KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

REGULATIONS, CURRICULUM & SYLLABI – 2022

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

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

MASTER OF TECHNOLOGY
IN
FOOD TECHNOLOGY

DEPARTMENT OF FOOD TECHNOLOGY

KONGU
Assuring the Best

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(An Autonomous Institution Affiliated to Anna University)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

MASTER OF ENGINEERING (ME) / MASTER OF TECHNOLOGY (MTech) DEGREE PROGRAMMES

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

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

iii. "Programme" means Master of Engineering (ME) / Master of Technology (MTech) Degree programme

iv. "Branch" means specialization or discipline of ME/MTech Degree programme, like Construction Engineering and Management, Information Technology, etc.

v. "Course" means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Engineering Design Methodology, Machine Learning Techniques, etc.

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

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

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

ix. "Principal" means Chairman, Academic Council of the College.

x. "Controller of Examinations" means authorized person who is responsible for all examination related activities of the College.

xi. "Head of the Department" means Head of the Department concerned of the College.

2. PROGRAMMES AND BRANCHES OF STUDY

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

Programme	Branch
	Structural Engineering
	VLSI Design
	Embedded Systems
	Computer Science and Engineering
MTech	Information Technology
	Food Technology

3. ADMISSION REQUIREMENTS

Candidates seeking admission to the first semester of the ME/MTech Degree programme shall be required to have passed an appropriate qualifying Degree Examination of Anna University or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto, subject to amendments as may be made by the Anna University, Chennai from time to time. The candidates shall also be required to satisfy all other conditions of admission prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

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

i. Foundation Courses (FC)

ii. Professional Core (PC) Courses

iii. Professional Elective (PE) Courses

iv. Open Elective (OE) Courses

v. Employability Enhancement Courses (EC) like Innovative Project, Internship cum Project work in Industry or elsewhere, Project Work

4.2 Credit Assignment

Each course is assigned certain number of credits as follows:

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

The minimum number of credits to complete the ME/MTech programme is 72.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like innovative project, internship cum project work and project work during the programme to gain/exhibit the knowledge/skills.

4.3.1 Innovative Project

A candidate shall earn two credits by successfully completing the project by using his/her innovations in second semester during his/her programme.

4.3.2 Internship cum Project Work

The curriculum enables a candidate to go for full time projects through internship during the third semester and can earn credits through it for his/her academics vide clause 7.6 and clause 7.12. Such candidate shall earn the minimum number of credits as mentioned in the third semester of the curriculum other than internship by either fast track mode or through approved courses in online mode or by self study mode. Such candidate can earn the number of credits for the internship same as that of Project Work in the third semester. Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.3.4 Project Work

A candidate shall earn nine credits by successfully completing the project work in fourth semester during the programme inside the campus or in industries.

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

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

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

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

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

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

4.4.5 A candidate can earn a maximum of 15 credits through all one /two credit courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

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

4.5.2 From the second to fourth semesters the candidates have the option of registering for additional elective courses or dropping of already registered additional elective courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates. Total number of credits of such courses during the entire programme of study cannot exceed eight.

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

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

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

5. DURATION OF THE PROGRAMME

5.1 A candidate is normally expected to complete the ME / MTech Degree programme in 4 consecutive semesters (2 Years), but in any case not more than 8 semesters (4 Years).

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

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

6. COURSE REGISTRATION FOR THE EXAMINATION

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

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

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

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The ME/MTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Innovative Project, Internship cum Project work and Project Work. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE) at the end of the semester except for the courses which are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100 marks as shown below:

Sl. No.	Category of Course	Continuous Assessment Marks	End Semester Examination Marks
1.	Theory	40	60
2.	Theory cum Practical (The distribution of marks shall be	50	50
3.	Practical	60	40

4.	Project Work / Internship cum Project Work	50	50
5.	One / Two credit Course	The distribution of marks shall be decided based on the credit weightage assigned	---
6.	All other Courses		

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

7.3 Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 40 marks and the end semester examination shall be for 60 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 50. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. Three tests shall be conducted for 50 marks each and reduced to 30 marks each. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

7.3.1 The assessment pattern for awarding continuous assessment marks shall be as follows:

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	12.5	---
	Test - II	12.5	
2.	Tutorial / Others (Tutorial/Problem Solving (or) Simulation (or) Simulation & Mini Project (or) Mini Project (or) Case Studies (or) Any other relevant to the course)	10	Type of assessment is to be chosen based on the nature of the course and to be approved by Principal
3.	Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	40	Rounded off to the one decimal place

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

7.3.2 A reassessment test or tutorial covering the respective test or tutorial portions may be conducted for those candidates who were absent with valid reasons

(Sports or any other reason approved by the Principal).

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

7.4 Theory cum Practical Courses

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

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 50 marks and the end semester examination shall be for 50 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidate's records shall be maintained.

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

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

7.6 Project Work

7.6.1 Project work shall becarried out individually. Candidates can opt for full time internship (vide clause 7.7) in lieu of project work in third semester. The project work is mandatory for all the candidates.

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

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

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Review I (Max..10 Marks)		Review II (Max.. 20 Marks)		Review III (Max. 20 Marks)		Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)		
Rv. Com	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Ext. Exr.	Guide	Exr.1	Exr.2
5	5	10	10	10	10	20	10	10	10

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

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

7.6.6 Every candidate shall, based on his/her project work, publish a paper in a reputed journal or reputed conference in which full papers are published after usual review. A copy of the full paper accepted and proof for that shall be produced at the time of evaluation.

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

7.6.8 If a candidate fails to secure 50 % of the end semester examination marks in the project work, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted as per clause 7.6.7.

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

7.7 Internship cum Project Work

Each candidate shall submit a brief report about the internship undergone and a certificate issued from the organization concerned at the time of Viva-voce examination to the review committee. The evaluation method shall be same as that of the Project Work as per clause 7.6 excluding 7.6.6.

7.8 One / Two Credit Course

Two assessments shall be conducted during the value added course duration by the offering department concerned.

7.9 Online Course

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

7.10 Self Study Course

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

7.11 Audit Course

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

The candidate can register only one Audit course in a semester starting from second semester subject to a maximum of two courses during the entire programme of study. Such courses shall be indicated as 'Audit' during the time of Registration itself. Only courses currently offered for credit to the candidates of other branches can be audited.

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

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

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

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

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

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

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

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

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

8.1.5 Candidate's progress is satisfactory.

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

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

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

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

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

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

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

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

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

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

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

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

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

11. PROVISION FOR BREAK OF STUDY

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

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

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

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

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

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

12. PASSING REQUIREMENTS

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

12.2 A candidate who secures not less than 50 % in continuous assessment marks prescribed for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course. If a candidate secures less than 50% in the continuous assessment marks, he / she shall have to re-enroll for the same in the subsequent semester and satisfy the attendance requirements.

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

13. REVALUATION OF ANSWER SCRIPTS

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

14. SUPPLEMENTARY EXAMINATION

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

15. AWARD OF LETTER GRADES

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

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

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

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

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

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

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

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

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

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

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

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the ME / MTech Degree provided the candidate has

i. Successfully completed all the courses under the different categories, as specified in the regulations.

ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).

iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2020 (vide clause 11.3)

iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

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

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

(OR)

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

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

17.2 First Class:

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

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

17.3 Second Class:

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

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

18. MALPRACTICES IN TESTS AND EXAMINATIONS

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

19. AMENDMENTS

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

******

M.TECH - FOOD TECHNOLOGY CURRICULUM – R2022

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22AMT14	Applied Statistics for Food Technology	3	1	0	4	40	60	100	FC
22GET11	Introduction to Research	2	1	0	3	40	60	100	FC
22MFT11	Advanced Drying Technology	3	1	0	4	40	60	100	PC
22MFT12 / 22MFT13	Unit operations in Food Process Engineering (For Science Graduates)/ Food Chemistry and Microbiology (For Engineering Graduates)	3	0	0	3	40	60	100	PC
22MFT14	Advanced Food Processing Technology	3	0	0	3	40	60	100	PC
22MFT15	Lipid Science and Technology	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22MFL11	Food Chemistry and Microbiology Laboratory	0	0	2	1	60	40	100	PC
22MFL12	Food Process Technology Laboratory	0	0	2	1	60	40	100	PC
Total Credits to be earned					**22**				

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22MFT21	Advanced Refrigeration and Cold Chain Management	3	1	0	4	40	60	100	PC
22MFT22	Instrumental Techniques and Methods for Food Analysis	3	0	0	3	40	60	100	PC
22MFT23	Food Safety and Quality Control	3	0	0	3	40	60	100	PC
	Professional Elective – I	3	0	0	3	40	60	100	PE
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Professional Elective - III	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
22MFL21	Instrumental Food Analysis Laboratory	0	0	2	1	60	40	100	PC
22MFL22	Food Products Development Laboratory	0	0	2	1	60	40	100	PC
Total Credits to be earned					**21**				

MTECH - FOOD TECHNOLOGY CURRICULUM – R2022

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Professional Elective – V	3	0	0	3	40	60	100	PE
	Professional Elective - VI	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
22MFP31	Project Work - I	---	---	16	8	50	50	100	EC
Total Credits to be earned					**17**				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Practical / Employability Enhancement									
22MFP41	Project Work - II	--	--	24	12	50	50	100	EC
Total Credits to be earned					**12**				

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES (PEs)						
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Semester - II						
Elective – I						
1.	22MFE01	Advanced Fruit and Vegetable Processing Technology	3	0	0	3
2.	22MFE02	Novel Technologies in Food Processing	3	0	0	3
3.	22MFE03	Heat and MassTransfer Operations in Food Processing	3	0	0	3
4.	22MFE04	Industrial Engineering	3	0	0	3
5.	22MFE05	Industrial Waste Management	3	0	0	3
Elective – II						
6.	22MFE06	Advanced Baking and Confectionery Technology	3	0	0	3
7.	22MFE07	Advanced Separation Techniques in Food Processing	3	0	0	3
8.	22MFE08	Food Packaging and Storage Engineering	3	0	0	3
9	22MFE09	Enzyme Engineering and Technology	3	0	0	3
10.	22MFE10	Machine Vision for Food Technology	3	0	0	3
Elective - III						
11.	22MFE11	Technology of Food Colours and Flavours	3	0	0	3
12.	22MFE12	Food Product Design and Development	3	0	0	3
13.	22MFE13	Transport Phenomena in Food Processing	3	0	0	3
14.	22MFE14	Operational Research	3	0	0	3
Semester - III						
Elective – IV						
15.	22MFE15	Advanced Grain Science and Technology	3	0	0	3
16.	22MFE16	Food Additives, Nutraceuticals and Functional Foods	3	0	0	3
17.	22MFE17	Food Process Plant Layout and Design	3	0	0	3
18.	22MFE18	Food Rheology	3	0	0	3
19.	22MFE19	Internet of Things in Food and Agriculture	3	0	0	3

Elective - V						
20.	22MFE20	Sensory Evaluation of Foods	3	0	0	3
21.	22MFE21	Advanced Meat Processing Technology	3	0	0	3
22.	22MFE22	Food Supply Chain Management	3	0	0	3
23.	22MFE23	Scaleup Methods in Process Engineering	3	0	0	3
24.	22MFE24	Design and Analysis of Experiments	3	0	0	3
Elective – VI						
31.	22MFE25	Plantation Crops and Spices Technology	3	0	0	3
32.	22MFE26	Advanced Dairy Technology	3	0	0	3
33.	22MFE27	Computational Fluids Dynamics	3	0	0	3
34.	22MFE28	Industrial Process Automation	3	0	0	3
35.	22MFE29	Project Engineering and Management	3	0	0	3
36.	22GET13	Innovation Entrepreneurship and Venture Development	3	0	0	3

22AMT14 - APPLIED STATISTICS FOR FOOD TECHNOLOGY							
Programme & Branch	**MTech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**FC**	**3**	**1**	**0**	**4**
Preamble	This course will help the students to identify, formulate and optimize processes using statistical tools in order to achieve the best products in food industry.						
Unit – I	**Testing of Hypothesis**:						**9+3**
Sampling Distributions – Large sample tests – Testing the significance of single mean - difference of means – Small sample tests – Testing the significance of means (student's t-test) – Testing the significance of Variances (F-test) - Testing the significance of goodness of fit - Independence of attributes (χ^2 - test).							
Unit – II	**Nonparametric Tests**:						**9+3**
Introduction – Sign test: One sample sign test – Sign test for paired samples – Signed rank test – Rank Sum test: Mann Whitney U test- Kruskal-Wallis test – One sample run test – Tests of randomness.							
Unit – III	**Design of Experiments**:						**9+3**
Analysis of variance – One-way classification – Completely Randomized Design – Two way classification – Randomized block design – Latin Square Design.							
Unit – IV	**Time Series Analysis**:						**9+3**
Significance of time series analysis - Components of Time series - Secular trend - Graphical method - Semi-average method - Method of Moving Averages - Method of Least squares - Seasonal variations - Method of Simple Averages - Ratio to trend method - Ratio to moving average method.							
Unit – V	**Statistical Quality Control:**						**9+3**
Introduction to Statistical quality control – Control charts – Control chart for variables: $\bar{X}$-chart – R-chart – s-chart – Charts for attributes: np-chart – p-chart – c-chart.							
Lecture:45, Tutorial:15, Total:60							

REFERENCES:

1.	S.C.Gupta, "Fundamentals of Statistics", 7th Revised Edition, Himalaya Publishing House Private Limited, Mumbai, 2019.
2.	G.C.Beri, "Business Statistics", 3rd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
3.	Johnson, R.A, "Miller and Freund's Probability and Statistics for Engineers", 8th Edition, Pearson Education Inc., New Jersey, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply statistical tests in testing hypotheses on data.	Applying (K3)
CO2	use appropriate non-parametric test to analyze experimental data.	Applying (K3)
CO3	adopt design of experiments techniques in engineering problems.	Applying (K3)
CO4	apply ideas to real time series data and interpret outcomes of analysis	Applying (K3)
CO5	identify suitable control charts for monitoring processes.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1		3			2
CO2		3			2
CO3		3			3
CO4		3			
CO5		3			2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	5	10	85				100
CAT2	5	10	85				100
CAT3	5	10	85				100
ESE	5	10	85				100

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

22GET11 - INTRODUCTION TO RESEARCH							
(Common to all ME / MTech Branches & MCA)							
Programme& Branch	**All ME/MTech branches & MCA**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**1 / 2**	**FC**	**2**	**1**	**0**	**3**

Preamble	This course will familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. Also will disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit - I	**Concept of Research:**	**6+3**
Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - II	**Research Methods and Journals:**	**6+3**
Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.		
Unit - III	**Paper Writing and Research Tools:**	**6+3**
Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.		
Unit - IV	**Effective Technical Thesis Writing/Presentation:**	**6+3**
How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.		
Unit - V	**Nature of Intellectual Property:**	**6+3**
Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - innovation - patenting - development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents.		
Lecture: 30, Tutorial:15, Total:45		

REFERENCES:

1.	DePoy, Elizabeth, and Laura N. Gitlin, “Introduction to Research-E-Book: Understanding and Applying Multiple Strategies”, Elsevier Health Sciences, 2015.
2.	Walliman, Nicholas, “Research Methods: The basics”, Routledge, 2017.
3.	Bettig Ronald V., “Copyrighting culture: The political economy of intellectual property”, Routledge, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	list the various stages in research and categorize the quality of journals.	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper.	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		
CO2	3	2	3		
CO3	3	3	1		
CO4	3	2	1		
CO5	3	2	1		

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

ASSESSMENT PATTERN - THEORY

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

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

22MFT11 - ADVANCED DRYING TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**I**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course imparts knowledge on various advanced drying techniques and selection of suitable dryers.	
Unit - I	**Introduction to Drying:**	**9+3**
Drying and dehydration - Principles - Mechanism of drying - Internal and external conditions of drying - Drying rate characteristic curves - Diffusion theories of drying - Effective Fickian diffusivity - Water activity -Water activity predictive models – Calculations– Sorption Isotherm - Hysteresis - Determination of sorption isotherms – Gravimetric method - Manometric method and Hygroscopic methods		
Unit - II	**Spray drying and Freeze drying:**	**9+3**
Spray drying - Concept - Components of spray drier - Spray dryer nozzle - Mechanism of atomization - Drop size and drop distribution. Drying of droplets - Fundamentals, residence time - Heat and mass balance -drier efficiency - New developments in Spray drying -Spray freeze drying. Freeze drying - Concept, principle. Stages in freeze drying - Heat and mass transfer, calculations, design considerations - Industrial freeze dryers - Advances in freeze drying – Microwave freeze drying.		
Unit - III	**Drying on inert particles:**	**9+3**
Introduction-Inert particle drying- Pneumatic drying-Principle- Mechanism - Working and its applications. Fluidized bed drying - Principles of fluidization - Components of fluidized bed system - Classification of fluidized bed dryers - Conventional and modified FBD.		
Unit - IV	**Novel drying:**	**9+3**
Super-heated steam drying - Principles - Classification - Selection - Applications. Heat pump drying (HPD) – Principle - Low temperature HPD - Chemical HPD - Developments and trends. Contact-Sorption drying - Mechanism - Characteristics of sorbents/carriers –High electric field drying		
Unit - V	**Advanced dryers:**	**9+3**
Microwave dryers - Basic concepts - Industrial applications - Hybrid microwave dryers - Infra-red drying - Principles - Industrial dryers - Applications - Sonic drying - Slush drying - Refractance Window drying.		
		Lecture:45, Tutorial:15, Total:60

