INSTITUTE OF CHEMICAL TECHNOLOGY
Syllabi relating to the Degree of
Master of Technology in Food Engineering and Technology

1. Introduction

The Institute is revamping its academic structure especially for the master's courses by way of introducing the compulsory industrial training for a period of six months (to be taken in the third semester of the program). The number of credits in the first two semesters has also been increased and a research component has been included. The total credits in the first two semesters now stand at 27 each instead of earlier 21. All the courses will continue to be credit based and the evaluation will be grade based.

The Departmental administrative committee and academic program committee periodically proposed the program outcomes having consistency with the graduate attributes available with NBA. The committee critically analysed information obtained from graduated students, employers and immediately passed out students. The program outcomes are as follows:

No.	PROGRAM OUTCOMES (POS)	Level
1	An ability to independently carry out research or investigation and development work to solve practical problems	K5
2	An ability to write and present a substantial technical report or document	K6
3	An ability to demonstrate a degree of mastery over the area of food engineering and technology	K5
4	An ability to use and evaluate modern techniques or tools applied in food processing, analysis and packaging	K5
5	An ability to provide solution to the issues related to nutrition, food safety and regulatory affairs	K4

Credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits may be based on different parameters, such as student workload, learning outcomes and contact hours. It is a student-centric system based on the **student workload** required to achieve the objectives of a programme. It should facilitate academic recognition of the courses and mobility of the students. Credits assignment is based on the principle that Credits can only be obtained after successful completion of the work required and appropriate assessment of the learning outcomes achieved. As per the AICTE norms 2L/week of lectures are 2 credits, while 2h/week of practical/ /seminar/literature review/research work are 1 credit. This has been taken as the basis during the working of the proposed syllabus.

Student workload consists of the time required to complete all prescribed learning activities such as attendance at lectures/practical, seminars, projects, etc. Credits are allocated to all the educational components of a study programme and indicate the quantity of work each component requires to achieve its specific objectives.

Evaluation is an important component of any teaching-learning process. The Institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation of the students. The performance of the student is documented by a **grade** at the end of the semester. The grading scale ranks the students on a statistical basis. Therefore, statistical data on student performance is a prerequisite for applying the grading system.

2. Course Credits

In general a certain quantum of work measured in terms of **credits** is laid down as the requirement for a particular degree. The student acquires credits by passing courses every semester, the amount of credit associated with a course being dependent upon the number of hours of instruction per week in that course.

There are mainly two types of courses in the Institute - lecture courses and laboratory courses. Lecture courses consist of lecture (L) and tutorial (T) hours. Laboratory courses consist of practical (P) hours. The credit (C) for a course is dependent on the number of hours of instruction per week in that course, as given below:

(1) 1h/week of lecture (L) or tutorial (T) = 1 credit
(2) 2h/week of Practical (P) = 1 credit
(3) Credit (C) for a theory course = No. of hours of lectures per week + No. of hours of tutorials per week = L + T
(4) Credits (C) for a Laboratory course/Seminar/research work = ½ x No. of hours per week

Credits will be assigned to In-plant, Seminar, Projects and other mandatory course requirements also and these will be mentioned in the respective syllabi. There may be some non-credit requirements. A student is required to earn credits as mentioned in the syllabus.

3. Evaluation

3.1 The weightages of different modes of assessments shall be as under.

	In-Semester evaluation		End-Semester-Exam	Components of continuous mode
	Continuous mode	Mid Semester-Exam		
Theory	20%	30%	50%	Quizzes, class tests (open or closed book), home assignments, group assignments, *viva-voce* assignments, discussions
Practical	50%	-	50%	Attendance, *viva -voce*, journal, assignments, project, experiments, tests
Seminar/ Research work			100%	Continuous evaluation not applicable, End semester evaluation will be based on written report evaluation and presentation in front of the external examiner within the Department

3.2. In-Semester Evaluation:

a) It is expected that the teacher would conduct at least two assessments (in any form as quizzes, tests, home work, group work etc) under the continuous mode in a Semester.
b) The teacher will announce at the beginning of the respective course the method of conducting the tests under the continuous mode and the assignment of marks
c) In-semester performance of all students should be displayed and sent to the academic office by the teacher at least 15 days before the end-semester examination.
d) For the theory courses, there will be one mid-semester test for each course to be held as per the schedule fixed in the Academic Calendar.
e) For mid –semester examinations in theory papers, duration of examination will be 1 hour for 3 credit courses and 2 hours for 4 credit courses

3.3. End-Semester examination:

a) The semester end examination will cover the full syllabus of the course and will be conducted as per the Institutional time table at the end of each semester.
b) For end –semester examinations in theory papers, duration of examination will be 1 hour for 3 credit courses and 2 hours for 4 credit courses
c) For the end semester evaluation of seminar/research work, student will be expected to submit a written report and also make a presentation. The evaluation will be based on the quality of the written report and presentation.

3.4 Passes and Fail

a) The candidates who obtain 40% and more marks of the total marks of a course head shall be deemed to have **passed** the respective course head.
b) The candidates who obtain marks less than 40% of the total marks of a course head shall be deemed to have **failed** in the respective course head **(Grade FF).**

3.5 Grades:

(a) The performance of a student shall be documented by a **Letter grade.** Each letter grade has a **Grade point** associated with it. The Grades and Grade points shall be assigned to each head of passing and both will be indicated in the mark-list of the semester examination.

(b) The total marks (in-semester + end-semester) of a candidate in a subject head are converted into a letter grade, based on the relative (and sometimes the absolute) performance of the student. For granting class, a grade point of 6.0 and above will be considered equivalent to First class.

Letter Grade	**Grade Point**
AA	10
AB	9
BB	8
BC	7

CC	6.5
CD	6
DD	5.5
EE	5

(c) The grades to be allotted in the case of students who fail or do not appear at the end-semester examination shall be as under.

