VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus

M.Tech., FOOD TECHNOLOGY (FDT)

(Effective from the Academic year 2022-23)

@# 03112023

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., FOOD TECHNOLOGY (FDT)
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22FDT11	Mathematical Modelling and Analysis In Food Technology	03	00	00	03	50	50	100	3
2	IPCC	22FDT12	Food Process Engineering-I +Lab	03	02	00	03	50	50	100	4
3	PCC	22FDT13	Food Microbiology	03	00	02	03	50	50	100	4
4	PCC	22FDT14	Food Chemistry	02	00	02	03	50	50	100	3
5	PCC	22FDT15	Food Packaging and Storage Engineering	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22FDTL17	Food Processing Laboratory	01	02	00	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	BOS Recommended ONLINE Courses (Annexure)	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course,
AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

@# 03112023

with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs. **Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	22FDT21	Fruit, Vegetable, and Milk process technology	02	00	02	03	50	50	100	3
2	IPCC	22FDT22	Food process engineering-II	03	02	00	03	50	50	100	4
3	PEC	22FDT23 x	Professional elective 1	02	00	02	03	50	50	100	3
4	PEC	22FDT24x	Professional elective 2	02	00	02	03	50	50	100	3
5	MPS	22FDT25	Mini Project with Seminar	00	04	02	--	100	--	100	3
6	PCCL	22FDTL26	Food Analysis and Quality Control Laboratory	01	02	00	03	50	50	100	02
7	AUD/AEC	22AUD27	Suggested ONLINE courses (Annexure)	Classes and evaluation procedures are as per the policy of the online course providers.							PP
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**18**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab,

Professional Elective 1		Professional Elective 2	
Course Code under 22FDT23X	**Course title**	**Course Code under 22FDT24X**	**Course title**
22FDT231	Grain Processing and Baking Technology	22FDT241	Functional Foods and Nutraceuticals
22FDT232	Sugar, Protein and Oil Technology	22FDT242	Enzyme and Fermentation Technology
22FDT233	Microbial Biotechnology	22FDT243	Livestock, Fish and Marine Products Processing
22FDT234	Food Product Development	22FDT244	Food Industry Byproduct and Waste Management
22FDT235	Water and Beverage Technology	22FDT245	Food Separation Engineering

Note:

1 Mini Project with Seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course.

2. Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	22FDT31	Food Laws, Regulations and Certifications	03	00	02	03	50	50	100	4
2	PEC	22FDT32X	Professional Elective 3	03	00	00	03	50	50	100	3
3	PEC	22FDT33X	Professional Elective 4	03	00	00	03	50	50	100	3
4	PROJ	22FDT34	Project Work Phase -1	00	06	00	--	100	--	100	3
5	SP	22FDT35	Societal Project	00	06	00	--	100	--	100	3
6	INT	22FDTI36	Internship	(06 weeks Internship Completed during the intervening vacation of II and III semesters.)			03	50	50	100	6
TOTAL				**09**	**12**	**03**	**12**	**400**	**200**	**600**	**22**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Professional elective 3		Professional elective 4	
Course Code under 22FDT32X	**Course title**	**Course Code under 22FDT33X**	**Course title**
22FDT321	Plantation Products and Spices Technology	22FDT331	Food Business Management and Entrepreneurship Development
22FDT322	Process Control and Instrumentation in Food Industry	22FDT332	Nanotechnology in Food Industry
22FDT323	Agricultural Biotechnology	22FDT333	Food Allergies and Allergens
22FDT324	Biosafety And Bioethics	22FDT334	Biomaterials and Applications
22FDT325	Biochemistry And Human Nutrition	22FDT335	Biosensors and Applications

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

3. Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	22FDT41	Project work phase -2	--	08	03	100	100	200	18
			TOTAL	--	**08**	**03**	**100**	**100**	**200**	**18**

