmission through pipes- Water hammer in pipes.

Suggested Readings:

1. Bansal, R.K., (2011). "Fluid Mechanics and Hydraulic Machines",9th edition, Laxmi Publications, New Delhi.
2. Modi, P.N. and Seth, S.M., (2007). "A Text book of Fluid Mechanics and Hydraulic Machines", Standard Book House, New Delhi.
3. Som, S.R and Biswas, (2007). "Introduction to Fluid Mechanics and Fluid Machines" 2nd edition, Tata McGraw Hill.
4. Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. (9th ed) Tata McGraw Hill, New Delhi, 1998
5. Grade, RJ.,."Fluid mechanics through problems". Wiley eastern Ltd., Madras,2002.

22BTFT403 **Semester- IV**

PLANTATION PRODUCTS AND SPICE PROCESSING TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students,

- Understand the chemistry and technology of coffee.
- Explain the chemistry and technology of tea.
- Outline the basic views on the chemistry and technology of cocoa and its products.
- Understand the views on chemistry of major spices and its technology.
- Explain the chemistry and technology of minor spices.

Course Outcomes

Upon completion of this course, students will be able,

1. Understand the chemistry and manufacturing of coffee.
2. Outline the views on tea production and its chemistry.
3. Infer the basic knowledge on manufacturing of cocoa products and its chemistry.
4. Outline the manufacturing of major spices and its chemistry.
5. Discuss the production of minor spices and chemistry behind its production.
6. Explain the various opportunities of plantation products and spice processing**.**

UNIT I - CHEMISTRY AND TECHNOLOGY OF COFFEE

Coffee – Occurrence – chemical constituents– harvesting – fermentation of coffee beans – changes taking place during fermentation – drying – roasting –Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee.

UNIT II - CHEMISTRY AND TECHNOLOGY OF TEA

Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea.

UNIT III - CHEMISTRY AND TECHNOLOGY OF COCOA AND COCOA PRODUCTS

Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates.

UNIT IV - CHEMISTRY AND TECHNOLOGY OF MAJOR SPICES

Pepper, Cardamom, ginger, Chili, mint, and turmeric – Oleoresins and essential oils – Method of manufacture-machineries and equipment, grades, products and standards-

Chemistry of the volatiles –Enzymatic synthesis of flavor identical - Quality control of major spices -Conditions in storage of spices-Types of dryers used in spice processing-milling of spices-selection of raw materials-Standards of ground spices.

UNIT V - CHEMISTRY AND TECHNOLOGY OF MINOR SPICES

Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove Vanilla, Coconut, Areca nut, Oil palm and Cashew - Oleoresins and essential oils –Method of manufacture-machineries and equipment, grades, products and standards – Chemistry of the volatiles – Quality control of minor spices- -Conditions in storage of spices-Types of dryers used in spice processing-Different uses of minor spices-milling of spices-selection of raw materials-Standards

Suggested Readings:

1. Peter, K.V. Hand book of herbs and spices. Volume 2. Wood head publishing Ltd., 2004**.** eBook ISBN**:** 9780857095688
2. Chakravarty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post-harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010. ISBN 13: 9780824705145
3. Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001. ISBN: 978-0-471-35575-5
4. Salunkhe, D.K. and Kadam S.S. Ed. 1998. Hand book of Vegetable Science and Technology, Marcel Dekker, New York, USA. ISBN: 0824701054
5. Minifie Bernard W. Chocolate, Cocoa and Confectionery Technology, 3rdEdition, Aspen Publication, 1999. ISBN: 9780834213012
6. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., New Delhi 2004. ISBN: 8178330946
7. Banerjee B. 2002. Tea Production and Processing – 3rdedition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

22BTFT441 **Semester-IV**

HEAT AND MASS TRANSFER
(Theory & Lab)

5H-4C

Instruction Hours/week: L:2 T:1 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students,

- To define laws of heat conduction and theories of insulation.
- To evaluate the different modes of convection heat transfer.
- To compare the different modes of radiation heat transfer.
- To classify the types of heat exchanger and their applications in food industry.
- To summarize the diffusion mass transfer.

Course Outcomes

Upon completion of the course, students will be able to:

1. Express the conduction mode of heat transfer in simple and composite systems.
2. Evaluate heat transfer coefficients for natural convection.
3. Discuss the influence of radiation in food processing operations.
4. Predict heat exchanger performance by using the method of heat exchanger effectiveness.
5. Analyze heat exchanger performance by using the method of log mean temperature difference.
6. Illustrate the basics of diffusion mass transfer and its application in food Processing.

UNIT I - HEAT TRANSFER – CONDUCTION

Modes of heat transfer – Conduction, Convection and Radiation. Fourier's Law of Heat Conduction-Thermal Conductivity for gases, liquids and solids-Thermal diffusivity-Thermal Resistance-Steady heat conduction in simple geometries: Plane wall, hollow cylinder and hollow sphere through solids in series -plane wall and multilayer cylinder. Heat conduction through materials in parallel. Theory of insulation, critical radius of insulation.

UNIT II - HEAT TRANSFER – CONVECTION

Convection heat transfer – forced and natural; Evaluation of convection heat transfer coefficient, Dimensionless numbers- Forced convection- Heat Transfer Coefficient for Laminar flow inside a tube -heat transfer coefficient for turbulent flow inside a pipe. – Heat Transfer outside various Geometries in Forced Convection – Flow parallel to flat

plate - Natural convection from vertical planes and cylinders –boiling andcondensation-mechanisms

UNIT III - HEAT TRANSFER – RADIATION

Basics of Radiation heat transfer- Types of surfaces – Concept of Black and Grey body-Kirchhoff's Law-radiation from a body and emissivity (Stephan Boltzmann Law), absorptivity, reflectivity, transmissivity to a small object from surroundings, heat exchange through non-absorbing media –Planck's Distribution law-Wein's Displacement law- combined Radiation and Convection Heat Transfer.

UNIT IV - HEAT EXCHANGERS

Types-Overall Heat Transfer Coefficient-Shell and Tube1-1, 1-2, 2-4 passes –Plate Heat Exchanger-tubular heat exchanger-Parallel Flow and Counter Flow- Cross flow Types- Scraped surface exchangers-Compact Heat exchanger- Heat exchanger Analysis-Log mean Temperature Difference. Fouling factor-applications of heat exchangers, Effectiveness – NTU method.

UNIT V - MASS TRANSFER

Mass transfer – introduction – Fick's law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of gas A through non diffusing or stagnant B - diffusion through a varying cross-sectional area and diffusion coefficients for gases - molecular diffusion in liquids, biological solutions and gels. Concept of mass transfer coefficients, Interphase mass transfer and over all mass transfer coefficients in binary systems.

Suggested Readings:

1. Rao,D.G. Fundamentals of Food Engineering. PHI learning Pvt Ltd. New Delhi, 2009.
2. Mccabe W.L., Smit J.C and Harriott P. Unit Operations of Chemical Engineering. McGraw- Hill International. New York, 7th Edition, 2017.
3. Paulsingh R, Dennis R. Heldman. Introduction to Food Engineering. Academic press 5th edition. 2013.

(ii) Laboratory

Course Objective

The goal of this course is for students to,

- Understand the basic heat transfer mechanisms.
- Calculate the heat transfer coefficient in heating and cooling applications.
- Study the heat transfer by conduction in solids for steady state and transient conditions.
- Explain the heat transfer with phase change.
- Understand surface emmissivity.

Course Outcome

Upon completion of this course, students will be able to,

1. Analyze the heat transfer in complex systems involving several heat transfer mechanisms.
2. Enable the students to calculate heat transfer by conduction and convection.
3. Measure the effective heat transfer through natural and forced convection.
4. Analyze the parallel and counter flow of heat.
5. Study the Stefan Boltzman's apparatus.
6. Measure the surface emmissivity.

List of Experiments

1. Experiment on conduction through composite wall.
2. Experiment on thermal conductivity of slab.
3. Experiment on heat transfer through pin-fin.
4. Study of parallel and counter flow heat exchanger.
5. Determination of two-phase heat transfer.
6. Estimation of heat transfer through natural convection.
7. Experiment of heat transfer through forced convection
8. Study of Stefan Boltzman's apparatus.
9. Experiment on thermal conductivity of concentric sphere.
10. Experiment on surface emmissivity measurement.

UNIT OPERATIONS IN FOOD PROCESSING
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students,

- To discuss the various types of equipments involved in drying and dehydration.
- To explain the operations involved in mechanical separations.
- To define the various attributes of evaporators in food processing.
- To recognize the role of milling equipments in size reduction.
- To outline the agitation and types of impellers employed in mixing.

Course Outcomes

Upon completion of the course, students will be able to,

1. Explain the models involved in the moisture and its measurements.
2. Summarize the various dryers employed in drying of food.
3. Demonstrate the filtration, sedimentation and centrifugal separations.
4. Evaluate the heat transfer coefficients and economy of different types of evaporators.
5. Estimate the energy and power requirement for the different size reduction operations.
6. Design and develop the agitators and impellers for mixing operations.

UNIT I - DRYING AND DEHYDRATION

Moisture and its measurements - direct and indirect methods – Equilibrium moisture – methods of determination – EMC Models – Henderson, Kelvin, PET and GAB models – importance of EMC- water activity – psychrometry — Drying theory – Drying rate – Mechanical Drying – hot air dryers – Types- fixed -fluidized bed – LSU drier-Spray drier- Osmotic dryer - vacuum shelf dryer - freeze dryer. Cleaning and Grading operations and equipments used in food industry

UNIT II - MECHANICAL SEPARATION

Screening: Types, Equipments; Filtration: Filter media types and requirement – constant rate filtration – constant pressure filtration – filter cake resistance – filtration equipments – filter press – rotary drum filters – sedimentation – sedimentation of particles in gas - cyclones – settling under sedimentation - gravitational sedimentation – Stoke's law – sedimentation in cyclones. Centrifugal separations – rate of separation-centrifuge equipment.

UNIT III - EVAPORATION

Definition – liquid characteristics – Types of evaporators -single and multiple effect evaporators - once through and circulation evaporators – Agitated film evaporators. Performance – evaporator capacity – boiling point elevation and Duhring's rule. Heat transfer coefficients – Evaporators economy – enthalpy balance of single effect evaporator – multiple effect evaporator – methods of feeding. Capacity and economy of multiple effect evaporator.

UNIT IV - SIZE REDUCTION

Principles of comminuting – characteristics of comminuted products – particle size distribution in comminuted products – energy and power requirements – crushing efficiency – Rittinger's, Kick's and Bond's law – Size reduction equipments – crushers – hammer mill – Ball Mill-Colloidal mill-attrition mills, grinders – construction and operation.

UNIT V - EXTRUDERS

Extrusion – methods – cold extrusion - Extrusion cooking – principles and types of extruders - single and double screw extruder- construction and working - Effect of different operational parameters – Effect on food - quality of the extruded products.

Suggested Readings:

1. Rao DG. Fundamentals of Food Engineering. PHI Learning Private Limited, New Delhi, 2009.
2. Geankoplis CJ. Transport Processes and Separation Processes Principles. Prentice Hall India, New Delhi, 5th Edition, 2018.
3. Warren, L McCabe, J.C. Smith and Peter Harriot. Unit Operations of Chemical Engineering McGraw Hill International Edition, Singapore, 7th Edition, 2004.
4. Earle, R.L. Unit Operations in Food Processing". Pergamon Press. UK, 2nd Edition, 2003.
5. Khurmi, R.S. and J.K. Gupta. 2003. A Text book of thermal Engg., S. Chand & Co. Ltd., Ram Nagar,New Delhi.
6. Zeki Berk. 2009. Food Process Engineering and Technology. Academic press, New York, USA.

(ii) Laboratory

Course Objective

The goal of this course is for students to,

- Estimate the drying characteristics of foods.
- Understand the working of different types of dryers.
- Study the principle of reverse osmosis.
- Understand the efficiency of sieve analysis, milling and filtration process.
- Study the working of evaporators.

Course Outcome

Upon completion of this course, students will be able to,

1. Analyze the effect of drying air temperature on drying time
2. Measure and calculate the kinetics of moisture loss.
3. Measure the effectiveness of reverse osmosis.
4. Measure the particle size of granular foods.
5. Analyze the efficiency of ball mill and hammer mill in size reduction.
6. Determine the efficacy of single and multiple evaporation.

List of Experiments

1. Experiment on drying of food samples in tray dryer
2. Study of fluidized bed dryer and drying process
3. Study of working principle of spray dryer and spray drying process
4. Study of freeze dryer and freeze-drying process
5. Experiments on reverse osmosis
6. Determination of particle size of granular foods by sieve analysis
7. Performance evaluation of ball mill
8. Performance evaluation of a hammer mill
9. Experiments on ultra-filtration
10. Solving problems on single effect evaporator and multiple effect evaporators

FOOD BIOCHEMISTRY AND NUTRITION
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students,

- To explain the digestion, absorption and metabolic pathways of carbohydrates.
- To describe the digestion, absorption, synthesis and metabolic pathways of fatty acids, proteins, and amino acids.
- To outline the important aspects of food relating to nutrition.
- To summarize the diets suitable for managing specific nutritional disorders.
- To formulate new range of food products and dietary management system for different age group people.

Course Outcomes

Upon successful completion of the course students will be able to:

1. Illustrate the structure of ATP and identify the major class of macromolecules to which ATP belongs.
2. List the stages in the catabolism of food molecules and describe what occurs during each stage.
3. Outline the biochemistry process, basic concept of human nutrition and the relationship of the consumption of foods to nutritional status and health.
4. Evaluate the biological functions of foods for health in addition to nutritional values.
5. Recall the dietary management system for nutrition and disorder with organs and inborn errors.
6. Design and develop new range of food products and nutritional supplements for different age group people, pregnancy and other.

UNIT I – METABOLISM OF CARBOHYDRATES AND PROTEINS

Carbohydrate – Digestion and absorption, physicochemical and metabolic functions, Glycolysis (EMP) pathway, CORI's cycle, Energy yield from glycolysis, TCA cycle, pentose phosphate pathway – Energetics, HMP or PP pathway, Gluconeogenesis, Glycogenolysis, Glycogenesis, oxidative phosphorylation. Proteins – Digestion and absorption, General metabolism of amino acids – trans deamination, transamination and oxidative deamination, Urea cycle, Metabolism of serine, cysteine, valine, leucine, isoleucine, tryptophan.

UNIT II-METABOLISM OF FATTY ACIDS, VITAMINS, MINERALS AND NUCLEIC ACIDS

Fatty acids – Digestion and absorption, Synthesis of TAG's, Metabolism of adipose tissue – fatty liver and lipotropic factors, Cholesterol – biosynthesis and metabolism. - Metabolism of fat soluble and water-soluble vitamins. Metabolism of micro and macro minerals. Nucleic acids; physicochemical and metabolic functions, metabolism – metabolism of purine and pyrimidine nucleotides.

UNIT III-CONCEPTS OF FOOD AND NUTRITION

Food as a source of nutrients, Food intake and regulations, Food groups, Utilization of nutrients and digestion process, calorific value of food, dietary need and recommended dietary allowances, Vegetarian diet – health, problems and advantages, Nutrition in phytochemicals and non- nutrient components, Malnutrition – PEM, Food fortification, Effect of processing on nutritive value of foods, vitamins and storage of nutrients, Food allergy, intolerance and sensitivity, Nutrigenomics, Molecular nutrition, e-Nutrition and personalized nutrition.

UNIT IV-NUTRITIONAL DISORDERS

Dietary management – Fever – definition, effects on metabolic processes and diet modifications: Overweight, underweight and obesity – definitions, types, causes, factors responsible, measurement of obesity, importance of weight regulation, diet during obesity, psychological disorders during dieting, practical suggestions for reducing weight: Burns – types and nutritional management: CVD – types of cardiac disorders, risk factors, dietary management in atherosclerosis and hyperlipidaemia, fat replacers, dietary management in acute diseases of the heart, cardiological society of India: Cancer – diets and effects of cancer: Skin care, Diabetes – causes, factors predisposing diabetes, classification, symptoms, tests, acute and chronic complications, use of artificial sweeteners, hypoglycaemic drugs, oral hypoglycaemic drugs, medicinal plants in control of diabetes: Inborn errors of metabolism – diet therapy, amino acid disorders, carbohydrate disorders.

UNIT V-SPECIALIZED NUTRITION

Nutritional requirement for infants – food and feeding, advantages and disadvantages of formula feeding, advantages of breast feeding for infants and mothers, feeding of solid foods: Food and feeding of toddler, preschool, school children and adolescent: Nutrition for aging and the aged- young, middle and older adulthood, biological changes in the aging process, problems of the aging process, nutritional requirement for adults, complications commonly occurring in late adulthood: Sports and fitness – measurement of body composition, energy from major nutrients, factors affecting fuel utilization, nutrition and athletic performance, effective hydration for fitness and sports, nutrition requirement for athletes, water and other fluids, sport supplements, broad guidelines for sports persons, pre-competition, during competition and post competition meal: Pregnancy and lactation – exercise, nutrition requirement, complications during pregnancy, nutrition during lactation.

Suggested Readings:

1. Sunetra Roday. Food Science and Nutrition. Oxford Education/Oxford University Press, 2nd Edition, 2012.
2. Shubhangini AJ. Nutrition and Dietetics. McGraw Hill education, 4th Edition, 2015.
3. Srilakshmi.B. 2011. Dietetics (sixth edition). New Age Intl. Publishers, New Delhi.
4. Vasudevan DM and Sreekumari S. Textbook of Biochemistry. Jaypee Brothers Medical Publsihers Pvt Ltd. New Delhi, 3rd Edition, 2001.
5. Norman. N. Potter and Joseph H. Hotchkiss. 1996. Food Science, 5thredition, CBS publishers and Distributors, New Delhi.
6. John W. Brady. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.

(ii) Laboratory

Course Objectives

The goal of this course is for students,

- To calculate the protein content present in the given food sample.
- To determine the amount of carbohydrate in the food materials.
- To analyze the content of ash and ascorbic acid present in the given foods.
- To identify the method of lipid extraction and measure the percent of cholesterol in the given sample.
- To recognize the calculations based on measuring protein quality indices.

Course Outcomes

Upon successful completion of the course students will be able to,

1. Examine the protein content of food samples using Lowry's and Biuret method
2. Perform the tests on quantifying carbohydrate content in the food samples.
3. Evaluate the amount of ascorbic acid in the given food materials.
4. Calculate the ash content and sample preparation of the AAS analysis.
5. Determine the fat and cholesterol content in the food samples.
6. Assess the calculations on protein quality indices.

List of Experiments

1. Estimation of proteins by Lowry's method.
2. Estimation of proteins by Biuret method.
3. Estimation of amino acid by ninhydrin method.
4. Estimation of total carbohydrate by anthrone method.
5. Estimation of reducing sugar by dinitro-salicylic acid (DNS) method.
6. Estimation of ascorbic acid content in the food.
7. Estimation of ash content and preparation of sample for AAS analysis.

8. Estimation of fat by Soxhlet method.
9. Estimation of cholesterol by Zak's method.
10. Calculation of protein quality indices using amino acid values of given sample.

SEMESTER V

B. Tech. - Food Technology **2022 - 2023**

22BTFT501 **Semester-V**

REFRIGERATION, AIR CONDITIONING AND COLD STORAGE FOR PERISHABLE FOODS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students,

- To recall various concepts behind refrigeration of food.
- To discuss the various aspects of cold storage.
- To explain the overall attributes of air conditioning in food industries.
- To describe food freezing and equipment involved.
- To illustrate the cold chain management in small- and large-scale refrigerators.

Course Outcomes

Upon completion of the course, students will be able to,

1. Discuss refrigeration of food and its operational components.
2. Locate food refrigeration in plants, stores and logistics.
3. Recognize food freezing concepts and techniques.
4. Report food safety aspects of chilled foods and frozen foods.
5. Evaluate the cold storage and packaging of frozen perishable products.
6. Employ the cold chain management system in the food distribution sector.

UNIT I - PRINCIPLES OF REFRIGERATION

Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, net refrigerating effect - Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls.

UNIT II - COLD STORAGE

Insulation, properties of insulating materials, air diffusion equipment, Cold load estimation; prefabricated systems, walk-in-coolers, and Refrigerated container trucks: Freezer Storages, Freezer room Temperatures, Cooling towers: introduction, Construction and Working; Cold Storage practice, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

UNIT III - AIR-CONDITIONING

Psychrometry, Psychrometric Processes, Simple Air Conditioning System –State and Mass Rate of Air. Evaporative, winter and All Year Air Conditioning Systems. Design Conditions. Load Calculation and Psychrometry of Air Conditioning Systems –Design of Air conditioning apparatus – Transmission and Distribution of Air. Selection of Air Conditioning Systems.

UNIT IV - FREEZING AND CHILLING OF FOODS

Freezing equipment, Freezing time, Freezing curve, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to different food sectors. Chilling equipment for liquid foods. Secondary refrigerants, Evaporative cooling and direct expansion techniques in chilling. Chilled food transport and retail cabinets - Basics of Chilled food microbiology, Packaging of Chilled foods.

UNIT V - COLD CHAIN MANAGEMENT

Supply chain system - Important Factors to consider- logistic supply- Protocols for Domestic, Sea and Air freight- Traceability and barcode – Product Temperature and Moisture monitoring- Refrigeration systems and Refrigerant types during field chilling, transportation via land, air and sea. Grocery stores and display cases, Home refrigerators - Cooling chain summary – Storage and packaging.