Letter Grade	**Grade Point**	**Explanation**
FF	0	The candidate fails in course head. The candidate will be allowed to take end-semester repeat or subsequent examinations as per rule.
XX		The candidate has not kept term for the course head due to attendance less than requisite. Further see 3.5(g) below. In the above cases, the candidate has to repeat the respective course by paying the fees.
I	0	The candidate has kept term for the course head, has taken all the internal examinations with satisfactory performance, but has failed to take the end-semester examination or repeat examination due to genuine reasons. The candidate will be allowed to take end-semester repeat or subsequent examinations as per rule.
FR	0	The candidate has exhausted all the permissible chances to clear the end-semester examinations. The candidate has to register for the respective semester again for all the subject heads or will be out of the respective degree course as per the rules.
DR	0	(i) The candidate hasn't participated in academic programme. (ii) The candidate has taken a drop for the subject head; - provided he/she intimates the same (i or ii) at least 7 days in advance of the commencement of the end-semester examination for the respective year.

(d) Grades **FF** and **I** are place-holders only and do not enter into CPI/SPI calculations directly. These grades get converted to one of the regular grades after the end-semester examination.

(e) A candidate with an **FR** grade is not eligible for any repeat examination in that course and has to re-register for that semester by paying the appropriate fees.

(f) **I** grade will not be continued beyond the permissible number of end-semester/repeat examinations.

(g) **'XX' Grade:** The grade **XX** in a course is awarded if – (i) candidate does not maintain the minimum 75% attendance in the Lecture/Tutorial/Practical classes, (ii) candidate receives less than 20% of the combined marks assigned for continuous assessment and mid-semester examination, and (iii) candidate indulges in a misconduct/uses unfair means in the examination, assignments, etc., of a nature serious enough to invite disciplinary action in the opinion of the teacher.

(**Note:** Award of the **XX** grade in the case of g(iii) above shall be done by Disciplinary Action Committee (DAC)).

(h) The names/roll numbers of students to be awarded the **XX** grade should be communicated by the teacher to the Academic office as per academic calendar before the last date of submission of the application for end-semester examination.

3.6. Awarding the grades

The grading scale ranks the students on a statistical basis on the basis of the overall performance of the students of a given class in the given course head. Therefore, statistical data on students' performance is a prerequisite for applying the grading system. While assigning grades in a given course head, it is essential to know the **average marks (AM)** obtained by the students *who have passed the subject head* and the **highest marks (HM)** obtained in the *same subject head*.

3.6.1. If the **average marks (AM)** obtained by the students *who have passed the subject head* is <60%, the interval AM shall be awarded grade CC and the other grades shall be decided as follows:

(i) AA, AB, BB, and BC grades shall be decided between the AM and HM by dividing the range in equal intervals.

(ii) CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

3.6.2. If the **average marks (AM)** obtained by the students *who have passed the subject head* is such that **60% ≤ AM < 70%,** the interval AM shall be awarded grade BC and the other grades shall be decided as follows:

(i) AA, AB, BB grades shall be decided between the AM and HM by dividing the range in equal intervals.

(ii) CC, CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

3.6.3. If the **average marks (AM)** obtained by the students *who have passed the subject head* is **≥ 70%,** the interval AM shall be awarded grade BB and the other grades shall be decided as follows:

(i) AA and AB grades shall be decided between the AM and HM by dividing the range in equal intervals.

(ii) BC CC, CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

4. SPI and CPI

(a) **Semester Performance Index (SPI):** The performance of a student in a semester is indicated by **Semester Performance Index (SPI),** which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SPI is to be calculated upto two decimal places.)
A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{\left(\sum_{i=1}^{n} c_i g_i\right)}{\left(\sum_{i=1}^{n} c_i\right)}$$

Where
'n' is the number of courses for the semester,
'c_i' is the number of credits allotted to a particular course, and
'g_i' is the grade-points awarded to the student for the course based on his performance as per the above table.
SGPA will be rounded off to the second place of decimal and recorded as such.

(b) **Cumulative Performance Index (CPI):** An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating **Cumulative Performance Index (CPI)** of a student. The CPI is weighted average of the grade points obtained in all the courses registered by the student since he entered the Institute. CPI is also calculated at the end of every semester (upto two decimal places).

Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{\left(\sum_{i=1}^{m} c_i g_i\right)}{\left(\sum_{i=1}^{m} c_i\right)}$$

Where
'm' is the total number of courses from the first semester onwards up to and including the semester S,
'c_i' is the number of credits allotted to a particular course, and
'g_i' is the grade-points awarded to the student for the course based on his performance as per the above table.
CGPA will be rounded off to the second place of decimal and recorded as such.

(c) The CGPA, SGPA and the grades obtained in all the subjects in a semester will be communicated to every student at the end of every semester / beginning of the next semester.

(d) **When** a student gets the grade 'FF', or I' in any subject head during a semester, the SGPA and CGPA from that semester onwards will be tentatively calculated, taking only 'zero' grade point for each such 'FF' or 'I' grade. When the 'FF' grade(s) has / have been substituted by better grades after the repeat examination or subsequent semester examination, the SGPA and CGPA will be recomputed and recorded.

5. Repeat End-Semester Examination

5.1. For those candidates who fail in a subject head or are eligible for appearing at the repeat examination, **Repeat End-Semester Examination** will be conducted within one month from the declaration of the results of regular end-semester examination, as per **Regulation R.14**.

5.2. The marks obtained by candidates in the in-semester examinations (continuous assessment and Mid-Semester Examination) will be carried forward in such cases.

5.3. Grading the performance in the Repeat Examination: The grades will be assigned as per 3.5 and 3.6 above. However, for a candidate taking any repeat examination or subsequent regular semester examination or performance improvement examination shall be awarded **one grade lower** than that decided on the basis of the actual marks obtained; provided 'EE' grade obtained in such an examination shall remain 'EE'. For reference see the table below.

Grade obtained in repeat or subsequent end-semester examination	Grade to be assigned	Grade point
AA	AB	9.0
AB	BB	8.0
BB	BC	7.0
BC	CC	6.5
CC	CD	6.0
CD	DD	5.5
DD	EE	5.0
EE	EE	5.0

5.4. Revaluation of end-semester and repeat examination
Candidate's performance in these examinations will be displayed on proper notice board and after 3 days of such display the marks will be sent to the Academic Office. No revaluation of these examinations will be allowed.