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Semester- I

Mathematical Modelling and Analysis In Food Technology (BSC)			
Course Code	22FDT11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn different errors and to solve problems in engineering
- To Learn numerical and statistical methods required for analyzing and interpretation
- To learn curve fitting and probability distribution for data analysis
- To Learn the analysis of variance of the statistical data through ANOVA
- To evaluate the sensory attributes of food samples by applying fuzzy logic and evaluate processing parameters using genetic algorithms and neural networking

Module-1

INTRODUCTION

Error definition, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
ROOTS OF EQUATIONS: False position method, Newton-Raphson method, Horner's Method. Developing mathematical relationship between the independent and dependent variables affecting the food processing operations by using physical and chemical principles governing the process.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
Probability distributions: Binomial, Poisson, Normal Sampling Theory: Testing of hypothesis using t and X2 test, Goodness of fit.	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

	Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
F-TEST, ANALYSIS OF VARIANCE: One – way with/without interactions, problems related to ANOVA, Design of experiments, RBD. Statistics: Correlation and Regression analysis.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
APPLICATION Application of fuzzy logic to sensory evaluation and ranking of food, predictive model using neural network, optimization of processing parameters using genetic algorithms	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Process	presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

2. Miller and Miller (2005) Statistics and Chemometrics for Analytical Chemistry (Pearson Education Ltd, Harlow) 5th Edition.
3. Food process operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
4. Neural network modeling of end-over-end thermal processing of particulates in viscous fluids. Yang Meng and Hosahalli S. Ramaswamy, Journal of food process engineering, ISSN:1745-4530, 33:23-47, 2010
5. Fundamental of Food Process Engineering. Romeo T. Toledo, Springer. 3rd Edition, 2007
6. Numerical Methods for Engineers. Steven C Chapra and Raymond P Canale, McGraw-Hill,6th Edition, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/111107113
- https://archive.nptel.ac.in/courses/102/106/102106051/ https://onlinecourses.nptel.ac.in/noc22_ma20/preview
- https://archive.nptel.ac.in/courses/126/105/126105015/
- https://onlinecourses.nptel.ac.in/noc22_ma33/preview

Skill Development Activities Suggested

- Sensory data Analysis
- Comparing fuzzy logic and simple mathematical calculations for the sensory evaluation of food samples
- AV presentation by students (on specific topics).
- Discussion of case studies based on research findings.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand different errors and engineering problem solving	L1, L2, L3, L4
CO2	Learn numerical and statistical methods required for analyzing and interpretation	L1, L2, L3, L4
CO3	do curve fitting and probability distribution for data analysis	L1, L2, L3, L4
CO4	Learn analysis of variance of the statistical data through ANOVA	L1, L2, L3, L4
CO5	evaluate the sensory attributes of food samples by applying fuzzy logic and evaluate processing parameters using genetic algorithms and neural networking	L1, L2, L3, L4,L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and	5

Mapping of COS and POs

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

Semester - I

Food Process Engineering-I +Lab (IPCC)			
Course Code	**22FDT12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- To understand food properties and food processing at ambient temperature
- To apply food processing methods at ambient temperature
- To apply and analyze heat removal methods for food processing
- To understand heat processing for food applications
- To apply and evaluate heat application methods for food processing

MODULE-1

Properties of Foods & Food Processing at ambient temperature I

Properties of Foods: Composition, Physical, Rheological and biochemical properties, Sensory characteristics, Nutritional quality Food Processing at ambient-temperature: Raw Food Processing- Cooling crops and carcasses; Cleaning- wet and dry cleaning; Sorting and grading- shape and size sorting, weight sorting, colour and machine vision sorting and grading; Peeling Reduction of Size- Solid foods- Theory, equipment, developments in size reduction technology, effects on foods and microbes; Liquid foods- Theory, emulsifying agents and stabilizers, equipment, effect on foods and microbes

Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Learning Process	Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology related problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
MODULE-2	
Food Processing at ambient temperature II Mixing and Forming- Mixing-Theories of solids and liquids mixing, equipment, effect on foods and microorganisms; Forming- Bread moulders, pie, tart and biscuit formers, confectionery moulders and depositors Separation and Concentration of components of Food: Theory and equipment for Centrifugation, Filtration and Expression; Solvent Extraction- Theory, solvents, supercritical CO2, Equipment; Membrane concentration- theory, equipment and applications, types of membrane system, effect on foods and microorganisms	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Food processing by heat removal Chilling and modified atmospheres- theory-refrigeration, modified atmospheres; equipment- mechanical refrigerators, cryogenic chilling, cold storage, temperature monitoring, modified and controlled atmospheric storage; applications- fresh and processed foods; effects on sensory and nutritional qualities of foods & microbes Freezing- theory- ice crystal formation, solute concentration, freezing time calculation, thawing; equipment- mechanical freezers, cryogenic freezers, new developments in freezing, frozen storage, thawing; effect on foods- freezing, frozen storage and thawing; effect on microbes Freeze drying- Theory, equipment and effect on foods and microbes; Freeze concentration- Theory, equipment and effect on foods and microbes	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
MODULE-4	

Food Processing by heat application Heat Processing – Theory- Thermal properties of foods, heat transfer; Heat sources and application methods- direct and indirect heating methods, energy use and methods to reduce energy consumption, types of heat exchangers; Effect of heat on microbes, enzymes, nutritional and sensory characteristics of food	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
MODULE 5	
Food Processing by heat application Processing by heat using steam or water: Blanching- Theory, Equipment- steam blanchers, hot water blanchers, new blanching methods, effect on food and microbes;Pasteurisation- Theory, Equipment- pasteurization of packaged and unpackaged foods, effect on foods; Sterilization by heat- In container sterilization- theory, retorting, equipment, Ultra high temperature (UHT)/aseptic processes- theory, processing, equipment, effect on foodcanning, UHT processing; Evaporation- theory, improvement of evaporation economics, equipment, effect on foods and microbes; Distillation- theory, equipment, effect on foods and microbes; Extrusion- theory of extrusion cooking- ingredient properties, operating characteristics of extruder; equipment- single and twin screw extruders, control of extruders; food applications- confectionery, cereal and protein based products; effects on sensory characteristics and nutritional	

value of foods & microorganisms	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Measuring different physical properties of foods
2	Milling operations
3	Batch sedimentation
4	Solvent extraction
5	Rotary vacuum evaporation
6	Blanching operations
7	Pasteurization of juice

8	Freeze drying operations
9	Drying experiment using hot air oven (Demonstration Experiments For CIE)
10	Sterilization of food material (Demonstration Experiments For CIE)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks**

Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**

Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for**

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009

2. Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4th Edition, 2009

3. Fundamentals of food engineering. D.G. Rao, PHI Leraning Private Limited, New Delhi, 2010

4. Food process engineering and technology. Zeki Berk, 1st edition, 2009, CRC Press, New York

5. Trends in Food Engineering. Jorge E. Lozano, Cristina Anon, Gustavo V. Barbosa-Canovas, Efren Parada-Arias, CRC Press; 1st Edition, 2000

6.Novel Food Processing Technologies (Food Science and Technology Series). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, 1st Edition, 2004

7.Minimal Processing Technologies in the Food Industry. Thomas Ohlsson and Nils Woodhead Publishing Limited, 1st Edition, 2002

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/126/105/126105011/
2. https://archive.nptel.ac.in/courses/126/105/126105015/
3. https://onlinecourses.nptel.ac.in/noc22_ag03/preview
4. https://onlinecourses.nptel.ac.in/noc19_ag02/preview
5. https://onlinecourses.nptel.ac.in/noc22_ch53/preview
6. https://nptel.ac.in/courses/126105011
7. https://www.youtube.com/watch?v=_U1PBYkuSVk