Suggested Readings:

1. Clive. V. J Dellino. Cold and Chilled Storage Technology. Chapman Hall India. 2nd Edition, 2012.
2. C.P. Arora. Refrigeration and Air conditioning. Tata McGraw Hill, 3rd Edition, 2008.
3. Da-Wen Sun. Handbook of Frozen Food Processing and Packaging. CRC Press 2ndEdition, 2011.
4. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E. Post Harvest Handling and System Approach. Academic Press, 3rd Edition, 2014.
5. Colin Dennis and Michael Stringer. Chilled Foods – A Comprehensive Guide Brown. M Wood Head Publishing, 3rd Edition, 2008.

22BTFT502 **Semester-V**

LIVESTOCK AND MARINE TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students,

- To describe meat composition, structure, chemistry and microbial safety of meat.
- To outline the various methods involved in the slaughtering and carcass processing of meat.
- To summarize the variety of meat products, equipment employed and safety of meat processing plant.
- To explain the overall processing of poultry meat and their products.
- To determine the processing of different marine based products.

Course Outcomes

Upon completion of the course, students will be able to,

1. Enumerate the chemical composition, structure, color, flavor, and microbial safety of meat.
2. Demonstrate the slaughtering, carcass processing methods and equipment used for processing meat.
3. Determine the various technological ideas in preparation of various types of meat products and design of equipment used for processing meat.
4. Adapt the HACCP and GMP of meat processing.
5. Evaluate the processing of poultry meat, meat products and egg products.
6. Assess the production, processing, spoilage, preservation and storage of marine products.

UNIT I - CHEMISTRY AND MICROBIOLOGY OF MEAT

Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety. - Preslaughter operations and slaughtering operations for animals – Kosher / Halal - Evaluation of animal carcasses - properties and shelf life of meat- Mechanical deboning - grading and aging - Eating and cooking quality of meat - Meat tenderization

UNIT – II PRESERVATION OF MEAT

Preservation of meat by chilling - freezing, pickling, curing, cooking and smoking, dehydration, radiation, chemical and biological preservatives - Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation

- Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation - Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation - Abattoir design and layout.

UNIT III - MEAT PRODUCTS

Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat, Prepared meat products, Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Safety standards in meat, poultry and egg industry: Good manufacturing practice(GMP)/ HACCP /ISO/MFPO/FSSAI.

UNIT IV – PROCESSING AND PRESERVATION OF POULTRY PRODUCTS AND EGGS

Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Plant sanitation; Poultry meat processing operations in detail along with equipment used – De feathering, bleeding, Scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat, – Egg-Structure of Egg - Chemical composition of egg- Nutritive value and Functional Properties of Egg - Preservation of Eggs - Shell Egg Preservation - Liquid Egg Preservation - Microbial Spoilage of Eggs - Evaluation of Egg Quality – Interior and Exterior quality - Grading of Eggs. by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

UNIT V - FISH AND OTHER MARINE PRODUCTS PROCESSING

Commercially important marine products from India, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing - relative merits and demerits, canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil. - HACCP - implementation of HACCP in fish and marine processing - Quality control and standards for fish, prawn and other sea foods - EU hygienic regulations in fish and marine industry.

Suggested Readings:

1. Hui, Y.H., Nip, W.K., Rogers, R.W. Meat Science and Applications". Marcel Dekkar Inc. New York, 1st Edition, 2001.
2. Sabel Guerrero and Hui YH. Handbook of Poultry Science Technology Volume-1. Wiley Publishing. 1st Edition, 2010.
3. Sabel Guerrero and Hui YH. Handbook of Poultry Science Technology Volume-2. Wiley Publishing. 1st Edition, 2010.
4. Mead, G. C.2004. Poultry meat processing and quality. CRC Press. Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, England.

5. Balachandran, K. K. Post-Harvest Technology of Fish and Fish Products. Daya Publishing House, New Delhi, 2002.
6. Hall, G.M. 1997. Fish Processing Technology, 2nd Ed. Chapman & Hall, London, UK.
7. Chichester, C.O. and H.D. Graham. 1973. Microbial safety of Fishery products. Academic Press, New York.

22BTFT541 **Semester-V**

DAIRY TECHNOLOGY
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60-** Total**:100**

End Semester Exam:3 Hour

(i) Theory

Course Objectives

The goal of this course is for students,

- To outline the concepts of physicochemical and functional properties of milk constituents.
- To demonstrate the construction and working of dairy processing equipment.
- To summarize the process involved in packaging and storage of milk.
- To discuss the production of milk and milk-based products.
- To recall the working principle and construction of equipment like spray drier, drum drier.

Course Outcomes

Upon completion of the course, students will be able to,

1. Infer the physical, chemical and functional properties of milk.
2. Perform the qualitative tests on milk quality.
3. Assess the dairy processing equipment for specific applications.
4. Illustrate the processes involved in packaging and storage of milk.
5. Develop the various types of fermented milk products.
6. Prepare the different types of dehydrated milk products.

UNIT I - DAIRY CHEMISTRY AND MICROBIOLOGY

Introduction - Basic dairy terminology - milk as raw material – composition - nutritive value - Physico-chemical constituents of milk and its constituents – contaminants - microbiology of milk- milk collection - cooling and milk transport - milkreception - Quality control tests - applications of enzymes in dairy industry.

UNIT II - DAIRY PROCESSING AND EQUIPMENT'S

Milk processing equipment – filtration/clarification – Pasteurization – HTST –LTLT - UHT methods - storage tanks - Cream separating Centrifuges - Homogenization – theory - working principle of homogenizers – homogenization efficiency - cream separation – principles – gravity and centrifugal separation – centrifugal separator – parts - construction and working principle – separation efficiency.

UNIT III - BOTTLE, CAN WASHING AND FILLING EQUIPMENT'S

Plant piping – Pumps - Bottle washers- and cappers- can washers-types of canwashers-care and maintenance-factors affecting washing operation – Fillers - types of

fillers-pouch filling form fill seal machines - aseptic filling - cleaning and sanitization - CIP cleaning- types of CIP systems – Energy use in Dairy plant - sources of energy - cost of energy - Control of energy losses and Energy conservation.

UNIT IV - MILK PRODUCT PROCESSING

Butter – method of manufacture – theory of churning - operation of butter churn – over run— batch and continuous methods of butter making. Ghee – methods of manufacture - Cheese – classification – cheddar and cottage cheese - equipment's – cheese vats and press – construction details. Ice cream - ingredients – preparation of ice cream mix - freezing – calculation of freezing point and refrigeration - batch and continuous freezers – Special milks - Quality aspects of dairy products.

UNIT V - FERMENTED AND DEHYDRATED DAIRY PRODUCTS

Fermented products – Yoghurt – Curd – cultured butter milk Bulgarian buttermilk – Kefir – paneer - acidophilus milk etc. - Concept of Probiotics and prebiotic foods – Vacuum Evaporators - drying of milk - drum drier and spray drier - components - construction and working principles.

Suggested Readings:

1. Tomar S. An Introduction to Dairy Technology. Pragun Publication, 2012.
2. NIIR Board. Modern Technology of Milk Processing and Dairy Products. NIIR ProjectConsultancy Services, 4th Edition, 2013.
3. Tufail Ahmad. Dairy Plant Engineering and Management. Kitab Mahal Publishers. NewDelhi, 2016.
4. Sukumar De. Outlines of Dairy Technology. Oxford University Press. New Delhi. 23rdimpression, 2006.
5. Walstra P, Wouters JTM, Geuris TJ. DairyTechnology. Taylor& Francis, 2005.
6. Frazier WC and Westhoff DC. Food Microbiology. McGraw Hill. 11th reprint, 2017.

(ii) Laboratory

Course Objective

The goal of this course is for students to,

- List the ingredients needed for preparations of food products.
- Calculate the quantity of ingredients for preparations of food products.
- Prepare different types of milk-based products.
- Explain the production of milk powder using the spray drier.
- Perform cost analysis of the developed products.

Course Outcome

Upon completion of this course, students will be able to,

1. Choose the appropriate ingredients for preparing food products.
2. Measure and calculate the quantity of ingredients for preparations of food products.

3. Formulate the ingredients for preparing a variety of milk-based products.
4. Apply the principle of spray drying to develop value added products from milk.
5. Analyze the cost of the developed products.
6. Conduct sensory tests for the developed products.

List of Experiments

1. Platform test - Methylene Blue Reduction Test, clot on boiling test.
2. Determination of protein in milk by formol titration (pynes method).
3. Estimation of milk fat by Gerber method or Milk o tester.
4. Determination of adulterant and preservatives of milk.
5. Efficiency of sterilization in preparation of sterilized milk by turbidity test.
6. Preparation of khoa, chana and paneer.
7. Preparation of Gulab Jamun and Rasagulla.
8. Preparation of Sandesh and peda.
9. Preparation of butter and ghee.
10. Preparation of milk beverage.
11. Studies on preparation of milk powder using spray drier.

22BTFT542 **Semester-V**

FRUITS AND VEGETABLES PROCESSING TECHNOLOGY
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students,

- To describe the processing of fruits and vegetables by chemical methods.
- To outline the preservation of fruits and vegetables by drying and dehydration.
- To discuss the various unit operations and fermented processes involved in fruits and vegetables.
- To illustrate the canning and bottling operations in fruits and vegetables.
- To explain the set of parameters influencing the aseptic processing of fruit juices.

Course Outcomes

Upon completion of the course, students will be able to,

1. Identify the nutritionally important fruits and vegetables and understand its maturity indices and its processing methods.
2. Demonstrate the manufacture, preservation and packaging of jam, jelly, marmalade, pickles and preserves.
3. Explain the different types of driers involved in the production of dehydrated fruit products.
4. Illustrate the minimal processing and fermentation methods of fruits and vegetables.
5. Enumerate the canning and bottling operations of fruits and vegetables.
6. Discuss the aseptic processing, packaging and storage of fruit juices.

UNIT I – PROCESSING BY CHEMICAL METHOD

Importance and scope of fruit and vegetables preservation. Nutritive value, nutraceutical properties – Harvesting of fruits and vegetables – Maturity indices. Methods of fruit and vegetable preservation - Processing using sugar – Preparation of jam, jelly, marmalade, squash, RTS, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt – Brining - Preparation of pickles, chutney and sauces, ketchup. Machineries involved in processing of fruits and vegetables products.

UNIT II - PRESERVATION BY DRYING AND DEHYDRATION

Drying and dehydration -Types of driers - Solar, cabinet, fluidized bed drier, spouted bed drier, heat pump drier, vacuum drier and freeze drier. Preparation of product. Changes during drying and dehydration. Problems related to storage of dried and dehydrated products

UNIT III - MINIMAL PROCESSING AND FERMENTATION

Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables, Minimal Processing of Fruits and Vegetables. Preservation by fermentation - wine, vinegar, cider and sauerkraut.

UNIT IV- CANNING AND BOTTLING

Canning - principles, types of cans– preparation of canned products - packing of canned products - spoilage of canned foods. Bottling of fruit and vegetable. Fruit Pulper: Design and working principle. Precautions in canning operations. General considerations in establishing a commercial fruit and vegetable cannery, machineries involvedin canning and bottling unit.

UNIT V - ASEPTIC PROCESSING

Aseptic processing and Bulk packing of Fruit juice concentrates. Aseptic heat exchangers for sterilizing and concentrating the product. Aseptic fillers. Tetra pack for small quantities, Dole system and Scholle system for bulk storage in Bag and Boxes and Bag & Drums. Storage of Aseptically packed products.

Suggested Readings:

1. Hui Y. H. Hand Book of Vegetable Preservation and Processing. Mercel Dekker, New York,2nd Edition, 2015.
2. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology. Marcel Dekker Press, USA, 2003.
3. L. R. Verma and V. K. Joshi. Post-Harvest Technology of fruits and vegetables. IndusPublishing Co, New Delhi, 2000.
4. P. Fellows. Food processing Technology: Principles and Practice". Wood Head publishingLimited, Cambridge, England, 4th Edition, 2016.
5. James G. Brennan. Food Processing Hand book. Wiley-Ych Verlag Gmbh & Co KgaA,Weinheim, Germany, 2006.
6. R.P. Srivastava and Sanjeev Kumar. Fruit and Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi. 2002.

(ii) Laboratory

Course Objective

The goal of this course is for students,

- To list the ingredients needed for preparations of food products.
- To calculate the quantity of ingredients for preparations of food products.
- To develop products from fruits and vegetables.
- To perform sensory analysis of developed products.
- To perform cost analysis for the developed products.

Course Outcome

Upon completion of the course, students will be able to,

1. Choose the appropriate ingredients for preparing food products.
2. Measure and calculate the quantity of ingredients for preparations of food products.

3. Develop the ingredients for preparing variety of fruit and vegetable-based products.
4. Understand the equipments related to processing of fruits and vegetables.
5. Assess the cost of the developed products.
6. Examine sensory tests for the developed products.

List of Experiments:

1. Preparation of RTS beverage.
2. Preparation of squash/cordial.
3. Preparation of jam - mixed and individual fruits.
4. Preparation of jelly/marmalades/ nectar.
5. Preparation of ketchup and tomato sauce.
6. Preparation of pickles.
7. Preparation of sauerkraut.
8. Preparation fruits-based wine.
9. Osmotic concentration/dehydration of fruits and vegetables.
10. Basic physicochemical and sensory analysis for food samples.

22BTFT543 **Semester-V**

FOOD ANALYSIS
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students,

- To determine the sampling and proximate analysis of food substances.
- To discuss the physical, chemical, quality standards and adulterants of lipids, protein and carbohydrate.
- To summarize the different spectroscopic techniques involved in food analysis.
- To explain the various chromatographic methods employed in analysis of foods.
- To outline the techniques on electrophoresis, refractometry, polarimetry and biosensors.

Course outcomes

Upon completion of the course, students will be able to,

1. Test the proximate composition of the given food sample.
2. Determine the physical, chemical and quality standards of lipids, proteins and carbohydrates.
3. Measure the adulterants in the given food commodities.
4. Examine the composition of foods using spectroscopic methods.
5. Inspect the food materials using chromatographic techniques.
6. Perform the tests on food substances using the principles of electrophoresis, refractometry, polarimetry and biosensors.

UNIT I - SAMPLING AND PROXIMATE ANALYSIS

Sampling methods - Sample preparation for analysis; Statistical evaluation of analytical data - Official Methods of Food Analysis. Moisture in foods - determination by different methods - ash content of foods, wet, dry ashing, microwave ashing methods; Significance of Sulphated Ash, water soluble ash and acid insoluble ash in foods; titratable Acidity in foods, determination of dietary fiber and crude fiber.

UNIT II - LIPIDS, PROTEIN AND CARBOHYDRATE ANALYSIS

Determination of Total fat in foods by different methods; Analysis of oils and fats for physical and chemical parameters, Quality standards, and adulterants; different methods of determination of protein and amino acids in foods; determination of total carbohydrates, starch, disaccharides and simple sugars in foods.

UNIT III – SPECTROSCOPIC TECHNIQUES

Basic Principles – Spectrophotometric analysis of food additives and food components – IR Spectroscopy in online determination of components in foods; AAS and ICP-AES in mineral element sand toxic metals analysis; use of fluorimeter in vitamin assay-specific use of Tintometer in vanaspathi analysis.

UNIT IV - CHROMATOGRAPHIC TECHNIQUES

Basic Principles, detection of adulterants in foods by paper chromatography and thin layer chromatography, column chromatography for purification analysis; analysis of food additives, sugars, phytochemicals and aflaotoxins, contaminants and other food components by HPLC, GC analysis of fatty acids, cis, trans Isomers - volatile oils, flavours and pesticides, contaminants and other volatile derivatives of food components; Significance MS detector in HPLC and GC.

UNIT V - ELECTROPHORESIS, REFRACTOMETRY AND POLARIMETRY

Basic Principles, application of electrophoresis in food analysis, refractive indices of oils and fats, total soluble solids in fruit juice and honey, specific rotation of sugars, estimation of simple sugars and disaccharides by polarimeter; Immunoassay techniques and its applications in foods. Introduction to sensors and Instrumentation of sensors - biosensors - electronic nose and electronic tongue.

Suggested Readings:

1. Nielson, S. Suzanne. Food Analysis. Springer, 5th Edition, 2017.
2. Wood R, Foster L, Damant A and Key Pauline. Analytical Methods for Food Additives. CRCWood head Publishing 2004.
3. Pomeranz, Yeshajahu and Clifton E. Meloan "Food Analysis: Theory and Practice",3rdEdition, Springer, 2004.
4. Nollet, Leo M.L. "Handbook of Food Analysis" 2nd Edition, Vol. 1-3. Marcel Dekker, 2004.
5. Hurst, Jeffrey W. "Methods of Analysis for Functional Foods and Nutraceuticals" 2nd Edition, CRC Press, 2008.
6. Bhalla, N., Jolly, P., Formiasano, N. Estrela, P. Introduction to biosensors, Essays in Biochemistry. 2016.

(ii) Laboratory

Course Objectives

The goal of this course is for students,

- To predict the saponification and iodine value of lipids.
- To interpret the reducing sugar, iodine content and iron content in the given food sample.
- To determine the swelling ratio and extract release of meat.
- To analyze the curcumin, gingerol, and fat content in the food commodities.
- To discuss the nitrogen estimation by Kjeldhal nitrogen analyzer.

Course Outcomes

Upon completion of the course, students will be able to,

1. Test the iodine content in iodized salt.
2. Identify the saponification and iodine value of lipids.
3. Estimate the fat, iron and reducing sugar in the given foods.
4. Evaluate the swelling ratio and extract release of meat.
5. Assess the curcumin and gingerol content in the spices.
6. Calculate the nitrogen content by Kjeldhal analyzer.

List of Experiments

1. Estimation of iodine value in lipids.
2. Estimation of saponification value in lipids.
3. Estimation of reducing sugars by Lane and Eynon's method.
4. Estimation of Iodine content in iodized salt.
5. Estimation of total extractives in tea.
6. Determine the swelling ratio and extract release.
7. Estimation of fat in milk by Gerber's method.
8. Estimation of curcumin in turmeric.
9. Estimation of gingerol in ginger.
10. Rapid detection of food adulterants.
11. Demonstration of nitrogen estimation by Kjeldhal method.

SEMESTER VI

B. Tech. - Food Technology **2022 - 2023**

22BTFT601 **Semester-VI**

FOOD SAFETY REGULATIONS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students,

- To understand the food safety and hygiene during food processing.
- To summarize the functions, responsibilities and concepts of various food regulatory bodies.
- To define the overall functions and responsibilities of food authority of India.
- To describe the need, limitations and standards for labeling of various food products.
- To outline the importance and implementation of HACCP in food industries.

Course Outcomes

Upon completion of the course, students will be able to,

1. Name the food hazards, physical, chemical and biological in the food industry.
2. Express the functions, responsibilities and concepts of various food regulatory bodies.
3. Report the overall functions and responsibilities of food authority of India.
4. List the overall requirements needed for labeling of various food products.
5. Design and implement the HACCP system in the food industries.
6. Infer the US and EU guidelines and standards governing the food safety and quality.

UNIT I – FOOD SAFETY

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection.

UNIT II – GLOBAL REGULATIONS

Food and Agriculture Organization - FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC) - Codex Alimentarius Commission - Codex India – Role of Codex Contact point,National Codex contact point (NCCP), National Codex Committee of India - ISO 22000 – Importance and Implementation.

UNIT III - FOOD AUTHORITY IN INDIA

Food safety and Standards Act – organizational chart – role of individual authority – principles to be followed –Provisions as to articles of food –imported items –Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Laws relatingto Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS.

UNIT IV - FOOD LABELING

Need for labeling – Developing labeling standards at the world level – Limitations of labeling safety issues – Labeling regarding methods of processing – Irradiated products –Products derived from modern biotechnology – organic produce -Genetically modified foods – EU rules on nutritional labeling – US rules on nutritionallabeling – Health claims – Approach of US and EU.

UNIT V – HACCP

Concept of HACCP – PRPs - Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCP - Establishing monitoring procedures- establishing corrective actions – establishing verification.

Suggested Readings:

1. Kees A. van der Heijden and Sanford Miller. International Food Safety Handbook Science,1999.
2. Government of India. Guide to the Food Safety and Standards Act. Tax-mann Allied ServicesPvt. Ltd. 2006.
3. Mehta R. and George J. Food Safety Regulation Concerns and Trade- The DevelopingCountry Perspective. Published by Macmillan India Ltd., New Delhi, 2005.
4. Barach JT. FSMS and Food Safety Systems: Understanding and implementing the rules.Wiley, Ist Edition, 2017.
5. Fortin ND. Food Regulation. Wiley, 2nd Edition, 2016.
6. Shaw IC. Food Safety: The science of keeping food safe. Wiley-Blackwell Publishing. 2ndEdition, 2018.
7. Mariott NG, Schilling MW and Gravani RB. Principles of Food Sanitation. Springer, 6thEdition, 2018.

22BTFT602 **Semester-VI**

BEVERAGE PROCESSING TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objective

The goal of this course is for students,

- To understand the types of ingredients used in beverage production.
- To impart knowledge on processes involved in carbonated beverage production.
- To define the processes and unit operations involved in noncarbonated beverage production.
- To outline the various grades, equipments used and ingredients for the production of alcoholic beverages.
- To discuss the quality standards, regulations and sanitation for beverage processing industries.