6. Passing of a Semester examination

A candidate shall be declared as **'PASSED'** any semester examination if he/she has
(a) Cleared all heads of passing by securing grades EE or higher in all the heads;
(b) Passed all the heads of passing such as project, seminar, training, etc as per the rules;
(c) Satisfactorily completed all the mandatory requirements of the course;
(d) paid all the Institute dues;
(e) No case of indiscipline pending against him/her.

7. Eligibility for the Award of a Degree

A candidate shall be declared eligible for the award of a degree, if he/she has cleared all the semester examinations as given in (6) above.

8. Allowed to keep terms (ATKT)

8.1 A candidate who has I grade in one or more heads of passing of an odd semester of an academic year shall be allowed to keep terms for the respective even semester.

8.2. A candidate shall be allowed to keep terms for the subsequent academic year if he/she has FF or I grades in not more than two heads of passing from all the heads of passing of the two terms of the previous academic year taken together. Such a candidate shall be declared as **FAILED, ATKT**.

9. Repeating a course

9.1 A student is required to repeat the course under the following situations:
(a) A student who gets an **XX, FR, or DR** grade in a course; or
(b) A student has exhausted all permissible chances to clear the course.

9.2 A candidate from first year who remains absent for the regular end-semester examination of a semester and the corresponding repeat examination for **ALL SUBJECTS** shall have to take fresh admission for the corresponding year; unless the candidate has dropped out / terminated from the course.

9.3 If a candidate at the Second, fails to pass any semester examination in not more than 4 consecutive examinations, including the repeat examinations, from the date of registering for the respective year, the candidate shall have to take readmission for the corresponding year again in which the failure has occurred, provided the course is not changed.

10. Improvement of performance

A candidate will be allowed to appear at the **entire examination** after the regular end-semester examination as per the respective rules to improve the performance. In such a case if the result of the examination repeated –

1. Is better than the previous one, the previous result shall be declared null and void; and
2. Is worse than the previous one, the result of the subsequent examination shall not be declared.
3. However, awarding of final grade will be made under the provision of sub clause 5.3 above.

11. Exit rules for poorly performing students

A candidate shall be excluded from a course under the following conditions:

a) If he/she fails to pass any semester examination of the any year of the course in not more than four consecutive attempts (Examination conducted by Institute) from the date of joining the course.
b) If he/she does not keep two consecutive terms without giving any reasonable justification (as prescribed by the institute) for doing so.
c) If a candidate fails to fulfill all the requirements of his/her respective degree within the prescribed period from the date of taking admission to the course, the candidate shall be excluded from the course.

12. Miscellaneous

a) Although CPI will be given in the Semester grade report, the final degree certificate will not mention any **Class** whatsoever.
b) Not withstanding anything said above if a course is revised /restructured then transient provisions applicable at the time of revision /restructuring shall be applicable.

Syllabus Structure- Master's courses 2017-18

BRANCH-Food Engineering and Technology

Semester- I

No.	Contents	Course Code	Subjects	Hours/ Week	Marks	Credits
1.	Core I	FDT 2001	Advances in Food Technology	**(2L+1T)**	**50**	**3**
2.	Core II	FDT 2005	Carbohydrate Chemistry & Technology	**(2L+1T)**	**50**	**3**
3.	Core III	FDT 2008	Comprehensive Techniques in Food Analysis	**(2L+1T)**	**50**	**3**
4.	Elective I	FDT 2021	Food Standards and Safety Regulations	**(2L+1T)**	**50**	**3**
5.	Elective II	FDT 2023	Food Packaging Science and Technology	**(2L+1T)**	**50**	**3**
6.	Practical I	FDP 2014	Food Analysis Lab	**6**	**50**	**3**
7		FDP 2016	Seminar and Critical Review of Research Paper	**6**	**50**	**3**
8		FDP 2017	Research I	**12**	**100**	**6**
TOTAL				**39**	**450**	

Semester- II

No.	Contents	Course Code	Subjects	Hours/ Week	Marks	Credits
1.	Core I	FDT 2004	Advances in Food Engineering	**(2L+1T)**	**50**	**3**
2.	Core II	FDT 2002	Food Safety & Toxicology	**(2L+1T)**	**50**	**3**
3.	Core III	FDT 2003	Advances in Nutrition	**(2L+1T)**	**50**	**3**
4.	Elective I	FDT 2058	Bioprocess Engineering and Technology	**(2L+1T)**	**50**	**3**
5.	Elective II	FDT 2026	Experimental Design and Optimization in Food Processing	**(2L+1T)**	**50**	**3**
6.	Practical II	FDP 2015	Food Process Engineering Lab	**6**	**50**	**3**
7.		FDP 2018	Research II	**18**	**150**	**9**
TOTAL				**39**	**450**	**27**

Semester- III

No.	Course Code	Course	Hours/Week	Marks	Credits
1.	FDP 2019	Industrial training	**40 (15 Weeks)**	**450**	**30**
	TOTAL		**40**	**450**	**30**

Semester- IV

No.	Course Code	Course	Hours/Week	Marks	Credits
1.	FDP 2020	Research III	**40 (15 Weeks)**	**450**	**30**
	TOTAL		**40**	**450**	**30**

LIST OF ELECTIVES

No.	Course Code	Subjects	Credit	Hours/ Week	Marks
1	FDT 2021	Food Standards and Safety Regulations	3	(2L+1T)	50
2	FDT 2023	Food Packaging Science and Technology	3	(2L+1T)	50
3	FDT 2058	Bioprocess Engineering and Technology	3	(2L+1T)	50
4	FDT 2024	Separation Techniques in Food Industry	3	(2L+1T)	50
5	FDT 2025	Food Process and Equipment Design	3	(2L+1T)	50
6	FDT 2026	Experimental Design and Optimization in Food Processing	3	(2L+1T)	50
7	FDT 2027	Supply Chain Management in Food Industry	3	(2L+1T)	50
8	FDT 2022	Advances in Commodity Technology	3	(2L+1T)	50
9	FDT 2077	Enzymes in Food and Feed Industry	3	(2L+1T)	50