8. https://onlinecourses.nptel.ac.in/noc22_me135/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand food properties and food processing at ambient temperature	L1, L2, L3
CO2	Apply food processing methods at ambient temperature	L1, L2, L3
CO3	Apply and analyze heat removal methods for food processing	L1, L2, L3,L4
CO4	Understand heat processing for food applications	L1, L2, L3
CO5	Apply and evaluate heat application methods for food processing	L1, L2, L3,L4, L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				**3**	
CO2				**3**	
CO3	**2**		**2**	**3**	
CO4				**3**	
CO5	**2**		**2**	**3**	**2**

Semester- I

Food Microbiology (PCC)			
Course Code	**22FDT13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	4	Exam Hours	3

Course Learning objectives:

- To understand different factors affecting microbial growth and survival in foods
- To analyze causes for microbial food spoilage
- To understand different microbial fermentations and analyze problems during the processing of fermented food products
- To analyze causes for food borne diseases and evaluate food samples by different methods for microbial contamination
- To create appropriate strategies for food preservation and controlling microbial quality of foods

Module-1

MICROBIAL GROWTH:

Importance of microbes in foods, type of microbes in foods, gram positive and negative bacteria, classification of food borne bacteria, important yeasts, molds and viruses in foods; Growth of microorganisms in foods-exponential growth, generation time, growth curve; Intrinsic (nutrient content, pH, redox potential, antimicrobial barriers or structures and constituents, water activity) and extrinsic factors (Relative humidity, Temperature, Gaseous atmosphere) governing growth of microorganisms in food.

Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.
Learning	Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-2	
FOOD SPOILAGE: Food composition, Degradation of food components- carbohydrates, lipids, proteins and other deterioration (appearance, slime formation); Microbial spoilage or defects in specified foods- fruits, vegetables, other carbohydrate foods, Animal products (Red meat-fresh meat, cured meat, canned meat; Poultry- eggs; Sea foods- fish, cray fish, clams, crabs, oysters, shrimps; Dairy products- milk, butter, cheese), fats and oils and canned food	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-3	

<table>
<tr><td colspan="2">FOOD FERMENTATIONS:
Different types of fermentations (solid -state, submerged, static, agitated, batch, continuous). Starter cultures, Probiotic cultures, Fermented foods - methods of manufacture for vinegar, ethyl alcohol, cheese, yoghurt, baker’s yeast and traditional Indian foods.</td></tr>
<tr><td>Teaching-Learning Process</td><td>Include traditional teaching learning process such as Chalk and Talk using writing boards.
Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.
Collaborate with students how tools are applied to solve food technology problems.
Integrate real time case studies in various scientific tools used.
Reflective approaches on analysing how and why the tools are used in self-reflected or published data.
Incorporate Inquiry based approach using demonstration, field study, experiments and project work.</td></tr>
<tr><td colspan="2">Module-4</td></tr>
<tr><td colspan="2">MICROBIAL FOOD BORNE DISEASES AND DETECTION OF MICROBES
Types of microbial food borne diseases (intoxications, infections and toxicoinfections), symptoms and prevention of some commonly occurring food borne diseases (Staphylococcal intoxication, Botulism, Salmonellosis, Listeriosis), detecting food borne pathogens and their toxins- conventional (cultural, enumeration and dye reduction methods), immunological (ELISA, Strip based immunoassays, Blotting methods) and genetic methods (blotting methods, real time PCR, microarray).</td></tr>
<tr><td>Teaching-Learning Process</td><td>Include traditional teaching learning process such as Chalk and Talk using writing boards.
Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.
Collaborate with students how tools are applied to solve food technology problems.</td></tr>
</table>

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
FOOD PRESERVATION BY CONTROLLING MICROBES: Principles and methods of preservation, Microbial control and preservation – by low temperature, drying, antimicrobial agents (different types of chemical and bio preservatives), high temperature, hurdle technology, novel or minimal processing technologies.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Food Microbiology. Adams MR and Moss MO, RSC Publishing, 3rd Edition, 2008
2. Fundamentals of Food Microbiology. Bibek Ray, CRC press, 3rd Edition, 2005
3. Modern Food Microbiology, James M. Jay, Martin J. Loessner, David A. Golden, 2005
4. Essentials of Food Microbiology. John Garbutt, Arnold, 1997
5. The Microbiology of Safe Food, S.J. Forsythe, Wiley, 2000
6. Food Microbiology, W C Frazier & D C Westoff, 2017
7. Food Microbiology. Doyle MP and Beuchat LR, ASM Press, 3rd Edition, 2007