Course Outcome

Upon completion of this course, students will be able,

1. Capable of formulating beverages using various ingredients.
2. Demonstrate various unit operations involved in the food beverage manufacturing
3. Understand the various production techniques in beverages.
4. Apply the knowledge obtained to produce nonalcoholic beverages.
5. Evaluate the quality parameters of all beverages.
6. Familiarize with food laws and regulations of beverages.

UNIT I - INGREDIENTS IN BEVERAGES

Beverage-definition-ingredients- water, quality evaluation and raw and processed water, bulk and intense sweeteners, water miscible and water dispersible flavoring agents, colors – natural and artificial, Micro and Nano-emulsions of flavors and colors in beverages, preservatives, emulsifiers and stabilizers.

UNIT II - CARBONATED BEVERAGES

Procedures- ingredients- preparation of Syrup making, carbonation of soft drinks. Carbonation equipment’s and machineries- -containers and closures. low-calorie and dry beverages; isotonic and sports drinks; Fruit based carbonated beverages, carbonated water.

UNIT III - NON-CARBONATED BEVERAGES

Beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy based beverages, RTS beverages, isotonic Beverages. Flash pasteurization, Canning and Aseptic Packaging of beverages. bottled. Water; mineral water, natural spring water, flavored water.

UNIT IV - ALCOHOLIC BEVERAGES

Alcoholic beverages- types, manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, technology of brewing process, equipment's used for brewing and distillation, wine and related beverages, distilled spirits.

UNIT V - FOOD ADDTIVES AND MISCELLANEOUS BEVERAGES AND QUALITY CONTROL

Sweeteners, colourants, acidulants, clouding, clarifying and flavouring agents, preservatives for beverages. Carbon di oxide and carbonation. Quality tests and control in beverages. Miscellaneous beverages- coconut water, coconut milk, sweet toddy, sugarcane juice and flavoured syrups -Quality control, Filling-inspection and quality controls-sanitation and hygiene in beverage industry-Quality of water used in beverages threshold limits of ingredients. FSSAI, EFSA and FDA regulations.

Suggested Readings:

1. L. Jagan Mohan Rao and K. Ramalakshmi (2011) "Recent trend in Soft beverages", Woodhead Publishing India Pvt. Ltd.
2. Boulton, Christopher, and David Quain (2008) Brewing yeast and fermentation. John Wiley & Sons.
3. Hui, Yiu H., et al., eds (2004) Handbook of food and beverage fermentation technology. Vol. 134. CRC Press.
4. Mitchell, Alan J. (1999) "Formulation and Production Carbonated Soft Drinks". Springer Science & Business Media.
5. Woodroof, Jasper Guy, and G. Frank Phillips. (1981) Beverages: carbonated and noncarbonated. AVI Pub. Co.
6. Ashurst, P.R, "Chemistry and technology of Soft drink and fruit juices", 2nd edition, Blackwell Publishing Ltd. 2005.
7. Steen, D.P and Ashurst, P.R, "Carbonated soft drinks – Formulation and manufacture", Blackwell Publishing Ltd. 2000.
8. "Brewing yeast and fermentation Chris Boulton and David Quain", Blackwell Science Ltd Prevention of Food Adulteration Acts and Rules Manual".
9. Philip R. Ashurst. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.

22BTFT603 **Semester- VI**

DESIGN OF FOOD PROCESS EQUIPMENT

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objective

The goal of this course is for students to,

- Emphasis the types of materials used in the food processing equipments.
- Discuss about the materials and designing of different storage vessel.
- Explain the importance of reaction vessel and their deskining techniques.
- Explain the materials and designing of heat exchanger and evaporators.
- Discuss the importance of dryers in food processing industries.

Course Outcome

Upon completion of this course, students will be able to,

1. Point out the materials suitable for the construction of equipments.
2. List out the vessels used for the food storage.
3. Categorize the different types of reaction vessel used for different purposes.
4. Understand the importance of heat exchanger in the designing of food processing equipments.
5. Understand the significance of dryers in food processing.
6. Understand the basic for design and develop equipments used in food Processing operations. To gain technical know-how about the material requirements and design of various equipments needed in Food industries.

Unit I - MATERIALS

Metals and non-metals, design of pressure vessels – cylindrical shell –internal and external pressure - under continued loadings. Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes Numerical problem and design of pressure vessel.

Unit II - STORAGE VESSELS

Design of storage vessels – Rectangular Tank without stiffeners –with stiffeners – shell design – Numerical problem and design. Design of agitators and baffles. Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations;

Unit III - REACTION VESSELS

Design of Reaction vessels – materials -classification – jackets-Design of vessel shell with half coil – Design of vessel shell with jacket – Numerical problem and design. Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

Unit IV - HEAT EXCHANGERS

Design of Heat exchangers – types – materials – Design pressure and temperature- shell design – tubes - Numerical problem. -Design of Equipment. Evaporator: Materials of concentration – types – design- consideration – Design of agitators – power requirements – Design based on Torque – critical speed.

Unit V – DRYERS

Types - General considerations – Design of Tray dryer, Rotary Dryer, fluidized bed dryer, spray dryer, vacuum dryer, microwave dryer – Material Balance, Thermal energy Requirements, electrical energy Requirements, Performance Indices

Suggested Readings:

1. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN- 0824743113, 2003.
2. Joshi M.V, "Process Equipment Design", Macmillan India Ltd.,1985.
3. Coulson, J.M. and Richardson, J. F,"Chemical Engineering " Butterworth-Heinemnn Elsevier, ISBN-0750644451, 2002.

21BTFT641 **Semester-VI**

BAKERY AND CONFECTIONARY TECHNOLOGY
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students,

- To recall the principles of baking on bread and cake.
- To explain the baking skills in the production of biscuits and cookies.
- To develop the various types of sugar and flour based confectionary products.
- To demonstrate the working of equipment used in baking processes.
- To outline the packaging materials and quality control systems applied in food industry.

Course Outcomes

Upon completion of the course, students will be able to,

1. Discuss the rheology and chemistry of ingredients used in baking and confectionary.
2. Prepare the different types of breads, cakes, biscuits and cookies.
3. Assess the faults and remedies of baking processes.
4. Produce the various types of confectionary products.
5. Design and develop the equipment employed for baking and confectionary.
6. Choose the appropriate packaging materials and audit quality standards required for baking and confectionary.

UNIT I BAKING PRINCIPLES AND BREAD & CAKE

Types of wheat, Dough rheology, Baking principles - Role of ingredients and its chemistry. Bread-Ingredients, additives - Varieties of bread. Methods of bread preparation – bread spoilage and remedies. Advantages and disadvantages of various methods of bread-making. cake- types of cakes - role of ingredients-essential and optional ingredients - cake mixing methods – Preparation. Fancy cakes and preparation– Bread, cake- faults and remedies.

UNIT II BISCUIT AND COOKIES

Biscuits and cookies - role of ingredients. Types of biscuit dough – Developed dough, soft dough, semi-sweet and enzyme modified dough - consistency of the dough and its importance. Production of biscuits and cookies. Selection and preparation of mould. Cookies classification - Quality control for biscuits and cookies. Faults and causes.

UNIT III CONFECTIONERY PRODUCTS

Introduction - importance of sugar confectionery and flour confectionery. Stages of Sugar Boiling-Ingredients used in confectionery. Role of chemical additives in confectionery. Cocoa products and its uses in confectionery. Types of confectionery products-chocolate boiled sweets, caramels toffees, fondants.

UNIT IV BAKERY EQUIPMENTS

Machineries for a bakery unit - Bulk handling of ingredients, Dough mixers, Dividers, rounding, sheeting, and laminating machines. Ovens and Slicers, Packaging materials and equipment. Mixing and forming characteristics of mixtures-measurements of mixing –particles mixing- rates of mixing, energy input in mixing, liquid mixing-power & Froude number-mixing equipment- liquid, powder and particles mixtures, dough and paste mixtures, emulsification and homogenization. Forming-Pie & biscuit formers-Bread and confectionery moulders**.**

UNIT V PACKAGING AND QUALITY CONTROL FOR BAKERY AND CONFECTIONERY PRODUCT

Packaging requirements and materials. Standards and regulations for bakery and confectionery products. Production standards and quality control - Good Manufacturing Practices (GMP) and other practices.

Suggested Reading:

1. Amsterdam, Cakes and pastries, Time - life books, 1985.
2. Baker’s Handbook on Practical Baking, US Wheat Associates, New Delhi, 1994.
3. Bernard, W. Minifie, Chocolate, cocoa and confectionery: CBS Publishers and Distributors, New Delhi, 1997.
4. Pomeranz. Y. Modern Cereal Science and Technology, MVCH Publications, New York, 1987.
5. Samuel A. Matz., Equipment for Bakers, Pan Tech International Publication, 1988.
6. Manley, Duncan., Biscuit Doughs Manual 2, Woodhead Publishing Ltd., England, 1998

(i) Laboratory

Course Objective

The goal of this course is for students to,

- List the ingredients needed for preparations of food products.
- Calculate the quantity of ingredients for preparations of food products.
- Prepare different types of bakery and confectionery products.
- Explain the analysis of flour and dough characteristics.
- Perform cost analysis of the developed products.

Course Outcome

Upon completion of this course, students will be able to,

1. Choose the appropriate ingredients for preparing food products
2. Measure and calculate the quantity of ingredients for preparations of food products.
3. Formulate the ingredients for preparing a variety of bakery and confectionery products
4. Analyse the physical properties of dough ingredients
5. Analyze the cost of the developed products
6. Conduct sensory tests for the developed products

List of Experiments

1. Study of ingredients (major and minor): characteristics of flour, yeast, shortening, sugar, egg and salts.
2. Experiment on leavening action of baking powder, sodium- bicarbonate and ammonium-bicarbonate.
3. Determination sedimentation value of flour
4. Estimation of water absorption power (atta, and maida)
5. Determination dough rising capacity of yeast
6. Preparation of cake
7. Preparation of biscuits-different types.
8. Preparation of bread-different types.
9. Preparation of toffees and chewing gum.
10. Preparation of sugar boiled confectionary.

FOOD ADDITIVES
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hour

(i) Theory

Course Objectives

The goal of this course is for students,

- To explain the basic concepts of food additives.
- To describe the types, chemical properties, levels of addition and toxicity of acidulants.
- To discuss the types, chemical properties, levels of addition and toxicity of humectants.
- To outline the types, chemical properties, levels of addition and toxicity of fat substitutes and replacers.
- To summarize the types, chemical properties, levels of addition and toxicity of sweeteners, chelating agents, anti-browning agents and nutritional additives.

Course Outcomes

Upon completion of the course, students will be able to,

1. Report the classification, safety levels and toxicity of food additives
2. List the properties, levels of addition and toxicity data of various food additives.
3. Illustrate the importance of additives in maintaining or improving food quality.
4. Develop the various instant premixes by addition of preservatives within the permissible limits.
5. Explain the principles of food additives to study the toxicity
6. Identify and design newer products, with better quality using additives which are economical and safe.

UNIT I - INTRODUCTION

Definition, role of food additives, classification of food additives based on their role, dual role of certain additives, INS numbering system of food additives, safety requirements of food additives, Acceptable daily intake of food additives, JECFA and Food Chemical Codex standards for food additives, status of food additives with respect to Indian laws, GMP and permissible upper levels of food additives under Indian food laws.

UNIT II - ACIDITY REGULATORS AND PRESERVATIVES

Acidity Regulators – definition, chemical structure, role and importance, pH modulation and taste, acidity profile, permitted acidity regulators, levels of usage and food applications. Preservatives of chemical and microbial origin; mode of action on spoilage organisms and pathogens, factors affecting the performance of preservatives, active forms of preservatives, necessity in a food and levels of usage; permitted preservatives and food applications. Case studies / illustrations**.**

UNIT III - EMULSIFIERS, STABILIZERS AND THICKENERS

Emulsion, surface tension, oil in water and water in oil emulsion, Hydrophilic and Lipophilic balance (HLB), role of emulsifiers, different classes of emulsifiers and their chemical structure, their HLB values and role in emulsion stabilization; role of different stabilizers and other substances in emulsion stability; emulsion formation process and equipment; measurement of emulsion stability; permitted emulsifiers and stabilizers and food applications. Thickeners – definition, chemical structure, role in food processing and product end characteristics, list of permitted thickeners and food applications.

UNIT IV – ANTIOXIDANTS AND ANTI-CAKING AGENTS

Antioxidants - Chemistry of oxidative deterioration of food and its constituents and its effect on the quality; defining antioxidant; water soluble and oil soluble antioxidants and their chemical structure, permitted antioxidants; mechanism of action, permitted levels and food application. Anti-foaming and propellants, Anti-caking agents – definition, role in preventing spoilage, mode of action, permitted list of anti-caking agents and food application.

UNIT V - COLOR AND ARTIFICIAL SWEETENERS

Color – Natural and synthetic food colors, their chemical structure, shades imparted, stability, permitted list of colors, usage levels and food application. Artificial Sweeteners – list, structure, taste profile, permitted list, usage levels and food applications.

Suggested Readings:

1. Mahindru, S. N. “Food Additives- Characteristics Detection and Estimation”, TATA McGraw Hill, 2000.
2. Wilson, R. “Ingredient Handbook Sweeteners”, Blackwell, 2007.
3. Emerton, V. “Food Colors”, Blackwell, 2008
4. Peter A Williams and Glyn O Philips, “Gums and stabilizers for the Food Industry”, RSC, 2006.
5. Branen, A. L. “Food Additives” 2nd Edition, CRC press, 2002.

(ii) Laboratory

Course Objectives

The goal of this course is for students to,

- Explain the Chemistry of the additives added to food.
- State the importance of additives in maintaining or improving food quality.
- Develop newer additives with improved safety standards.
- Investigate the properties of toxicity data of various food additives.
- Use food additives in food industries.

Course Outcomes

Upon completion of this course, students will be able to,

1. Report the classification, safety levels and toxicity of food additives.
2. List the properties, levels of addition and toxicity data of various food additives.
3. Illustrate the importance of additives in maintaining or improving food quality.
4. Develop the various instant premixes by the addition of preservatives within the permissible limits.
5. Apply the principles of food additives to study the toxicity.
6. Identify and design new products, with better quality using additives which are economical and safe

List of Experiments

1. Estimation of Sulphur-Di-Oxide.
2. Estimation of Sodium Benzoate.
3. Estimation of Sorbic Acid.
4. Estimation of Butylated hydroxyl toluene.
5. Estimation of Propyl Gallate.
6. Determination of Saccharin.
7. Estimation of capsaicin.
8. Estimation of salt in pickled products.
9. Identification of adulterants in solid foods.
10. Identification of adulterants in liquid foods.

SEMESTER VII

B. Tech. – Food Technology **2022 - 2023**

22BTCC701 **Semester-VII**

PROFESSIONAL ETHICS AND ENTREPRENEURSHIP DEVELOPMENT

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Practice the students to create an awareness on Engineering Ethics
- Incorporate Moral and Social Values and Loyalty.
- Appreciate the rights of other.
- Motivate the leadership skills.
- Train to become an entrepreneur.

Course Outcomes

Upon completion of this course, students will be able to,

1. Explain the engineering ethics.
2. Outline the Moral and Social Values and Loyalty.
3. Justify the rights of other.
4. Illustrate the values of leadership skills.
5. Assess the skills of entrepreneur.
6. Discuss the management skills.

UNIT I ENGINEERING ETHICS

Senses of 'Engineering Ethics' – variety of moral issued – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – Models of Professional Roles – theories about right action – Self–interest – customs and religion – use of ethical theories.

UNIT II FACTORS OF CHANGES

Forces that shape culture, social control – Meaning, Agencies, Institution, Customs, Values, Folkways, Norms and Laws. Social changes – Meaning and nature – Theories.

UNIT III HISTORICAL DEVELOPMENT, PLANNING, ORGANISING

Definition of Management – Management and Administration – Development of Management Thought – Contribution of Taylor and Fayol – Functions of Management – Steps involved in Planning – Objectives – Setting Objectives – Process of Managing by Objectives – Strategies, Policies and Planning Premises– Forecasting – Decision–making – Formal and informal organization – Organization Chart.

UNIT IV DIRECTING AND CONTROLLING

Human Factors – Creativity and Innovation – Harmonizing Objectives – Leadership – Types of Leadership Motivation – Hierarchy of needs – Motivation theories – Motivational Techniques – Job Enrichment –Process of Communication – System and process of Controlling – Requirements for effective control – Control of Overall Performance – Direct and Preventive Control – Reporting.

UNIT V ENTREPRENEURSHIP AND MOTIVATION

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Entrepreneurship in Economic Growth– Major Motives Influencing an Entrepreneur – Achievement Motivation Training, self Rating, Business Game, Thematic Apperception Test – Stress management, Entrepreneurship Development Programs – Need, Objectives.

Suggested Readings:

1. Sharma S. Entrepreneurship Development. PHI Learning Pvt. Ltd. 2016.
2. Charles E Harris and Michael J Rabins. Engineering Ethics – Concepts and Cases. Wadsworth Thompson, Cengage Learning. New Delhi, 2013.
3. Whitebeck C. Ethics in Engineering research and Practice. Cambridge University Press, 2nd Edition, 2011.
4. Harold Kooritz and Heinz Weihrich. Essentials of Management. Tata McGraw Hill, New Delhi, 2010.
5. Khanka S.S. Entrepreneurial Development. S. Chand and Co. Ltd., New Delhi, 2006.

22BTFT702 **Semester-VII**

PROCESS ECONOMICS AND PLANT LAYOUT DESIGN

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students to,

- State the different specifications and processes involved in the design and development of food processing plant.
- Define the processes involved in layout design.
- Evaluate the projects and cost estimation of designing food plant.
- Outline the product cost and plant overheads.
- Perform profitability analysis in food processing industry.

Course Outcomes

Upon completion of this course, students will be able to,

1. Design and construct the well-equipped food processing plant for effective processing.
2. List the start – to – end facilities, infrastructure, utilities, investments along with the government regulations and specifications for plant layout.
3. Evaluate and estimate the capital investments and methods of cost estimation of designing foodplants.
4. Assess the overall production cost, profitability and factors involved in the cost estimation of products manufactured.
5. Analyze the problems involved in deciding the level of manufacture of a food product.
6. Develop own industry or plan turn-key projects based on the request from customers.

UNIT I - FOOD PROCESS DESIGN DEVELOPMENT

Technical feasibility survey of Food Industry, process development, Food Process flow sheets - Hygienic food process design – CIP Systems- Working principles and operating procedures. Equipment design and specifications – Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only).

UNIT II - PLANT LAYOUT

Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product. Systematic plant layout, Richard Muther's Simple Systematic Plant Layout.

UNIT III - PROJECT EVALUATION AND COST ESTIMATION

Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical

installation and other utilities), working capital investments. Methods of Cost estimation – Cost Indices.

UNIT IV - PRODUCT COST AND PLANT OVERHEADS

Manufacturing costs – Direct production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing- Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. Depreciation, Amortization and methods of determining the same. Introduction to Food Safety Management System.

UNIT V - PROFITABILITY ANALYSIS

Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Cash flow diagram and its importance – Optimization techniques - Linear and Dynamics programming, Optimization strategies.

Suggested Readings:

1. Peters and Timmer haus. Plant design and Economics for Chemical Engineers. McGraw Hill5thEdition, 2017.
2. Rudd D F and Watson C C. Strategy of Process Engineering. John Wiley & Sons Inc. 2013.
3. Maroulis Z.B. and Saravacos G.D. Food Process Design. Marcel Dekker Inc, 2003.
4. Towler G and Sinnott R.K. Chemical Engineering design principles, practice and Economicsof Plant and Process. 2nd Edition. Elsevier, 2012.

22BTFT703 **Semester-VII**

WASTE MANAGEMENT IN FOOD INDUSTRIES

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Importance of treating waste product from food industry.
- Treatment methods and recycling of waste product from food industry.
- Effective utilization or disposal of food waste.
- Understand the characterization and chemical properties of food waste.
- Control or minimize the impact of food waste on the environment.
- Prepare value added products from food processing, industrial wastes.

Course outcomes

Upon completion of this course, students will be able to,

1. Awareness of Importance in treating waste product from food industry.
2. Knowledge of Treatment methods and recycling of waste product from food industry.
3. Handle industrial waste with necessary precautions to avoid infection and cross contamination.
4. Enable the student to understand the methods of treatment.
5. Monitor the sludge and effluents discharged from food industries meet the limitation by law.
6. Control environmental pollution by proper treatment of food waste.

UNIT I – ENVIRONMENTAL POLLUTION AND FOOD WASTE CHARACTERIZATION

Environmental problems – Pollution – air, water, soil, noise, and radiation pollution. Classification and characterization of waste from various food industries. Need for treating waste from various food industries. Pollution due to Food Industry wastes - solid and liquid wastes – characteristics and impact on environmental quality.

UNIT II – WASTE FROM FOOD INDUSTRIES AND BY-PRODCUT UTILIZATION

Wastes from fruit and vegetable processing, meat and poultry processing, fish processing, dairy processing, cereal processing and beverage processing industries– characteristics and effect on soil, water and air quality – by-product utilization.