REFERENCES:

1.	Mujumdar A.S., “Handbook of Industrial Drying”, 3rd Edition, 1., Taylor and Francis group, UK, 2007.
2.	Xiao Dong Chen and Mujumdar A.S., “Drying Technologies in Food Processing”,1st Edition, Wiley-Blackwell, 2008.
3.	Kudra T. and Mujumdar A.S., “Advanced Drying Technologies”, 2nd Edition, CRC Press, Taylor and Francis Group, UK, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply drying mechanism and calculate water activity	Analyzing (K4)
CO2	make use of spray and freeze drying techniques for food materials	Applying (K3)
CO3	outline inert particle drying, pneumatic and fluidized bed drying	Understanding (K2)
CO4	select appropriate novel drying techniques	Applying(K3)
CO5	choose suitable advanced dryers for different food materials	Applying(K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1		1
CO2	3	3	1		1
CO3	3	3	1		1
CO4	3	3	1		2
CO5	3	3	1		2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFT12 - UNIT OPERATIONS IN FOOD PROCESS ENGINEERING							
(For Science Graduates)							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**I**	**PC**	**3**	**0**	**0**	**3**

Preamble	The subject will help the students to have knowledge on the material and energy balance, fluid properties,mechanical operations, heat and mass transfer operations.	
Unit - I	**Material and Energy Balance:**	**9**
Stoichiometric principles - Material balance without chemical reaction like distillation – Evaporation – Crystallization - Drying and extraction - Heat capacity of solids - Liquids, gases - enthalpy changes in food. Standard heat of reaction- Heats of formation - Combustion - Energy balance for systems without chemical reaction.		
Unit - II	**Fluid flow:**	**9**
Principles of fluid flow - Properties of liquids - Fluid dynamics - Potential energy - Kinetic energy - Pressure energy - Friction loss - Mechanical energy - Newtonian and non**-**Newtonian fluids - Stream line and turbulent flow - Flow measurement and measurement of viscosity - Kinematics of fluid flow - Concept of boundary layer - Basic equation of fluid flow: Equation of continuity and Bernoulli equation - Correction of Bernoulli equation for fluid friction - Application of Bernoulli equation for pump work.		
Unit - III	**Mechanical Operation:**	**9**
Screening - Screening equipment - Effectiveness of screens - Gravity settling – Sedimentation - Thickening - Clarifier- Floatation - Filtration Principle - Types of filtration - equipment.		
Unit - IV	**Heat Transfer:**	**9**
Concept of heat conduction - Fourier's law of heat conduction - One dimensional steady state heat conduction equation for flat plate and cylinder - Concept of heat convection - Natural and forced convection - Individual and overall heat transfer coefficient - Concept of radiations - Black body and grey body concept - Radiation Properties - Stefan Boltzmann law - Emissivity and absorptivity – Kirchhoff's Law - Introduction to Heat exchanger and Evaporator equipment.		
Unit - V	**Mass Transfer:**	**9**
Types of mass transfer operations – Fick's law - Molecular and eddy diffusion in gas and liquids - Steady state diffusion under stagnant and laminar flow conditions - Diffusivity measurement - Local and overall mass transfer coefficients - Introduction to mass transfer operation: absorption - distillation - extraction - Leaching - Humidification.		
		Total:45

REFERENCES:

1.	Goshal S.K., Sanyal S.K.,Datta S., "Introduction to Chemical Engineering",19th Edition, Tata McGraw-Hill, Delhi, 2006.
2.	McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw-Hill, New York, 2005.
3.	Gavahane K.A., "Unit operation I", 27th Edition, Nirali Prakasham Publications, Pune, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	make use of material and energy balance in food processing operations	Applying (K3)
CO2	explain the concepts of fluids and fluid flow properties	Understanding (K2)
CO3	outline the various mechanical operations carried in food processing	Understanding (K2)
CO4	classify modes of heat transfer and explain heat exchangers and evaporators	Understanding (K2)
CO5	summarize the various mass transfer operations	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1		1
CO3	3	2	1		1
CO4	3	2	1		1
CO5	3	2	1	1	1

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

ASSESSMENT PATTERN - THEORY

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

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

22MFT13 - FOOD CHEMISTRY AND MICROBIOLOGY							
(For Engineering Graduates)							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**I**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge about water activity, influence of biomolecules on food quality and understanding the microbial spoilage and food infection	
Unit - I	**Water relationships in Food and Carbohydrates:**	**9**
Water activity and its relevance to deteriorative processes in foods - Glass transitions and molecular mobility - their relevance to quality and stability of foods. Structure and properties of simple and complex food carbohydrates - Modified starch and cellulose - Manufacture ofmaltodextrins and corn syrup - Cyclodextrins - Chemistry and food applications - Polyols and its applications - Carbohydrates as fat substitutes.		
Unit - II	**Lipids:**	**9**
Classifications -Structure and roles of fatty acids. Food lipids and health – trans fatty acid, ω-3 fatty acid, conjugated linolenic acid, phytosterols, carotenoids. Processing of oils and fats - refining - hydrogenation - interesterification and winterization. Deterioration of oils - hydrolytic rancidity - oxidative rancidity and their prevention.		
Unit - III	**Proteins:**	**9**
Protein structure and conformation - Properties and reactions of proteins in food systems -Dissociation -Optical activity - solubility - hydration - swelling - foam formation - stabilization - gel formation - emulsifying effect - Denaturation of proteins - Food sources - functional role in foods - Texturized Proteins - methods.		
Unit - IV	**Microbial growth and Microbial Spoilage:**	**9**
Types of microorganism normally associated with food-mold, yeast, and bacteria - Physical and chemical factorsinfluencing growth of microorganisms - Biochemical changes caused by microorganisms - Microbial food fermentation– Microbiological standards for different foods - Food poisoning and microbial toxins. Principle and types of food spoilage - Microbial spoilage of different types of foods - Spoilage of fruits and vegetables - Fresh and processed meats, poultry, sea foods, cereals products, bakery products, dairy products, fermented foods and canned foods.		
Unit - V	**Microbiology and Food Preservation:**	**9**
Effect of high temperature on microbes - TDT, D value, Z value, 12D concept - Calculation of process time. Effect of low temperature, radiation, drying on microbes. Chemical preservatives. Advances in preservation of food by various biotechnological processes.		
		Total:45

REFERENCES:

1.	Belitz H. D., Grosch W., and Schieberle P., “Food Chemistry”, 3rd Edition, Springer Verley, Berlin, 2008.
2.	Vaclavik V.A. , Christian E.W., “Essential of Food Science”, 5th Ilustrated Edition, Springer, 2020.
3.	Frazier W.C. , Westhoff, “Food Microbiology”, 5th Edition, McGraw Hill Education, 2017.
4.	Vijaya R.K., “Food Microbiology”, 5th edition, MJP Publishers, Chennai, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the role of water in food stability	Understanding (K2)
CO2	outline the structure and functional role of food biomolecules	Understanding (K2)
CO3	identify suitable technique for the modification of biomolecules	Applying (K3)
CO4	outline the significance of microbes in fermentation, spoilage and food borne infectiousdiseases	Understanding (K2)
CO5	infer the importance of preservation techniques in microbial control	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	2	1
CO2	3	3	1	2	2
CO3	3	3	1	2	2
CO4	3	3	1	3	1
CO5	3	3	1	3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	30	40	30				100
CAT3	40	60					100
ESE	40	50	10				100

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

22MFT14 - ADVANCED FOOD PROCESSING TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**I**	**PC**	**3**	**0**	**0**	**3**

Preamble	To gain insight on the selected advanced food processing, fortification and products forming technology	
Unit - I	**Extraction Processes:**	**9**
Introduction, Extraction of bioactive compounds. Conventional extraction, Advanced extraction techniques and applications in food – enzyme assisted extraction; ultrasound assisted extraction, microwave assisted extraction, high pressure extraction, supercritical fluid extraction and pressurized liquid extraction. Challenges and future trends in extraction techniques.		
Unit - II	**Encapsulation:**	**9**
Introduction, wall materials used for encapsulation, Methods of encapsulation process – nano and micro encapsulation– physical and chemical methods. Bioavailability. Controlled release techniques in food industry.Applications and current trends.		
Unit - III	**Instantization and Agglomeration:**	**9**
Introduction, Instantization and agglomeration process, Methods - pressure, extrusion, tumbling of powders, straight through, spray bed dryer agglomeration, steam jet and agglomeration by heating. Characteristics of agglomerated products, Applications – instant food products.		
Unit - IV	**Cold Plasma and impregnation methods in Food Processing:**	**9**
Plasma, properties of plasma, chemistry of plasma, plasma generation methods, Applications of plasma in food processing, Limitations and toxicology. Current research trends.Food modification – vacuum impregnation, osmotic dehydration – parameters influencing food modification by vacuumimpregnation and osmotic dehydration – traditional and future applications – combination of osmotic dehydration and vacuum impregnation with pre-treatment and downstream processes.		
Unit - V	**3D Food Printing:**	**9**
Introduction, Food printing platform, food printing materials – natively printable and non-printable foods, 3D food printing technologies - Selective Laser Sintering/Hot Air Sintering, Hot-Melt Extrusion/Room Temperature Extrusion, Binder Jetting, Inkjet Printing. Multi material and multi print head. Potential technologies applicable to Food Printing, impacts from 3D Food Printing.		
		Total:45

REFERENCES:

1.	Sahu, Jatindra Kumar, (Eds)., “Introduction to Advanced Food Process Engineering”, 1st Edition, CRC Press,2014.
2.	Bhattacharya, Suvendu, (Eds)., “Conventional and Advanced Food Processing Technologies”, 1st Edition, John Wiley & Sons, 2014.
3.	Misra N.N., Oliver Schlüter, Patrick J. Cullen, (Eds)., “Cold plasma in Food and Agriculture: Fundamentals and Applications”, 1st Edition, Academic Press, 2016.
4.	C. Anandharamakrishnan, S. Padma ishwarya.,” Essential and applications of food engineering”,1st Edition, CRC Press, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	examine different techniques for extraction of active components	Analyzing (K4)
CO2	identify suitable encapsulation techniques for food ingredients	Applying (K3)
CO3	utilize agglomeration process for the production of instant food products	Applying (K3)
CO4	inspect the effect of cold plasma, fortification and impregnation methods on food processand products	Analyzing (K4)
CO5	explain 3D food printing techniques	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	2	1	1	2
CO3	3	2	1	1	2
CO4	3	3	1	1	2
CO5	3	3	1	1	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	50	10			100
CAT2	20	20	60				100
CAT3	20	50	20	10			100
ESE	20	30	40	10			100

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

22MFT15 - LIPID SCIENCE AND TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**I**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course imparts an idea about the different techniques of lipid processing and its products.	
Unit - I	**Food Lipids:**	**9**
Classification, composition, Sources - Nutritional profile and its significance in food industries - Physical properties: Color, odour, specific gravity. Chemical constant: Iodine value - Saponification value - Polenske Number - Reichert Meissl Value - Acetyl Value. Optical properties - Refractive index - Absorption spectra - Rheological and Thermal properties - Importance of flavour emulsion and its stability in food systems.		
Unit - II	**Processing of Oils and Fats:**	**9**
Extraction and refining of oils and fats - Traditional Method - Solvent Extraction - Mechanical Extraction - Modern trends in extraction of oils and fats - Supercritical technology - Membrane technology - Liquid-liquid extraction - Wipe film evaporation - Application of encapsulation and nano-encapsulation - Bioactive lipids extraction and stabilization – Basic Processing steps of refining -oil-degumming, neutralization, bleaching and deodorization - Chemical adjuncts - lecithin, mono-glycerides and its derivatives - Applications in food industries.		
Unit - III	**Modification of Oils and its Applications in Food Industries:**	**9**
Modification of oil - Recent developments in plant and processes – Hydrogenation – Fractionation – Blending – Winterization – Interesterification - Types of Interesterification - Applications of Interesterification - Cocoa butter alternatives - CBR, CBS, CBE - Fat mimetics and substitutes - Dairy Imitation Products - Enzymatic Modification -Structured Lipids - Speciality fats - Lipid as micronutrients and nutraceuticals.		
Unit - IV	**Formulation and Characterization:**	**9**
Margarines, Low-fat spreads - Peanut butter - Vegetable ghee –mayonnaise - whipped creams - salad oils and dressings - cooking oils - fat powders - cream, butter, cod liver - Formulation and technological aspects of bakery and confectionery shortenings – Rendering - dry and wet methods - lard and tallow.		
Unit - V	**Frying and Storage of Oils:**	**9**
Frying of oil - Role of fat and oil in frying - Applications of frying oil - Selection of frying oil - Changes occurring in food and oil during frying - Rancidity - Types - Causes – Prevention. Measurement of lipid degradation parameters during storage. Quality standards of oil - Shortenings - Cooking oils - Salad oils. Packaging standards and requirements of fats and oils.		
		Total:45

REFERENCES:

1.	Chakrabathy M.M., “Chemistry and Technology of Oils and Fats”, 1st Edition Allied Publishers Pvt. Ltd., 2003.
2.	Bailey., “Bailey's Industrial Oil and Fat Products”, 6th Edition, Volume 1- 6, John Wiley & Sons, 2005.
3.	Wolf Hamm and Richard J. Hamilton., “Edible Oil Processing”, 2nd Edition Blackwell Science Ltd., 2013.
4.	Richard D. O'Brien., “Fats and Oils: Formulating and Processing for Application”, 3rd Edition CRC Press, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the composition and properties of fats and oils	Understanding(K2)
CO2	apply suitable technology for processing of fats and oils	Applying (K3)
CO3	choose appropriate techniques for modifying oil and fat	Applying (K3)
CO4	identify the formulations for development of different lipid products	Applying (K3)
CO5	analyze the changes during frying and storage of fats and oils	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	2	1	1	1
CO3	3	3	1	2	2
CO4	3	2	1	1	2
CO5	3	2	1	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	20	50	15	15			100
ESE	20	50	15	15			100

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

22MFL11 - FOOD CHEMISTRY AND MICROBIOLOGY LABORATORY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**PC**	**0**	**0**	**2**	**1**

Preamble	To deal about analysis and estimation of biomolecule and to identify, characterize microbes associated with foods.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Assessment of freshness and characterization of oil
2.	Determination of total polyphenols and flavonoids in food products
3.	Determination of moisture content by oven, IR and distillation methods
4.	Estimation of total carbohydrates in food products
5.	Estimation of protein by Lowry's method and kjeldhal method
6.	Study on degradation kinetics of pigments
7.	Cultivation and enumeration of microorganisms using different plating methods
8.	Microbial examination and enumeration of microorganisms in spoiled bakery/ fruits and vegetable products
9.	Study on Antibiotic sensitivity/antimicrobial activity of plant extract
10.	Accelerated shelf life study of a food product
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual
2.	"Manual of methods for the Analysis of Foods", Ministry of Health and Family Welfare, Government of India, New Delhi, 2016.
3.	Sadasivam, S., Manickam, A., "Biochemical Methods", 3rd Edition, New Age International, Delhi, 2018.
4.	James G. Cappuccino, Natalie Sherman, "Microbiology A Laboratory Manual", 12 , illustrated, Pearson, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	analyze and estimate macronutrients in food products	Analyzing (K5), Precision (K3)
CO2	extract and estimate phytochemicals in food products	Evaluating (K5), Precision (K3)
CO3	enumerate microorganisms in food products	Evaluating (K5), Precision (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	2

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

22MFL12 - FOOD PROCESS TECHNOLOGY LABORATORY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**PC**	**0**	**0**	**2**	**1**

Preamble	To apply various food process technologies in food applications

LIST OF EXPERIMENTS / EXERCISES:	
1.	Determination of different properties of grains
2.	Comparative studies on effectiveness of size reduction equipments
3.	Encapsulation characteristics using freeze drying
4.	Experiment on batch drying characteristics of food material and fitting drying models using MATLAB
5.	Experiment on drying characteristics of food material using microwave dryer
6.	Experiment on osmotic dehydration characteristics of food materials
7.	Experiment on drying characteristics of food material using fluidized bed dryer
8.	Experiment on drying characteristics of food material using foam mat dryer
9.	Encapsulation and anti caking characteristics using spray drying
10.	Experiment on ultrasound and microwave assisted solvent extraction of bioactive components
11.	Virtual lab: Experiment on rheological and thermo physical properties of food
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual
2.	Kavitha Marwaha., “Food Process Engineering: Theory & Laboratory Experiments”, 1st Edition,Gene Tech Books, 2010.
3.	Xiao Dong Chen, Majumdar A.S., “Drying Technologies in Food Processing”, John Wiley & Sons, 2009.
4.	http://www.rpaulsingh.com/learning/virtual/virtual.html