SYLLABUS

SEMESTER I

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Core I	FDT 2001	Advances in Food Technology	**3**	**50**	**(30+15)**

Prerequisite

Principles of Food Preservation, Food Engineering, Food Process Engineering

Course Objectives

1. To understand different modes of food preservation methods
2. To understand the processing and design aspects of thermal processing of food
3. To explain the newer techniques in thermal and non-thermal processing of food
4. To explain the effects of different processing methods on the food quality attributes.
5. To describe the recent developments related to food processing

No.	Syllabus	L+T	Related CO
1	Thermal processing principles; Inactivation Kinetics; Process time calculation; Retort processing; UHT; Advances in food processing techniques both thermal and non-thermal. Extrusion	**12+5**	1, 5
2	Ohmic heating, pulsed electric field, high-intensity light pulses, radio-frequency heating, microwave, thermo-sonication, modified atmosphere, enzymic processing and hurdle technology etc.	**5+2**	2, 5
3	Advanced Membrane Technology for water and liquid foods and effluent treatment., dehydration. Freezing, VCRS, Freezing time, Freeze drying	**7+3**	3, 5
4	High hydrostatic processing of foods. Effect on enzymes, microorganisms in various food systems Equipment for batch and continuous processing. Other applications of HPP including thawing	**5+2**	4, 5
5	Recent developments in Food Processing with focus on Indian Industry	**4+2**	5

Course Outcomes (students will be able to….)

1) To analyse different design aspects of thermal processing applied to food (K4).
2) To demonstrate and apply the concepts of non-thermal food processing methods (K3).
3) To solve issues related to membrane, packaging and hurdle technology in food processing (K3).
4) To develop and analyse the efficacies of high-pressure processing to food applications (K4)
5) To infer about recent developments in advanced thermal and non-thermal techniques of food processing (K4)

Books Recommended

- Advances in food and nutrition research by Steve L. Taylor, 2009
- Advances in food research by C.O.Chichester, 1986
- Handbook of food and bioprocess modeling by Sablani S., Rahman M, 2007
- Advances in food processing and technology by Peter Fellows
- Food processing and technology: Principle and practice by P Fellows, Taylor and Francis, 2009

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Core II	FDT 2005	Carbohydrate Chemistry & Technology	**3**	**50**	**(30+15)**

Prerequisite

Basic understanding of the Chemistry of Food Constituents, Food Chemistry

Course Objective

1) To provide the basic understanding of the chemistry of carbohydrates in food
2) To discuss the mechanism of different carbohydrate induced reactions in food systems
3) To highlight the changes in quality attributes of carbohydrate based foods during processing
4) To provide the details of different applications of carbohydrate based polymers for food application

No.	Syllabus	L+T	Related CO
1	Different carbohydrates in food products such as starch, cellulose, sugars, pectin, fibre etc. and their significance in diet	**10+5**	1,2,3
2	Their chemistry & changes in them during processing; Chemical & enzymatic modification; Interactions with other food constituents and their implications	**10+5**	4,5
3	Special application of carbohydrates in gels, emulsions, stabilization of food systems, simulated and low-fat foods, edible packages etc.	**10+5**	3,5

Course Outcomes (students will be able to ...)

1. Classify different types of carbohydrate and highlight their chemistry in specific food (K4)
2. Demonstrate the different composition and functions of carbohydrates specific to food products (K3)
3. Highlight the function and mechanism of carbohydrate-based polymers for food stabilization (K4)
4. Interpret the chemistry & mechanism of different chemical changes within the food involving carbohydrate components (K4)
5. Apply and develop the carbohydrate based formulations for different food applications (K3)

Books Recommended

- Glycochemistry Principles, Synthesis and application by Wang, Peng and George, 2001
- Food Chemistry by Belitz and Grosch, 2004
- Sugar Chemistry by Shallemberger and Birch, 1975
- Advances in carbohydrate chemistry& biochemistry by Derek Horton
- Food chemistry by Meyer, 1974

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Core III	FDT 2008	Comprehensive Techniques in Food Analysis	**3**	**50**	**(30+15)**

Prerequisite

Biochemistry, Food Chemistry, Instrumentation Lab

Course Objectives

1. To comprehend the principles of modern techniques used in food analysis for quality assurance
2. Design labels for food products on the basis of food analysis
3. To develop analytical techniques for on-line monitoring of food quality during processing and storage
4. To ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements
5. To assess the environmental impact of products life from farm to fork.
6. To explain newer and relevant analytical techniques in food systems

No.	Syllabus	L+T	Related CO
1	Analysis of chemical constituents, their characterization and significance; Application of modern techniques including spectroscopy, chromatography including GC, GC –MS, HPLC, HPTLC, gel permeation, ion-exchange, etc.	**10+5**	**1, 2, 3, 5**
2	Enzymes in food analysis; Supercritical fluid extraction in food analysis; Rapid methods for detection of food pathogens, biosensors, automation and use of computers in food analysis	**10+5**	**1, 2, 3, 5**
3	Sensory evaluation – different scales, training, skills and importance for consumer acceptance, Quantification of sensory attributes - Artificial Tongue, Artificial Nose; Life cycle analysis	**10+5**	**1, 3, 4**

Course Outcomes (Students will be able to ...)