UNIT III - WASTEWATER MANAGEMENT IN FOOD INDUSTRIES

Principles of Physical treatment - screening, sedimentation, filtration, back washing, membrane separation. Principles of Chemical treatment - coagulation, flocculation, precipitation, flotation, disinfection and fluoridation. Principles of biological treatment

– aerobic process, activated sludge process, trickling filters, anaerobic digestion, UASBreactor.

UNIT IV – SOLID WASTE MANAGEMENT IN FOOD INDUSTRIES

Solid waste management techniques – Principles and practices, 4R concept. Composting – methods of composting, vermicomposting. Incineration, pyrolysis, briquetting – value addition – SCP, enzymes, pectin and other products.

UNIT V-ENVIRONMENTAL PROTECTION AND POLLUTION CONTROL IN FOODINDUSTRIES

International and national scenario on disposal of waste from food industries. Green chemistry - Principles and application in food Industries - CDM - Eco friendly products in food industry - Biocolorants - Eco friendly packaging - ¬Eco labeling – Occupational and Bio safety in food industries.

Global treaties, conventions – National and State Level Organizations – Environmental Laws and Acts; Regulatory issues with food industry waste.

Suggested Readings:

1. Ioannis S. Arvanitoyannis, Waste Management for the Food Industries, Academic Press,2008.
2. S.N. Jogdhand, Environmental Biotechnology: Industrial Pollution Management, (III ed),Himalaya Publishing House, New Delhi, 2010.
3. Lawrence K.Wang, Yung-Tse Hung, Howard H.L and Constantine Yapijakis, Waste Treatment in the Food Processing Industry, CRC press, Taylor and Francis Group, 2006.
4. Singh, N Shree and Tripathi D Rudra, Environmental Bioremediation Technologies, SpringerVerlag Publishers, 2007.
5. D. Hamilton and Stephen Crossley, Pesticide Residues in Food and Drinking Water - HumanExposure and Risks, John Wiley & Sons Publishers, 2003.
6. Vasso Oreopoulou and Winfried Russ. “Utilization of by-products and Treatment of Waste inthe Food Industry”. Springer, 2007.
7. Patwardhan., Industrial Waste Water Treatment, Prentice-Hall of India Pvt Ltd, 1st edition, 2008.

22BTFT741 **Semester-VII**

FOOD PACKAGING TECHNOLOGY
(Theory & Lab)

5H-4C

Instruction Hours/week: L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

(i) Theory

Course Objectives

The goal of this course is for students to,

- Describe the functions of packaging along with the influence of various factors on food.
- Explain the various factors of different packaging materials include metallic cans and glass.
- State the types, production and applications of paper, paperboards and polymers in food packaging.
- Summarize the filling, sealing, labeling, barcodes and printing on packages along with the legislative requirements.
- Outline the various types of innovative packaging technologies to improve the shelf life of the products.

Course Outcomes

Upon completion of this course, students will be able to,

1. Discuss the need and functions of packaging as a solution to various factors affecting food.
2. Estimate the shelf life of food packed in different types of packaging materials.
3. Explain the different packaging materials, their manufacturing process and equipment involved.
4. Compile the various closures and sealing mechanisms for different packaging materials.
5. Select the different printing and labeling methods with legislative requirements.
6. Devise innovations in food packaging and their applications.

UNIT I - INTRODUCTION TO FOOD PACKAGING

Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food - general principles of control of the spoilage agents - General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging- Retort packaging, principles, application -Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

UNIT II - METAL CANS AS PACKAGING

Metallic can types - Tin cans and Aluminum cans. Specialty of Open top sanitary cans, Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers -Design features effect of these materials on packed commodities.

UNIT III - FLEXIBLE FILMS PACKAGING

Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Poyvinylidene Chloride, Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates. Rigid and Semi rigid plastic packaging – fabrication methods – Thermo forming, Blow moulding, Injection moulding, Extrusion. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

UNIT IV - FILLING AND SEALING OPERATIONS FOR VARIOUS TYPES OF PACKAGES

Closing and sealing of rigid containers. Filling and sealing of Flexible plastic containers, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements. Filling and Sealing of pouches, pouch from fill seal machines – Applications of form fill seal machines.

UNIT V - INNOVATIONS IN FOOD PACKAGING

Aseptic Packaging. Active packaging, Moisture control, CO2 and Oxygen scavenging. Modified atmosphere packaging – principles, applications. Green packaging, Permeability of gases in packs. Antimicrobial Packaging, Edible packaging films and coating. Packaging for non-thermal food processing. Sensors in food packaging with their applications, Intelligent Packaging – Time-temperature indicators, RFID, Tamper evident packaging.

Suggested Readings:

1. Coles R and Kirwan J. Food and Beverage Packaging Technology. Wiley-Blackwell Publishing. 2nd Edition, 2011.

2. Coles, R., Dowell, D.M., Kirwan, J. Food Packaging Technology, Black Well Publishing Ltd, 2009.

3. Gordon L. Robertson. Food Packaging Principles & Practice. CRC Press, 2016.

4. Kit L Yam and Dong Sun Lee. Emerging Food Packaging Technologies: Principles and Practice. Wood head Publishing Ltd, 2012.

5. Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House

6. Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication
John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House.

7.Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill.

(ii) Laboratory

Course Objectives

The goal of this course is for students to,

- Determine the quality of different types of packaging materials.
- Determine the migration characteristics of the various packaging materials.
- Investigate the water vapour transmission rate of packaging materials.
- Develop skills related to basic tests on food packaging materials.
- Infer the basics for operating the different types of packaging equipments.

Course Outcomes

Upon completion of this course, students will be able to,

1. Test the quality of different types of packaging materials.
2. Experiment the migration characteristics of the given packaging materials.
3. Conduct test on water vapour transmission rate of packaging materials.
4. Examine the water absorption capacity of paper and paperboards.
5. Demonstrate packaging requirements and their selection for raw and processed food.
6. Estimating the shelf life of coated foods.

List of Experiments

1. Measurement of thickness of packaging materials.
2. Measurement of basic weight and grammage of paper and paperboards.
3. Measurement of water absorption of paper and paper boards (Cobb Test).
4. Study of vacuum packaging machine, bottle filling machine and form-fill-seal machine.
5. Determination of lacquer integrity test.
6. Determination of Water Vapor Transmission rate of Packaging Material.
7. Determination of grease resistance of papers used in food industry – butter paper & toffee wraps.
8. Determination of adhesive test of tapes.
9. Experiment on sealing of plastic cups.
10. Estimation the shelf life of edible coated Food Samples.

22BTFT791 **Semester-VII**

PROJECT WORK PHASE I

2H-1C

Instruction Hours/week: L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

The students will be directed to do a project work which will be the Phase I if their main project works that will be performed in the eighth semester during. Their projects will be evaluated for forty percentages in Continuous Internal Assessment and sixty percentages in End Semester Examination.

End Semester Examination evaluation will be based on the report submitted by the student after the completion of the project work.

SEMESTER - VIII

B. Tech. – Food Technology **2022 - 2023**

22BTFT801 **Semester- VIII**

FOOD FERMENTATION TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Understand the benefits, nutritive value, and microorganisms associated with the fermentation processes.
- Practice the preparation and culture maintenance of bacteria, yeast and mold.
- Explain the production of different types of fermented products.
- Discuss the production processes of fermented drinks and fermented vegetables.
- Understand the production of yeast, enzymes, proteins, fats and HFCS.

Course outcomes

Upon completion of this course, students will be able to,

1. List the overall benefits, nutritive value, and microorganisms involved in the fermentation processes.
2. Prepare and maintain the cultures of bacteria, yeast and mold for fermentation processes.
3. Develop the different types of fermented dairy products.
4. Understand the processes involved in the production of fermented drinks.
5. Illustrate the overall steps employed in the production of fermented vegetables.
6. Outline the different set of processes followed in the production of yeast, enzymes, proteins, fats and HFCS.

UNIT I - INTRODUCTION TO FERMENTATION

Definition - benefit of fermentation - design of fermenters - nutritive value of fermented foods - microbial changes in fermented foods – selection and importance of microorganism - proteolytic, liploytic and fermentative bacteria.

UNIT II - CULTURE MAINTENANCE

Preparation and Maintenance of Bacterial, Yeast and Mold cultures for food fermentations. Probiotics - Lactic acid bacteria-activities and health-promoting effects. Mushrooms: Cultivation and preservation.

UNIT III - FERMENTED PRODUCTS

Fermented Vegetables (Pickles) Fermented meat and fish products, Oriental fermented foods - Fermented Dairy Products: Cheeses, Curd and Yoghurt. Spoilages and defects of fermented products and their control.

UNIT IV - FERMENTED DRINKS

Fermentative Production of Beer, Wines, Cider and Vinegar, distilled spirits (eg. Rum, gin, whisky), Fermented Dairy drinks: Butter milk and the fermented milks.

UNIT V - MICROBIAL PROTEINS

Microbial proteins, Production of Baker's Yeast, Microbial Proteins and fats, Food enzymes (eg. Amylases, protease, lipases, pectinases, rennin) - production and their applications in food fermentation. HFCS (High Fructose Corn Syrup). Health benefits of microbial protein.

Suggested Readings:

1. K.H. Steinkrus, Handbook of Indigenous Fermented Foods, Marcel Dekker publisher,1983.
2. Sukumar De, Outlines of Dairy Technology, Oxford University Press N Delhi , 1991.
3. Prescott and Dunn, Industrial Microbiology, Agrobios (India) publisher, 2009
4. L.E.Casida, Industrial Microbiology, New Age International(p) Ltd N Delhi, 2007
5. W.C.frazier and D.C.Westhoff, Food Microbiology, Tata McGraw Hill publisher, 3rd edition, 2008

22BTFT791 **Semester-VIII**

PROJECT WORK PHASE II

12H-6C

Instruction Hours/week: L:0 T:0 P:12 **Marks:** Internal**:120** External**:180** Total**:300**

End Semester Exam:3 Hours

The students will be performing their main project work as a continuation of the Phase I project completed in the seventh semester. Their projects will be evaluated for a total of three hundred marks, out of which one twenty marks will be for Continuous Internal Assessment and one hundred and eighty marks for End Semester Examination.

End Semester Examination evaluation will be based on the report submitted and presentation of his/her work by the student to a panel of evaluators after the completion of the project work.

PROFESSIONAL ELECTIVES

SEMESTER – V

B. Tech. – Food Technology **2022 - 2023**

22BTFT5E01 **Semester-V**

LIPID PROCESSING TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students,

- To understand the physical and chemical properties of fats and oils.
- To study the extraction and refining processes of various oils and fats.
- To learn the packaging, quality standards of fats and oils.
- To explain the industrial applications of oils.
- To discuss the quality standards and specifications followed in oil processing industries

Course Outcomes

Upon completion of this course, students will be able,

1. To enumerate the importance of fats and oils.
2. To describe the manufacturing process of oils and fats.
3. To apply knowledge on manufacture of designer fats.
4. To appraise the quality attributes of oils and fats.
5. To design suitable packaging materials.
6. To invent methods for industrial applications of oils and fats.

UNIT I - PHYSICAL AND CHEMICAL PROPERTIES

Introduction - Fats and oils – formation – functions of oil in human body - fatty acids – double bonds and their position in oil – Geneva type classification - sources of vegetable oils – production status-oil content – coconut , palm, peanut , rice bran, sesame, mustard and sunflower seeds oil – physical and chemical properties of fats and oils - chemical reactions of oil – hydrolysis – hydrogenation, oxidation and polymerization.

UNIT II - EXTRACTION METHODS

Oil extraction methods –mechanical expression – ghani, power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

UNIT III - REFINING OF OILS

Refining of oils – objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil – continuous

bleaching process – decolourising agents-deodorization process winterization processes-hydrogenation of oil –selectivity – catalyst –batch type hydrogenation – regeneration of Catalyst-Vanaspati, ghee and margarine – production process-partial sterilization, emulsification, chilling, kneading and rolling, incorporation of salt, colouring substances production of special fats – butter – types - production and storage.

UNIT IV - PACKAGING OF EDIBLE OILS AND ITS ANALYTICAL PROPERTY

Packaging of edible oils – requirements – types – tinplate, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for Vanaspati and ghee changes during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – colour-non edible oils – castor oil, linseed oil, vegetable waxes – production and processing. Analytical property-melting behaviour, low temperature properties, unsaturation, saponification, GC, NIR, FTIR, NMR, mass spectrometry.

UNIT V - INDUSTRIAL APPLICATIONS AND QUALITY STANDARDS

Industrial applications of fats and oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and Agmark standards – site selection for oilextraction plant- safety aspects- HACCP standards in oil industries.

Suggested Readings:

1. Harry Lawson, (1997) “Food oils and Fats - Technology, Utilization and Nutrition”, CBS Publishers and Distributors, New Delhi.
2. Gunstone F.D., (2008) “Oils and Fats in Food Industry”, Blackwell Publishing, United Kingdom, ISBN – 13: 9781405171212.
3. Gunstone F.D., (2011) “Vegetable Oils in Food Technology: Composition, Properties and Uses”, 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681.
4. Bailey's Industrial Oil & Fat Products, Daniel Swern, 2000, 4th ed.John Wiley & Sons.
5. The Industrial Chemistry of Facts &Waxes 3rd edition. by Balliere, Tindall & Cox.
6. Henry Basil Wilberforce Patterson, Handling & Storage of Oiseeds, Oils, Fats & Meal,1989, Elsevier Applied Science Publishers.
7. Frank Gunstone, Oils and Fats in the Food Industry, 2008, 1st edition, Wiley
8. Frank Gunstone, The Chemistry of Oils and Fats: Sources, Composition, Properties and Uses, 2004, 1st edition, Blackwell Publishing
9. Modern Technology of Oils, Fats & Its Derivatives (2nd Revised Edition) By NIIR Board of consultants and Engineers, 2013, Asia Pacific Business Press.

22BTFT5E02 **Semester- V**

NON-THERMAL TECHNIQUES IN FOOD PROCESSING

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Discuss the principles, applications and effect on foods of high-pressure processing.
- Understand the principle, types, effects and limitations of radiation processing of foods.
- Explain the complete processes of osmotic dehydration of foods.
- Demonstrate the ohmic heating and ultrasound processing of foods.
- Summarize the application of pulsed light and hurdle technology in food processing.

Course Outcomes

Upon completion of this course, students will be able to,

1. Illustrate the overall processes involved in the high-pressure processing of foods.
2. Outline the multiple aspects of radiation processing of foods.
3. Assess the principle, mechanism, applications and limitations of osmotic dehydration of foods.
4. Infer the application of ultrasound in processing and preservation of food.
5. Discuss the basics, electrical properties and treatment of foods using ohmic heating technology.
6. Understand the overall processes of pulsed light and hurdle technology in food processing.

UNIT I - HIGH PRESSURE PROCESSING OF FOODS

Non thermal technologies in preservation of foods – necessity and advantages – status and trends of non-thermal technologies in processing and preservation of foods- Principles – applications to food systems – effect on quality – textural, nutritional and Microbiological quality – factors affecting the quality – modelling of high-pressure processes – High Pressure Freezing, Principles and Applications.

UNIT II - RADIATION PROCESSING OF FOODS

Principle, Types of radiation sources. Biological effects of irradiation, Irradiation of Foods– Gamma Irradiation, X-Ray Irradiation, UV Irradiation–Combined treatments. – Mechanism of microbial and enzyme inactivation - Applications and Limitations.

UNIT III - OSMOTIC DEHYDRATION OF FOODS & MICROWAVE

Principle – Mechanism of osmotic dehydration – Effect of process parameters on mass transfer – Methods to increase the rate of mass transfer – Applications – Limitations of osmotic Dehydration – Management of osmotic solutions – Microwave –Principles- sterilization, tempering, drying, puffing, -Applications and Limitations.

UNIT IV - OHMIC AND ULTRASOUND PROCESSING OF FOODS

Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid – Effect on properties of foods Basics of ohmic heating – Electrical conductivity - generic configurations- treatment of products- Mechanism of microbial and enzyme inactivation.

UNIT V - Pulsed Electric Field Processing of Foods

Principles – Mechanism of action – PEF treatment systems – Main processing parameters – PEF Technology – Equipments – Mechanism of microbial and enzyme inactivation- safety aspects– Processing of liquid foods using PEF – Process models – Comparison of High-pressure processing and PEF – Enzymatic Inactivation by PEF, Examples – Microbiological and chemical safety of PEF foods.

Suggested Readings:

1. Da-wen Sun: Emerging Technologies for Food Processing, Elsevier Academic Press and Marcel Dekker Inc, 2014.
2. Gustavo V. Barbosa- Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Novel Food Processing Technologies (Food Science and Technology Series), CRC Press,2004.
3. Cullen, P.J., Tiwari, B.K. and Valdramidis V.P. Novel thermal and non-thermal technologies for fluid foods. Academic press, 32 Jamestown Road, London NW1 7BY, UK. 2012.
4. Sun, D. Emerging Technologies for Food Processing, Academic Press, 2005.
5. Ohlsson, T. and Bengtsson, N. Minimal Processing technologies in the food industry, Woodhead Publishing Limited, 2002.

22BTFT5E03 **Semester-V**

PROCESS CONTROL FOR FOOD ENGINEERS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Contrast the fundamentals of sensors and control concepts.
- Explain the concepts of system analysis and control.
- Summarize the knowledge about the working of various sensors.
- Define mathematical model for a system.
- Interpret the suitable control schemes of particular system.

Course Outcomes

Upon completion of this course, students will be able to,

1. Represent the mathematical model of a system.
2. Determine the response of different order systems for various test inputs.
3. Analyze the stability of the system.
4. Apply the knowledge of various Measuring Instruments design a simple Instrumentation system.
5. Derive the Mathematical Model of a physical system.
6. Analyze and decide suitable control schemes for a particular system.

UNIT I - INTRODUCTION TO PROCESS CONTROL

Introduction – measurement system - characteristics of instruments, static and dynamic characteristics System – steady state design – process control – process control block diagram – definition of a process, measurement, controller, and control element, loop – damped and cyclic response- feedback control – transient responses – lap lace transform - transforms of simple functions – step function, exponential function, ramp function and sine function.

UNIT II - CONTROL SYSTEMS

Open and closed loop systems, servo - mechanisms, hydraulic and pneumatic control systems, two-way control, proportional control, differential control and integral control. Control valve – Construction and working of pneumatically operated valve and spring – diaphragm Actuator.

UNIT III - STABILITY ANALYSIS

Signal flow graph – Mason's Gain formula, Block diagram algebra. Stability – concept of stability, definition of stability in a linear system, stability criterion, characteristic equation, Routh test for stability

UNIT IV - PRESSURE AND TEMPERATURE SENSORS

Pressure measurement – Construction and working of capacitive pressure sensor, Inductive pressure sensor, strain gauge, pressure sensor, diaphragm, bourdon tube, differential pressure cell Temperature sensors –Construction and working of RTD, Thermistors, Thermocouples, bimetallic strips.

UNIT V - LEVEL SENSOR

Simple float systems, capacitive sensing element, radioactive methods (nucleonic level sensing) – ultrasonic level sensor. Measurement of density – U-type densitometer, Buoyancy meter Measurement of composition – Electrical conductivity cell, non-dispersive photometers, pH meter, Gas chromatograph, Mass spectrometer.

Suggested Readings:

1. J.F Richardson A D. G. Peacock, Coulson & Richardson's (2006),"Chemical Engineering", Volume3, Butherworth – Heinemann, an imprint of Elsevier.
2. Donald R. Coughanowr. (2008), "Process System analysis and control" Mc- Graw Hill International Edition, Second Edition, singapore.
3. Nagoorkani. A (2012),"Control Systems", RBA publications, 2nd edition, ninteenth reprint.
4. S. Baskar (2004)," Instrumentation control system measurements and controls"Anuradha Agencies Publishers.
5. Nagrath, M and Gopal, I.J (2003), "Control Systems Engineering", Wiley Eastern Limited, Third Edition Reprint.
6. Renganathan (2003), "Transducer engineering, Allied publishers, New Delhi.
7. Patranabis (2004), "Principles of industrial instrumentation", Prentice Hall India. Patranabis, D., (1997) Second Edit Tata McGraw Hill Publishing Co. Ltd. New Delhi. ISBN 0074623346.
8. Bakshi.U.A and A.V.Baksi 2004. Measurements and Instrumentation. Technical Publications Pune.
9. E.O.Doeblin. Measurement Systems application and design, McGraw-Hill Publishing Company Limited.

22BTFT5E04 **Semester-V**

CEREALS AND PULSES TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students,

- To explain the processing of major cereals like paddy, maize etc.
- To recognize the milling techniques of cereals and pulses.
- To outline the byproducts obtained during processing along with their uses.
- To develop value added products from maize.
- To analyze various aspects of milling of pulses.

Course Outcomes

Upon completion of the course, students will be able to,

1. Evaluate the basic composition and structural parts of food grains.
2. Practice the various methods on drying of grains.
3. Illustrate the techniques of rice, wheat and pulse milling.
4. Prepare value added products from the byproducts obtained during milling.
5. Assess the production, processing and preparation of value added products from maize.
6. Demonstrate the equipment involved in the milling of pulses.