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	estimate the engineering properties of food materials and determine the size reduction effectiveness	Evaluating (K5), Precision (K3)
CO2	assess the drying characteristics and kinetics of food materials	Evaluating (K5) Precision (K3)
CO3	evaluate the encapsulation and anti-caking characteristics of food products	Evaluating (K5) Precision (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	1
CO2	3	3	3	1	1
CO3	3	3	3	1	2

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

22MFT21 - ADVANCED REFRIGERATION AND COLD CHAIN MANAGEMENT							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**II**	**PC**	**3**	**1**	**0**	**4**

Preamble	To impart the knowledge on concepts of refrigeration and cold chain management.	
Unit - I	**Introduction to Refrigeration:**	**9+3**
Refrigeration, Ton of refrigeration, refrigeration capacity calculations, Single vapour compression and vapour absorption systems - COP determinations and calculations. Refrigerants - characteristics of different refrigerants, ozone depletion potentials, pressure enthalpy charts.		
Unit - II	**Components of Refrigeration System:**	**9+3**
Types of Compressors - positive displacement and roto-dynamic type and performance, Evaporators and their functional aspects, Condensing units and cooling towers, Expansion valves, humidifying systems, piping and differentcontrols.		
Unit - III	**Low Temperature Storage of Foods:**	**9+3**
Effect of temperature on food spoilage, Low temperature storage Methods-Chilling, Freezing, Evaporative cooling and its applications. Novel freezing methods and freezer types, Freezing rates, growth rate of ice crystals, crystal sizeand its effect on texture and quality of foods.		
Unit - IV	**Cold and Frozen Storage:**	**9+3**
Construction, Operation **–** Insulation**,** Types of storage rooms, Design and requirements of cold store and frozen store, total refrigeration load calculations, Automated cold store, temperature requirements in frozen storage, maintenance, packaging, energy conservation.		
Unit - V	**Cold Chain Management:**	**9+3**
Scope and importance of cold chain in food processing industry and retail chain, Cold chain – overview, planning and designing, transport of frozen foods – different modes, Time temperature indicators - data loggers, safety aspects, Flexibility storage systems, cold chain transportation inland and export, retail and supermarket cold chain- Retail display cabinets.		
Lecture:45, Tutorial:15, Total:60		

REFERENCES:

1.	Rajput R.K., “Refrigeration and Air-conditioning”, 3rd Edition, S.K. Kataria& Sons, Delhi, 2013.
2.	Dellino C.V.J., “Cold and Chilled Storage Technology”, 2nd Edition, Springer, 2012.
3.	Kennedy C.J., “Managing Frozen Foods”, 1st Edition, Woodhead Publishing Ltd.,2000.
4.	Fellows P J “Food Processing Technology: Principles and Practice” 3rd Edition, Woodhead Publishing Ltd.,2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of refrigeration systems and determine COP	Applying(K3)
CO2	illustrate the working and function of various components of refrigeration systems	Understanding(K2)
CO3	examine the effect of low temperature storage on product quality	Analyzing(K4)
CO4	classify and construct cold storage unit and calculate cooling loads	Analyzing(K4)
CO5	develop cold chain system for transporting food products	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1		1
CO3	3	2	1	2	2
CO4	3	2	1	2	2
CO5	3	2	1	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30				100
CAT2	10	60	15	15			100
CAT3	10	60	15	15			100
ESE	10	60	15	15			100

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

22MFT22 - INSTRUMENTAL TECHNIQUES AND METHODS FOR FOOD ANALYSIS							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PC**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge about the principle and applications of different instrumental techniques used in food analysis.	
Unit - I	**Introduction to Instrumental Methods and UV-Visible and IR Spectroscopy:**	**9**
Classification of instrumental methods based on physical properties of molecules - The Electromagnetic spectrum - Interaction of photons with matter - Absorbance and transmittance - Beer and Lambert's laws. Deviation from Beer- Lambert's Law.Ultra violet and Visible spectrometry: Theory - Types of Transitions - Red and blue shifts - Instrumentation - Single beam and double beam spectrophotometers and applications. Fluorimetry: Theory - Factors affecting fluorescence - Instrumentation and applications. Infrared spectrometry: Requirements for IR absorption - Modes of vibrations-Instrumentation- Applications - Finger print region.		
Unit - II	**X-Ray and Flame Photometer and Thermal Methods and Morphology Analysis:**	**9**
X-ray - Interaction of X-ray with matter -Absorption - Non-dispersive Method - Diffraction - Rotating and powder crystalmethods – Instrumentation, Applications. Flame photometer, Polarimetry and Refractometry - Principle and instrumentation - Saccharimetry - Analysis of sugar. Thermogravimetry - Differential Thermal Analysis - Differential scanning calorimetry - Factors affecting the results - Instrumentation and applications. Morphology Analysis **-** Scanning Electron Microscopy - Transmission Electron Microscopy and Laser diffraction for particle analysis - Principle and Applications.		
Unit - III	**Electrophoresis and Rapid Techniques**:	**9**
Basic Principle of paper - Starch gel, agarose, PAGE, SDS-PAGE electrophoresis Immuno affinity techniques - Radio Assay Electrophoresis and applications. Isoelectric focusing, capillary electrophoresis- Microchip and 2D electrophoresis. Recent Development of Rapid Techniques **-** E sensors **-** e-nose, e-tongue instrumentation - Applications and working principles - Flow cytometry - Epifluorescence microscopy - Principle and Applications.		
Unit - IV	**Atomic Absorption Spectrophotometer and NMR and Mass spectroscopy:**	**9**
Principle, Advantages of ASS over FES - Instrumentation - Interference and applications. Nuclear Magnetic Resonance: Introduction to NMR - Energy levels of nucleus - Equivalent and non-equivalent protons - Chemical shift - Shielding - TMS - Factors affecting chemical shift - Splitting of signals and instrumentation (proton NMR) - Applications. Theory – components of mass spectrometer – Mass spectrum. Resolution of mass spectrometer. Types of ions produced –General rules for Interpretation of mass spectra -Fragmentation methods - Applications of mass spectra.		
Unit - V	**Chromatography Techniques and Hyphenated Techniques**:	**9**
Introduction - Classification of chromatographic methods: Column chromatography, Thin Layer chromatography, Paper chromatography, Gas chromatography and High Performance Liquid Chromatography (HPLC) - Principle, important components and their functions mode of separation, Instrumentation and applications.ICP-MS, HR-MS, HPTLC, GC-MS, LC-MS and GC-FTIR – Principle, Instrumentations and applications.		
		Total:45

REFERENCES:

1.	Chatwal Gurdeep R. , Anand Sham K., "Instrumentation Methods of Chemical Analysis", 5th Edition, Himalaya Publications, Bombay, 2018.
2.	Willard H.H., Merritt L.L., Dean J.A., Settle F.A., "Instrumental Methods of Analysis", 7th Edition, C B S Publishers & Distributors, Delhi, 2004.
3.	Yeshasahupomeranz , Clifton E. Meloan., "Food Analysis", 2nd Edition, CBS Publishers & Distributors, Delhi,1996.
4.	Rouessac F., "Chemical Analysis: Modern International Method and Techniques", 7th Edition Wiley, New Delhi,2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply UV-Visible and IR spectroscopy in food analysis	Applying (K3)
CO2	select suitable technique for internal structure, thermal and morphology analysis of food materials	Applying (K3)
CO3	choose appropriate electrophoretic and rapid techniques to separate and identify food components	Applying (K3)
CO4	make use of AAS, NMR and mass spectroscopy to analyse different food materials	Applying (K3)
CO5	Identify suitable chromatographic methods to separate and quantify the food components.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	1	1	2
CO3	3	3	1	1	2
CO4	3	3	1	1	2
CO5	3	3	1	1	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFT23 - FOOD SAFETY AND QUALITY CONTROL							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**II**	**PC**	**3**	**0**	**0**	**3**
Preamble	This course delivers the knowledge of food hazards, food safety, quality control methods and regulatoryaspects						
Unit - I	**Contemporary Food Safety Strategies:**						**9**
Principles and need for quality control and safety, strategy and criteria for food safety. Consumer lifestyle and demand, issues in food safety, food traceability and recall, case against food biotechnology and irradiation. Case studies in food safety.							
Unit - II	**Food Hazards and Contaminants:**						**9**
Characterization of food hazards, Food borne diseases and their control, food contaminants and their control. Naturally available toxins in foods, Cross contamination: toxicants resulting from food processing. Management of food allergens. Risk analysis of food hazards.							
Unit - III	**Microbial Growth and Modelling:**						**9**
Inactivation of microbial growth - thermal and non-thermal methods, process dependent microbial modelling, integration of process and microbial growth modelling. Applications of predictive microbial modelling. Advanced methods for rapid detection of food spoilage.							
Unit - IV	**Food safety- National and International Regulatory Agencies:**						**9**
Quality control Importance, measures and procedures. BIS, AGMARK, FSSAI. Organizational structure and functions of United States Food and Drug Administration (USFDA), Global Food Safety Initiative (GFSI), International Consultative Group on Food Irradiation (ICGFI), European Food Safety Authority (EFSA), British Retail Consortium (BRC) global standards, Codex Alimentarius, Sanitary and Phyto-Sanitary measures (SPS), Plant Quarantine Act.							
Unit - V	**Food Quality Management System:**						**9**
Duties and responsibilities of food safety regulators, food safety and standards for food products, implementation, validation, verification and improvement of food safety management systems. HACCP, Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Laboratory Practices (GLP), ISO 22000, FSSC 22000, Food Safety Audit.							
							Total:45

REFERENCES:

1.	Da-Wen Sun., “Handbook of Food Safety Engineering”, 1st Edition, John Wiley & Sons, New Jersey, 2011.
2.	Ronald H. Schmidt, Gary E. Rodrick., “Food Safety Handbook”,1st Edition, John Wiley & Sons, New Jersey,2003.
3.	Yasmine Motarjemi , HuubLelieveld., “Food Safety Management - A Practical Guide For The Food Industry”, 1stedition Elsevier, New York, 2013.
4.	S.P.Singh “Food safety., Quality Assurance and Global Trade:Concerns and Strategies”, 1st Edition, InternationalBook Distribution Company, India, 2009

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the importance of food quality and safety	Understanding(K2)
CO2	outline different food hazards and their control measures	Understanding(K2)
CO3	select suitable method for microbial inactivation and microbial growth modeling	Applying (K3)
CO4	outline the functions of various national and international food agencies	Understanding(K2)
CO5	identify suitable food safety management systems for food product	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	3	1
CO2	2	2	1	3	1
CO3	3	2	1	3	2
CO4	3	1	1	3	2
CO5	3	2	1	3	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFL21 - INSTRUMENTAL FOOD ANALYSIS LABORATORY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**PC**	**0**	**0**	**2**	**1**

Preamble	To provide practical exposure to different equipment for food analysis.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Analysis of turmeric – UV spectroscopy
2.	Analysis of coffee – Caffeine (HPLC), Water activity, Solubility
3.	Evaluation and comparison of cooking quality characteristics of different types of pasta and comply the results with FSSAI standards
4.	Detection of adulterants present in agriculture commodities and food products
5.	Atomic absorption spectroscopic analysis of heavy metals in foods
6.	Discriminative and descriptive sensory analysis of food products with statistical correlation
7.	Estimation of viscosity and consistency of liquid foods using viscometer and consistometer
8.	Estimation of energy value of food products using bomb calorimeter
9.	Color analysis of food products using color spectrophotometer
10.	Determination of textural properties of solid foods-Texture profile analysis of foods
11.	Virtual Laboratory Experiment: a. Flame photometer
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual
2.	Manual of methods for the Analysis of Foods", Ministry of Health and Family Welfare, Government of India, New Delhi, 2016.
3.	Sadasivam, S., Manickam, A., "Biochemical Methods", 3rd Edition, New Age International, Delhi, 2018.
4.	http://www.rpaulsingh.com/learning/virtual/experiments/rheology/index.html

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	estimate active components in food products	Evaluating (K5), Precision (K3)
CO2	evaluate quality characteristics and genuinity in agriculture commodities ad food products	Evaluating (K5), Precision (K3)
CO3	assess sensory properties and energy value of food products	Evaluating (K5), Precision (K3)

Mapping of Cos with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	2

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

22MFL22 - FOOD PRODUCTS DEVELOPMENT LABORATORY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course imparts the technical knowledge on development and analysis of different food products.

LIST OF EXPERIMENTS / EXERCISES:

1.	Development of protein enriched biscuits/cookies and evaluation.
2.	Development of deep fat fried snack product and analysis of quality parameters.
3.	Development of phytochemicals rich beverage and estimation of phytochemicals content in the product.
4.	Development of blended food flavour based products and quality evaluation.
5.	Development of dry health food premix and evaluation of quality and sensory attributes.
6.	Development of marshmallow and assessment of texture and quality.
7.	Development of product using dairy replacer specialty fats and quality evaluation.
8.	Development of eggless cake and quality evaluation.
9.	Development of Nutritional/Energy bar and product analysis.
10.	Development of low fat spread and sensory evaluation.
11.	Development of symbiotic dairy product and its sensory and microbiological analysis
12.	Development of sugar free confectionery product and evaluation.
13.	Virtual Lab: Canning of foods - Demo

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual.
2.	Wildman, Robert E.C., “Handbook of Nutraceuticals and Functional Foods”, 3rd Edition, CRC Press, New York, 2019.
3.	Richard D. O’Brien.,“Fats and oils: Formulating and Processing for Application”, 3rd Edition, CRC press, NewYork, 2008.
4.	http://www.rpaulsingh.com/learning/virtual/experiments/canning/index.html

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop and evaluate novel food products in the bakery, confectionery, beverage, dairy and snack foods.	Evaluating (K5), Manipulation (S2)
CO2	make use of functional and specialty ingredients in preparing and evaluating food products	Evaluating (K5), Manipulation (S2)
CO3	develop and evaluate nutrition and conscious food products	Evaluating (K5), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	2
CO2	3	3	3	1	3
CO3	3	3	3	3	2

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

22MFP31 – PROJECT WORK - I							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PC**	**0**	**0**	**16**	**8**

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

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	3	1
CO2	3	1	2	1	3
CO3	3	3	3	3	3
CO4	3	3	1	3	3
CO5	3	2	1	1	2

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

22MFP41 – PROJECT WORK - II							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**4**	**PC**	**0**	**0**	**24**	**12**

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

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	3	1
CO2	3	1	2	1	3
CO3	3	3	3	3	3
CO4	3	3	1	3	3
CO5	3	2	1	1	2

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

22MFE01- ADVANCED FRUIT AND VEGETABLE PROCESSING TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**II**	**PE**	**3**	**0**	**0**	**3**

Preamble	To study about the advanced techniques in fruit and vegetable processing and its effects on quality offinished product	
Unit - I	**Post-harvest Processing and Improving the shelf-life of vegetables by genetic modification:**	**9**
Pre-harvest factors on postharvest life, Maturity index, Precooling, Post-harvest treatments- curing, sprout suppressants, degreening. Storage – Refrigerated storage, Hypobaric storage. Controlled atmosphere stores. MAP. Fruit ripening – changes during ripening, ripening rooms. Ethylene – sources, alternatives. Genetic control of leaf senescence and fruit ripening, future trends.		
Unit - II	**Edible Coatings and Vacuum Technology:**	**9**
Introduction, Principle, selection of edible coatings, Polysaccharide, protein and lipid based coatings. Gas permeation properties, Wettability, coating effectiveness, Diffusivities of fruits – determination. Measuring internal gas composition. Future trends. Introduction, principles – mass transfer and product behavior. Applications and future trends.		
Unit - III	**Minimal Processing:**	**9**
Introduction, quality changes, Processing – physiological and microbiological impacts, Fresh cut products – Fresh produces quality and safety. Strategies for minimizing quality loss improving quality, bio-control agents, browning inhibition. Storage and packaging. Fresh-cut chain – harvest to market. Equipment requirements. Traceability of fresh cut products. Layout of a fresh cut processing facility.		
Unit - IV	**Fruit and Vegetable Product:**	**9**
Manufacturing: jams and jellies – gelling agent, sweetening agent, acidulants, coloring and flavoring agents, method of manufacturing. Fruit Beverages – Classification, Production of filtered and cloudy fruit drinks – preparation steps, Juice extraction, clarification, concentrate production. Production of fruit nectars – preparation steps, freezes concentration.		
Unit - V	**Ozonation and Enzyme Maceration:**	**9**
Introduction, ozone properties, ozone generation methods – electrical, electrochemical, radiochemical and ultraviolet method. Ozone in fruit juice processing – gaseous and aqueous applications, factors affecting efficacy of ozone processing – Extrinsic and intrinsic parameters. Mechanism of microbial inactivation. Effect on food quality. Industrial health and safety. Introduction-function of enzymes in fruit juice processing- Applications and future trends.		
		Total:45

REFERENCES:

1.	Jongen W., “Fruit and Vegetable Processing: Improving Quality”, 1st Edition, Woodhead Publishing Series in Food Science, Technology and Nutrition, 2002
2.	Nirmal Sinha, Jiwan Sidhu, JozsefBarta, James Wu, M.PilaCano, “Handbook of Fruits and Fruit Processing”, 2nd Edition, Blackwell Publishing, 2012.
3.	Srivastava R.P, Sanjeev Kumar, “Fruit and vegetable preservation: Principles and practices”, 3rd Edition, CBSPublishers & Distributers, New Delhi, 2014.
4.	Rodrigues Sueli, Fabiano Andre NarcisoFernandes, (Eds), “Advances in Fruit Processing Technologies”, 1st Edition, CRC Press, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	choose suitable post-harvest processing methods and genetic modification for freshproduce	Applying (K3)
CO2	select suitable edible coatings for fruits and vegetables and outline the applications ofvacuum technology on fruit processing	Applying (K3)
CO3	apply minimal processing techniques for the production of fresh cut fruits and vegetables	Applying (K3)
CO4	develop fruit and vegetable based jam, jelly and juice products	Applying (K3)
CO5	examine the effect of ozone and enzyme maceration in fruit processing	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	2
CO2	3	3	1	1	2
CO3	3	3	1	1	2
CO4	3	3	1	1	2
CO5	3	3	1	1	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	30	30	20	20			100
ESE	35	20	35	10			100

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

22MFE02 - NOVEL TECHNOLOGIES IN FOOD PROCESSING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**II**	**PE**	**3**	**0**	**0**	**3**
Preamble	To impart knowledge on novel processing techniques in the field of food technology						
Unit - I	**Hurdle Technology, Super Critical Fluid Extraction & High Pressure Processing of Foods**						**9**
Emerging technologies in food processing – necessity and advantages. Hurdle technology – concepts, applications – non thermal processing methods as hurdles. Super critical and sub critical extraction of functional ingredients in food materials. High Pressure Processing – Principles – applications to food systems – effect on food quality.							
Unit - II	**Pulsed Electric Field Processing, Light Based Technologies and Microwave Processing**						**9**
Pulsed Electric Field Processing – Equipment and mechanisms – microbial and enzyme inactivation - PEF enhanced drying, brining, marinating and by-products valorization. Light based technology for food processing: Principles of microbial inactivation of UV, IR and Pulsed light - Effect of pulsed light Technology on food products and food properties. Microwave processing of fluid foods – principle – processing – factors influencing dielectric processing properties of foods – interaction of microwave with food components – equipment – challenges.							
Unit - III	**Irradiation, Ultrasound and Ohmic Heating**						**9**
Irradiation – types of radiations used for food preservation - lethal effects on microorganisms and food constituents - dosimetry and applications. Ultrasound: Principles – Ultrasound assisted extraction, decontamination, preservation, freezing, thawing and drying – parameters influencing ultrasound processing. Ohmic Heating: Fundamentals of Ohmic Heating – Basic Principles, electrical heat generation -electricalconductivity. Generic Configurations - Product suitability for thermal treatments.							
Unit - IV	**Vacuum Cooling and Osmotic Membrane Distillation**						**9**
Vacuum Cooling - Principles – Process – Equipment – Application – Fruits and Vegetables, Bakery, Fishery, Particulate foods, ready meals. Advantages and Disadvantages – Process Parameters. Osmotic Membrane Distillation: Fundamentals – OMD membranes – Process parameters – Osmotic agent, Concentration, Temperature, Membrane. Direct osmosis. Applications.							
Unit – V	**Other Novel Food Processing Methods**						**9**
Shockwaves – principles and applications. Novel crosslinking enzymes applications in food. Vacuum frying – effect onfood quality – combination with microwave drying. Computer vision technology to prevent quality loss of products.							
							Total:45

REFERENCES:

1.	Da-wen Sun, “Emerging Technologies for Food Processing”, 2nd Edition, Elsevier Academic Press, USA, 2005
2.	Howard Q. Zhang, Gustavo V. Barbosa-Canovas, Bala Balasubramaniam V.M., Patrick Dunne C., Daniel F. Farkas, James T.C. Yuan, “Non Thermal Processing Technologies for Food”, 1st edition, Wiley- Blackwell, IFT Press, 2011

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of hurdle technology, super critical fluid extraction and high pressure processing in food preservation	Applying (K3)
CO2	outline the basics of pulsed electric field, light technologies and microwaveprocessing for food materials	Understanding (K2)
CO3	demonstrate the concept of irradiation, ultrasound and ohmic heating for foodtreatments	Understanding (K2)
CO4	apply the concepts of vacuum cooling and osmotic membrane distillation in foodprocessing	Applying (K3)
CO5	explain the concepts of shockwaves, vacuum frying and computer visiontechnology for food processing applications	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	2	2
CO2	3	3	1	2	2
CO3	3	3	1	2	2
CO4	3	3	1	1	2
CO5	3	3	1	1	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	40	60					100
CAT3	20	60	20				100
ESE	10	60	30				100

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

22MFE03- HEAT AND MASS TRANSFER OPERATIONS IN FOOD PROCESSING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course provides in-depth knowledge on selected heat and mass transfer operations.						
Unit - I	**Condensation, Boiling and Evaporation:**						**9**
Condensation number – Film condensation – Boiling heat transfer - Simplified relations. Single and multiple effect evaporators – Performance of evaporators and boiling point elevation – capacity – economy and heat balance - Typesof evaporators.							
Unit - II	**Heat Exchangers:**						**9**
Overall heat transfer coefficients – Fouling factor **-** Types of Heat Exchanger- LMTD - Heat exchanger effectiveness by NTU method- Compact Heat Exchangers – Analysis for variable Properties							
Unit - III	**Distillation:**						**9**
Batch Distillation **–** Flash Vaporization – Continuous fractionation**-** Design of multistage tray towers for binary systems: McCabe Thiele method and Panchon Savorit method. Introduction to multicomponent distillation							
Unit - IV	**Extraction:**						**9**
Single stage, multistage cross current and multi stage counter current operations - Introduction to newer extraction techniques: Super critical extraction, pulsed electric field extraction, microwave extraction, ultrasound assisted extraction, subcritical water extraction, High pressure assisted extraction.							
Unit - V	**Leaching:**						**9**
Solid liquid equilibria, single stage leaching, multistage crosscurrent and counter current leaching, Calculations fornumber of stages - leaching equipment. Batch percolators – Fixed bed multistage systems – continuous contactors.							
							Total:45
REFERENCES:							
1.	McCabe W. L., Smith J. C., Harriott P., “Unit Operations of Chemical Engineering”, 5th Edition, McGraw HillEducation, 2010.						
2.	Holman J.P., “Heat Transfer”, 10th Edition, McGraw-Hill, New York, 2012.						
3.	Treybal R.E., “Mass Transfer Operations”, 3rd Edition, McGraw-Hill, New York, 2012.						
4.	Albert Ibarz, “Unit Operations in Food Engineering”, 1st Edition, CRC Press, 2003.						

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain condensation and evaporative heat transfer phenomena	Understanding (K2)
CO2	analyze the heat exchanger performance	Analyzing (K4)
CO3	explain distillation process and estimate number of stages	Evaluating (K5)
CO4	choose and apply extraction techniques	Applying (K3)
CO5	explain leaching process and estimate number of stages	Evaluating (K5)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1		1
CO3	3	2	1	1	1
CO4	3	2	1	1	1
CO5	3	2	1	1	1

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE04 - INDUSTRIAL ENGINEERING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course gives deep insight in Industrial Engineering, productivity as well as significance of forecasting and planning.						
Unit - I	**Productivity:**						**9**
Historical Evolution of Production and Operations Management - Industrial Engineering–Role of Industrial Engineering - System concept of production-Types of production system-flow, job, batch and project- Productivity- Factors affecting productivity-Productivity measures-Productivity improvement techniques -Business Process Reengineering (BPR)							
Unit - II	**Work Study:**						**9**
Method, basic procedure-Selection-Recording of process -Critical analysis, Development - Implementation -Micromotion and memo motion study –Principles of motion economy-Work measurement Techniques of work measurement -Time study – computation of standard time-Work sampling -Synthetic data -Predetermined motion time standards-Job Evaluation, Merit Rating-Ergonomics and Safety.							
Unit - III	**Modules of pre-planning:**						**9**
Introduction - Forecasting: Need for forecasting -demand patterns-Forecasting models -Judgmental Techniques, Time series analysis, moving average, exponential smoothing, Regression and correlation method-Forecast error costs and accuracy of forecasts.							
Unit - IV	**Facility Planning:**						**9**
Facility location-factors influencing plant location-single and multi facility location problems-Minimax, Gravity and Euclidean –Distance location problem. Capacity planning, Models for Facility Decisions - Plant layout- Layout classification-Layout Design Procedures-CRAFT, ALDEP, CORELAP-Material handling systems unit load concept-material handling principles- Types of material handling equipments and its selection							
Unit - V	**Value Engineering:**						**9**
Value engineering–function, aims, procedure. Make or buy decision, Interest formulae and their applications: Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor - Uniform gradient series, annual equivalent factor, Effective interest rate, Introduction to Methods of comparison of alternatives							
							Total:45

REFERENCES:

1.	Gupta S. and Starr M., “Production and Operations Management Systems”, 1st Edition, CRC Press, 2014.
2.	Hoover C., “Industrial Engineering and Production Management”, 1st Edition, Clanrye International, 2017.
3.	Telsang M., “Industrial Engineering and Production Management”, 1st Edition, S. Chand and Company, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the role of industrial engineering and concept of productivity	Understanding(K2)
CO2	make use of concepts of work study and apply existing methods of working for specified job	Applying (K3)
CO3	explain the significance of forecasting in pre-planning	Understanding(K2)
CO4	select suitable layout design procedures of facility	Applying (K3)
CO5	identify the importance of industrial engineering in cost analysis	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1	1	1
CO3	3	2	1		1
CO4	3	2	1		1
CO5	3	2	1		1

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	50	10				100
CAT2	40	50	10				100
CAT3	20	40	40				100
ESE	36	48	16				100

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

22MFE05 - INDUSTRIAL WASTE MANAGEMENT							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	To educate the students on management of waste water and solid waste, starting from source identification to reuse concepts.	
Unit - I	**Industries and Environment:**	**9**
Industrial scenario in India – Industrial activity and Environment – Uses of water by industry – Sources and types ofindustrial wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment ofindustrial wastewater – Industrial waste survey – Industrial wastewater generation rates, characterization and variables – Population equivalent – Toxicity of industrial effluents and Bioassay tests.		
Unit - II	**Management of Industrial Waste Water and Treatment Plants:**	**9**
Treatments: Aerobic and anaerobic biological treatment – batch and high rate reactors – Chemical oxidation – Ozonation – Photo catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies.Individual and common Effluent Treatment plants – Joint treatment of industrial wastewater – Zero effluent discharge systems – Quality requirements for wastewater reuse – Industrial reuse – Disposal on water and land – Residuals of Industrial wastewater treatment.		
Unit - III	**Solid Waste Sources and Segregation:**	**9**
Sources: Types and Sources of solid wastes – Need for solid waste management – Elements of integrated wast management and roles of stakeholders – Salient features of Indian legislations on management and handling of municipsolid wastes. Handling and segregation of wastes at sources – storage and collection of municipal solid wastes – Analysis of collection systems – Need for transfer and transport – Transfer stations - Optimizing waste allocation – compatibility.		
Unit - IV	**Energy Recovery and Waste Disposal:**	**9**
Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of composting – energy recovery and other modern techniques in managing solid waste – case studies. Energy Auditing. Waste disposal options – Disposal in landfills – Landfill classification, types and methods – site selection – design and operation of sanitary landfills, secure landfills – leachate and landfill gas management – landfill closure of landfills– landfill remediation.		
Unit - V	**Waste Management in different industrial segments:**	**9**
Industrial manufacturing process description- wastewater and solid waste characteristics - source reduction options and waste treatment flow sheet for Textiles – Tanneries – pulp and paper – petroleum refining – pharmaceuticals – sugar and distilleries – Food processing – fertilizers – Thermal power plants and Industrial Estates.		
		Total:45

REFERENCES:

1.	Arceivals S.J., “Wastewater Treatment for Pollution Control”, 3rd Edition, Tata McGraw-Hill, 2017.
2.	Eckenfelder W.W., “Industrial Water Pollution Control”, 3rd Edition, McGraw-Hill, 2017.
3.	Landreth R.E. , Rebers P.A., “Municipal Solid Wastes - Problems and Solutions”,1st Edition, CRC Publishers,2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the present industrial impact on environment	Understanding (K2)
CO2	select suitable waste water treatment options and reuse	Applying (K3)
CO3	outline the sources of solid waste and segregation	Understanding (K2)
CO4	utilize solid waste for energy recovery and disposal	Applying (K3)
CO5	apply waste management principles in different industries	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	1
CO2	3	3	1	2	2
CO3	3	3	1	2	1
CO4	3	3	1	2	2
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE06 - ADVANCED BAKING AND CONFECTIONERY TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will provide in depth knowledge in context of ingredients, equipment and technical aspects inmanufacturing of various bakery and confectionery products.	
Unit - I	**Bakery Ingredients** and **Equipment**:	**9**
Essential bakery ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavor, fat, milk, bread improvers, leavening agents, shortenings, enzymes, emulsifiers and antioxidants. Role of fat and sugar replacers, clean label ingredients. Bulk handling of ingredients, dough mixers, dividers, rounders, sheeters, laminators, Fermentation enclosures and brew equipment, ovens and slicers.		
Unit - II	**Rheological Properties of Dough and Batter**:	**9**
Rheological methods - Fundamental testing and Empirical methods, Rheological testing equipment, compression, penetration, modified penetrometers, transient tests, dynamic tests, extensional viscosity. Effect of ingredients, mixing, dosing and temperature on rheological properties, cake batter rheology and bread dough rheology.		
Unit - III	**Technology of Bakery Products:**	**9**
Various stages and methods, Formulation and production -frozen dough, refrigerated dough and partially baked bread. Types - Foam style and shortened style, industrial preparation and baking of cakes. Production process and quality control, healthy biscuit formulation. Manufacture of cookies, pretzels and pastries. Requirement of dietetic bakery		
Unit - IV	**Ingredient Interactions and their implications in bakery and confectionery products:**	**9**
Basic concepts of heat and mass transfer mechanism in bakery products. Foam to sponge conversion and the collapseof bakery products, Effect of ingredient, recipe and product interactions. Classification of Confectionery products, Ingredients sources and their role for various products: sweeteners –alternative and high intensity sweeteners, water, lipids, emulsifiers, starch, protein, pectin, gums and other ingredients.Factors influencing rheology of candy mass and chocolates		
Unit - V	**Technology of confectionery products:**	**9**
Formulation and Processing – Hard candy, fondant, creams, jellies, gummies, licorices, compressed tablets, chocolates and compound coatings, sugar free confections. Quality standards of confectionery products. Packaging and shelf life of Confectionery products.		
		Total:45

REFERENCES:

1.	Weibiao Zhou ,Y. H. Hui., “Bakery Products Science and Technology”, 2nd Edition, Wiley Blackwell, US, 2014.
2.	Servet Gulum Sumnu , Serpil Sahin., “Food Engineering Aspects of Baking Sweet Goods”, 1st Edition, CRCPress, USA, 2008.
3.	Richard W. Hartel , Joachim H. von Elbe, Randy Hofberger., “Confectionery science and technology”, 1st Edition,Springer, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the role of ingredients and working of equipment in production of bakery products	Understanding (K2)
CO2	analyze and interpret rheological properties of bakery products	Analyzing (K4)
CO3	select appropriate techniques in industrial production of bakery products	Applying (K3)
CO4	apply heat and mass transfer phenomena in bakery product processing and outline therole of confectionery ingredients	Applying (K3)
CO5	apply the process technology for development of confectionery products	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	2
CO2	3	3	1	1	2
CO3	3	3	1	2	2
CO4	3	3	1	1	2
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	30	10			100
CAT2	20	20	40	20			100
CAT3	30	40	30				100
ESE	20	30	30	20			100

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

22MFE07- ADVANCED SEPARATION TECHNIQUES IN FOOD PROCESSING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This subject imparts knowledge on separation techniques required for food process industry.	
Unit - I	**Separation Techniques:**	**9**
Introduction, separation from solids, separation from liquids, separation from gases and vapours, Filtration- centrifugation- equipment and application in food processing.		
Unit - II	**Solid Separation Process:**	**9**
Separation Concept based on particle size and shape. Magnetic separation, Eddy-current separation, Ballistic separation, Color separation, Wet Separation Process, liquid-solid and liquid- liquid separation by hydro cyclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation.		
Unit - III	**Other Separation Processes and Powder Technology:**	**9**
Types and choice of adsorbents, Mechanisms of Affinity chromatography and immuno chromatography. Foam separation, Super critical fluid extraction - Food Application. Classification of powder, separation of powder sieving, air classification and its factors affecting, air separation, particle size distribution.		
Unit - IV	**Membrane Technology:**	**9**
Membrane modules, Mechanism and equipment employed for micro-filtration, ultrafiltration, nanofiltration, reverse osmosis, concentration polarization, pervaporation and application of membrane technology in food industry.		
Unit - V	**Ionic Separation Processes and Permeation Techniques:**	**9**
Electrophoresis, dielectrophoresis, ion exchange chromatography, electro dialysis -Theory and equipment Permeation of liquids and gases.		
		Total:45