1) Demonstrate the basic principles of modern techniques used in food analysis for quality assurance (K3)
2) Infer about labels for food products based on food analysis (K5)
3) Develop analytical techniques for on-line monitoring of food quality during processing and storage (K3)
4) Ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements (K5)
5) Discuss about the newer and relevant analytical techniques in food systems (K4)

Books Recommended

- Introduction to Chemical Analysis of Foods. By Nielsen, S.(Eds), Jones & Bartlett, 1994.
- Spectral method in food analysis by Magdi Mossoba, 1999
- Sensory evaluation technique by Morton C. Meilgaard, 2007
- Sensory evaluation of food: Principle & practices by Harry L. Lawless, Hildegarde, Heymann, 1999
- Food Chemistry by W. Grosch by Belitz, H.D., Grosch, W. 2nd ed., 1999
- Sensory Evaluation of Food by M.O`Mahony,1986

Course Type	Course Code	Subjects	Credit	Marks	Total Hours
Practical	FDP 2014	Food Analysis Lab	**6**	**50**	**15 x 6 hr/week**

Prerequisite

Chemistry of Food Constituents, Technical Analysis, Biochemistry Lab

Course objectives

- To give students hands on training on chemical analysis of specific food products
- To analyse and quantify chemically the quality attributes of food
- To identify adulterants and quality analysis of food
- To train the students on different biochemical assay for food products

No.	Syllabus	No of wk	Related CO
1	Proximate composition in food	2	1, 2, 3
2	Analysis of milk and dairy products & Detection of adulterants in milk (liquid)	2	1, 2, 3
3	Analysis of wheat flour; Determination of damaged starch from whole wheat flour	2	1, 2, 3
4	Analysis of tea and coffee	2	1, 2, 3
5	Estimation of phenolics, antioxidant activity, chlorophyll and carotenoids	2	1, 2, 3, 4
6	Analysis of Food adulteration with respect to specific foods dairy, cereal, muscles food etc.	1	1, 2, 3
7	Microbial and Enzyme assay	2	2, 4
8	Discriminative and Descriptive Sensory analysis of Foods	1	3
9	Demo of colorimeter, texture analyzer, DSC, HPLC, GC-MS etc.	1	2, 3

Course Outcomes (students will be able to.....)

1) Demonstrate the knowledge of redox chemical reactions to develop a protocol for analysing specific food attributes (K4)
2) Interpret different chemical and biochemical analysis specific to food (K4)
3) Compare protocols on different types of chemical and sensory analysis in foods (K5)
4) Apply and infer about the principles of different enzyme and vitamin assays (K4)

Books Recommended

- AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities
- Kirk, RS and Sawyer, R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Harlow, UK, Longman Scientific and Technical.
- Leo ML.2004. Handbook of Food Analysis. 2nd Edition. Vol 1,2 and 3, Marcel Dekker.
- Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2016	Seminar and Critical Review of Research Paper	**3**	**50**	**6h/week 90 hours**

Unit No.	Syllabus	Time
1	Each Student will conduct literature survey, collect full papers, reviews, book chapters etc. and prepare presentation and written review report on the given seminar topic. Oral presentation and written report of the seminar will be evaluated for 2 credits.	**4h/week 60 hours**
2	One original research paper from the same topic will be specified by the teacher for critical review in depth. Separate presentation and critical review report of 1 paper will have to be done and will be evaluated for 1 credit.	**2h/week 30 hours**
	Course Outcomes (students will be able to.....) 1. Develop critical thinking regarding the research paper given (K5) 2. Analyse different literature sources about a certain topic (K4) 3. Comment on others' work in terms of the scientific content, novelty and correctness of published work (K5) 4. Evaluate the research methodologies, data analysis and interpretation (K5) 5. Develop skills for presentation and writing scientific documents (K6)	

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2017	Research I	**6**	**100**	**12h/wk 180h**

Unit No.	Syllabus	Time
1	**Project Proposal Preparation** - Teachers will communicate various research project topics to all the students based on interest and facilities available and relevance to the area of Food Engineering and technology. - Each student based on his/her interest and merit selects the research topic and is allotted a supervisor. - Review of literature, formulation of research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, conducting preliminary experimental trials, data generation and analysis. - Oral presentation of proposed research work with initial data generated being shown	**12h/week 180 hours**
	Course Outcomes (students will be able to.....) 1. Develop critical thinking to identify the research gap for the project (K5) 2. Formulate a scientific question and approach to solve it (K6) 3. Plan the experimental methodology for the project (K5) 4. Develop skills to communicate the research plan effectively (K6) 5. Develop skills for writing scientific documents (K6)	

SEMESTER II

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Core I	FDT 2004	Advances in Food Engineering	**3**	**50**	**(30+15)**

Prerequisite

Advances in Food Technology, Food Engineering, Food Process Engineering

Course Objectives

1. To apply the concept of conservation of mass and energy as a basic tool in food engineering analysis.
2. To apply the mechanism of transport phenomenon in food processing operations
3. To apply engineering principles to design process and equipment for food processing.

No.	Syllabus	L+T	Related CO
1	Application of Transport Phenomena for food systems. Unsteady state Heat Transfer with phase change. Heat transfer during freezing and thawing.	**10+5**	**1, 2**
2	Flow profile and behavior of non Newtonian fluids; Flow under packed and fluidized bed; Rheology of dough with special reference to wheat.	**5+2**	**3**
3	Process and Equipment design aspects of evaporators, advanced dryers, freezers, cold storage. FFS, Vacuum and other packaging machines. Materials used for food processing equipment and corrosion control.	**10+5**	**4, 5**
4	Plant lay out, process control and optimization, Flow sheet development with material and energy balance, preliminary project costing	**5+2**	**1**

Course Outcomes (students will be able to….)

1) Perform and analyse simultaneous material and energy balances in food processes (K4)
2) Demonstrate the concept of heat and mass transfer in food processing and its integration to actual process design (K4)
3) Analyse the complexity of fluid flow problems associated with food operations (K4)
4) Design and estimate the performance of food processing equipment (K5)
5) Interpret the properties of materials used for food processing equipment and corrosion control (K5)

Books Recommended

- Food Engineering Operations by Brennan J.G, 1976
- Fundamentals of food process engineering by Romeo Toledo, 1999
- Engineering Properties of Foods by Rao MA and Rizvi SSH, 1986
- Elements of Food Engineering by Watson EL and Harper JC, 1989
- Food Process Engineering by Heldman DR and Singh RP, 1984
- Food Engg. Fundamentals by J. Clair Batty, 1983

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Core II	FDT 2002	Food Safety and Toxicology	**3**	**50**	**(30+15)**

No.	Syllabus	L+T
1	Types of food hazards: biological, chemical and physical; Risk assessment; Existing and emerging pathogens due to globalisation of food trade; Newer systems of safety evaluation such as HACCP	**10+5**
2	Testing of food ingredients & additives; Animal studies including LD50; Ames test for teratogenicity; Natural toxic constituents in plant foods; Shellfish poisoning; Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods and pyrolysis, pesticides and herbicides	**10+5**
3	Intentional and unintentional additives; Toxicity due to microbial toxins including botulinum and staphylococcal toxins, mycotoxin and due to other food pathogens; Food allergy and intolerance; Detoxication strategy	**10+5**

Course Outcomes (students will be able to….)