UNIT I - PADDY PROCESSING

Present status and future prospects of cereals; Morphology, Classification and types - Chemical composition - Structure and Composition of paddy – Cleaning of paddy - Pre Cleaners, -Paddy Parboiling Processes. Physico-chemical changes during parboiling – effect of parboiling on cooking qualities - Parboiling methods - Methods of grain drying- LSU, rotary, columnar, recirculatory dryers – Byproducts of paddy processing - Paddy husk and its uses as husk ash, activated carbon, furfural and other by products – Value added products - Flattened and Puffed Rice.

UNIT II - RICE MILLING

Rice milling flow chart - Modern Rice Milling equipments – paddy milling - Dehusking of paddy - Engelberg Huller, Under runner disc shellers, rubber roll sheller and Centrifugal dehusker- Paddy Separators – Satake and Schule Designs – Rice Polishers - Cone polishers and other types - Bran and Brokens separators - Rice mill yields and loss due to brokens at different stages of milling – milling efficiency -Use of Rice Bran in Edible oil Industry.

UNIT III - WHEAT MILLING

Structure and composition of wheat – flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat – products and byproducts of wheat.

UNIT IV - PROCESSING OF MAIZE/CORN

Structure and composition of maize – milling methods - Precleaning-cleaning equipment degermination and dehusking- Dry milling of maize – wet milling – flow chart- Products of milling – Flour – Semolina - Brewers' grits etc and their applications - Branand Fibre separation - Gluten and Starch Separation - Equipment used - Starch conversion into other value-added products – Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes - Processing for Dextrose, Malto Dextrin and other products - Extraction and refining of Corn oil in brief.

UNIT V - MILLING OF PULSES

Structure and composition – need for pulse milling – Unit operations of pulse milling – domestic and commercial scale pulse milling methods – Dry and wet milling,CFTRI, CIAE, Jadavpur methods - Process flow chart – Pulse milling machineries - dehusking in Pulse Pearler - splitting of pulses in Pulse splitter - Mini dhal mill - working principle - advantages and disadvantages – pulse milling efficiency - Grindingof split pulses - pulse flour products - their applications and equipments used.

Suggested Readings:

1. KM. Sahay and KK. Singh. Unit operations of Agricultural Processing, Vikash Publishing house PVT Ltd. Delhi, 2nd Edition, 2004.
2. Chakraverty, A. Post-Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 3rd Edition, 2018.
3. Karel Kulp and Joseph P Pante. Handbook of Cereal Science and Technology, Mercel Dekker, USA, 2nd edition, 2000.

SEMESTER – VI

B. Tech. – Food Technology **2022 - 2023**

22BTFT6E01 **Semester- VI**

MILLING TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students to,

- Discuss about the structure and properties of grains and cereals.
- Summarize milling process and equipments used for rice.
- Extrapolate the process of milling and separation of wheat and corn.
- Outline the steps in involved in milling of pulses along with equipments.
- Explain about the properties of oil seed and their extraction and refining techniques.

Course Outcomes

Upon completion of this course, students will be able to,

1. Understand the importance of grains and cereals along with storage.
2. Understand the byproducts obtained from rice milling and its wastes.
3. Acquire detailed knowledge of Wheat and corn milling and its waste utilization.
4. Understand the techniques and processes involved in pulse milling.
5. Learn about the extraction, separation and refining of oil seed milling.
6. Emphasize the various processing methods involved in converting raw material into quality food products.

UNIT I - GRAIN PROPERTIES

Importance of grains and cereals - definitions, Grain structure, physicochemical properties of grains and its nutritional value. Storage of cereal grains in relation to maintaining grain quality – types of storage structures. Packaging systems, materials and machinery. Structure and quality standards of cereals.

UNIT II - RICE MILLING

Rice milling flow sheet. Paddy procurement Explanation of steps in milling operations - Cleaning, Parboiling- Physio – chemical changes during Parboiling and effects of qualities of rice. Methods of Parboiling, Milling, Shellers, Paddy Separator, Whitener, Polisher, Grader, and modern rice mill, Grain drying techniques and technology. Ageing of Rice Byproducts from rice milling and waste utilization. Rice economy in India.

UNIT III - WHEAT MILLING

Wheat milling flow sheet. Wheat Reception - Explanation of steps in milling, Cleaning Principles of Parboiling of wheat- Methods of Parboiling, Sifters, De-stoners,Roller milling – Break rolls, and reduction rolls, Sifting and purifying, plan sifters. Bran separation. Efficiency of milling process. Packaging of wheat products. Durrum wheat products. By products from wheat milling and waste utilization. Milling of Corn: Corn–

types. Dry and wet milling of corn– flow sheet and explanation, Byproducts from corn milling, corn starch, corn syrup, corn flakes. Waste utilization. Wheat economy in India.

UNIT IV - PULSE MILLING

Importance of legumes. Milling and processing of Legumes- Methods of milling(dry and wet) of pulses. Preconditioning of pulses before milling Processing methods- dehulling losses and effect of dehulling on nutritive value. Grading methods, cooking quality.

UNIT V - OIL SEED MILLING

Oil seed processing- natural sources of oil. Physio-chemical properties, mechanical extraction - Oil processing machinery, solvent extraction, factors influencing extraction, types of solvents. Refining of oil -Degumming, neutralization, bleaching, filtration, deodorization, their Principles and process controls, hydrogenation, winterization, Purification of oil – gravity settling, filter press; changes during storage. Packaging. Oil seed flour concentrates and isolate. Utilization of oil seed meals of different food uses. Importance and application of oils in food and health. New technologies in oil seed processing. Handling and storage of oilseeds. Quality of oil – different standards;

Suggested Readings:

1. Kulp K and Pont J G, ―Handbook of Cereal Science and Technology, Second Edition, Chips Ltd. USA, 2000.
2. Khader, Vijaya and Vimala, V., ―Grain Quality and Processing, Agrotech Publishing, Udaipur, 2007.
3. Harry Lawson. ―Food Oils and Fats, Technology, Utilization and Nutrition, CBSPublishers and Distributors, New Delhi, 1997.
4. Chakraverty, A. ―Post Harvest Technology of Cereals, Pulses and Oil Seeds, Third Edition, Oxford & IBH publishing & Co., New Delhi, 2000.
5. Sahay, K.M. and Singh. K.K. Unit operations of Agricultural Processing, Vikas Publishing House, New Delhi, 1996.

22BTFT6E02 **Semester- VI**

TECHNOLOGY OF OILSEEDS PROCESSING

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students to,

- Discuss about the nutritional value and future roles of oil seeds.
- Know the importance of milling at different scale of operations.
- List the equipments involved in oil seed milling processes.
- Understand the refining in oilseed processing.
- Discuss about the use of oil seeds meals in protein products and byproducts.

Course Outcomes

Upon completion of this course, students will be able to,

1. Understand the composition, nutritional values and classification of oil seeds.
2. Identify the problems affecting milling and develop new methods in different scale of operations.
3. Gain Knowledge about the principles and working of oil seed milling equipments.
4. Understand the importance of refining stage in oil processing.
5. Interpret the use of higher protein products and their byproducts.
6. Understand and identify the specific processing technologies used for oil seeds and the various products derived from these materials.

UNIT I - INTRODUCTION

Present status and future prospects of oilseeds; Morphology of oilseeds;Classification and types of oilseeds; Chemical composition, nutritional value and anti- nutritional compounds in oilseeds; Methods of removal of anti- nutritional compounds.

UNIT II - OILSEED PROCESSING

Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines, Milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry.

UNIT III - STAGES OF REFINING

Refining of oils and its types: Degumming, neutralization, bleaching, filtration, deodorization, winterization and their principles and process controls; Hydrogenation of oils; Purification of oil – gravity settling, filter press. Rancidity of oils & its prevention; Aflatoxin in oil bearing materials.

UNIT IV - PACKAGING AND STORAGE

Packaging and storage of edible oils. New technologies in oilseed processing;Oilseed economy in India. Industrial applications of oils - quality regulations, Protein texturization, fibre spinning.

UNIT V - UTILIZATION OF BYPRODUCTS

Utilization of oil seed meals for different food uses: Oil seeds as direct edible products. High protein products like protein concentrates and isolates; Oil cake analysis;defating of oil meals / cakes; Oil meal/ cake as raw material for animal / poultry feed; Oil cake export - By-products of oil milling and their value addition.

Suggested Readings:

1. Guriqbal Singh, Harbhajan Singh Sekhon, Jaspinder Singh Kolar and Masood Ali. 2005. Pulses. Agrotech Publishing Academy, Udaipur.
2. Chakraverty. 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rdEd. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Frank D. Gunstone. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.
4. Fereidoon Shahidi. 2005. Bailey's Industrial Oil & Fat Products, 6th Ed., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA.
5. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy.2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices.Marcel Dekker, Inc., NY, USA.
6. K.M. Sahay and K.K. Singh. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida.

22BTFT6E03 **Semester- VI**

DESIGN AND FORMULATION OF FOODS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students to,

- Explain the importance of nutrition and nutritive value of different foods in relation with health.
- State and illustrate the terms, principles and steps involved in menu planning.
- Explain the vital role of geriatric and therapeutic balanced diet in human life.
- Understand the methods involved in the measurement and estimation of energy requirements in individuals.
- State the concepts of nutraceuticals designing and Anti-nutritional factors.

Course Outcomes.

Upon completion of this course, students will be able to,

1. Know the nutritional value of different food groups.
2. Identify the nutritional requirements of infants, preschool going children and athletes.
3. Learn the principles of menu planning process and understand and use the concept of food exchange lists.
4. Plan therapeutic diets for diseases like diabetes, and CHD.
5. Understand the overall terms and methods applied in the measurement and estimation of energy.
6. Discuss the concepts of anti-nutritional, functional and special foods.

UNIT I - NUTRITION AND BALANCED DIET

Nutritive value and anti- nutritional factors present in cereals, pulses, oil seeds, fruits, vegetables, fish, meat and eggs- effect of processing on nutritive value of foods- Principles of Nutrition and Health-Food Preparation and Service: Principles and Methods. Basic terms used in study of food and nutrition, BMI and Nutritional Status, Understanding relationship between food, nutrition and health. Nutritional labelling in India

UNIT II - MENU PLANNING

Explanation of terms- Principles of planning menus- Steps involved in planning menus- Food guide pyramid- Infant Foods: Formulation of weaning foods, Protein energy malnutrition- Formulating diet for preschool going (2-5 years) children-Food Selection and Meal Planning for different age groups. Factors affecting meal planning

UNIT III - BALANCED DIET

Diets during normal life cycle- Concept of Balanced Diet-Nutrition from infancy to adolescence- Nutritional requirements of different age groups- Geriatric nutrition-

Nutrition for athletes- Therapeutic Diet: Diet therapy and types of therapeutic diet- Diet for diabetic mellitus- Diet for cardio vascular disease- Diet for gastro intestinal disease.

UNIT IV - ENERGY REQUIREMENT

Definition- units of energy- Energy content of foods- Physiological fuel value- Measurement of energy expenditure- BMR- Thermic effect of food- SDA- Methods of measurement- Factorial methods of estimating energy requirement of individuals- Regulation of energy metabolism. Factors affecting absorption of the following in brief: Energy, Carbohydrates, lipids and 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, iodine, fluorine, copper and zinc.

UNIT V - FUNCTIONAL AND SPECIAL FOODS

Concepts for functional foods design, prebiotics & probiotics- nutraceuticals- designer foods- Anti-Nutritional Factors in Foods: Trypsin inhibitors, Phytins, Tannins, Oxalates, Goitrogens, Aflatoxins, and Process induced toxins- Space Foods-Army foods-Athlete Foods-Packaged food supply in Flights.

Suggested Readings:

1. C Gopalan, BV Ramshastri, S C Balasubramaniam, 1989, Nutritive Value of Indian Foods Nation Institute of Nutrition, Hyderabad.
2. M Swaminathan, 1974, Essentials of Nutrition, Ganesh Co.
3. K.H. Steinkrauss, 1995, Handbook of Indigenous Fermented Foods, Marcel Dekker.
4. J Pokorny, N Yanishlieva, and M Gordon, 2001, Antioxidants in Food,Published by Woodhe Publishing Limited, Abington Hall, Abington
5. N N Potter, and J H Hotchkiss, 1995, Food Science, (5thEdition), Aspen Publishers, Inc., Gaithersbur Maryland.
6. Food and Nutrition Bulletin, Vol. 23, 24, 25 and 26. The United Nations University, Press.
7. G Mazza, 1998, Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.
8. Corrine Robinson, 1975, Basic Nutrition and Diet Therapy, Macmillan.
9. F.P. Antia, 1974, Clinical Dietetics and Nutrition, Oxford Medicine Publications.
10. Davidson and Passmore, 1986, Human Nutrition and Dietetics, Churchill Livingstone.

22BTFT6E04 **Semester- VI**

FUNCTIONAL FOODS AND NUTRACEUTICALS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

Course objectives

The goal of this course is for students to,

- Discuss the historical reviews, teleology, models, classification and sources of nutraceuticals.
- Explain the role of flavonoids and carotenoids as antioxidant agents.
- Understand the metabolism, mechanism, sources and analysis of omega-3 fatty acids & CLA.
- Summarize the health implications of lycopene, garlic, olive oil, nuts, prebiotics and probiotics.
- Discuss the various aspects of herbs, stability testing, marketing strategies and regulatory issues in nutraceutical and functional foods.

Course outcomes

Upon completion of this course, students will be able to,

1. Illustrate the historical, technological aspects and classification of nutraceuticals
2. Outline the significance of flavonoids and carotenoids as antioxidants.
3. Assess the potential health benefits, sources, mechanism of action and metabolism of omega- 3 fatty acids and CLA.
4. Infer the multiple aspects of consuming lycopene, garlic, olive oil, nuts, prebiotics and probiotics as a nutraceutical.
5. Understand the role of herbs as a nutraceutical and conduct the accelerated shelf life testing of various nutraceuticals and functional foods.
6. Assess the marketing strategies and regulatory issues in nutraceutical and functional food market.

UNIT I - NUTRACEUTICALS: HISTORICAL, TECHNOLOGICAL ASPECTS AND CLASSIFICATIONS

Nutraceuticals- concept and definition – Historical Reviews - Teleology of nutraceuticals - Organization models for nutraceuticals – Classification of Nutraceuticals based on the sources– Animal, Plant and Microbial – Perceived effect of functional foods - Nutraceuticals in specific foods - Mechanism of Action - Chemical nature - Relation of functional foods and nutraceutical (FFN) to foods and drugs.

UNIT II - FLAVANOIDS AND CAROTENOIDS AS ANTIOXIDANTS

General background on phytochemicals as antioxidants - Flavonoids and Lipoprotein oxidation - Evidence for specific Antioxidant mechanisms of Flavonoids - Antioxidant role as nutraceuticals and functional foods- health benefits of antioxidants - Anticancer and Cholesterol-lowering effect of citrus flavonoids - Dietary carotenoid and carotenoid

absorption - Approaches to measurement of absorption - Metabolism of Carotenoids – Carotenoids as anticancer agents.

UNIT III - OMEGA-3 FATTY ACIDS AND CLA

Introduction to Lipoprotein metabolism – PUFA and Cardiac Arrhythmias - Preventative role of n-3 fatty acids in cardiac arrhythmias -Mechanism of action on n-3 PUFA's - ω – 3 fish oils and their role in Glycemic control- ω –3 fatty acids and rheumatoid arthritis - Chemistry and Nomenclature of CLA – Analysis of CLA in food and biological samples – CLA in food products and biological samples –Biological actions and potential health benefits of CLA – Mechanisms of CLA action – Potential adverse effects of CLA, Applications of CLA in foods.

UNIT IV - LYCOPENE, GARLIC, OLIVE OIL, NUTS, PROBIOTICS AND PREBIOTICS

Lycopene overview – lycopene and disease - Garlic – Chemistry – Implication inHealth - Olive oil – CHD – Cancer - Nuts – Nutrient components and Composition – Nut Consumption and CHD epidemiological evidence, Human nutritional studies on nut consumption and serum lipid changes, Mechanism of action- Probiotics- criteria – products on market – probiotic products – Microbiology of the gastrointestinal tract - Prebiotics – effect of processing, physiological effects, effects on human health and potential applications in risk reduction of diseases- future for probiotics and prebiotics.

UNIT V - HERBS AS FUNCTIONAL FOODS, STABILITY, TESTING AND MARKETING ISSUES FOR NUTRACEUTICALS AND FUNCTIONAL FOODS

Herbal medicine – Herbs as ingredients in functional foods – actions of herbal and evidenceof efficacy -Kinetic modelling of chemical reactions – Accelerated shelf life testing - Cruciferous vegetables and cancer prevention – Dietary fiber and coronaryheart disease - Evolution of marketing environment for Functional foods and nutraceuticals - Regulatory background - Introduction to consumer marketing issues fornutraceuticals - Potential product positioning.

Suggested Readings:

1. Shi, John, Fereidoon Shahidi and Chi-Tang Ho "Asian Functional Foods". CRC/Taylor & Francis, 2007.
2. Watson, Robald Ross "Functional Foods and Nutraceuticals in Cancer Prevention". Blackwell Publishing, 2007.
3. Gibson, G.R. and C.M.Willams. "Functional Foods: Concept to Product". Woodhead, 2000
4. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", 2nd Edition, CRC, 2001.
5. Wildman, Robert "Handbook of Nutraceuticals and Functional Foods". CRC, 2006.
6. Webb, P P. "Dietary Supplements and Functional Foods". Blackwell, 2006.
7. Ikan, Raphael "Natural Products: A Laboratory Guide", 2nd Edition, Academic Press / Elsevier, 2005.

SEMESTER VII

B. Tech. – Food Technology **2022 - 2023**

22BTFT7E01 **Semester- VII**

ANALYTICAL METHODS FOR FOOD PRODUCTS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course objectives

The goal of this course is for students to,

- Explain about the techniques of water analysis.
- Illustrate the methods involved in the analysis of plantation products.
- Create a different knowledge on analysis methods of fruit and vegetable products.
- State the basic analysis concepts of bakery products.
- Outline the processes involved in livestock food product analysis.

Course outcomes

Upon completion of this course, students will be able to,

1. Relate the various food analysis techniques.
2. Identify the methods used for water evaluation.
3. Understand the analysis methods involved in plantation and fruit products.
4. Understand the basic concepts of bakery and confectionary product analysis.
5. Explain the process of analysis of livestock products.
6. Discuss the various strategies involved in the product analysis and its standard methods.

UNIT I - ANALYSIS OF WATER

Parameters tested as per FSSAI Regulations- Organoleptic and Physico-chemical Parameters- Colour, Odour, pH, Taste, Turbidity, General Chemical parameters- Ammoniacal nitrogen, Anionic surface active agent, Boron, Nitrate, Chloride, Magnesium, Fluoride, Total hardness, Alkalinity, Sulphates, Residual free chlorine& Chloramines Sulphide , Cyanide, Calcium, Total Dissolved Solids, Phenol, Sodium , Hexavalent chromium ,Total solids, Nitrite , Mineral Oil, Estimation of Anions in Drinking water by Ion Chromatography, Metals A By AAS- By Flame AAS (Zn, Mg, Ca,), By Graphite furnace AAS(Al, Cu, Fe, Mn, Se, Ag, Cd, Pb, Hg, Mo, Ni, As, Cr), By Cold Vapour AAS (Hg) B. By ICP-MS (Zn, Mg, Ca, Al, Cu, Fe, Mn, Se, Ag, Cd, Pb, Hg, Mo, Ni, As, Cr, Hg), Toxic substances- Pesticide Residues, Polychlorinated Biphenyls, Polyaromatic Hydrocarbons, IS protocol 10500 and 14543.

UNIT II-ANALYSIS OF PLANTATION PRODUCTS

Tea & Coffee- Preparation of sample, Moisture content, Total ash, Water soluble ash, Determination of Caffeine content by different methods, Microscopic examination, Determination of solubility in boiling water, Determination of Iron filings and size of the particles, Test for presence of added colouring matter - Spices- Sample preparation, Determination of moisture, Acid insoluble ash, Determination of Cold Water Extract,

Determination of Alcohol Soluble Extract , Calcium Oxide, Non Volatile Ether Extract, Volatile Oil, Crude Fibre, Allyl isothiocyanate in Mustard, p-hydroxybenzyl isothiocyanate in white mustard, Microscopic Examination of Spices, Black Pepper- Determination of Bulk density, Light berries, Piperine content, Turmeric- Determination of curcumin content, Starch content, Detection of chromate content, Detection of Argemone seeds in Mustard, Detection of Mineral Oil in Black Pepper, Detection of Papaya seeds in Black Pepper, Detection of Turmeric in Chillies and Coriander, Detection of Oil Soluble Colour, Determination of Light and Heavy Filth in Spices and Condiments, Determination of capsaicin content in chilli powder.

UNIT III - ANALYSIS OF FRUIT & VEGETABLE PRODUCTS, OILS & FATS

Thermally Processes fruits and vegetables- Physical examination, Determination of Vacuum, Drained weight, Internal conditions of can, Determination of sodium chloride in brine; Jams and Jellies- Insoluble matter, pH, Titratable Acidity, Volatile oils, Total sugars, Vitamin C, Determination of fruit content.