REFERENCES:

1.	King, C.J., “Separation Processes”, 2nd Edition, Dover Publications, inc.Mineola, New York, 2013.
2.	Grandison A.S., Lewis M.J., “Separation process in the food & biotechnology industries”, 1st Edition, woodheadpublication, England, 1996.
3.	Ronald.W. Rousseau., “Handbook of Separation Process Technology”, 1st Edition, Wiley India Pvt Ltd, 2009.
4.	Jimmy L. Humphery , George E. Keller., “Separation Process Technology”, 1st Edition, McGraw-Hill Publishers,1997.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the concepts of separation techniques	Understanding (K2)
CO2	choose different solid liquid separation process	Applying (K3)
CO3	outline the adsorption and particle separation process	Understanding (K2)
CO4	categorize separation based on membranes	Analyzing (K4)
CO5	make use of ionic separation and permeation processes	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1		1
CO3	3	2	1		2
CO4	3	2	1		1
CO5	3	2	1		2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	20	40	20			100
ESE	10	30	40	20			100

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

22MFE08 - FOOD PACKAGING AND STORAGE ENGINEERING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will deliver knowledge on recent developments and trends in food packaging and storagemethods.	
Unit - I	**Packaging Materials and Selection of Package:**	**9**
Functions of packaging, Type of packaging materials, Selection of packaging materials and methods for different foods solid, semi–solid and liquid food. Optimizing packaging. Advances in sealing, seaming and methods to detect defects, improving the performance of retortable pouches, testing consumer responses to new packaging concepts.		
Unit - II	**Developments in Active Packaging:**	**9**
Controlled release packaging – process, structure, property and food variables, target release rate, active nanocomposites packaging – free radical scavenging nanocomposites, oxygen scavenging nanocomposites, antimicrobial nanocomposites, edible chitosan coatings – properties of chitosan, application of chitosan based coatings, flavor-release packaging – mechanism of flavor release, practical applications.		
Unit - III	**Trends in Packaging, Labeling and Shelf life Studies:**	**9**
MAP - novel gases, high oxygen MAP, applications, Natural non-toxic insect repellent packaging materials, Interactivepackaging using internet, Smart Labeling - Labeling to detect changes in temperature, monitor freshness, detect changes in oxygen and carbon dioxide concentration. Shelf life studies - Shelf life models – constant H2O and O2 driving forces, variable H2O driving force, variable O2 driving force. Accelerated Shelf Life Study. Advances in freshness and safety indicators in food packaging.		
Unit - IV	**Storage Engineering:**	**9**
Storage of grains–biochemical changes during storage– production, distribution and storage capacity estimate models– ecology, storage factors affecting losses, storage requirements, bag and bulk storage– pressure distribution– method of stacking–preventive method, the behavior of grains as bulk cargo, function structural and thermal design of structures. Parameters of good storage structure. Controlled Atmospheric Storage (CAS). Ceiling and Plinth Storage		
Unit - V	**Grain Protection and Handling:**	**9**
Grain inspection techniques, Theories of rodent control, Protection against Fungi, Pests and Mites, Insect light traps,Biological control of stored product pests. Commodity and space fumigation – movement of gases, dosage and exposure periods, choice of fumigants, fumigation management plan. Dust control.		
		Total:45

REFERENCES:

1.	Kit L. Yam., Dong Sun Lee., “Emerging Food Packaging Technologies: Principles and practice”, 1st Edition,Woodhead Publishing, UK, 2012
2.	Jerry Heaps., “Insect Management for Food Storage and Processing”, 2nd Edition, Elsevier, USA, 2006.
3.	Raija Ahvenainen., “Novel Food Packaging Techniques”, 1st Edition, Wood head Publishing, UK, 2003.
4.	Bala B. K., “Drying and Storage of Cereal Grains”, 2nd Edition, Wiley Blackwell, UK, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	select appropriate packaging materials based on food products	Applying (K3)
CO2	make use of suitable active packaging techniques for different food products	Applying (K3)
CO3	develop smart labels and predict shelf life of food products	Applying (K3)
CO4	outline factors influencing different types of food storage	Understanding(K2)
CO5	Choose appropriate grain protection and handling methods	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	3	1	2	3
CO3	3	3	1	2	3
CO4	3	2	1	2	2
CO5	3	1	1	2	1

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE09 - ENZYME ENGINEERING AND TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course gives an insight about the properties, kinetics and application of enzymes in food industry	
Unit - I	**Introduction to Enzymes:**	**9**
Classification and nomenclature of enzymes according to IUB. Mechanisms of enzyme action, concept of active site and energetic of enzyme substrate complex formation, specificity of enzyme action, Mechanism of enzyme catalysis- electrostatic proximity and orientation effect, role of entropy in catalysis. Co-enzyme, cofactor and prosthetic group – reaction involving TPP, Pyridoxal phosphate, Nicotinamide, Flavin Nucleotides, Co-A, Biotin and Vitamin K dependent carboxylation. Isozymes, abzymes, synzymes.		
Unit - II	**Kinetics of Enzyme Action**:	**9**
Order of reaction, Activation energy, Kinetics of single substrate reactions, Estimation of Michelis-Menten parameters, Lineweaver burk plot, multisubstrate reactions-mechanisms and kinetics, turn over number, pH and temperature effect on enzymes and deactivation kinetics.		
Unit - III	**Enzyme Kinetics and Inhibition**:	**9**
Reversible inhibition - Kinetics of competitive, non-competitive and uncompetitive inhibition. Irreversible inhibition – suicide inhibition. Allosteric regulation of enzymes, Monod Wyman Changeux model. Enzyme Immobilization - Physical and chemical techniques for enzyme immobilization-adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding - examples, advantages and disadvantages.		
Unit - IV	**Application of Enzyme Extracts**:	**9**
Plant, animal and microbial sources, methods of characterization of enzyme extract, development of enzymatic assays. Enzyme application in food processing, meat industry, fruit and vegetable industry, dairy industry, healthcare and environment		
Unit - V	**Enzyme Engineering and Biosensor:**	**9**
Enzyme engineering- design and construction of novel enzymes, random mutagenesis, site directed mutagenesis, rational and computational design, artificial enzymes. Design of enzyme electrodes and their application as biosensors in industry		
		Total:45

REFERENCES:

1.	Young Je Yoo, Yan Feng., Yong Hwan Kim, Camila Flor J. Yagonia., “Fundamentals of Enzyme Engineering”, 1stedition, Springer Netherlands, 2017.
2.	Parmjit S.Panesar, Satwinder S. Marwaha, Harish K. Chopra., “Enzymes in Food Processing: Fundamentals &Potential Applications”, 1st edition, I.K. International Publishing House, 2010.
3.	Whitehurst R. , Law B., “Enzymes in Food Technology”, 2nd edition, Blackwell Publishing, 2010.
4.	Trevor Palmer., “Enzymes: Biochemistry, Biotechnology and Clinical Chemistry”, 2nd edition, HorwoodPublishing, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline enzyme classification and understand the influence of environmental factors onenzyme activity	Understanding(K2)
CO2	interpret enzyme kinetics	Understanding(K2)
CO3	apply suitable methods for enzyme inhibition and immobilization	Applying (K3)
CO4	identify suitable enzymes for processing and development of food products	Applying (K3)
CO5	make use of concepts of enzyme engineering and biosensors	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1		1
CO3	3	3	1		2
CO4	3	3	1	2	2
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE10 - MACHINE VISION FOR FOOD TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	To give an outline on theories of machine vision and to develop suitable food engineering solutions.	
Unit - I	**Image Acquisition Systems:**	**9**
Electromagnetic spectrum - Image acquisition system –computer vision system: Ultrasound, Infrared, Tomographic imaging, comparison of human visual system with computer vision, Image Segmentation Techniques: Pre-processing Techniques - Noise Removal - Contrast Enhancing, Segmentation Techniques – Thresholding-based Segmentation - Edge-based Segmentation - Region-Based Segmentation - Gradient-Based Segmentation – Classification Based Segmentation. Image processing Techniques: Data reduction, Windowing, Digital conversion.		
Unit - II	**Object Measurement System:**	**9**
Size – shape – size dependent and independent - colour – human and hardware oriented, instrumental – texture – structural, statistical, transform and model-based, Object classification methods: Artificial Neural Network – statistical classification – Fuzzy logic – Decision tree – Support vector machine.		
Unit - III	**Hyper spectral Imaging Technology:**	**9**
Fundamentals – multivariate data analysis - spectral pre-processing, development of multivariate calibration, model validation and evaluation, selection of important wavelengths, Multivariate Image Analysis. Application for muscle foods.		
Unit - IV	**Raman Chemical Imaging Technology:**	**9**
Principles – Raman spectroscopy techniques – Raman imaging instruments – Raman image analysis techniques – Image pre-processing, target identification, mapping and quantitative analysis. Raman chemical imaging technology application in foods.		
Unit - V	**Quality Evaluation of Foods:**	**9**
Meat: noncontact quality evaluation of meat cuts, non-destructive technologies for cooked meat quality judgment, poultry and sea foods - hyper spectral imaging. Fruits and vegetables: surface and internal defects, assessing texture and flavour. Grains: assessing classes and quality. 3D machine vision technology, Decision making considerations for machine vision applications.		
		Total:45

REFERENCES:

1.	Alexander Hornberg., “Handbook of Machine and Computer Vision: The Guide for Developers and Users”, 2ndEdition, John Wiley & Sons, Germany, 2017.
2.	Da-Wen Sun., “Computer Vision Technology for Food Quality Evaluation”, 2nd Edition, Academic Press, London,2011.
3.	Davis E. R., “Image Processing for the Food Industry”, 1st Edition, World Scientific, Singapore, 2000.
4.	Bosoon Park, Renfu Lu., “Hyperspectral Imaging Technology in Food and Agriculture”, 1st Edition, Springer,2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	select appropriate image acquisition and segmentation techniques for different types food	Applying (K3)
CO2	apply suitable machine vision technology for food material measurement and classification	Applying (K3)
CO3	make use of hyper spectral imaging technology in food products	Applying (K3)
CO4	identify the applications of raman chemical imaging technology in food materials	Applying (K3)
CO5	select and use suitable machine vision technology for quality evaluation of various food materials	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1		2
CO2	3	3	1		2
CO3	3	3	1	1	2
CO4	3	3	1	1	2
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE11 - TECHNOLOGY OF FOOD COLOURS AND FLAVOURS							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will help students to understand the chemistry, technology and application of flavours and colours in food products.	
Unit - I	**Basics of Food Flavours and Colours:**	**9**
Introduction, classification of food flavours, perception of flavour and taste–Theories of olfaction -Molecular structure and activity relationships of taste – sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Regulations regarding additions, toxicology and safety aspects of food flavour. Introduction, classification of food colours, perception of colour, basics of colour – hue, chroma, brightness, saturation. Regulations regarding additions, toxicology and safety aspects of food colours.		
Unit - II	**Origin and Technology of Food colours:**	**9**
Plant **-** Chlorophyll and chlorophyll derivatives, carotenoids, annatto, saffron, turmeric, Caramel colour, anthocyanins and betalains. Animal**-** Haems and bilins , monascus, cochineal and related pigments. Synthetic -Forms and types, certified F,D and C colourants. Technology for the production of dried colorants, stability - pH, temperature and other processing conditions. Role of micro organism in synthesis of food colours, encapsulated food colourants.		
Unit - III	**Food flavours from plant origin and its processing:**	**9**
Alliaceous flavours, bittering agents, coffee and cocoa, fruit flavours. Enzymatic development, effect of roasting, cooking, frying on flavour developments Essential oils and oleoresins – extraction methods. Liquid and dry flavour production, encapsulated flavours, microbial synthesis of flavours, flavour enhancer and seasonings. factors affecting stability of flavours		
Unit - IV	**Flavour and Colour Analysis:**	**9**
Aroma Compounds - Sample Selection/Preparation, Principles of Aroma Isolation – Solubility, Sorptive Extraction, Volatility. Methods of Aroma Isolation – Static Headspace, Headspace Concentration Methods (Dynamic Headspace) - Distillation Methods – Solvent Extraction, Sorptive Extraction - Concentration for Analysis, Aroma Isolation, Prefractionation - Gas Chromatography, GC/Olfactometry (GC/O) GC- MS/Olfactometry (GC-MS/O), Mass Spectrometry. Preparation and isolation of sample**, s**pectrophotometry, colorimetry, Hunter Colour lab, CIE system, Lovibond Tintometer, Munsell colour system.		
Unit - V	**Flavourants and Colourants applications in food:**	**9**
Soups and stocks, sauces, seasonings, and marinades, baked goods and bakery products, snack foods, sugar based confectionery products and chewing gum, dairy Products - flavoured milks, flavoured yogurts, flavoured dairy desserts.Beverages, dairy products, confections, baked products and other foods.		
		Total:45

REFERENCES:

1.	Reineccius G. , Heath H.B., “Flavor Chemistry and Technology”, 2nd Edition, CRC Press, 2006.
2.	Carmen Socaciu., “Food Colorants: Chemical and Functional Proerties”,1st Edition, CRC Press, 2008.
3.	Rowe D.J., “Chemistry and Technology of Flavors and Fragrances”, 1st Edition, Blackwell Publishing Ltd., 2005.
4.	NIIR board., “Food Colours, Flavours and Additives Technology Handbook, 1st Edition, National Institute of Industrial Research,2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the basic concepts related to flavours and colours	Understanding(K2)
CO2	apply the technological aspects of colours in food product development	Applying (K3)
CO3	apply the technological aspects of flavours in food product development	Applying (K3)
CO4	examine the techniques involved in analysis of flavor and color	Analyzing (K4)
CO5	select and apply appropriate flavours and colours for different food products	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	1
CO2	3	3	1	2	2
CO3	3	3	1	2	2
CO4	3	3	1	1	2
CO5	3	3	1	1	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	30	50	20				100
CAT3	20	40	30	10			100
ESE	30	30	30	10			100

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

22MFE12 - FOOD PRODUCT DESIGN AND DEVELOPMENT							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Cate-gory**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides an insight for design, development, standardization, regulatory aspects and commercialization of food products.	
Unit - I	**Role of ingredient in new product development:**	**9**
Introduction, Characteristics of food ingredient industry, development process. New ingredients – Fat ingredients, carbohydrate ingredients, fibre ingredients, Protein as ingredients. Ingredients and new nutrition – Biologically active non-nutrient, Functional foods, prebiotics and probiotics, Prebiotics and phytochemicals. Other ingredients – Antioxidants, Antimicrobial agents, colourants. Challenges for new nutrition.		
Unit - II	**Designing new products:**	**9**
New Food Product Development (NPD) process and activities, NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe development; use of traditional recipe and modification; involvement of consumers, chefs and recipe experts; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.		
Unit - III	**Standardization & Large scale production:**	**9**
Process and equipment design; establishing process parameters for optimum quality; sensory evaluation; lab requirements; different techniques and tests; statistical analysis; application in product development and comparison of market samples; stages of the integration of market and sensory analysis		
Unit - IV	**Quality, Safety & Regulatory aspects:**	**9**
Product stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness;regulatory aspects; approval for proprietary product		
Unit - V	**Advertisement, Marketing & Case studies:**	**9**
Customers and consumers, value addition, market. Marketing characteristics of new products-Product life cycle, profit picture. Corporate avenues for growth and profitability, opportunities in the marketplace for new product development, technological advances driving new product development, government's role in new product development.		
		Total:45

REFERENCES:

1.	Brody, A. L., John B. L., "Developing New Food Products for a Changing Marketplace", 2nd Edition, CRC press,Taylor and Francis Group, UK, 2008.
2.	Gordon W Fuller., "New Food Product Development: From Concept to Marketplace", 3rd Edition, CRC press,Taylor and Francis Group, UK, 2016.
3.	Catherine Side., "Food Product Development: Based on Experience", 2nd Edition, Iowa State Press, Blackwell publications, 2008.
4.	Macfie, H., "Consumer-led Food Product Development", 1st Edition CRC press, Wood Head publications, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the concept and importance of ingredients in developing new food products	Understanding (K2)
CO2	outline the process for developing new food products	Understanding (K2)
CO3	identify process parameters for standardization and product scale up	Applying (K3)
CO4	apply the quality, safety and regulatory aspects for new product development	Applying (K3)
CO5	utilize the advertisement and marketing strategies for the commercialization of products	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	1
CO2	3	3	1	2	3
CO3	3	3	1	2	2
CO4	3	3	1	3	3
CO5	3	1	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE13 - TRANSPORT PHENOMENA IN FOOD PROCESSING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the basic principles, laws, relations and similarities among different types of transport (Momentum, Energy, and Mass) that may occur in any system.	
Unit - I	**Momentum Transport**:	**9**
Phenomenological laws of transport properties, Newtonian and non-Newtonian fluids, rheological models, theories of transport properties of low density gases and liquids, effect of pressure and temperature. Shell momentum balances – boundary conditions and flow of falling film.		
Unit - II	**Interphase Transport in Isothermal System:**	**9**
Friction factor, Fluid–Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces acting on stagnant and moving solids, Flow through porous medium, Capillary tube model and its applications.		
Unit - III	**Energy Transport:**	**9**
Fourier's law of heat conduction, theory of thermal conductivity of liquids and solids, shell energy balances- boundary conditions, heat conduction with an electrical heat source, composite walls, viscous heat source.		
Unit - IV	**Interphase Transport in Non-Isothermal System**	**9**
Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and drop wise condensation and equations for heat transfer, Heat transfer in boiling liquids.		
Unit - V	**Mass Transport and Interphase Mass Transfer**	**9**
Ficks law of diffusion, Theories of ordinary diffusion in gases and liquids, shell mass balances- boundary conditions, diffusion with heterogeneous and homogeneous reaction – effectiveness factor. Mass transfer co-efficient in single and multiple phases at low and high mass transfer rates. Macroscopic balance to solve steady and Unsteady state problems.		
		Total:45

REFERENCES:

1.	Bird R.B., Stewart W.E., Lightfoot E.N., “Transport Phenomena”, 2nd Edition, John Wiley and Sons, 2006.
2.	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt., “Fundamentals of Heat and Mass Transfer”, 8th Edition, John Wiley and Sons, 2011.
3.	Jorge WeltiChanes, Jorge Vélez-Ruiz, Gustavo V. Barbosa-Cánovas., “Transport Phenomena in Food Processing”,1st Edition, CRC Press, 2013.
4.	Bodh Raj., "Introduction to Transport Phenomena", 1st Edition, PHI Learning Private Limited, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the phenomena behind the transport of momentum, mass and energy	Understanding(K2)
CO2	make use of the shell balance approach to solve momentum, mass and energy transport problems	Applying (K3)
CO3	explain and apply the concept of interphase transport in isothermal systems	Applying (K3)
CO4	identify and apply the concept of interphase transport in non-isothermal systems	Applying (K3)
CO5	analyze the unsteady state problems	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	3	1		1
CO3	3	2	1		1
CO4	3	2	1		1
CO5	3	2	1		1

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	30	50				100
CAT3	10	30	40	20			100
ESE	15	30	45	10			100

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

22MFE14 - OPERATIONAL RESEARCH							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course delivers the knowledge of operational research methods to improve operational efficiency and decision making.	
Unit - I	**Introduction to Operation Research (OR):**	**9**
History of Operations Research- Stages of Development of Operations Research - Relationship Between Manager and OR Specialist- OR Tools and Techniques- Scope and Applications of Operations Research- Limitations of Operations Research.		
Unit - II	**Linear Programming:**	**9**
Introduction to Linear Programming, Graphical Method, Minimization case, Mixed constraint linear programing problem, special cases, Simplex method, Big M method, Two phase method, Types of linear programming solutions, Product Formulation and Process Optimization Using Linear Programming		
Unit - III	**Non – Linear Programming:**	**9**
Constrained problems- Equality constraints- Lagrangean method- In equality Constraints- Karush- Kuhn- Tucker (KKT) Conditions- Quaradic Programming. Applications of non - linear programming in food processing		
Unit - IV	**Game Theory and Queuing Theory:**	**9**
Introduction to the theory of games- The definition of a game, Competitive game, Managerial applications of the theoryof games, Key concepts in the theory of games, Types of games. Introduction, Mathematical Analysis of Queuing Process, Properties of Queuing System, Notations, Service System, Single Channel Models, Multiple Service Channels, Erlang Family of Distribution of Service Times, Food processing plant applications of queueing equations, Limitations of Queueing Theory.		
Unit - V	**Forecasting of operations:**	**9**
Applications of Forecasting, Judgmental Forecasting Methods, Time Series, Forecasting Methods for a Constant- Level Model, Incorporating Seasonal Effects into Forecasting Methods, An Exponential Smoothing Method for a Linear Trend Model, Forecasting Errors, Box-Jenkins method, Causal Forecasting with Linear Regression, forecasting in practice.		
		Total:45

REFERENCES:

1.	Tiwari N.K., Shishir K. Shandilya, “Operations Research”, 1st Edition, Prentice Hall, New Delhi, 2006.
2.	Sharma J. K., “Operations Research: Theory and Applications”, 5th Edition, Macmillan Publishers, New Delhi,2012.
3.	Ferruh Erdogdu., “Optimization in Food Engineering”, 1st Edition, CRC Press, USA, 2008.
4.	SerafimBakalis, Kai Knorzer, Peter J. Fryer., “Modelling Food Processing Operations”, 1st Edition, WoodheadPublishing, UK, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the basics of operation research	Understanding (K2)
CO2	solve different kinds of linear programming problems	Applying (K3)
CO3	apply non-linear programming for solving problems	Applying (K3)
CO4	make use of Game and Queuing theory concepts in food processing	Applying (K3)
CO5	apply forecasting methods in food production planning and sales	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1		1
CO2	3	2	1		1
CO3	3	2	1		1
CO4	3	2	1		1
CO5	3	2	1		1

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE15 - ADVANCED GRAIN SCIENCE AND TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	To learn about the milling of various cereals along with the recent advancements in milling and variouscereal based products	
Unit - I	**Grains:**	**9**
Introduction, structural components of cereal grains, engineering properties of grains, harvesting, threshing, grain cleaning, grading, drying, storage, aeration and stored grain management, control of insects, microorganisms and rodents during storage.		
Unit - II	**Rice Milling:**	**9**
Structure. Principles of size reduction, rice milling - flowsheet. Improving nutritional properties of rice by different methods. Changes in physico-chemical, pasting and milling properties during aging of rice. Water mist polishing, rice moisture conditioning, Instruments for rice quality control – rice analyzer, broken rice analyzer, FWM analyzer, rice taste analyzer.		
Unit - III	**Wheat Milling:**	**9**
Morphology of wheat, Classification, Wheat milling - Flow sheet. Turbo milling, air classifiers. Criteria of wheat and flour quality, structure and functional properties of gluten, wheat grain protein, starch, phytochemcials, dough chemistry, rheology, evaluation of flour quality by farinograph, mixograph, extensiograh, alveograph, rapid viscoanalyzer, dynamic rheometry, mixolab.		
Unit - IV	**Barley, Corn and Oat Milling:**	**9**
Barley – Processing, finishes products and end uses. Corn – wet and dry milling, Manufacture of value added products such as zein from corn. Oat milling and flaking. Dietary fibre from barley and oats: β glucan structure, extraction, physiological effects and functional properties.		
Unit - V	**Cereal Products:**	**9**
Rice snack foods, Rice noodles, quick cooking rice, canned and frozen rice, Baby foods, extruded rice, puffed rice cake, pasta, instant noodles, breakfast cereals, cereal enrichment, malted cereals, special food ingredients from cereals,future trends.		
		Total:45

REFERENCES:

1.	KarelKulp., “Handbook of Cereal Science and Technology”, 2nd Edition, CRC Press, 2000.
2.	Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy., “Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices”, 1st Edition, CRC Press, 2003.
3.	Serna-Saldivar, Sergio O., “Cereal grains: Properties, Processing and Nutritional Attributes”, 1st Edition, CRCPress, 2016.
4.	K M Sahay, KK Singh., “Unit operations of agricultural processing” 2nd Edition, Vikash Publication.2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the grain properties and pre processing operations of grains	Understanding (K2)
CO2	identify the suitable milling technologies for rice processing	Applying (K3)
CO3	make use of appropriate wheat milling process and flour treatment methods	Applying (K3)
CO4	choose various milling methods suitable for barley, corn and oats	Applying (K3)
CO5	develop different cereal based products	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	2	1
CO2	3	2	1	2	2
CO3	3	2	1	2	2
CO4	3	2	1	1	2
CO5	3	2	1	2	3

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE16 - FOOD ADDITIVES, NUTRACEUTICALS AND FUNCTIONAL FOODS							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge about food additives, nutraceuticals and functional foods	
Unit - I	**Food Additives:**	**9**
Introduction, classification and functions; Role of additives in foods - preservatives, antioxidants, sequestrants, emulsifiers - selection of emulsifier based on Hydrophilic and Lipophilic balance (HLB) and its application, stabilizers and thickeners, bleaching and maturing agents, starch modifiers, food colourants and colour retention agents, sweeteners, humectants, flavorants and flavor enhancers, leavening agents, pH control agents, fat substitutes and replacers, anti- foaming agents. International Product Code.		
Unit - II	**Introduction to Nutraceuticals and therapeutic ingredients:**	**9**
Sources, understanding benefits of nutraceuticals. Scope involved in industry, Indian and global scenario. Eye health ingredients –lutein, zeaxanthin, astaxanthin, beta-carotene, bilberry extracts; Heart health ingredients - omega-3, omega-6, omega-9, beta-glucan, soy protein, phytosterols; Digestive Health Ingredients– prebiotics, probiotics, synbiotics, digestive enzymes, zinc carnosine.		
Unit - III	**Health promoting ingredients for women:**	**9**
Women health ingredients - Vitamin D, iron, calcium, soy isoflavones, folic acid, cranberry extract, lycopene,phytoestrogens. Prebiotic fiber, glucosamine, chondroitin, collagen peptide, hyaluronic acid, devils claw, olive polyphenols, boswelia Serrata, horsetail extract.		
Unit - IV	**Dietary Supplements and its Functional sources:**	**9**
Introduction to dietary supplements, Dietary supplements – Need for dietary supplements, supplements forms- tablets,capsules, powders, soft gels, gel caps, liquids.Agnus castus, Aloe vera, Bee products, Chitosan, Echinacea, Garlic, Ginger, Ginkgo biloba, Ginseng, Guarana, Kelp, Milk thistle, Saw palmetto, Spirulina, Chlorella, Hypericum perforatum, Tea extracts.		
Unit - V	**Asian Functional Food:**	**9**
Functional Foods from Meat, Fruit, Fermented Vegetable Products: Kimchi, Sugarcane, Garlic, Onion, Date Fruits, Japanese Green Tea, Miso, Fermented Soybean Products. Cereal based Functional food and their health effects.		
		Total:45

REFERENCES:

1.	Wildman, RobertE.C.,Robert Wildman, Taylor C. Wallace(Eds)., “Handbook of Nutraceuticals and FunctionalFoods”, 2nd edition, CRC Press, New York, 2007.
2.	Titus A. M. Msagati., “Chemistry of Food Additives and Preservatives”, 1st edition, Wiley-Blackwell, 2013.
3.	John Shi, Chi-Tang Ho, Fereidoon Shahidi., “Asian Functional Foods”, 1st Edition, CRC Press, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify and choose food additives for various food applications	Applying (K3)
CO2	select suitable therapeutic ingredients for eye, heart and digestive health	Applying (K3)
CO3	make use of appropriate ingredients for promoting health in women	Applying (K3)
CO4	summarise various functional foods and dietary supplement available in the market	Understanding(K2)
CO5	infer the significance of asian functional foods	Understanding(K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	3	1
CO2	3	2	1	3	2
CO3	3	2	1	3	2
CO4	3	2	1	3	2
CO5	3	2	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE17 - FOOD PROCESS PLANT LAYOUT AND DESIGN							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge on designing the food process, equipment and plant layout.	
Unit - I	**Process design and plant layout:**	**9**
Overview of plant layout and design- Process Flow sheets, Types of process design, Material and energy balances, detailed plant layout aspects, construction materials and plant buildings, Economic analysis in process/plant design, Manufacturing cost and profitability, Computer aided process/plant design and layout.		
Unit - II	**Food Plant Design:**	**9**
Elements of Food Plant Design- General aspects, new food plants, plant improvement, plant expansion, mobile food plants, advanced food plants. Good Manufacturing Practices, Food Plant Economics.		
Unit - III	**Selection of Food Processing Equipment:**	**9**
Construction characteristics. Operational characteristics- reliability, convenience, safety, instrumentation, ergonomics, efficiency, accuracy, environmental impact. Testing of equipments. Equipment specifications.		
Unit - IV	**Sizing, construction and costing of Equipment:**	**9**
Sizing and costing of Equipment, materials of construction, Fabrication of equipment- Strength of Construction, Fabrication and Installation of Equipment, Hygienic Design of Food Processing Equipment.		
Unit - V	**Design of food process equipment:**	**9**
Heat exchangers- Heat transfer factor. Baking Oven- Load of baking chamber, Load by products, Load by heat loss, Total thermal load, types of heating source. Reactors- process operation, design considerations, location, support and elevation, nozzle location, platform, piping arrangements. Design of equipment for industrial food processing such as evaporation, dehydration, refrigeration, freezing, thermal processing, and dehydration.		
		Total:45

REFERENCES:

1.	George D. Saravacos ,Athanasios E. Kostaropoulos, “Handbook of Food Processing Equipment”, 2nd Edition, Springer Science & Business Media, New York, 2016.
2.	Ed Bausbacher , Roger Hunt, “Process plant layout and piping design”,1st Edition, P T R Prentice Hall, Englewood Cliffs, New Jersey, 1993.
3.	Georgina Calderón-Domínguez, Gustavo F. Gutiérrez-López, and Keshavan Niranjan, “Advances in Heat Transfer Unit Operations”, 1st Edition, CRC/Taylor & Francis, 2016.
4.	Teixeira, Arthur A., Shoemaker, Charles F. “Computerized Food Processing Operations” 1st Edition, Springer, 1989.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain process design and plant layout	Understanding(K2)
CO2	apply process layout concepts to construct food plant	Applying (K3)
CO3	select food process equipment based on constructional and operational characteristics	Applying (K3)
CO4	make use of sizing, construction and costing of food process equipment	Applying (K3)
CO5	appraise the criteria for design of food process equipment	Evaluating (K5)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1	1	1
CO3	3	2	1	2	1
CO4	3	2	1	2	1
CO5	3	3	1	1	1

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	30	40	30				100
CAT3	20	20	20	30	10		100
ESE	20	20	25	20	15		100

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

22MFE18 - FOOD RHEOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on concepts, models, and applications of rheology in food systems.	
Unit - I	**Food rheology:**	**9**
Stress and strain tensors, viscometric properties, shear stress-shear rate relationships, units in rheological measurements, types of fluid flow behavior, apparent viscosity, intrinsic viscosity, stress-strain behavior of solid foods, linear viscoelasticity, phase transitions in foods.		
Unit - II	**Models for Rheological Properties of Foods:**	**9**
Time-Independent Flow Behaviour - Newtonian Model, Power Law Model, Herschel–Bulkley Model, Quemada Model. Time-Dependent Flow Behaviour - Weltman Model, Tiu–Boger Model. Shear Thinning Foods - Cross and Carreau Models. Effect of Temperature on Viscosity, Peclet Number of Dispersions.		
Unit - III	**Rheological Behaviour of Processed Fluid and Semi solid Foods:**	**9**
Fruit Juices and Purees: Role of Soluble and Insoluble Solids, Rheological Properties of Chocolate, Rheology of Milk and Milk Concentrate, Rheology of Mayonnaise, Salad Dressing, and Margarine, Rheology of Salad Dressings, Structural Analysis of Food Dispersions.		
Unit - IV	**Rheological Behaviour of Food Gels:**	**9**
Rheological Tests to Evaluate Properties of Gel Systems, Mechanisms of Gelation, Classification of Gels. Theoretical Treatment of Gels - Rubber Elasticity, Percolation Theory, Cascade Theory. Gel Point and Sol-Gel Transition by Rheological Measurements. Mixed Polymer Gels, Starch Gels.		
Unit - V	**Rheology in Fluid Food Handling and Processing:**	**9**
Velocity Profiles in Tubes, Pump Selection and Pipe Sizing, Energy Requirements for Pumping, Power Consumption in Agitation, Residence Time Distribution in Aseptic Processing Systems, Role of Rheology in Thermal Processing of Canned Foods, Continuous Flow Sterilization.		
		Total:45

REFERENCES:

1.	Rao M.A., “Rheology of Fluid and Semi solid Foods: Principles and Applications”, 2nd illustrated Edition, Springer Science & Business Media, 2010.
2.	Bourne M.C., “Food Texture and Viscosity: Concept and Measurement”, Elsevier, 2014.
3.	Jasim Ahmed, Santanu Basu, “Advances in Food Rheology and Its Applications”, 2nd illustrated Edition, Elsevier Science, 2022.
4.	Borwankar R.P., Shoemaker C.F., “Rheology of Foods”, 2nd Edition, Elesvier, USA, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamentals of food rheology	Understanding (K2)
CO2	interpret the different rheological models	Understanding (K2)
CO3	assess the rheological behaviour of processed fluids and semi-solid foods	Evaluating (K5)
CO4	evaluate the rheological behaviour of food gels	Evaluating (K5)
CO5	analyze the importance of rheology in fluid food handling and processing	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1	1	2
CO3	3	3	1		2
CO4	3	3	1		2
CO5	3	3	1	2	1