- Analyze different types of hazards associated with foods and risk assessment for the hazards and safety evaluation systems (K4)
- Explain the principles of toxicity testing in foods, role of additives in toxicity, and define sources of food allergens (K4)
- Analyze the action of different toxic compounds of chemical and biological origin (K4)
- Interpret the mechanisms of action of various microbial toxins in foods (K5)
- Suggest appropriate detoxification strategies for microbial toxins (K5)

Books Recommended

- Handbook of food toxicology by S. S. Deshpande
- Nutritional and safety aspects of food processing by Tannenbaum SR
- Microbiological safety of food by Hobbs BC, 1973,
- Chemical toxicology of food by Galli, C.L, 1978
- Principle method of toxicology by Andrew Wallace Hayes, 2001
- Food toxicology by William Helferich, Karl Winter, 2001
- The food safety information handbook by Cynthia A. Robert, 2009

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2003	Advances in Nutrition	**3**	**50**	**(30+15)**

No.	Syllabus	L+T
1	Recent advances in biochemistry of food metabolism and nutritional aspects of foods; Nutritional requirements of special group of people such as aged, infants, pregnant & lactating mothers, patients etc.	**10+5**
2	Therapeutic nutrition & formulation of special dietary foods; Relation of food and diseases; Deficiencies of essential nutrients; Assessment of nutritional status & RDA; Effect of processing on nutrients; Functional foods and nutraceuticals with attributes to control cardiovascular diseases, cancer, obesity, ageing etc.	**10+5**
3	Food components and nutrients affecting immune systems, behaviour and performance; Functional aspects of dietary fibre, amino acids & peptides, lactic acid bacteria, antioxidants, vitamins, fatty acids etc.	**10+5**

Course Outcomes (students will be able to….)

- Highlight the emerging areas of biochemistry of food metabolism and nutrition (K4)
- Interpret the nutritional needs as a lifecycle approach (K5)
- Evaluate the impact of processing, storage, interactions and fortification on nutritional quality of food (K5)
- Analyze the role of diet in disease management and special nutritional needs (K4)
- Interpret the role of functional aspects of food components and nutrients affecting immune systems (K5)

Books Recommended

- Advances in food and nutrition research by Steve L. Taylor
- Human nutrition by Alfin-Slater, 1979,
- Human nutrition by Burton, BT, 1976,
- Food, Nutrition and Diet Therapy by Krause and Mahan 1996,
- Modern Nutrition in Health & Disease by Young & Shils.

Course Type	Course Code	Subjects	Credit	Marks	Total Hours
Practical	FDP 2015	Food Process Engineering Lab	**6**	**50**	**15 x 6 hr/week**

Prerequisite
Advanced Food Technology, Food Processing

Course Objectives

1. To apply the food processing principles to develop a process for a food product.
2. To develop hands- on experience on different mechanical operations in food processes
3. To develop hand on experiences on different types of thermal operations in food process
4. Ability to analyze the integration of processing in food formulations

No.	Syllabus	No of wk	Related CO
1	Milling, Particle size reduction and sieve analysis of cereal and wheat flour	2	1, 4
2	Homogenization, Rheological Study and mixing index in a food mixture	2	1, 4
3	Kinetics in thermal process design: Retort processing & pasteurization of liquid food	2	1, 4
4	Effect of process and product parameters on baking of bread & biscuit	2	2, 3, 4
5	Effect of Process and product parameters on quality of fruit products	2	2, 3, 4
6	Effect of Process and product parameters on quality of dairy products	1	2,3, 4
7	Effect of material and air properties on tray & spray drying of food materials	2	3, 4
8	Non-thermal processing of food	1	1, 2
9	Study of extraction of oleoresins from spices using liquid carbon dioxide	1	1, 2

Course Outcomes (students will be able to…..)

1) Estimate the efficacy of different unit operations in developing a process specific to food (K5)
2) Analyse the effect of different process variables on the quality of food product (K4)
3) Analyse the effect of compositional variables on quality of food products (K4)
4) Design and develop the food process and products using the experimental design concept (K6)

Books Recommended

- Fuller, G.W. (2011). New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, UK.
- Barbosa-Cánovas, G. V., Ma, L., & Barletta, B. J. (1997). Food Engg Laboratory Manual. CRC Press. UK
- Ibarz, A., & Barbosa-Canovas, G. V. (2002). Unit Operations in Food Engineering. CRC Press, UK.

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2018	Research II	**9**	**150**	**18h/wk 270h**

Unit No.	Syllabus	Time
1	The topic of the research with defined objectives and hypothesis should be explored by scientifically planned rational experiments. Students should have actual experimental data collected on the chosen research topic.	**12h/week 180 hours**
2	Oral presentation of proposed research work with data generated during actual trial targeted towards the objectives Submission of report of research proposal	**6h/week 90 hours**

Course Outcomes (students will be able to…..)

1. Perform various experiments and troubleshoot the methods in order to generate reliable data (K5)
2. Apply different statistical tools for scientific data analysis (K4)
3. Evaluate critically the experimental data and draw meaningful inferences (K5)
4. Develop skills to communicate scientific results effectively (K6)
5. Develop skills for writing scientific documents (K6)

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2019	Industrial Training	**30**	**450**	**40 h/week (15 weeks)**

Course Outcomes (students will be able to.....)

1. Develop critical thinking regarding the various operations involved in food industry (K5)
2. Develop skills to address and solve certain industrial challenges in food processes (K6)
3. Develop skills for presentation and writing scientific documents (K6)

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2020	Research III	**30**	**450**	**40 h/week (15 weeks)**

Course Outcomes (students will be able to.....)