UNIT IV - ANALYSIS OF BAKING AND CONFECTIONERY PRODUCTS

Bread- Sample preparation, Determination of alcoholic acidity, Acid-insoluble ash, Non-Fat milk, solids in milk bread, Biscuits- Determination of acidity of extracted fat, Confectionery- Preparation of Sample, Determination of Moisture, Determination of Sulphated Ash, Determination of Sulphated Ash on salt free basis, Determination of Ash in dil. HCl, Test for presence of added synthetic colour, Determination of Total Protein, Determination of Fat, Determination of Reducing Sugar, Determination of Sucrose, Determination of Sulphur dioxide, Determination of Lead, Copper and Zinc.

UNIT V - ANALYSIS OF MEAT AND FISH PRODUCTS

Preparation of Sample for Meat and Processed Meat products, Determination of Nitrite in Processed animal foods, Determination of Ascorbic acid, Alternate method for Determination of Ascorbic acid, Determination of Total Phosphorous, Test for presence of Polyphosphates, Determination of Glucono-delta-lactone, Additional tests , Determination of physico-chemical quality of meat and meat products- pH, Extract Release Volume (ERV), Meat Swelling Capacity (MSC), Total Volatile Basic Nitrogen (TVBN), Picric Acid Turbidity (PAT), Determination of dye reduction capacity. Preparation of sample for Fish and Processed Fish, Frozen Fish- Determination of Histamine, Dried fish- Moisture content, Sodium chloride content, Acid insoluble ash. Milk & Milk products- Preparation of sample, Detection test for adulterants and contaminants, Alkaline phosphatase test, Turbidity test, Determination of Total solids, Determination of fat.

Suggested Readings:

1. FSSAI Lab Manual 6, “Manual of Methods of Food Analysis- Meat& Meat Products/ Fish & Fish Products”, 2016.
2. FSSAI Lab Manual 3, “Manual of Methods of Food Analysis- Cereal & Cereal Products”, 2016.
3. FSSAI Lab Manual 4, “Manual of Methods of Food Analysis- Beverages, Sugar & Confectionery Products”, 2016.

4. FSSAI Lab Manual 10, “Manual of Methods of Food Analysis- Spices and Condiments”, 2016.
5. FSSAI Lab Manual 5, “Manual of Methods of Food Analysis- Fruit & Vegetable Products”, 2016.
6. FSSAI Lab Manual, “Manual of Methods of Food Analysis- Water”, 2016.

22BTFT7E02 **Semester- VII**

TRADITIONAL AND ORGANIC FOODS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course objectives

The goal of this course is for students to,

- Understand the traditional methods of food processing.
- Explain the traditional food production process.
- Illustrate the traditional food pattern.
- Understand the commercialization of traditional foods.
- Outline the health aspects of traditional and organic foods.

Course Outcomes

Upon completion of this course, students will be able to,

1. Understand the historical aspects of traditional foods.
2. Explain traditional perspective of foods and food habits.
3. Relate the importance of traditional and organic foods.
4. Understand the wide diversity and common features of traditional Indian foods and meal patterns.
5. Identify the commercial food products.
6. Familiarize with health benefits of bioactive components rich traditional foods over junk foods.

UNIT I - HISTORICAL AND CULTURAL PERSPECTIVES

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts. Present status of traditional food products. Globalization of traditional food products; Plans and policies of the Government and developmental agencies.

UNIT II - TRADITIONAL METHODS OF FOOD PROCESSING

Traditional methods of milling grains – rice, wheat and corn – equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sun drying, osmotic drying, brining, pickling and smoking.

UNIT III - TRADITIONAL FOOD PATTERNS

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods. Techno-economic aspects for establishing commercial units for traditional products.

UNIT IV - COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters. Use of natural and permitted synthetic preservatives and new packaging systems for traditional food products

UNIT V - HEALTH ASPECTS

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. Organic foods types of organic foods, identifying organic foods, organic food & preservatives.

Suggested Readings:

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.
2. Davidar, Ruth N. “Indian Food Science A Health and Nutrition Guide to Traditional Recipes, East West Books, 2001.

22BTFT7E03 **Semester- VII**

NEW PRODUCT DEVELOPMENT AND SENSORY SCIENCE

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Explain about the importance and applications of sensory analysis.
- Illustrate the methods and different types of test used for sensory analysis.
- Create a different knowledge on assessors and its role on sensory valuation.
- State the basic concepts of product development along with their success and failures.
- Outline the processes involved in product development.

Course outcomes

Upon completion of this course, students will be able to,

1. Relate the applications of sensory analysis.
2. Identify the methods used for various sensory evaluations.
3. Understand the assessor's role in sensory test.
4. Understand the basic concepts of product development.
5. Explain the process of product development
6. Discuss the various strategies involved in the new product development process.

UNIT I - INTRODUCTION TO SENSORY ANALYSIS

Background and importance of Sensory Analysis, Definition of Sensory Analysis, Fields of Application of Sensory Analysis, Legislation on Sensory Analysis, Sensory perception and the organs of senses

UNIT II - METHODOLOGY OF SENSORY ANALYSIS

Preparation of trial, Location of test and tasting Rooms, Sample preparation, supplies and equipment, materials, preparation procedure, sample preparation, order, coding, number of samples, product sampling Sensory evaluation techniques, Types of tests Differentiation sensory tests, Variables and scales, Descriptive sensory tests Affective sensory tests. Factors affecting sensory verdicts, physiological factors, psychological factors, poor physical condition,

UNIT III - ASSESSORS

Selection, training and monitoring, Assessors, Types of assessors, Factors influencing sensory evaluations, Features of assessors, Selection, training and monitoring of assessors: Recruitment, Selection, Training, Monitoring. Applications and Advances in Electronic-Nose Technologies, Aroma Types and Characteristics, Conceptual Development of the Electronic Nose and instrumentation, Data Analysis for Electronic Noses, E nose applications. Computer aided sensory evaluation of food & beverage, statistical analysis of sensory data.

UNIT IV - CONCEPTS

Concept of product development - product success and failure, factors for success, process of product development, managing for product's success. Innovation strategy - possibilities for innovation, building up strategy, product development programme.

UNIT V - PRODUCT DEVELOPMENT PROCESS

The product development process - Open Innovation Stage Gates Processes - product strategy, product design and process development, product commercialization, product launch and evaluation. Legal issues in product development.

Suggested Readings:

1. Meilgaard Morten; Sensory evaluation techniques Stone Herbert; Sensory evaluation practices. ISBN: 0-12-672690-6
2. Schaffner, D. J., W. R. Schroeder e M. D. Earle; Food Marketing: An International Perspective 2nd ed, McGraw Hill, 2003. ISBN: 978-0072952889
3. Varela, P. e G. Ares; Novel Techniques in Sensory Characterization and Consumer Profiling, CRC Press, 2014. ISBN: ISBN 9781466566293.

22BTFT7E04 **Semester- VII**

MARKETING MANAGEMENT AND INTERNATIONAL TRADE

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Understand the concepts in marketing management and realize its scope.
- Explain the consumers buying behavior and information systems in marketing.
- Understand the marketing planning processes and classify the types of food consumption across the globe.
- Outline the concepts involved in international marketing and trading.
- Explain the major role of government in trading process.

Course outcomes

Upon completion of this course, students will be able to,

1. Discuss the concepts of marketing and market Structure.
2. Discuss the market segmentation and market resources.
3. Interpret the policies in marketing planning and advertisements.
4. Understand the overall concepts involved in international marketing and trade developments.
5. Discuss the role of export and import strategies and government roles in marketing.
6. Summarize the marketing principles, its structure and government policies in export and import tradings.

UNIT I - CONCEPTS OF MARKETING AND MARKET STRUCTURE

Concept of marketing, functions of marketing, Concepts of marketing management, scope of marketing management, Marketing management process, Concepts of marketing- mix, elements of marketing- mix, Types of marketing channel, Concept of market structure, Marketing environment -Micro and macro environments.

UNIT II - CONSUMERS BUYING BEHAVIOR

Consumers buying behaviour, consumerism, Marketing opportunities analysis: marketing research and marketing information systems, Market measurement- present and future demand, market forecasting, Market segmentation – bases of market segmentation- industrial market segmentation, targeting and positioning, Allocation and marketing resources.

UNIT III - MARKETING PLANNING PROCESS AND ADVERTISING

Marketing planning process, Product policy and planning: product-mix, productline, product life Cycle, New product development process, Product brand, packaging, services decisions, Marketing channel decisions. Retailing, wholesaling and distribution, Pricing decisions, Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry, Promotion-mix decisions,

Advertising, how advertising works, deciding advertising objectives, Advertising budget, Advertising message, media planning, personal selling, publicity, sales, promotion. World consumption of food: Patterns and types of food consumption across the globe.

UNIT IV - INTERNATIONAL MARKETING AND TRADE

International marketing and international trade, salient features of international marketing Composition & direction of Indian exports, international marketing environment.

UNIT V - EXPORTS AND ROLE OF GOVERNMENT AGENCIES IN TRADE

Exports- direct exports, indirect exports, Licensing, Joint ventures, Direct investment, product price, place and promotion elements. Export trends and prospects of food products in Indian Government institutions related to international food trade: APEDA, Tea Board, Spice Board, MOFPI, etc. WTO and world trade agreements related to food business.

Suggested Readings:

1. Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha. 2013. Marketing Management: A South Asian Perspective, 14th Ed. Pearson Education.
2. Willium J. Stanton. 2010. Fundamentals of Marketing. Tata McGraw-Hill Publication, New Delhi.
3. C.N. Sontakki. 2014. Marketing Management. Kalyani Publishers, New Delhi.
4. John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. 2013. International Business, 15th Ed., Pearson Education. Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi.

21BTFT7E05 **Semester- VII**

FOOD COLORANTS AND FLAVORANTS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objective

The goal of this course is for students to,

- Explain different food colors.
- Explain properties and application of food colors.
- Describe different food flavors and its application.
- Explain the applications of food colors and its emerging techniques.
- Describe the Quality control techniques and regulations involved in colors and flavors.

Course Outcomes

Upon completion of this course, students will be able to,

1. Discuss the synthetic and natural food colors.
2. Outline the importance of food colors and their applications in different fields.
3. List the various food flavors and their application.
4. Infer the applications of food coloring and its advancement.
5. Outline the regulations involved in the safer use of colors and flavors in foods.
6. Discuss the importance of food colorants and flavorants.

UNIT I - FOOD COLOURS

Introduction – Natural and Synthetic food Colors – Class and description of food colors – Physical form of food colors – Stability, storage and solubility of food colors – Regulations and safety assessment – Labeling requirements for food containing color additives – Adulteration and misbranding of color additives in foods.

UNIT II - PROPERTIES AND ANALYSIS OF FOOD COLOURS

Food color stability, Importance of food colors for food products - Methods of analysis for food colour - Quality and safety assessment – Applications of natural and synthetic food colours.

UNIT III - FOOD FLAVOURS

Introduction – Classification - flavor forms: water soluble liquid flavours – oil soluble liquid flavours, emulsion based flavours, dispersed flavours, spray dried flavours – commercial considerations -Flavor characteristics – Flavor compounds - Natural and artificial flavoring materials - Flavoring constituent of various foods like meat, fish, milk, vegetables, fruits, fats & oils, spices & herbs, cereals and pulses. Changes in flavouring components and characteristics during cooking/processing of various foods. Effects of storage, processing, transportation and environmental conditions on flavor Components/constituents.

UNIT IV - FOOD FLAVOR: APPLICATIONS AND RECENT DEVELOPMENT

Culinary and Meat Products, bakery products, snack foods, sugar based confectionary products, dairy products and soft drinks - Changes in food flavor due to processing – flavor release from foods - Factors that affect the flavour and control of flavour in processed foods. Recent developments in flavor research, processing and technology.

UNIT V - FOOD FLAVOR: QUALITY CONTROL

Flavouring and coating technologies for preservation and processing of foods. Natural flavor enhancers for food and beverage, Quality Control – analytical, sensory and adulteration testing. Measurement of flavour, particularly for wine, tea, coffee, species and condiment.

Suggested Readings:

1. Spices and Flavor Technology. J.S. Pruthi, ICAR Publications, 2nd Edition, 1998.
2. Fenaroli, G, Handbook of flavour ingredients, CRC Press. Bota Rica, New York, 2005.
3. Yamanishi, T, Recent advances in flavour researches, Dekker, New York, 2005.
4. Andrew J. Taylor and Robert S. T. Linforth, Food Flavour Technology, Blackwell Publishing Ltd, 2010.
5. Suvendu Bhattacharya, Conventional and Advanced Food Processing Technologies, Wiley Publishers, 2015.
6. Heath, HB, Flavour chemistry and technology, CBS Publ., New Delhi, 2005.

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22BTFT7E06 **Semester- VII**

NOVEL FOOD PROCESSING TECHNOLOGIES

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Understand the concepts of novel food processing techniques.
- Explain the principle and working behind the novel processing techniques.
- Understand the application of such processes in food industry.
- Outline the concepts involved in food printing and meat analogues.
- Explain the major role of e-nose and e-tongue in sensory evaluation.

Course outcomes

Upon completion of this course, students will be able to,

1. Discuss the concepts and application of pulsed light and UV ration technology.
2. Discuss the concepts and application of ultrasound and high-pressure processing.
3. Interpret the concept, equipments involved and application of food irradiation and cold plasma.
4. Understand the overall concepts involved in microwave and ohmic heating.
5. Discuss the role of food printing in production of designer foods.
6. Summarize the application of e-nose and e-tongue in sensory evaluation of foods.

UNIT I - PULSE LIGHT AND UV TECHNIQUE

High-intensity pulse technique- Processing systems- design of static chambers- continuous chambers- other chamber designs- generation of different voltage waveforms-oscillation magnetic fields for food processing- generation of magnetic fields - mechanisms of inactivation of microorganisms in food preservation – UV treatment – principle involved – mechanism of inactivation – Pulsed electric field – principles of microbial inactivation – Generation of PEF – application in food processing.

UNIT II - ULTRASOUND & HIGH-PRESSURE PROCESSING

Ultra sound – introduction – types of pressure waves – generation of ultrasound – mechanism of microbial inactivation – application in food processing – High pressure processing – Principles –concepts – basic laws related to HPP - design of equipment - processing of food using HPP - effect on microorganisms – Application in industry.

UNIT III - FOOD IRRADIATION AND COLD PLASMA TECHNOLOGY

Food irradiation – principle of irradiation – radioactive substances – types of irradiation – construction and working of equipment – effect of irradiation on the nutritional and biochemical changes – application in food sectors – social and ethical issues – cold plasma technology – electron beam radiation - application in foodprocessing.

UNIT IV - MICROWAVE AND OHMIC HEATING

Microwave properties – principle – design aspects of microwave equipment - interaction with food materials, material properties - application of microwave in food processing – merits and demerits – recent advancement in microwave processing - inactivation of microorganisms and enzymes – electrical resistance heating of food - ohmic heating - treatment of products - Elsteril process - influence on microorganisms
- food ingredients.

UNIT V - NOVEL FOODS AND BIOSENSORS

Definition-Designer foods-3D and 4D food printing-meat analogues-free from foods – Biosensors types- application of biosensors to food industry requirements-Development of Biosensors – e- nose and e- tongue and their applications in sensory evaluation of foods.

Suggested Readings:

1. Nonthermal Preservation of Foods. Gustavo V. Barbosa-Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. Published by Marcel Dekker, Inc., 270, Madison Avenue, New Yorkm 10016, 1998.
2. Biosensors for food analysis, A O Scott, The Tetley Group Limited, UK, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB21 6AH, England, 2008.
3. Trends in Food Engineering, Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa Canovas, Contributor Jorge E. Lozano, Published by CRC Press, 2000.
4. Gould G.W., "New Methods of Food Preservation", Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.

SEMESTER – VIII

B. Tech. – Food Technology **2022 - 2023**

22BTFT8E01 **Semester- VIII**

FOOD BIOTECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Understand the role of biotechnology in various food processing applications.
- Explain the production of metabolites, flavors, colors, protein rich foods and preservatives using biotechnological methodologies.
- Discuss the various downstream processing techniques.
- Explain the molecular diagnostic tools and methods applied to detect pathogens, pesticides and toxins in the raw materials and food.
- Summarize the application and classification of biosensors and discuss the social, ethical and safety aspects of GM foods.

Course Outcomes

Upon completion of this course, students will be able to,

1. Outline the biotechnological applications in the various food processing sectors.
2. Illustrate the production of various biotechnologically derived food products.
3. Understand the importance of downstream processing techniques in biotechnology and food processing.
4. Infer the different types of molecular diagnostic tools, assays and methods in the detection of pathogens, pesticides and toxins in the raw materials and food.
5. Understand the classification and applications of biosensors.
6. Discuss the ethical, social, and safety aspects of production and consumption of GM foods.

UNIT I - INTRODUCTION TO BIOTECHNOLOGY

Introduction -Biotechnology relating to the food industry – application ofgenetics to food production – Genetic Engineering Techniques- Recombinant DNA Techniques and Cloning Strategies - Genetically modified organisms- Classical and modern biotechnology - Role of bio process engineering in biotechnology industry. Regulatory and Social aspects of biotechnology of foods. Biotechnological approachesto improve nutritional qualities and shelf life of fruits and vegetables, livestock, poultryand fish products.

UNIT II - PRODUCTION OF PRIMARY AND SECONDARY METABOLITES

Production of commercially important metabolites – citric acid, lactic acid, acidic acid, gluconic acid, amino acids, Flavoring agents, colouring agents and vitamins. Stages in industrial production of microbial metabolites - New protein foods - SCP; mushroom; algal proteins. Natural bio-preservatives – Nisin, Lacticin.

UNIT III – FOOD BIOTECHNOLOGY

Principle of Downstream Processing – stages in downstream processing – solid liquid separation – flotation – flocculation – filtration – types – centrifugation- cell disruption – concentration – evaporation liquid – liquid extraction – membrane filtration precipitation – adsorption – purification by chromatography.

UNIT IV - MOLECULAR DIAGNOSTIC TOOLS

Rapid detection techniques for food borne pathogens and their toxins; In-vitro evaluation of bacterial toxins by immunological techniques like slide agglutination, tube agglutination, gel diffusion assay; Genetic based diagnostic systems - Polymerase Chain Reaction (PCR). The development of novel molecular diagnostic methods for different diseases, including nanotechnology-based diagnostics, and their application in medical clinics. Micro array diagnostic methods to detect pathogens, pesticides, and toxins in the raw materials and food.

UNIT V - BIOSENSORS AND GM FOODS – SOCIAL AND ETHICAL ISSUES

Biosensors: Introduction, classification and application in food industries Potential Impact of Biotechnology on Food Industries. GM foods and food security- modern approaches to the detection of raw materials or food from genetically modified food biotechnology – legal frame work for the production of raw matrials or food from genetically modified organisms - Safety aspects and social acceptance - Ethical issues. GMOs- current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects

Suggested Readings:

1. Bielecki S., Ed., Polak J., J. and Bielecki, Tramper S., Food Biotechnology, Elsevier Science Publishing Company, New Delhi, 2000.
2. Gutierre, Gustavo F., Food Science and Food Biotechnology, CRC Press, New York, 2003.
3. Rita Singh, Food Biotechnology, Global vision publication house, Delhi, 2004.
4. B.D. Singh. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.
5. Meenakshi Paul. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.
6. James D. Watson. 2013. Molecular Biology of the Gene, 7th Ed. Benjamin Cummings, San Francisco, USA.
7. Oliver Brandenberg, Zephaniah Dhlamini, Alessandra Sensi, Kakoli Ghosh and Andrea Sonnino 2011.

22BTFT8E02 **Semester-VIII**

SUPPLY CHAIN MANAGEMENT

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Understand the various concepts of food marketing system.
- Explain the different constraints involved in the marketing research.
- Discuss the innovations in food chains, quality and safety standards in the retail management.
- Explain the important key areas relating to supply chain management in food processing industries.
- Understand the overall concepts of globalization and logistics.

Course outcomes

Upon completion of this course, students will be able to,

1. Outline the important concepts and approaches of food marketing system.
2. Illustrate the various attributes of marketing research.
3. Assess the multivariate techniques involved in market research.
4. Understand the innovations in food chains, quality and safety standards in the retail management.
5. Discuss the multiple strategies of supply chain management system in food industries.
6. Infer the important concepts of globalization and logistics.

UNIT I - INTRODUCTION

Supply chain, logistics, Evolution of logistics concept, Logistical mission and strategic Issues, Logistics in India, Importance of logistics management, Strategic logistics planning process, Operational objectives, Components of logistics management, Functions of logistics management, Integrated logistics system, Agribusiness Environment & Policy – Agricultural Production Management - Business Ethics & Global Business Environment Sources of cereals and legumes, fruits and vegetables, milk and milk products, meat and meat products, marine products in India, its importance in national economy. Supply chain business opportunities, Market, Assessment, Technical Analysis, and Financial Analysis, Forecasting, Facilities and Aggregate Planning.

UNIT II - LOGISTICS, SUPPLY AND DISTRIBUTION

Principles of Logistics Production and sale of food products at global level, and the life cycle of the product is short. The right and wrong of logistics are influencing the success or failure of corporate management. Learning CSF (critical success factor) of Logistics through the study of successful food industry. Quantitative Management Analysis

Business logistics - The supply chain Importance of Logistics/Supply Chain (SC) Costs analysis Logistics customer service Supply and distribution lines lengthening with greater complexity Quick customized response Logistics, Food supply chain management from farm to fork, Elements of the supply chain, Transport and storage, Social and environmental concerns associated with the food supply chain.