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE19 - INTERNET OF THINGS IN FOOD AND AGRICULTURE							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course aims to deliver knowledge about concepts of IoT and its applications in food and agriculture.	
Unit - I	**Introduction to Internet of Things (IoT):**	**9**
Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT Communication Models - IoT Communication application programing interfaces – IoT enabled technologies – Wireless Sensor Networks - Cloud Computing – Big data analytics – Communication Protocols, Embedded Systems – IoT Levels and Templates- organizational implementation and management challenges.		
Unit - II	**Python, Physical Devices and Endpoints for IoT:**	**9**
Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, classes, exception handling. Python packages – HTTPLib, URLLib, SMTPLib.: Introduction to Raspberry PI – Interfaces (serial, Serial Peripheral Index (SPI), 12C Programming – Python program with Raspberry PI with focus of interfacing external gadgets – controlling output – reading input from pins – connecting IoT to Cloud – Xively.		
Unit - III	**IoT in Agriculture and IoT in Food:**	**9**
Smart agriculture, type of IoT sensors for agriculture – monitoring of climate conditions, Greenhouse automation, crop management, cattle monitoring and management, End-to-End farm management systems. Benefits and applications of smart farming, Issues and challenges in food and agriculture- efficient routing protocols and ambient energy harvesting for IoT. RFID and sensor network integration in food industry-RFID in food production, food supply chain, retailing and sustainability. RFID in sensor network and food processing-Case studies-Big data analytics in food industries-Food supply chain visibility, Intelligent food supply chain. Block chain-Concepts-Potential Applications in Food Industry.		
Unit - IV	**IoT in Food Spoilage and Safety:**	**9**
Importance of IoT concerning food quality, safety and security. Biosensors for detection of food borne pathogens – prevention & retardation of food spoilage. Microbial detection, GIS, Sensor Networks. Case study on ensuring safety by enhanced IoT. IoT linked wearable devices for managing food safety in the healthcare sector.		
Unit - V	**IoT in Food Traceability and IoT in Food Waste Management:**	**9**
Food Traceability: Need of new technologies in food traceability systems. Architecture of traceability system- ICT & Electronic Product Code (EPC) enabled systems. Real time tracking and remote monitoring – Wireless sensing technologies, remote communications and Intelligent traceability. Food Waste Management: Scope and significance of IoT in food waste management. Smart Garbage System (SGS)- components, design, architecture of SGS, implementation and efficiency, real-time application in food waste minimization.		
		Total:45

REFERENCES:

1.	Qusay F. Hassan, Attaur Rehman Khan, Sajjad A. Madani., "Internet of Things Challenges, Advances and Applications", 1st Edition, CRC Press, Taylor and Francis Group, 2017.
2.	Selwyn Piramuthu, Weibiao Zhou., "RFID and Sensor Network Automation in the Food Industry: Ensuring Quality and Safety through Supply Chain Visibility", 1st Edition, John Wiley & Sons, UK, 2016.
3.	Montserrat Espiñeira, Francisco J. Santaclara., "Advances in Food Traceability Techniques and Technologies -Improving Quality Throughout the Food Chain", 1st Edition, Wood head Publishing, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the basic concepts of IoT	Understanding(K2)
CO2	summarize the fundamental concepts of Internet-connected product	Understanding(K2)
CO3	apply the concept of IoT for management of agriculture and supply chain	Applying (K3)
CO4	make use of appropriate IoT concepts for rapid detection of food spoilage	Applying (K3)
CO5	utilize IoT methods to solve food traceability and food waste management problems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1		3
CO2	2	2	1		3
CO3	3	3	1	2	3
CO4	3	3	1	3	3
CO5	3	3	1	3	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	25	35	40				100

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

22MFE20 - SENSORY EVALUATION OF FOODS							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course aims to enrich the knowledge of planning and executing sensory evaluation programme.	
Unit - I	**Introduction:**	**9**
Sensory evaluation – definition, Role of sensory evaluation in food industry, Sensory perception – vision, gustation, olfaction, touch, audition, multimodal perception. Factors affecting sensory measurements, Factors contributing to successful sensory evaluation. Requirements for sensory testing – Resources, Sample preparation and presentation, Assessors – screening and selection, training, motivation, advantages and disadvantages of internal and externalpanels.		
Unit - II	**Planning a Sensory Project:**	**9**
Product type, Budget, Timings, Selecting the test method, Setting action standards, Experimental design – treatmentstructure, design structure, Measurement scales, Sensory data analysis – types of data, distribution, data handling, choosing appropriate statistical test.		
Unit - III	**Discriminative Test Methods:**	**9**
Overall Difference tests - Triangle test, Duo-trio test, Difference from control test, Same and different test, 'A' 'not A' test. Attribute specific test - Paired comparison, Alternative forced choice, Ranking test. Similarity test - The power of the test, Proportion of true discriminators, Selecting the correct number of assessors.		
Unit - IV	**Descriptive Tests and Affective Tests:**	**9**
Consensus profiling, FlavourProfiling, Texture Profiling, Quantitative Descriptive Analysis, Spectrum method, Free choice profiling, Flash profiling, Difference from control profiling, Temporal dominance of sensations. Questionnaire design, Qualitative methods - Focus groups, Preference tests, Acceptance tests, Attribute diagnostics. Linking consumer, sensory and product data.Advantages and disadvantages of test locations.		
Unit - V	**Sensory applications in new product development and consumer research:**	**9**
Adoption and use of Flash Profiling in standardizing new product development, Improving team tasting in the food industry, Alternative methods of sensory testing -working with chefs, culinary professionals and brew masters, Sensory testing with flavourists: challenges and solutions. Working with children, older people. Empathy and experiment – working with new population groups.		
		Total:45

REFERENCES:

1.	Sarah Kemp, Tracey Hollowood, Joanne Hort., "Sensory Evaluation: A Practical Handbook", John Wiley & Sons, 2011.
2.	Julien Delarue, J., Ben Lawlor, Michel Rogeaux., "Rapid Sensory Profiling Techniques: Applications in New Product Development and Consumer Research", 2nd Edition, Elsevier Science, 2022.
3.	Herbert Stone, Rebecca N. Bleibaum, Heather A.Thomas., "Sensory Evaluation Practices", 5th Edition, Academic Press, USA, 2020.
4.	Harry T. Lawless and Hildegarde Heymann., "Sensory Evaluation of Food: Principle and Practices", Softcoverreprint of the original 2nd ed. 2010 edition, SPRINGER-VERLAG NEW YORK, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the concepts in sensory evaluation	Understanding (K2)
CO2	organize sensory evaluation session appropriate to the product	Applying (K3)
CO3	choose suitable discriminative test method for sensory evaluation	Applying (K3)
CO4	select suitable descriptive and affective tests for sensory evaluation	Applying (K3)
CO5	analyse the role of sensory evaluation in new product development and consumer research	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	3	3	1	2	1
CO3	3	3	1		1
CO4	3	3	1		1
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE21 - ADVANCED MEAT PROCESSING TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts the knowledge about the advances in ensuring originality, processing, preservation and product development from meat and fish.	
Unit - I	**Meat and Advances in meat quality assurance:**	**9**
Chemical composition and structure of meat. Scientific slaughter: Stunning techniques – mechanical & electrical. Pre-and post-slaughter operations. Factors affecting post-mortem changes. Advances in meat fraud detection. Gene technology for meat traceability and safety. Rapid identification of animal and meat quality. Drug residues in meat.		
Unit - II	**Poultry Meat:**	**9**
Birds common to the live bird marketing system. Poultry birds - pre-slaughter care and dressing. Strategies for shelf life extension of poultry meat and its products. Co-products and by-products from poultry processing. Low fat, low salt poultry products. Problems and solutions in deboning of poultry meat. Poultry waste management – selecting the right approach.		
Unit - III	**Egg:**	**9**
Commercially important eggs. Hen egg - structure, composition, chemical contaminants in eggs. Preharvest measures to improve the safety of eggs. Advances in egg defect detection and quality assessment. Traceability of eggs along the supply chain. Effects of processing on the allergenicity of egg proteins. Bioactive egg compounds - applications. Frozen egg products. Designer eggs.		
Unit - IV	**Marine products processing:**	**9**
Edible products from the sea. Fish – types, on board fish processing and its advantages. Individual quick freezing. Retort pouch processing of fish. Quality chain management in fish processing. Food utilization of by-catch and underutilized species; Advances in fishery by-products technology - Production of fish protein concentrate, fish liver oil, fish sauce and insulin.		
Unit - V	**Advances in Meat Products and Processing Operations:**	**9**
Accelerated conditioning technologies for meat. New approaches for development of functional meat products. Tailordesigning of nitrite free meat products. Latest developments in meat bacterial starters. Probiotic meat products, Spreadable raw fermented sausage. Advances in the manufacture of sausage casings. Advances in bulk packaging for the transport of fresh fish. New sources of animal protein – cultured meat, edible insects.		
		Total:45

REFERENCES:

1.	Alaa El-Din A, Bekhit., “Advances in Meat Processing Technology”, 1st Edition, CRC Press, USA, 2017.
2.	George M. Hall., “Fish Processing: Sustainability and New Opportunities”, 1st Edition, Wiley Blackwell Publications, USA, 2010.
3.	Enda J. Cummins, James G. Lyng., “Emerging Technologies in Meat Processing: Production, Processing and Technology”, 1st Edition, Wiley Blackwell Publications, USA, 2016.
4.	Patricia Hester., “Egg Innovations and Strategies for Improvements”, 1st Edition, Academic Press, UK, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	select suitable techniques for meat slaughter and meat quality evaluation	Applying (K3)
CO2	apply various methods to preserve poultry products and utilize poultry waste	Applying (K3)
CO3	identify the quality of eggs and develop beneficial egg products	Applying (K3)
CO4	select suitable method for utilization and preservation of marine products	Applying (K3)
CO5	make use of advance technologies in meat and fish processing	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	3	2
CO2	3	2	1	3	2
CO3	3	2	1	2	2
CO4	3	2	1	2	2
CO5	3	2	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE22 - FOOD SUPPLY CHAIN MANAGEMENT							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge in various components, future and challenges involved in food supply chain.	
Unit - I	**Introduction to Food Supply Chain:**	**9**
Introduction to Food Supply Chain: Types of food chain, Decision Phases in Supply Chain, Food consumer and supply chain, International Food Supply Chains – factors affecting and challenges, Impact of Globalization on Supply Chain Networks, Food supply chain in India, Entities in the agriculture supply chain and case examples.		
Unit - II	**Collaboration within Food Supply Chain:**	**9**
Current relationship models within food sector, Current practices in food supply chain, Perceived risk and product safety in food supply chains, Food packaging and supply chain management, Building blocks of Food Supply Chain Management, Designing food supply chains, Food inventory management, Future of Food Supply Chain Management.		
Unit - III	**Operational Challenges:**	**9**
Food retail environment, Food routes to consumer, Impact of expanding consumer choice, Online grocery retailing, Future of food retailing – Challenges and case examples. Food logistics – packaging in logistics, temperature- controlled supply chains, case examples. Supply chain collaboration and relationship. Food Sourcing and Procurement: Sourcing models, Purchasing models, Supplier segmentation, Supplier development, Strategic sourcing, Sustainable procurement.		
Unit - IV	**Development in Food Supply Chains and Risk Management:**	**9**
Traceability - legislations and standards, Use of traceability technology in food supply chains, Design of Traceability systems, Product development in food supply chains, Innovations within food supply chains, Risk management and uncertainty, Risks in food supply chain, Managing risks in food supply chains.		
Unit - V	**Sustainability Challenges in Food Supply Chains:**	**9**
Sustainable food supply chains, Measuring sustainability within food supply chains, Developing sustainability within food supply chains – case examples, Food hubs, Information Technology in food supply chain, Carbon Footprint of food supply chains, Quality Management Schemes in food supply chain.		
		Total:45

REFERENCES:

1.	Samir Dani., "Food Supply Chain Management and Logistics: From farm to fork", 2nd Edition, Kogan Page, New Delhi, 2021.
2.	Bourlakis M.A. and Weightman P.W.H., "Food Supply Chain Management",1st Edition, John Wiley and Sons, UK,2008.
3.	Iakovou E., Bochtis D., Vlachos D. and Aidonis D., "Supply Chain Management for Sustainable Food Networks", 1st Edition, John Wiley and Sons, UK, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the various food supply chain models in India and in global perspective	Understanding(K2)
CO2	translate collaborative approach to balance supply-side inventory to consumer demand	Understanding(K2)
CO3	outline the operational challenges in food retailing, logistics, sourcing and procurement	Understanding(K2)
CO4	summarize the concepts of traceability, innovation and risk management in food supply chain	Understanding(K2)
CO5	interpret sustainability performance in different stages of supply chain	Understanding(K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	2
CO2	3	3	1	3	2
CO3	3	3	1	1	2
CO4	3	3	1	3	2
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE23 - SCALE UP METHODS IN PROCESS ENGINEERING							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course covers similarity criterion, pilot plant models and dimensional analysis for scaling up ofprocess.						
Unit - I	**Food Product Scale- Up and Principles of Similarity, Pilot Plants and Models:**						**9**
Need and challenges - Scale -up of formulations - Product and package information matrix- Batch versus continuousprocessing - Product transfers and facility scale- up. Introduction to scale–up methods, pilot and models and principles of similarity							
Unit - II	**Dimensional Analysis and Scale–Up Criterion:**						**9**
Dimensional analysis, regime concept: static, dynamic and mixed regime concepts. Similarity criterion and scale- up methods used in process Engineering.							
Unit - III	**Scale-Up of Mixing and Heat Transfer Equipment:**						**9**
Typical problems in scale–up of mixers, Scaling up of Heat Exchangers and Evaporators.							
Unit - IV	**Scale-Up of Mass Transfer Equipments:**						**9**
Scale-up of distillation columns and packed towers for continuous and batch processes.							
Unit - V	**Scale - up of other Selected Processes:**						**9**
Supercritical Fluid Extraction - Screw Extruders - Spray dryers - Ball Mill - Furnaces and Kilns . Limitations of scale- up techniques.							
							Total:45

REFERENCES:

1.	Marko Zlokarnik., " Scale-Up in Chemical Engineering", 2nd Edition, Wiley-VCH–Verlag, Germany, 2006.
2.	Kenneth J. Valentas, J. Peter Clark, Leon Levin., "Food Processing Operations and Scale-up", 1st Edition, MarcelDekker Inc, USA, 1990.
3.	Donald G. Jordan., "Chemical Process Development" (Part 1 and 2), 1st Edition, R.E.Krieger Pub. Co., USA 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Illustrate the importance and aspects of food product scale -up	Understanding (K2)
CO2	Infer fundamentals of scale- up, dimensional analysis and scale - up criterion	Understanding (K2)
CO3	apply the similarity and scale up principles in the scale-up of mixing and heat transfer equipment.	Applying (K3)
CO4	apply acquired knowledge in scale-up of mass transfer equipment.	Applying (K3)
CO5	make use of scaling up of miscellaneous process equipment.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1		
CO2	3	3	1		
CO3	3	3	1		1
CO4	3	3	1		1
CO5	3	3	1		1

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	35	45				100

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

22MFE24 - DESIGN AND ANALYSIS OF EXPERIMENTS							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course highlights different techniques for designing and optimizing experimental data.						
Unit - I	**Introduction to Experimental Design:**						**9**
Introduction – Principles and applications of Design of Experiments, Design of a process and product, Guidelines fordesigning experiments, Using statistical techniques for experimentation, Case studies.							
Unit - II	**Statistical Analysis:**						**9**
Sampling and Sampling Distributions, Inferences on Randomized and paired comparison designs, Analysis of Variances, Regression Analysis – Linear, Multiple regressions, Testing for lack of fit.							
Unit - III	**Randomized Complete Block Design:**						**9**
Framing RCBD experiments, Latin Square Design, Graeco-Latin Square Design, Central Composite Design, Box Behnken Design, Balanced Incomplete Block Design, Model adequacy checking, Least Square estimation, regression, Contour profile of response surface plot, Case Studies.							
Unit - IV	**Factorial Design:**						**9**
Principles and Merits of Factorial design, Analysis of two factorial experiments, Analysis of two level Fractional factorial experiments, Three level Factorial experiments, Introduction to mixed and non regular factorial designs, Case Studies.							
Unit - V	**Software Tools and their Applications in data processing:**						**9**
Introduction to RSM, Steepest Ascent method, Analysis of Second order response surface, Designs for FittingResponse surfaces, Mixture experiments. Curve fitting tools -OriginPro, Spread sheet, Matlab. Statistical analysis of data – Design Expert and Minitab.							
							Total:45

REFERENCES:

1.	Douglas C. Montgomery., “Design and Analysis of Experiments”, 8thEdition, Wiley, USA, 2017.
2.	Hoshmand A.R., “Design of Experiments for Agriculture and the Natural Sciences”, 2nd Edition, CRC Press,USA, 2018.
3.	Castillo E.D., “Process Optimization – A Statistical Approach”, 2nd Edition, Springer Science Business Media, USA,2007.
4.	Angela Dean , Daniel Voss., “Design and Analysis of Experiments”, 1st Edition, Springer, USA, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the basic principles and strategies of experimental design to real time experimental data	Applying (K3)
CO2	apply fundamental concepts of statistics for testing a hypothesis	Applying (K3)
CO3	analyze randomized complete block experiments	Analyzing (K4)
CO4	analyze factorial experiments for deriving conclusions	Analyzing (K4)
CO5	perform response surface analysis using software tools and interpret the results	Evaluating (K5)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1		1
CO2	3	2	1		1
CO3	3	2	1		1
CO4	3	2	1		1
CO5	3	2	1		2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	24	36				100
CAT2	32	24	28	16			100
CAT3	20	24	20	20	16		100
ESE	30	24	26	20			100

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

22MFE25 - PLANTATION CROPS AND SPICES TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge on processing of plantation crops, spices and herbs.	
Unit - I	**Plantation Crops:**	**9**
Types of Plantation crops. Recent trends and innovation in cocoa, coconut, cashew and tuber crops processing. Tea: Manufacturing of diversified tea products – instant tea, functional and herbal tea products. Coffee: Chemistry, Recent Trends in coffee technology, Quality grading of coffee, Chicory chemistry.		
Unit - II	**Spices & Condiments:**	**9**
Classification of spices. Functions of spices – Primary, secondary and emerging functions. Nutritive value of spices and their health benefits. Different forms of spices based on application – fresh, dried, volatile oils, oleoresins, paste, and other extractives. Commercial spice blends and seasonings formulations. Emerging spice blends and seasonings – Popular global spice blends. Growing demand for authenticity.		
Unit - III	**Advances in spice processing:**	**9**
Spice oil - advances in SCFE, novel solvent free extraction methods using microwave, ultrasound. Cryogenic grinding of spices. Extraction of oleoresins, concepts and technology, desolventization methods, regulatory and statutory requirements for oleoresin processing. Spice encapsulation. Recent spice research- antioxidants, antimicrobial and health benefits of spice compounds.		
Unit - IV	**Herbal spices:**	**9**
Description of various types of herbs - Basil, Cilantro, Dill, Coriander, Mint, Oregano, Borage, Thyme, Parsley, Curry leaves, bilva leaves, Bay leaves, Safflower, Rosemary, Lavender. Processing and post - harvest handling. Functional properties. Quality issues. Recent trends, health benefits and innovations of herbs in food Industry.		
Unit - V	**Flavoring Materials Recent advances and trends**:	**9**
Natural flavors, sources of natural flavoring materials – herbs and spices, Genetic engineering in flavour, Flavours generated by enzymes and biological systems, Key aroma and taste components, Flavour stability during food processing and storage, Retention and release of flavours.		
		Total:45

REFERENCES:

1.	Peter K.V., “Handbook of Herbs and Spices”, 2nd Edition, Wood head Publishing, UK, 2012.
2.	P.S. Ahuja, A. Gulati, R.D. Singh, R.K. Sud, R.C. Boruah., “Science of Tea Technology”, 1st Edition, ScientificPublishers, India, 2013.
3.	AmitBaran Sharangi, Suchand Datta., “Value Addition of Horticultural Crops: Recent Trends and FutureDirections”, 1st edition, Springer, India, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the recent trends in plantation crops processing	Understanding (K2)
CO2	utilize functional properties of spices and condiments in product development	Applying (K3)
CO3	select extraction methods required for spices processing	Applying (K3)
CO4	outline different herbs and their processing	Understanding (K2)
CO5	identify the advances in processing of flavour materials	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	2
CO2	3	2	1	1	2
CO3	3	2	1	2	2
CO4	3	2	1	2	2
CO5	3	2	1	1	2

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE26 - ADVANCED DAIRY TECHNOLOGY							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course aims to provide technological advances in processing of milk and milk products.						
Unit - I	**Milk Constituents and Its Properties**:						**9**
Constituents of milk, Factors affecting milk composition, Properties of milk - Thermal, Optical, Electrical and Rheological properties, Refractive Index, Effects of high-pressure treatment on constituents and properties of milk, Bioactive compounds from milk, Advances in Fractionation and Analysis of Milk.							
Unit - II	**Heat-induced Changes and Biotech Approaches in Dairy Products:**						**9**
Chemical and physical changes in Ultra High Temperature treatment, Heat-induced reactions in milk – surface reactions, bulk reactions. Genetically Modified Cheese: A Novel Biotechnological Development, Recent Biotechnological Approaches in Dairy and Food Industry: Bio-Functional Whey Based Beverages, Production and enrichment of bioactive peptides derived from milk proteins, membrane bioreactors: classification, theory, Applications of membrane bioreactors and fermenters in dairy industry							
Unit - III	**Advanced Dairy Processing:**						**9**
Microwave processing, High Pressure processing, Pulsed Electric Field processing, Ultrasound processing, Ultraviolet and Pulsed Light Processing, Advanced heating processes - Extended Shelf Life (ESL), Innovative Steam Injection (ISI), Modern approaches to lactose production.							
Unit - IV	**Dairy Products Manufacture:**						**9**
Liquid infant formulae, Anhydrous Milk Fat, Frozen cream, Dried cream, Processed Cheese, Dairy protein products,Blends and blended spreads – production and quality aspects, Glycosylated whey proteins, Milk imitations, Fermented whey, Indirect Biological Acidification process, manufacturing process for cholesterol reduction.							
Unit - V	**Operational Constraints and Automation in Dairy Industry:**						**9**
Fouling - types, mechanisms, factors affecting fouling, Biofilm - formation, detection, control. Factors contributing to automation, Stages in automation in dairy, Automation at enterprise level - Enterprise Resource Planning.							
							Total:45

REFERENCES:

1. Spreer E., “Milk and Dairy Product Technology”, 1st Edition, Routlege, UK, 2017.
2. Nurcan Koca., “Technological Approaches for Novel Applications in Dairy Processing”, 1st Edition, InTechOpen,UK, 2018.
3. Datta N., Tomasula P.M., “Emerging Dairy Processing Technologies: Opportunities for the Dairy Industry”, 1st Edition, John Wiley & Sons, US, 2015.
4. Burton H., “Ultra-High-Temperature Processing of Milk and Milk Products”, 1st Edition, Springer Science & Business Media, New York, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the characteristics of milk constituents and its analytical techniques	Understanding(K2)
CO2	Infer the changes in milk due to heat and biotechnological interventions	Understanding (K2)
CO3	identify the advanced methods in dairy processing	Applying (K3)
CO4	make use of advances in Technology for manufacturing dairy products	Applying (K3)
CO5	interpret fouling process and automation in dairy industry	Understanding(K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	3	1	2	2
CO3	3	3	1	1	2
CO4	3	3	1	2	2
CO5	3	3	1	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70	-	-	-	-	100
CAT2	20	60	20	-	-	-	100
CAT3	20	60	20	-	-	-	100
ESE	30	50	20	-	-	-	100

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

22MFE27 - COMPUTATIONAL FLUID DYNAMICS							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamental concepts of CFD applicable for engineering design, simulation and performance analysis.	
Unit - I	**Conservation Laws of Fluid Motion and Boundary Conditions:**	**9**
Introduction to CFD, Governing equations of fluid flow and heat transfer, equations of state, Navier-Stokes equations for Newtonian fluid, conservative form of governing equations of flow, differential and integral forms of general transport equations, classification of physical behaviour, Auxillary conditions for viscous fluid flow equations.		
Unit - II	**Finite Volume Method for Diffusion and Convective- Diffusion Problems:**	**9**
Finite volume method for one-dimensional, two-dimensional and three-dimensional steady state diffusion, steady one-dimensional convection and diffusion, the central differencing scheme. Properties of discretization schemes, assessment of the central differencing scheme for convection-diffusion problems, the upwind differencing scheme, the hybrid differencing scheme, the power-law scheme, higher order differencing schemes for convection-diffusion problems – QUICK scheme.		
Unit - III	**Solution Algorithms for Pressure-Velocity Coupling in Steady Flows:**	**9**
Staggered grid, momentum equations, SIMPLE algorithm, assembly of a complete method, SIMPLER, SIMPLEC, and PISO algorithms; Solution of discretised equations: tri-diagonal matrix algorithm, application of TDMA to two- dimensional and three-dimensional problems.		
Unit - IV	**Finite Volume Method for Unsteady Flows:**	**9**
One-dimensional unsteady state heat conduction, implicit method for two-and three-dimensional problems, discretisation of transient convection-diffusion equation, transient convection-diffusion using QUICK differencing scheme, solution procedures for unsteady flow calculations, steady state calculations using pseudo-transient approach.		
Unit - V	**Turbulence and its Modeling:**	**9**
Transition from laminar to turbulent flow, effect of turbulence on properties of the mean flow, Reynolds-averaged Navier-Stokes equations and classical turbulence models, mixing length model, k-Ɛ model, Reynolds Stress equation models and Advanced turbulence models, Large eddy simulation.		
		Total:45

REFERENCES:

1.	Versteeg H.K., Malalasekara W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”,2nd Edition, Pearson Education Ltd., 2007.
2.	Anderson John D., “Computational Fluid Dynamics - The Basics with Applications”, 1st Edition, Tata-McGraw Hill Publisher, 2012.
3.	H. Lomax T. H. Pulliam D. W. Zingg., “Fundamentals of Computational Fluid Dynamics”, 1st Edition, Springer,2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the laws governing CFD techniques in developing fluid flow models	Applying (K3)
CO2	make use of finite volume method for developing solution for diffusion problems	Applying (K3)
CO3	analyze the problems using different algorithms	Analyzing (K4)
CO4	apply the finite volume method in solving unsteady processes	Applying (K3)
CO5	analyze and apply turbulence models	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1		1
CO2	3	3	1		1
CO3	3	3	1		1
CO4	3	3	1		1
CO5	3	3	1		1

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

ASSESSMENT PATTERN - THEORY

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

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

22MFE28 - INDUSTRIAL PROCESS AUTOMATION							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	The subject imparts knowledge on data acquisition, data analysis, modeling and computer based automation in process industries.	
Unit - I	**Introduction**	**9**
Food quality, automated evaluation of food quality, food quality quantization and process control, problems associated in food quality evaluation and need for process automation.		
Unit - II	**Data acquisition**:	**9**
Sampling, concepts and systems for data acquisition: Ultrasonic A mode, electronic nose, data acquisition for food quality process control, Image acquisition: Ultrasonic B mode, Elastography.		
Unit - III	**Data analysis and Modeling :**	**9**
Data pre-processing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction. Modeling strategies: Theoretical and empirical modeling, Static and dynamic modeling, Linear statistical modeling, ANN modelling.		
Unit - IV	**Computer based controls**	**9**
Computer based measurement and control system- role, basic components, architecture- Human machine Interface, Hardware for computer based process control system, Interface computer system with process, Industrial Applications.		
Unit - V	**Automation in Food Processing**	**9**
General considerations, Packaging, palletizing, and mixed pallet automation, raw product handling and assembly, Decorative product finishing, integrated automation.		
		Total:45

REFERENCES:

1.	Nof, Y.S., “Handbook of Automation”, 1st Edition, Springer Publications, New York, 2009.
2.	Huang, Y., Whittaker, A.D., Lacey, R.E., “Automation for food engineering- Food Quality Quantization and Process Control” 1st Edition, CRC press, Florida, 2001.
3.	Mittal, G.S., “Computerized control systems in food industry”, 1st Edition, Marcel Dekker Inc, New York, USA, 1996.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the role of automation in quality food processing	Understanding (K2)
CO2	explain data acquisition in process automation	Understanding (K2)
CO3	interpret the data analysis and modeling in automation	Evaluating (K5)
CO4	summarize the concept of computer based control in automation	Understanding (K2)
CO5	examine the role of automation in food processing	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	2	1		2
CO3	3	2	1		2
CO4	3	2	1		2
CO5	3	2	1		2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	10	20	40	20	10		100
CAT3	20	40	20	20			100
ESE	10	20	30	30	10		100

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

22MFE29 - PROJECT ENGINEERING AND MANAGEMENT							
Programme & Branch	**M.Tech & Food Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course will provide knowledge on management principles followed in process industries.						
Unit - I	**Principles of Management and Legal aspects of business enterprise:**						**9**
Management and its function: Planning, organizing, coordination and control, Human relations and performance in organization, Human and cultural variables in global organizations. Industrial relations and disputes. Importance and necessity of industrial legislation, Export – Import regulations. Labour laws, Social welfare legalmeasurements, Factory Act.							
Unit - II	**Project identification and process planning:**						**9**
Project definition, Project profile and standards, Feedback information (MIS), Evaluation and Modification, Selection, Criteria. Planning the process, Strategic and Managerial Planning, Organizing the process planning.							
Unit - III	**Project Engineering:**						**9**
Economic Balancing, Network Planning, Methods (PERT/CPM), Engineering Flow Diagrams, Cost requirements, Analysis and Estimation of Process Feasibilities (Technical/Economical) Analysis, Application of reliability theory.							
Unit - IV	**Plant Engineering management:**						**9**
Objectives, Programme, Control, Plant Location and Site Selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Commissioning and Recommissioning, performance appraisal, Strategies choice and Influence, Product planning and development, Provision and maintenance of service facilities.							
Unit - V	**Financial management, Marketing and Sales:**						**9**
Finance: Important, ledger, Journal, Profit and Loss Account, Balance Sheet, Interpretation of Statements, Ration Analysis, Project financing, Project appraisal, return on investments. New Issues in Marketing: Globalization and its impact, Consumerization, Green Marketing and Event Marketing-Sellers and Buyers markets, monopoly, oligopoly,perfect competition, Cost - Elements of Cost, Contribution, Break even analysis, Budgets, Pricing Policies.							
							Total:45

REFERENCES:

1.	Banga, T.R., Agarwal, N.K., Sharma, S.C., “Industrial Engineering and Management Science”, 5th Edition,Khanna Publishers, New Delhi 2007.
2.	Bagad, V.S., “Industrial Management”, 1st edition, Technical Publications, Pune, 2014.
3.	Clements, J. P., Gido.J., “Effective Project Management”, 5th edition, South Western Cengage Learning press,USA, 2012.
4.	Peters, M.S. and Timmerhaus, K.D., “Plant design and economics for chemical engineers, 5th edition, McGrawHill Education”, USA, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the functions of management related to industrial organization and the legalaspects of business enterprises	Understanding(K2)
CO2	identify the projects and meticulously plan the process	Applying (K3)
CO3	explain the significance of various models relevant to project engineering	Understanding(K2)
CO4	outline the importance of project engineering and management	Understanding(K2)
CO5	utilize the knowledge of finance, marketing and sales	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	2	1
CO2	3	1	1		1
CO3	2	2	1		1
CO4	3	1	1	1	1
CO5	2	1	1		1

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

ASSESSMENT PATTERN - THEORY

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

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

22GET13 - INNOVATION, ENTREPRENEURSHIP AND VENTURE DEVELOPMENT							
(Common to ME/MTech and MCA Programmes)							
Programme & Branch	**All ME/MTech and MCA Programmes**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will direct the students on how to employ their innovations towards a successful entrepreneurial venture development.	
Unit – I	**Innovation and Entrepreneurship:**	**9**
Creativity and Innovation – Types of innovation – challenges in innovation- steps in innovation management- Meaning and concept of entrepreneurship - Role of Entrepreneurship in Economic Development - Factors affecting Entrepreneurship – Entrepreneurship vs Intrapreneurship.		
Unit – II	**Design Thinking and Product Design:**	**9**
Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping. Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction.		
Unit – III	**Business Model Canvas (BMC) and Business Plan Preparation:**	**9**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies. Objectives of a Business Plan - Business Planning Process and Preparation.		
Unit – IV	**IPR and Commercialization:**	**9**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing.		
Unit – V	**Venture Planning and Means of Finance:**	**9**
Startup Stages - Forms of Business Ownership - Sources of Finance – Idea Grant – Seed Fund – Angel & Venture Fund – Institutional Support to Entrepreneurs – Bank and Institutional Finance to Entrepreneurs.		
		Total:45

REFERENCES:

1.	Gordon E. & Natarajan K., "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.
2.	Sangeeta Sharma, "Entrepreneurship Development", 1st Edition, PHI Learning Pvt. Ltd., New Delhi, 2017.
3.	Charantimath Poornima M., "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
4.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, "Entrepreneurship", 10th Edition, McGraw Hill, Noida, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the relationship between innovation and entrepreneurship	Understanding (K2)
CO2	understand and employ design thinking process during product design and development	Analyzing (K4)
CO3	develop suitable business models as per the requirement of the customers	Analyzing (K4)
CO4	practice the procedures for protection of their ideas IPR	Applying (K3)
CO5	understand and plan for suitable type of venture and modes of finances	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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