1. Perform experiments systematically to accomplish the set objectives (K3)
2. Evaluate critically the experimental data and draw meaningful inferences (K5)
3. Develop skills to defend own research effectively (K6)
4. Develop skills for writing scientific documents (K6)

ELECTIVES

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2021	Food Standards and Safety Regulations	**3**	**50**	**(30+15)**

Prerequisite

Basic understanding of the Chemistry of Food Constituents, Food Processing

Course Objective

1) To explain the functional role and safety issues of food contaminants, food adulteration,
2) To describe the hygiene and sanitation in food processing plant, equipment, storage and handling
3) To explain the various quality attributes of food and emphasizing on microbial quality control in food and water quality
4) To identify and analyze the critical quality control point in different stages of production of food and thereby designing the HACCP system

No.	Syllabus	L+T	Related CO
1	Salient features of Food Safety & Standards Act, 2006, Structure of FSSAI, Administrative set up at the State level. Roles and Responsibilities of diff. Food safety Regulators, Food Safety Commissioner, Designated Officer, Food safety Officer, Adjudicating Officer Licensing and registration, Licenses to be granted by Central Licensing Authority, Documents/ Format required for Registration/ Licensing	**5+3**	**1, 5**
2	Introduction to Food Safety, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling (Packaging types, understanding labelling rules & Regulations, Nutritional labelling, labelling requirements for pre-packaged food as per CODEX)	**5+2**	**1, 2, 5**
3	Organic food, Identifying Organic foods, Advantages, The Organic Certification Process, Organic Food labeling, GM food,Why are GM food produced, Main issues of concern for Human Health, How are GM Food regulated Internationally, Regulation in India.	**5+3**	**1, 4**
4	Role of WHO to improve evaluation of GM food, Benefits & Controversies, Irradiated Food, Labelling of Irradiated Food. Freeze dried food, Functional Foods & Nutraceuticals, Functional foods from plant sources, animal sources, dietary supplements, Regulation. World Trade Organization (WTO), Principles of trading system. SPS and TBT, Differences between SPS & TBT. WTO agreement on the application of SPS measures. Food & Agriculture Organization (FAO)	**5+2**	**1, 5**
5	FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC); Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.	**5+3**	**1, 5**
6	Need for Food analysis, Accreditation of Food Laboratory, Referral labs. Risk analysis and management in food safety, What is food surveillance, Steps to be taken for reporting and dealing with food incidents. Food alerts. Offences in food, Trials (Case Study)and procedure to launch prosecution	**5+2**	**2, 3, 4**

Course Outcomes (students will be able to…..)

1) Demonstrate the functional role and safety issues of food contaminants, adulteration, additives, packaging & labelling (K3).
2) Evaluate the hygiene and sanitation condition in food processing plant, equipment, storage and handling (K5)
3) Analyse the issues on microbial quality control of food and water in Food Processing Industry (K4)
4) Identify and analyse the critical quality control point for organic and GM food and thereby designing the HACCP system (K4)
5) Interpret the role, standard and law set by Indian and global regulatory authorities with respect to food quality control (K5)

Books Recommended

- Environmental regulation and food safety by Veena Jha.
- Microbiological safety of food by Hobbs, 1973
- Emerging technologies; food process by Da-wen, 2005
- Food safety by Laura K Egendorf, 2000
- International standards of food safety by Naomi Rees, David Watson, 2000
- Codex alimentarius by FAO & WHO, 2007

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Core III	FDT 2023	Food Packaging Science and Technology	**3**	**50**	**(30+15)**

No.	Syllabus	L+T
1	Introduction to food packaging, causes of food spoilage, Packaging as a method for preservation of foods; functions of food packaging, levels of packaging, different materials used in food packaging such as paper, board, glass, metal containers, aluminium foil, plastics, composites, traditional materials and their physico –chemical characteristics, additives used in packaging materials, packaging applications for various food commodities	**10+5**
2	Testing of various packaging materials and packages for evaluation of quality, for identification, for evaluation of performance (barrier and strength properties) for transport worthiness, for biodegradability, for migration etc; Package design; Cushioning materials; Criteria for selection of packaging materials and package design for food products; shelf life testing of packaged foods; food labeling	**10+5**
3	Packaging materials for newer techniques like radiation processing, microwave and radiowave processing, high pressure processing, CAP/ MAP and thermal processing as retortable pouches, aseptic packaging; biodegradable packaging; active packaging; intelligent packaging; migration; flavor scalping, application of nanotechnology in food packaging, environmental concerns and life cycle assessment	**10+5**

Course Outcomes (students will be able to…..)

1. Highlight about food packaging as a method of food preservation (K4)
2. Interpret the role of different packaging materials and their physico-chemical properties (K5)
3. Establish the concepts of quality evaluation and testing of packaging materials (K4)
4. Asses the criteria for selecting a packaging material for a specific application (K5)
5. Develop the packaging materials suitable for newer processing techniques (K6)

Books Recommended

- Modern food packaging, Indian Institute of Packaging, 1998
- Profile on food packaging/C.F.T.R.I and Indian Institute of packaging, 1995.
- Food packaging and preservation by M.Malthlouthi, 1994
- Food and Packaging Interactions by Risch.S.H. 1991
- Handbook of Food Packaging by F.A. Paine and H.Y. Paine 1983
- Food Packaging Technology (Vol.1 & 2) by G. Bureau and J.L.Multon, 1996

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2058	Bioprocess Engineering and Technology	**3**	**50**	**(30+15)**

Prerequisite
Fundamentals of Food Process Engineering

Course Objective

1) To explain the basic principles of biochemical engineering and microbial growth kinetics
2) To describe the design aspects of bioreactor including the upstream and downstream processing
3) To describe the applications of microbial technology in food processing and biorefineries
4) To apply the biotechnological concept in the production of biologicals