UNIT III - MANAGEMENT CHALLENGES IN COLD CHAIN

Post-Harvest Food Management - Supply Chain Management, The major cold chain technologies Dry ice, Gel packs, Eutectic plates, Liquid nitrogen, Quilts, Reefers Refrigerated Containers, Managerial Economics - Fresh Food and Supply Chain Management Challenges, Life Cycle Assessment Studies of Food Product, Retail logistics changes and challenges Retail Logistics and supply chain Transformation The Cold Chain and its Logistics, From a geographical perspective, the cold chain has the following impacts The major cold chain technologies, Value Chain, Global Value Chain.

UNIT IV - FOOD SAFETY MANAGEMENT

Food safety - The risk management, internationally agreed definition, framework and process of risk management. Risk analysis, risk assessment, risk management and risk communication. Food Safety and Standards - Agricultural Marketing - Production and Operations Management Commodity Markets and Futures Trading - Retail Management - Management Concepts - Business Communication, Traceability system in order to nurture a diverse viewpoint capable of understanding and analyzing traceability, Recalls.

UNIT V - QUALITY CONTROL AND MANAGEMENT REGULATION

Organizational Behavior - Human Resource Management - Financial Management of Agribusiness Managerial Accounting and Control, Quality Management in Agribusiness - Agribusiness and Society International food Legislation & Standards Concepts and trends in food legislation. International and federal standards Codex Alimentarius, ISO series, food safety in USA. Legislation in Europe EU, Enforcers of Food Laws Approval Process for Food Additives Nutritional Labeling. Distribution - Purpose of Quality Control Raw Material Safety, Product Value, Accident Prevention QC Issues in Food System Raw Material Sourcing, Manufacturer, Distributer, Retailer. Safety/Quality/Price required by consumers, Consumer Needs The practices of QC in wholesalers the practices of QC in retailers.

Suggested Readings:

1. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dream tech Press, 2005.
2. Total Supply Chain Management by Ron Basu, J. Nevan Wright, 1st edition 2008, Elsevier.
3. Supply Chain Management, Chopra and peter, Pearson, 5th edition, 2013.
4. Logistics Engineering and Management, Blanchard, pearson, 6th edition 2004.

DRYING TECHNOLOGY OF FOODS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- To understand the basic theory of drying and its significance in food systems.
- To understand the importance of drying as a method of food processing.
- Understand drying mechanism of food products.
- Understand moisture content measurement and thermal properties related to drying judge quality of dried product.
- To learn about the relative advantages / disadvantages of each method of drying.

Course outcomes

Upon completion of this course, students will be able to,

1. Understand novel and hybrid drying technology.
2. Select suitable dryer meeting requirement.
3. Develop functional design of dryers.
4. Understand the importance of drying as a method of food processing.
5. Understand the principle and working of various types of dryers.
6. Apply the knowledge on drying technology in various food industries.

UNIT I – PRINCIPLES OF DRYING

Principles of drying – Fundamentals of air-water mixtures – Theories of drying - Psychometric chart – Problems based on psychometry – Drying curves – constant and falling rate period - Heat and mass transfer in dryers – with and without recirculation– Dryers in food processing industry – Issues in food drying technology - Water content in foods and its determination

UNIT II - DRUM DRYING, FOAM MAT DRYING AND OSMOTIC DEHYDRATION OF FOODS

Drum driers - Types of Drum Dryers - Principles of Operation of the Drum Dryer – Steam Consumption – Types of Feeding – Final product form. Foam Mat Drying- Principles- Equipments- Factors affecting Foam mat drying. Rotary Dryer. Osmotic dehydration – Principles – Osmotic agents - Factors affecting osmosis- Equipment used.

UNIT III - SPRAY DRYING OF FOODS

Fundamentals –Nozzles, Rotary atomizers and two fluid feeds- Interaction of droplets with air- Drying of droplets with soluble and insoluble solids – factors affecting

spray drying- glass transition temperature - Microstructure of spray dried products – properties of spray dried powders – Packing and storage of spray dried powder - Reconstitution – Foam spray drying – Applications in the Food industry.

UNIT IV – FLUIDIZED BED, PNEUMATIC AND FREEZE DRYING

Fluidized bed drying – Introduction – Effect of operating parameters – conventional and modified fluidized bed dryer – Effects of processing parameters in fluidized bed dryer - Fundamentals of freeze drying – Freezing – Primary drying stage
– secondary drying stage -Changes during freeze drying – Condensation, defrosting – Industrial freeze driers. Pneumatic / Flash dryers - Basic Operation Principle and Applications of Flash Dryers - Design of Flash Dryers - Materials Dried in Flash Dryers.

UNIT V - NOVEL DRYING METHODS

Special drying techniques - contact-sorption drying - drying on inert particles –pulse combustion drying - drying with induction heating - novel dryers - Airless drying,drying in mobilized beds, vacuum jet drying, Refractance window drying. Dryerperformance indices. Pulsed fluid bed drying: Principle and layout - dehydration of foods using cyclic pressure.

Suggested Readings:

1. Paul Singh, R and Dennis R. Heldman. Introduction to Food Engineering Academic Press, 2001
2. Loasecke H.W.V., Drying and dehydration of Foods, Agrobios, Jodhpur, 2001
3. Kudra, T and Majumdar, A.S., Advanced Drying Technologies, Marcel Dekker Inc., New York, 2002.
4. Loeseck ,H. W. V, “Drying & Dehydration of Foods”, Published by Agrobios, 2005
5. Arun S. Mujumdar, “Handbook of Industrial Drying”, CHIPS, 3rd Edition, 2006.
6. Hui Y. H,:”Food Drying Science and Technology, Microbiology, Chemistry, Application”, CHIPS, 2008.

EXTRUSION TECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course Objectives

The goal of this course is for students to,

- Explain the basics principles, types and uses of extrusion cooking.
- Understand the importance of pre-conditioning and de-volatilization of raw materials.
- Discuss the constructional, operational and working of single and twin-screw extruders.
- Summarize the nutritional, functional and sensory properties of extruded food products.
- Discuss the application of extrusion technology in the production and development of new product.

Course outcomes

Upon completion of this course, students will be able to,

1. Outline the principles, types and uses of extrusion cooking
2. Illustrate the importance of pre-conditioning and de-volatilization of raw materials
3. Infer the constructional, operational and working of single and twin-screw extruders
4. Assess the nutritional, functional and sensory properties of extruded food products
5. Understand the techniques of cold extrusion cooking
6. Apply the new extrusion technology concepts for the preparation of new products

UNIT I - INTRODUCTION

Extrusion: definition, introduction to extruders and their principles, types of extruders. Extruders in the food industry: History and uses of extruders in the food industry. Physical and chemical changes during extrusion cooking.

UNIT II - PRECONDITIONING

Pre-conditioning of raw materials used in extrusion process, Pre-conditioning operations and benefits of pre-conditioning and devolatilization. Interpreted-flight expanders - extruders, dry extruders- dry extruders in extrusion – pre-extrusion processes – practical considerations in extrusion processing – addition and subtraction of materials, shaping and forming at the die – post extrusion process.

UNIT III - SINGLE AND TWIN SCREW EXTRUDER

Single screw extruder: Constructional and operational characteristics, principle of working, net flow, factors affecting extrusion process, co-kneaders. Twin screw extruder: counter rotating and co-rotating twin screw extruder. Process characteristics

of the twin-screw extruder: feeding, screw design, screw speed, screw configurations, die design. Barrel temperature and heat transfer, adiabatic operation, heat transfer operations and energy balances. Problems associated with twin screw extruder.

UNIT IV - CHARACTERISTICS OF VARIOUS EXTRUDED FOOD PRODUCTS

Physicochemical, rheological, textural and nutritional properties of extruded products- Sensory characteristics and nutritional value. Chemical and nutritional changes in food during extrusion -. Storage of extruded products- Practical considerations in extrusion processing: pre-extrusion processes, cooker extruder profiling. Addition and subtraction of materials, shaping and forming at the die, post extrusion processes

UNIT V - APPLICATION

Cold extrusion; extrusion cooking, New extrusion technology for confectionery product; Applications in different food commodities- Breakfast cereal products**.** Breakfast cereals: introduction, type of cooking - High shear cooking process, steam cookers, low shear, low pressure cookers and continuous steam pre-cooking, available brands. Traditional and extrusion methods, classification of breakfast cereals - flaked cereals, oven puffed cereals, gun puffed cereals, shredded products. Texturized vegetable protein: Definition, processing techniques, and foods. Snack food extrusion: Direct expanded (DX) and third generation (3G) Snacks: types, available brands, co- extruded snacks and indirect-expanded products

Suggessted Readings:

1. Richardson P., Thermal Technologies in Food Processing, Wood head Publishers, Cambridge, CRC Press, 2001.
2. Guy R. Extrusion Cooking, Technologies and Applications. Wood head Publishing Limited, Abington, Cambridge, 2001.
3. Fast R.B. and Caldwell E.F. Breakfast Cereals and How they are made. American Association of Cereal Chemists, St. Paul, Minnesota, 2000.
4. Riaz M.N. Extruders in Food Application. CRC Press, 2000.
5. N.D. Frame. Technology of Extrusion Cooking. Springer, 2012.

FOOD ALLERGY AND TOXICOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course objectives

The goal of this course is for students to,

- Familiarize with hazards, and toxicity associated with food and their implications for health.
- Know the various kinds of allergens and basis of allergic reactions.
- The objective of the course is to introduce food related toxicological compounds in different foods.
- To understand the protocols of sampling techniques in food toxicology measurements.
- To gain the knowledge on level of processing of food to destroy allergens / toxins.
- Creates an awareness to choose food with highly safe.

Course outcomes

Upon completion of this course, students will be able to,

1. Awareness about the different types of allergens and Natural toxins associated with food.
2. Understand about food toxicology and its hazards.
3. Understand about food sensitivity and allergy.
4. Analyze food toxin in food samples.
5. Adapting toxin formed during processing and controlling.
6. To prepare or process foods with zero toxicity.

UNIT I - INTRODUCTION

Definition and need for understanding food toxicology; Hazards - Microbiological, nutritional and environmental. Basics of immune resources - humeraland cell media resources. Food Allergens and mechanism of allergic resources.

UNIT II - FOOD ALLERGY AND SENSITIVITY

Chemistry of food allergens, celiac disease, food disorders associated with metabolism, IgE and non IgE based diseases, lactose intolerance, gluten intolerance, and asthma, primary, secondary and tertiary prevention of allergic disease and the evidencefor food desensitisation.

UNIT III - PRINCIPLES OF TOXICOLOGY

Natural food toxicants - toxicity of mushroom alkaloids, seafood, vegetables, fruits, pulses, and antinutritional compounds. Labelling on processed foods. Biologicalfactors that influence toxicity, toxin absorption in the G.I.track, Industrial microflora, blood, brain barrier, storage and excretion of toxins.

UNIT IV - DETERMINATION OF TOXICANTS IN FOOD SAMPLING

Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants Assessment of food safety – Pesticidal residues – Permitted limits, Toxicology on public health Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagen city and carcinogenicity, reproductive anddevelopmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.

UNIT V - TOXICANTS FORMED DURING FOOD PROCESSING

Intentional direct additives, preservatives, nitrate, nitrite, and N- nitroso compound flavor 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.

Suggessted Readings:

1. Helferich, William and Carl K.Winter, Food Toxicology, CRC Press, 2001.
2. Alluwalia and Vikas, Food Hygiene and Toxicology, Paragon International Publishers, 2007.
3. Shibamoto, Taka yuki and Leonard F.Bjeldanzes, Introduction to Food Toxicology, 2nd Edition, Academic Press, 2009.
4. Maleki, Soheila J. A.Wesley Burks, and Ricki M.Helm, Food Allergy, ASM Press, 2006.
5. Cliver, Dean O. and Hans P.Riemann, Food Borne Diseases, 2nd Edition, Academic Press/Elsevier, 2002.
6. Riemann, Hans P. and Dean O. Cliver, Food Borne Infections and Intoxications, 3rd Edition, Academic Press/Elsevier, 2006.

B. Tech. – Food Technology **2022 - 2023**

22BTFT8E06 **Semester-VIII**

TOTAL QUALITY MANAGEMENT

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course objectives

The goal of this course is for students to,

- To make the students understand the basic concepts of total quality management and appreciate its importance in today's business environment.
- To enable them to acquire required diagnostic skills and use various quality tools.
- To familiarize the students about the Quality Management System
- To understand the various principles, practices of TQM to achieve quality.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems

Course outcomes

Upon completion of this course, students will be able to,

1. Capable of applying TQM concepts for improving the quality of products and services.
2. Use tools and techniques of TQM for continuous improvement in quality.
3. Implement Quality Management System.
4. Ability to understand principles, practices and statistical techniques.
5. Ability to understand quality, systems, tools and techniques.
6. To prepare food products with high quality.

UNIT I - INTRODUCTION

Introduction - Need for quality - Vision, mission and policy statements of quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Quality Gurus – Barriers to TQM – Cost of Quality.

UNIT II - TQM PRINCIPLES

Quality statements - Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement – PDCA cycle, 5s, 8D methodology - Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III - TQM TOOLS & TECHNIQUES I

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Requirements of reliability, Failure rate, Stages, Types, Process and Documentation.

UNIT IV - TQM TOOLS & TECHNIQUES II

Quality circles – House of quality – Building of HOQ- Quality Function Deployment (QFD) – Taguchi quality loss function – TPM - Concepts, improvement needs – Performance measures - BPR.

UNIT V - QUALITY SYSTEMS

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, guideline for performance improvement - Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits –Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

Suggessted Readings:

1. Besterfiled, Dale H. et al., “Total Quality Management”, 4thEdition, Pearson Education Asia, 2006.
2. Evans, James R. and William M. Lindsay, “The Management and Control of Quality”. 6th Edition South-Western (Thomson Learning), 2005.
3. Oakland, J.S. “TQM – Text with Cases”, 3rd Edition. Butterworth – Heinemann, 2003.
4. Suganthi, L and Anand Samuel, “Total Quality Management”, PHI, 2006 .
5. Janakiraman, B and Gopal, R.K, “Total Quality Management – Text and Cases”. PHI, 2006.
6. Poornima M. Charantimath., Total quality management, Pearson Education, 2ND Edition, 2011.

OPEN ELECTIVES

B. Tech. – Food Technology **2022 - 2023**

22BTFTOE01

PROCESSING OF FOOD MATERIALS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students to,

- Explain the milling, extraction and manufacture of tremendous products from cereals, pulses and oil seeds.
- Summarize the production and processing methods of fruits and vegetables.
- Discuss the chemical composition, processing, production, spoilage and quality of milk and milk products.
- Outline the overall processes involved in the production of meat, poultry and fish products.
- Review the production and processing methods of plantation and spice products.

Course Outcomes

Upon completion of this course, students will be able to,

1. Discuss the basics of food processing.
2. Demonstrate the various processing technologies involved in fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products.
3. Infer the basics on microbiology of food products.
4. Describe the process of manufacture of various food products.
5. Recognize various methods of preservation of food.
6. Express the possible arena of entrepreneurial activity related to food products.

UNIT I - CEREAL, PULSES AND OIL SEEDS TECHNOLOGY

Rice milling, Pulse milling, Wheat milling – Recent trends in milling process- Oil extraction – different methods in oil extraction - Methods of manufacture of Bread - different processes of manufacture - types of breads - buns, biscuits, cakes and cookies - Pasta products - Tortilla - Method of manufacture.

UNIT II - FRUITS AND VEGETABLE PROCESSING

Production of Fruits and vegetables in India, Maturity standards, Cause for heavy losses, preservation treatments - Basics of Canning, Minimal processing and Hurdle technology as applied to Vegetable and Fruit processing, Processing of fruit juices, Dehydration, Aseptic processing- Indian Food Regulation and Quality assuranceFruit Juice / pulp/ Nectar/Drinks, concentrates.

UNIT III – DAIRY PROCESSING

Basic dairy terminology, composition, General tests at reception, Dairy Processing - Method of manufacture of Standardized, toned and double toned milk, milkpowder - Equipments - Pasteurizers, homogenizers and pumps - Method of manufactureof dairy products - Ice-cream, Cheese, Paneer, Yoghurt - Pasteurization and microorganisms involved in spoilage of milk – Major pathogens, Plant construction, Sanitation management, Cleaning equipment.

UNIT IV - MEAT, POULTRY AND FISH PROCESSING

Meat composition from different sources, Definitions and measurements, Carcass Processing, Meat Products, Processing of Poultry Products, Common pathogens, Sanitation management, Sanitizers for meat & poultry plants, Fish and otherMarine Products Processing, Sources of sea food contamination.

UNIT V - PLANTATION PRODUCT TECHNOLOGY

Processing of Tea, Coffee and Cocoa - Outline of the methods of manufacture of - green tea, black tea, instant tea, Instant coffee, Cocoa and Chocolate. Outline of themethods of processing of Pepper, cardamom, ginger, vanilla and turmeric. By products from plantation crops and spices.

Suggested Readings:

1. Srivastava R.P. and Kumar S. Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow. 3rd Edition. 2010.
2. Chakraverty A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post- harvest Technology: Marcel Dekker Press. USA. 1st Edition. 2003.
3. Sukumar De. Outlines of Dairy Technology. Oxford University Press. New Delhi. 23rd impression. 2016.
4. James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.

22BTFTOE02

NUTRITION AND DIETETICS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam: 3 Hour

Course objectives

The goal of this course is for students,

- To explain the basic concepts of food and nutrition.
- To define the overall classification, function, and source of carbohydrates, lipids and proteins.
- To recite the availability, source, deficiency and physiological role of fat and water soluble vitamins.
- To outline the role of health and nutritional importance of micro and macro minerals.
- To discuss the recent trends and developments in nutrition.

Course outcomes

Upon successful completion of this, students will be able to

1. Recognize the basics in the area of nutritional assessment in health and disease.
2. Evaluate the biological functions of various macromolecules in terms of food and health.
3. Select the balanced diet for healthy life to avoid or prevent the deficiency disorders.
4. Choose an appropriate diet, products that prevent vitamin deficiency disorders.
5. Identify the proper foods rich in minerals to live a healthy life.
6. Design the diet with the recent concepts of human nutrition to prevent / treat the dreadful diseases.

UNIT I - HUMAN NUTRITION

Six classes of nutrients - Historical perspective of nutrient requirements – Assessment of nutritional status - recommended dietary allowances of macronutrients for all age groups - Assessment of protein quality - Malnutrition and related disorders –Balanced Diet. Factors influencing dietary intake: Food habits, food fads and fallacies, their influence on health and wellbeing.

UNIT II - BIOMOLECULES

Carbohydrates- Definition, classification, Functions, Sources of Carbohydrates, Deficiency. Lipids – Definition, classification, function, sources, Properties of fats and oils, Refined & Hydrogenated fats process. Proteins - Definitions, Classification, Function, Amino Acids, Sources of Proteins, Texturized proteins.

UNIT III - VITAMINS

Physiological role, bio-availability, requirements, sources and deficiency of FatSoluble Vitamins: Vitamin A, Vitamin D, E & K. *f* Water soluble vitamins: Vitamin C,Thiamine, Riboflavin, Niacin, Pantothenic acid, Biotin, Folic acid, Vitamin B12, VitaminB6. Stability under different food processing conditions.

UNIT IV – MINERALS AND WATER

Physiological role, bio-availability, requirements, sources and deficiency of Macro minerals: Calcium, Phosphorus Magnesium, Sodium, Potassium chloride. Micro minerals: Iron, Zinc, copper, selenium, chromium, iodine, manganese, Molybdenum and fluoride - Chemistry and physical properties of free, bounded and entrapped water, water activity, quality parameters of drinking and mineral water.

UNIT V - RECENT TRENDS IN NUTRITION

Principles of dietary management in gout, rheumatism, AIDS/HIV - Cancer-risk factors, symptoms, dietary management, role of food in prevention of Cancer. Role of functional foods Health foods and novel foods, organically grown foods, personalized nutrition, recent concepts in human nutrition like nutrigenomics, nutraceuticals etc.

Suggested Readings:

1. Sunetra Roday. Food Science and Nutrition. Oxford Higher Education/Oxford University Press. 3rd edition 2018. (ISBN-13: 9780199489084).
2. Charis Galanakis. Nutraceutical and Functional Food Components. Academic Press, 1st Edition, 2017. (ISBN: 9780128052570).
3. Ashley Martin. Nutrition and Dietetics. Syrawood Publishing House. 1st Edition, 2016. (ISBN:9781682860588).
4. Robert E. C. Wildman. Handbook of Nutraceuticals and Functional Foods. CRC Press, 2nd Edition, 2016. (ISBN-10: 9781498770637).
5. Srilakshmi. B. Nutrition Science. New Age International Pvt. Ltd, Publishers. 6th Edition. 2017. (ISBN-13: 9789386418883).

22BTFTOE03

READY TO EAT FOODS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students to,

- Outline the current status of snack food Industry.
- Describe the production, processing and marketing trends of potato and tortilla chips.
- Outline the overall processing of popcorn.
- Explain the production and processing of fruits involved in snack food preparation.
- Summarize the sensory analysis methods and packaging techniques of snack foods.

Course Outcomes

Upon completion of this course, students will be able to,

1. List the various manufacturing process in snack food industries.
2. Acquire knowledge about current production and marketing status of Snack foods.
3. Elucidate the advantages of Sensory Evaluation.
4. Packaging technologies in Snack Food Industries.
5. Demonstrate the *equipments involved in the snack production processes.
6. Use flavorings in the popcorn industries.

UNIT I - INTRODUCTION TO SNACK FOODS

Introduction- Types – processing methods - Nutrition- Quality and standards for snack foods - GHP and GMP for snack food industries - Outline of snack food industry - Domestic Snack Food Market-Global Market.

UNIT II - POTATO AND TORTILLA CHIPS PROCESSING

Potato Production- selection and grading of potato - Potato snack Ingredients- Potato Analysis and Composition-Potato chip manufacturing process-Unit Operations-Other value added products from Potato. Tortilla chips - Raw Materials- Processing steps-Equipment involved-Reconstitution of Dry Maize Flour-Unit operations - Nutritional properties of potato and tortilla chips.

UNIT III - POPCORN PROCESSING

Introduction- Raw popcorn selection and preparation-Popping Methods-Home preparation of Popcorn-Equipments-Industrial manufacturing process- Flavorings and Applicators-Popcorn Packaging- Relative Nutrition- Marketing.

UNIT IV - FRUIT BASED SNACKS

Introduction-production and processing of fruit crops – fruit purees – fruit powders – canned fruit snacks – alcoholic preservation of fruit snacks – fruit candies – fruit bars – exotic fruits – Nutritions and health benefits of fruit snacks.

UNIT V - SENSORY EVALUATION AND PACKAGING

Introduction- importance of sensory evaluation – Analytical methods -Sensory methods- Sensory Aspect of Processing- Limitations of sensory evaluation- Quality properties of Snack Foods and Packaging Materials-Automated Bag- Pouch Packaging- Cartoning Case Packing- Labelling requirements - Current Issues in Snack Foods Packaging.

Suggested Readings:

1. Lusas, E. W and Rooney, L. W. Snack Foods Processing. CRC Press,1st Edition 2001.
2. Panda, H. The Complete Technology Book on Snack Foods, National Institute of Industrial Research, Delhi. 2nd Edition 2013.
3. Sergio O Serna-Saldivar, Industrial Manufacture of Snack Foods, Kennedys Books Ltd. 2008.
4. Lusas, E. W and Rooney, L. W. Snack Foods Processing. CRC Press,1st Edition 2001.
5. Panda, H. The Complete Technology Book on Snack Foods, National Institute of Industrial Research, Delhi. 2nd Edition 2013.
6. Sergio O Serna-Saldivar, Industrial Manufacture of Snack Foods, Kennedys Books Ltd. 2008.

22BTFTOE04

AGRICULTURAL WASTE AND BYPRODUCTS UTILIZATION

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hour

Course Objectives

The goal of this course is for students,

- To categorize the types of agricultural wastes.
- To outline the production and utilization of biomass.
- To explain the various parameters considered to be important in the designing of biogas units.
- To discuss the methods employed in the production of alcohol from agricultural wastes / byproducts.
- To summarize the overall aspects involved in the production of paperboards and particleboards from agricultural wastes.

Course Outcomes

Upon successful completion of this, students will be able to,

1. List and classify the types of agricultural wastes.
2. Collect and generate number of value-added products from agricultural wastes.
3. Recall the techniques involved in the production and utilization of biomass.
4. Assess the various parameters considered to be important in the designing of biogas units.
5. Illustrate the various methods employed in the production of alcohol from the byproducts of agricultural wastes.
6. Choose the appropriate materials to produce paperboards and particleboards from agricultural wastes.

UNIT I - TYPES OF AGRICULTURAL WASTES

Introduction and Background Agricultural Waste, Crop Waste, Agricultural Residues (annual crops), Technical terms, properties of agricultural waste- storage and handling - rice by-products utilization-rice bran and germ, rice bran oil, economic products from agriculture waste/by-products.

UNIT II - BIOMASS PRODUCTION AND UTILIZATION

Biomass – types – production and utilization Technology used for the utilization of agricultural wastes: Biomass Gasifier, Nimbkar Agricultural Research Institute (NARI) Gasifier, Rice-Husk Based Gasifier, Heat and Steam from Sugarcane Leaf and Bagasse.

UNIT III - BIOGAS DESIGN AND PRODUCTION

Biogas: Definition, composition, history of biogas, Production of biogas – factors affecting the efficiency; types of biogas plant (floating drum type and fixed dome type) and their components (inlet, outlet, stirrer, slanting pipe, digester, gas holder and gas outer pipe), Selection and Design of biogas plant.

UNIT IV - PRODUCTION OF ALCOHOL FROM WASTE MATERIALS

Production of Alcohol from waste materials: Introduction, Production methods, Cellulolysis (biological approach): Pretreatment, Cellulolytic processes (Chemical and Enzymatic hydrolysis), Microbial fermentation, Gasification process (thermochemical approach).

UNIT V – PRODUCTION OF PAPERBOARD AND PARTICLEBOARDS FROM AGRICULTURAL WASTE

Biodegradable packing materials: merits and demerits, Production and testing of Paperboards and Particleboards from Agricultural Waste: Introduction, History, Terminology and classification, Raw materials, Production steps- Pulping, Classifications of pulp, Bleaching, Plies, Coating, Grades.

Suggested Readings:

1. Efthymia Alexopoulou. Bioenergy and Biomass from Industrial Crops on Marginal Lands. Elsevier, 1st Edition, 2020. (ISBN: 9780128188644).
2. Navanietha Krishnaraj Rathinam, Rajesh Sani. Biovalorisation of Wastes to Renewable Chemicals and Biofuels. Elsevier, 1st Edition, 2019. (ISBN: 9780128179529).
3. Simona Ciuta, Demetra Tsiamis, Marco J. Castaldi. Gasification of Waste Materials. Academic Press, 1st Edition, 2017. (ISBN: 9780128127162).
4. Nicholas E. Korres, Padraig O'Kiely, John A.H. Benzie, Jonathan S. West. Bioenergy Production by Anaerobic Digestion: Using Agricultural Biomass and Organic Wastes. Routledge, 1st Edition, 2013. (ISBN-13: 9780415698405).
5. Albert Howard, Yashwant Wad. The Waste Products of Agriculture. Benediction Classics, 1st Edition, 2011. (ISBN-13: 9781849025).

22BTFTOEO5

DESIGN OF FOOD PROCESS EQUIPMENT

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hour

Course Objective

The goal of this course is for students to,

- Emphasis the types of materials used in the food processing equipments.
- Discuss about the materials and designing of different storage vessel.
- Explain the importance of reaction vessel and their deskining techniques.
- Explain the materials and designing of heat exchanger and evaporators.
- Discuss the importance of dryers in food processing industries.

Course Outcome

Upon completion of this course, students will be able to,

1. Point out the materials suitable for the construction of equipments.
2. List out the vessels used for the food storage.
3. Categorize the different types of reaction vessel used for different purposes.
4. Understand the importance of heat exchanger in the designing of food processing equipments.
5. Understand the significance of dryers in food processing.
6. Understand the basic for design and develop equipments used in food Processing operations. To gain technical know-how about the material requirements and design of various equipments needed in Food industries.

UNIT I - MATERIALS

Metals and non-metals, design of pressure vessels – cylindrical shell –internal and external pressure - under continued loadings. Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes Numerical problem and design of pressure vessel.

UNIT II - STORAGE VESSELS

Design of storage vessels – Rectangular Tank without stiffeners –with stiffeners – shell design – Numerical problem and design. Design of agitators and baffles. Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations;

UNIT III - REACTION VESSELS

Design of Reaction vessels – materials -classification – jackets-Design of vessel shell with half coil – Design of vessel shell with jacket – Numerical problem and design.

Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

UNIT IV - HEAT EXCHANGERS

Design of Heat exchangers – types – materials – Design pressure and temperature- shell design – tubes - Numerical problem. -Design of Equipment. Evaporator: Materials of concentration – types – design- consideration – Design of agitators – power requirements – Design based on Torque – critical speed.

UNIT V – DRYERS

Types - General considerations – Design of Tray dryer, Rotary Dryer, fluidized bed dryer, spray dryer, vacuum dryer, microwave dryer – Material Balance, Thermal energy Requirements, electrical energy Requirements, Performance Indices

Suggested Readings:

1. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN- 0824743113, 2003.
2. Joshi M.V, "Process Equipment Design", Macmillan India Ltd.,1985.
3. Coulson, J.M. and Richardson, J. F,"Chemical Engineering " Butterworth-HeinemnnElsevier, ISBN-0750644451, 2002.

OPEN ELECTIVES

(PREFERRED BY FOOD TECHNOLOGY)

B.E. Computer Science and Engineering **2022-2023**

22BECSOE01

INTERNET OF THINGS

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60**Total**:100**

End Semester Exam:3 Hours

Course Objectives:

The goal of this course is for the students:

- To understand the basics of Internet of Things.
- To get an idea of some of the application areas where Internet of Things can be applied.
- To understand the middleware for Internet of Things.
- To understand the concepts of Web of Things.
- To understand the concepts of Cloud of Things with emphasis on Mobile cloud computing.
- To understand the IOT protocols.

Course Outcomes:

Upon completion of the course, the students will be able to:

- Identify and design the new models for various applications using IoT.
- Explain the underlying architectures and models in IoT.
- Analyse different connectivity technologies for IoT.
- Develop simple applications using Arduino / Raspberry Pi.
- Analyze and design different models for network dynamics.
- Apply data analytics techniques to IoT. Study the needs and suggest appropriate solutions for Industrial applications.

UNIT I ARCHITECTURES AND MODELS

Introduction to IoT – IoT Architectures – Core IoT Functional Stack, Sensors and Actuators Layer, Communications Network Layer, Applications and Analytics Layer – IoT Data Management and Compute Stack, Fog Computing, Edge Computing, Cloud Computing – Sensors, Actuators, Smart Objects, Sensor networks. Middleware for IoT: Overview – Communication middleware for IoT – IoT Information Security

UNIT II CONNECTIVITY

Communications Criteria – Access Technologies – IP as IoT Network Layer – Business case – Optimization – Profiles and compliances – Application Protocols – Transport Layer – Application Transport Methods.

UNIT III SYSTEM DEVELOPMENT

Design Methodology – Case study – Basic blocks of IoT device – Raspberry Pi – Board, Interfaces, Linux, Setting up, Programming – Arduino – Other IoT Devices.

UNIT IV DATA ANALYTICS AND IOT SECURITY

Data Analytics for IoT – Big Data Analytics Tools and Technology – Edge Streaming Analytics – Network Analytics Applications. Security history, challenges, variations – Risk Analysis Structures –Application in Operational Environment.

UNIT V IOT IN INDUSTRY

Manufacturing, Architecture, Protocols – Utilities, Grid Blocks - Smart Cities, Architecture, Use cases – Transportation, Architecture, Use cases.

Text Books:

1. Honbo Zhou, The Internet of Things in the Cloud: A Middleware Perspective, CRC Press,2013.
2. Dieter Uckelmann; Mark Harrison, Florian Michahelles, Architecting the Internet of Things,Springer, 2011.
3. David Easley and Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a HighlyConnected World, Cambridge University Press – 2010.

References:

1. Olivier Hersent, Omar Elloumi and David Boswarthick, The Internet ofThings: Applicationsto the Smart Grid and Building Automation, Wiley -2012.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things – Keyapplications and Protocols, Wiley, 2012.

Websites:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106105166/lec1.pdf
2. https://nptel.ac.in/courses/106105166/
3. https://nptel.ac.in/courses/108108098/

22BECSOE03

BLOCK CHAIN TECHNOLOGIES

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for the students to:

- Understand how blockchain systems (mainly Bitcoin and Ethereum) work.
- To securely interact with them.
- Design, build, and deploy smart contracts and distributed applications.
- Integrate ideas from blockchain technology into their projects.
- Introduce application areas, current practices, and research activity.

Course Outcomes

Upon completion of the course, the student will be able to:

- Understand the design principles of Bitcoin and Ethereum.
- Understand the Nakamoto consensus.
- Understand the Simplified Payment Verification protocol.
- List and describe differences between proof-of-work and proof-of-stakeconsensus.
- Interact with a blockchain system by sending and reading transactions.
- Design, build and deploy a distributed application.
- Evaluate the security, privacy, and efficiency of a given blockchain system.

UNIT I: BASICS

Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. **Cryptography:** Hash function, Digital Signature - ECDSA (Elliptic Curve Digital Signature Algorithm), Memory Hard Algorithm, Zero Knowledge Proof.

UNIT II: BLOCKCHAIN

Introduction, Advantage over the conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.

UNIT III: DISTRIBUTED CONSENSUS

Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization, and alternate.

UNIT IV: CRYPTOCURRENCY

History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum -Construction, DAO (Decentralized Autonomous Organization), Smart Contract, GHOST (Greedy Heaviest Observed Subtree), Vulnerability, Attacks, Sidechain, Namecoin.

UNIT V: CRYPTOCURRENCY REGULATION

Stakeholders, Roots of Bitcoin, Legal Aspects-Crypto currency Exchange, Black Market, and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.

Tutorial & Practical: Naive Blockchain construction, Memory Hard algorithm - Hashcash implementation, Direct Acyclic Graph, Play with Go-ethereum, Smart Contract Construction, Toy application using Blockchain, Mining puzzles.

TEXTBOOK:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press (2016).
2. 2.Andreas M.Antonopoulos, "Mastering Bitcoin: Programming the Open Blockchain" O'Reilly, Media;2 edition(2017).

REFERENCE BOOKS:

1. Andreas M. Antonopoulos,Gavin Wood "Mastering Ethereum: Building Smart Contracts and DApps" O'Reilly Media; 1 edition (13 November 2018).
2. Don Tapscott, Alex Tapscott "Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies" Penguin; 01 edition (10 May 2016)
3. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System.
4. Dr.Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger", Yellow paper.2014.
5. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts.

WEBSITES:

1. https://swayam.gov.in/nd1_noc20_cs01/preview.
2. https://hyperledger.github.io/composer/latest/introduction/introduction.html.
3. https://ethereumbuilders.gitbooks.io/guide/content/en/index.html.

22BEMEOE01

COMPUTER AIDED DESIGN

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for the students to:

1. To apply basic concepts to develop construction (drawing) techniques.
2. To ability to manipulate drawings through editing and plotting techniques.
3. To understand geometric construction and Produce template drawings.
4. To understand and demonstrate dimensioning concepts and techniques.
5. To understand Section and Auxiliary Views.
6. To become familiar with Solid Modelling concepts and techniques.

Course Outcomes

Upon completion of the course, the students will be able to

1. Apply basic concepts to develop construction (drawing) techniques.
2. Ability to manipulate drawings through editing and plotting techniques.
3. Understand geometric construction and Produce template drawings.
4. Understand and demonstrate dimensioning concepts and techniques
5. Understand Section and Auxiliary Views.
6. Become familiar with Solid Modelling concepts and techniques.

UNIT I - OVERVIEW OF CAD SYSTEMS

Conventional and computer aided design processes-advantages and disadvantages. Subsystems of CAD-CAD hardware and software, analytical and graphics packages, CAD workstations. Networking of CAD systems.

UNIT II - INTERACTIVE COMPUTER GRAPHICS AND GRAPHICS TRANSFORMATIONS

Generative, cognitive and image processing graphics. Static and dynamic data graphics. Transport of graphics data. Graphic standards. Generation of graphic primitives - display transformation in Two- and Three – Dimensional graphics concepts, Graphical input technique, Geometric transformations, Visual Realism, Computer animation, customizing graphics software.

UNIT III - GEOMETRIC MODELING

Wireframe, surface, NURBS and solid modeling-applications and advantages. Creating primitive solids, sweeping solids, Boolean operations. Extracting entities from a solid. Filleting of edges of solids. Boundary representation (B-rep)

Constructive Solid Geometry (CSG) and Analytical Solid Modeling (ASM).

UNIT IV - PARAMETRIC DESIGN AND OBJECT REPRESENTATION

Types of co-ordinate systems. Parametric design - definition and advantages. Parametric representation of analytic and synthetic curves. Parametric representation of surfaces and solids - manipulations.

UNIT V - PRODUCT DESIGN AND DEVELOPMENT

Automated 2D drafting - basics, mating conditions – Types of translators (IGES, STEP, ACIS and DXF). Massproperty calculations.

Suggested Readings

1. Vera B Anand, Computer Graphics and Geometric Modeling for Engineers,1st edition, John Wiley & Sons,New York, 2000.
2. Radhakrishnan P and Subramanyan S, CAD/CAM/CIM, 2nd edition, New Age International Pvt. Ltd, 2008.
3. Ibrahim Zeid, CAD/CAM Theory and Practice,2nd edition,McGraw Hill Inc., New York, 2009.
4. Barry Hawhes, The CAD/CAM Process,1st edition, Pitman Publishing, London, 2007(digital).
5. William M Newman and Robert Sproul, Principles of Interactive Computer Graphics,1st edition,McGrawHill Inc., New York, 2001.
6. Rao S S, Optimization Techniques, 1stedition, Wiley Eastern, New Delhi, 2006.

22BTBTOE04

FUNDAMENTALS OF NANOBIOTECHNOLOGY

3H-3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam:3 Hours

Course Objectives

The goal of this course is for the students to:

- Impart the skills in the field of nano biotechnology and its applications.
- Acquire knowledge in the nano particles and its significance in various fields.
- Extend the knowledge in types and application of nano particles in sensors.
- Define the concepts of biomaterials through molecular self-assembly.
- Equip students with clinical applications of nano devices.
- Describe deeper understanding of the socio-economic issues in nanobiotechnology.

Course Outcomes

After completing the course, the students will be able to,

- Develop skills in the field of nano biotechnology and its applications.
- Summarize the nanoparticles and its significance in various fields.
- Extend the knowledge in types and application of nano particles in sensors.
- Define the concepts of biomaterials through molecular self-assembly.
- Outline the clinical applications of nano devices.
- Describe the socio-economic issues in nanobiotechnology.

UNIT I - INTRODUCTION

Introduction to Nanotechnology and nanobiotechnology: Properties at nanoscale, Scope and Overview, Length scales , Importance of Nanoscale and Technology,History of Nanotechnology, Future of Nanotechnology: Nano Technology Revolution, ; General synthesis methods of nanoscale materials; top down and bottom up approaches; Silicon based Technology, Benefits and challenges in Molecular manufacturing: The Molecular assembler concept, Controversies and confusions, Understanding advanced capabilities, Nanotechnology in Different, Fields: Nanobiotechnology, Materials, Medicine, Dental care.

UNIT II - NANO PARTICLES

Introduction, Types of Nanoparticles, Techniques to Synthesize Nanoparticles, Characterization of Nanoparticles, Applications, Toxic effects of Nanomaterials, Significance of Nanoparticles Nanofabrications- MEMS/NEMS, Atomic Force Microscopy, Self assembled monolayers/ Dip- pen Nanolithography, Soft Lithography, PDMS Molding, Nano Particles, Nano wires and Nanotubes. X-ray diffraction technique; Scanning Electron Microscopy with EDX; Transmission Electron Microscopy including high-resolution imaging;

UNIT III: MEDICAL NANOTECHNOLOGY

Nanomedicine, Nanobiosensor and Nanofludics. Nanocrystals in biological detection, Electrochemical DNA sensors and Integrated Nanoliter systems. Nano-Biodevicesand Systems. Fabrication of Novel Biomaterials through molecular self-assembly- Small scale systems for in vivo drug delivery- Future nanomachine. Case study on drug delivery of gold nanoparticles against breast cancer

UNIT IV - NANOBIOTECHNOLOGY

Nanoscale devices for drug delivery: micelles for drug delivery; targeting; bioimaging; microarray and genome chips; Clinical applications of nanodevices. Artificial neurons. Real-time nanosensors- Applications in cancer biology. Nanomedicine. Synthetic retinyl chips based on bacteriorhodopsins. High throughput DNA sequencing with nano carbontubules. Nanosurgical devices.

UNIT V - ETHICAL ISSUES IN NANOTECHNOLOGY

Introduction, Socioeconomic Challenges, Ethical Issues in Nanotechnology: With Especial Reference to Nanomedicine, Nanomedicine Applied in NonmedicalContexts, Social Issues Relating to Nanomedicine. Social and Ethical Issues, Economic Impacts, Other Issues, Nanotechnology and Future Socio-economic challenges.

Suggested Readings:

1. Niemeyer, C.M. and Mirkin, C.A (2005). Nanobiotechnology: Concepts, Applications andPerspectives. Wiley-VCH.
2. Goodsell, D.S. (2004). Bionanotechnology. John Wiley and Sons, Inc.
3. Shoseyov, O. and Levy, I (2008). Nanobiotechnology: Bioinspired Devices and Materials of theFuture. Humana Press.
4. Bhushan, B. (2017). Springer Handbook of Nanotechnology. Springer-Verlag BerlinHeidelberg.
5. FreitasJr R.A (2006) Nanomedicine. Landes Biosciences.
6. Kohler, M. and Fritzsche, W. (2008). Nanotechnology – An Introduction to NanostructuringTechniques. Wiley-VCH.
7. Niemeyer, C. M., and CA Mirkin, C. A., (2010); NanoBiotechnology II – Moreconcepts, and applications. First edition, Wiley –VCH publications.