No.	Syllabus	L+T	Related CO
1	**Basic principles of Biochemical engineering** Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.	**4+2**	**1**
2	**Stoichiometry and Models of Microbial Growth** Elemental balance equations; metabolic coupling; yield coefficients; unstructured models of microbial growth; structured models of microbial growth	**4+2**	**2**
3	**Bioreactor Design and Analysis** Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformations; immobilized cell systems; large scale animal and plant cell cultivation; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.	**8+4**	**3**
4	**Downstream Processing and Process Economics** Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging. Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media: sterilization, heating and cooling; aeration and agitation; batch-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.	**4+2**	**4**
5	**Applications of Microbial Technology in food processing and biorefineries** Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria: production and applications in food preservation; biofuels and biorefinery; production of antibiotics in a reactor; single cell protein; probiotics and prebiotics.	**5+3**	**5**
6	**Applications of Biotechnology in the production of biologicals** Industrial production of penicillin via fungal route, insulin from recombinant E. coli; Production of metabolites such as shikonin using plant cell culture, astaxanthin from algae, and biotransformation routes for novel/specialty chemicals; Production of HBsAg using yeast cultures, erythropoietin using CHO cells, monoclonal antibodies such as Humira using mammalian cells.	**5+2**	**5**

Course Outcomes (students will be able to…..)

1) Demonstrate the concept of microbial kinetics in biochemical engineering (K3)
2) Apply the concept of stoichiometry in the modelling of microbial growth (K3)
3) Design and analyse different bioreactor systems and their components (K4)
4) Apply the principles of different upstream and downstream processes involved in bioprocesses (K3)
5) Apply the concept of microbial technologies in food processing and biorefineries as well as production of biologicals (K3)

Books Recommended

- Shuler, M. L., & Kargi, F. (2002). Bioprocess engineering: Basic concepts. Upper Saddle River, NJ: Prentice Hall.
- Stanbury, P. F., & Whitaker, A. (1997). Principles of fermentation technology.Oxford: Pergamon Press.
- Pauline Doran (1995) Bioprocess engineering principles. Elsevier Science & Technology Books
- Mansi EMTEL, Bryce CFA. Fermentation Microbiology and Biotechnology, Taylor & Francis Ltd, UK, 2007
- Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). Bioseparations Science and Engineering. 2nd Edition. Oxford University Press.

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2025	Food Process and Equipment Design	**3**	**50**	**(30+15)**

Prerequisite
Food Engineering, Food Process Engineering

Course Objective

1) To explain the basic design consideration for food plant and equipment
2) To describe the design criteria for different unit operations involved in food processing
3) To design and analyse different food equipment and processes

No.	Syllabus	L+T	Related CO
1	Physical properties of food materials and energy balance calculations for preliminary estimation of plant; capacity and equipment sizes. Preparation of flow sheets for material movement and utility consumption in food plant. Design considerations for location of food plant; Equipment layout and ventilation in food process plants.	4+2	1
2	Materials of construction : welding and machining of stainless steel; Design of storage vessels for liquid food and grains; Pressure vessels design and design of vessel for drum drying; Design of fluid conveyance system; pipe, sanitary pipe fitting and valves; Performance characteristics and selection of centrifugal and positive displacement sanitary pumps.	8+4	2, 4
3	Design of CIP system; Design of heat exchanger equipment-plate, scraped surface and extended surface for heating and cooling of gas and liquid. Design of evaporator calandria, vapour separator and condenser, Bulk milk cooler; Advanced dryer system;	10+5	3, 5
4	Design aspects of different mechanical operations like homogenization, extrusion, filtration, differential settling, size reduction applied for food processes	8+4	4

Course Outcomes (students will be able to…..)

1) Apply the concept of material and energy balances, flow sheet and plant layout in designing the food processes (K4)
2) Describe the applicability of different materials of construction, and design criteria for pumps, storage and pressure vessel. (K4)
3) Design different CIP system specific to food processes (K3)
4) Design the equipment and mechanical operations required for specific food processes (K4)
5) Design the equipment required for different thermal processes in food (K4)

Books Recommended

- Handbook of Food Engineering, Dennis R. Heldman,Daryl B. Lund,Christina Sabliov, 2006
- Food Process Design, Zacharias B. Maroulis, George D. Saravacos, CRC Press, 2013
- Processing and Conveying Equipment Design. Phirke P.S. (2004), Publisher-Jain Brothers, New Delhi
- Food Processing Operations Analysis, H. Das, Asian Books Private Limited, 2005

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2026	Experimental Design and Optimization in Food Processing	**3**	**50**	**(30+15)**

Prerequisite
Engineering Mathematics, Statistics

Course Objective

1) To explain the basic concept of experimental design in food processes
2) To describe the concept of mathematical modelling in food systems
3) To familiarize students with different statistical analysis and optimization methods applied for food processing

No.	Syllabus	L+T	Related CO
1	Identification of design, operating and performance parameters in different food processing operations; Statistical tests; significance tests (t-tests, z-test, chi square test); Analysis of Variance (one way & two way), hypothesis testing.	7+3	1
2	Concept of Experimental Design: Factorial (Full and mixed), fractional factorial and rotatable central composite, face centered composite experimental design. Response surface methodology; Numerical optimization	5+3	2
3	Developing mathematical relationship between the independent and dependent variables affecting the food processing operations. Developing empirical equations using experimental data.	8+2	3
4	Predictive modelling using Neural network. Application of Genetic algorithm in process optimization; Fuzzy logic for descriptive sensory analysis and ranking of foods.	7+5	4
5	Multivariate statistical analysis; MANOVA; Principal component analysis; Multiple linear and non-linear regressions; Cluster analysis; Partial least square regression	3+2	5

Course Outcomes (students will be able to…..)

1) Analyse different the statistical tests and hypothesis testing methods used in food processes (K4)
2) Apply the concept of experimental design in different food processes (K3)
3) Develop empirical equation using experimental data (K6)
4) Evaluate different types of optimization techniques in food processing (K5)
5) Apply multivariate analysis on a data set (K3)

Books Recommended

- Food Processing Operations Analysis, H. Das, Asian Books Private Limited, 2005
- Design and Analysis of Experiments, Douglas Montgomery, 2001
- An Introduction to Neural Networks, Kevin Gurney, 1997