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=shWayTlt4hk
2. https://www.youtube.com/watch?v=AMJYn3hgv3o
3. https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-bt21/
4. https://dth.ac.in/medical/courses/Microbiology/block-1/2/index.php
5. https://onlinecourses.nptel.ac.in/noc22_ag03/preview

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand different factors affecting microbial growth and survival in foods	L1, L2, L3
CO2	Analyze causes for microbial food spoilage	L1, L2, L3,L4
CO3	Understand different microbial fermentations and analyze problems during the processing of fermented food products	L1, L2, L3, L4
CO4	Analyze causes for food borne diseases and evaluate food samples by different methods for microbial contamination	L1, L2, L3,L4,L5
CO5	Create appropriate strategies for food preservation and controlling microbial quality of foods	L1, L2, L3,L4,L5,L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

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

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Semester- I

Food Chemistry (PCC)			
Course Code	**22FDT14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand and analyse amino acids, peptides and enzymes for utilization in food processing
- To understand the chemistry carbohydrates, types, importance during food processing
- To understand chemistry of classification and importance of lipids in food processing
- To understand different kinds of nutrient supplements and their chemistry
- To analyse and evaluate levels of food ingredients and addition for the acceptability of food products

Module-1

PROTEINS:

Nomenclature, classification, structure, chemistry and properties of amino acids, peptides, proteins; Essential and non-essential amino acids, Qualitative and quantitative analysis of amino acids and proteins, Changes during food processing. Browning reactions: Enzymatic and non enzymatic browning, advantages and disadvantages, factors affecting their reaction and control.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-2	
CARBOHYDRATES: Nomenclature and classification, structure, physical and chemical properties of polysaccharides and their functions; Qualitative and quantitative analysis of carbohydrates; changes in carbohydrates during food processing.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-3	
LIPIDS: Structure, classification, physical and chemical properties including rancidity, hydrogenation, saponification of oils and Iodine number, utilization of fats and oils, margarine, shortenings, salad and cooking oils, importance of fats and oils in diet, introduction to hydrogenation and its importance.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-4	
INTRODUCTION TO HUMAN NUTRITION AND DIETARY REQUIREMENTS OF NUTRIENTS: Introduction to human nutrition, energy value of foods and its determination by calorimetry and from proximate principles, daily caloric needs for basal metabolism, physical activity and diet induced thermogenesis. Requirements and role of carbohydrates, lipids, water, vitamins and minerals in human health, recommended dietary allowance (RDA), dietary sources.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	

FOOD INGREDIENTS AND ADDITIVES: Classification and functions, need for food ingredients and additives, Permitted dosages of food additives, food preservatives, antimicrobial agents, thickeners- polysaccharides, bulking agents; Antifoaming agents, synergists, antagonists. Antioxidants (synthetic and natural, mechanism of oxidation inhibition), chelating agents- types, uses and mode of action; Coloring agents-color retention agents, applications and levels of use, natural colorants, sources of natural color (plant, microbial, animal and insects), Sweeteners-natural and artificial sweeteners, nutritive and non-nutritive sweeteners, properties and uses of various sweeteners in food products; Emulsifiers: Types, selection of emulsifiers, emulsion stability, functions and mechanism of action.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Lehninger Principles of Biochemistry, David L. Nelson, WH Freeman, 2017
2. Textbook of biochemistry (4th edition). E. S. West, W. R. Todd, H. S. Mason, and J. T. Van Bruggen. MacMillan, New York, 1966
3. Nutrition and Dietetics Paperback , Shubhangini A. Joshi, McGraw Hill Education, 2017
4. General Biochemistry. J.H. Weil, New Age International, 2005
5. Biochemistry of Foods. N.A.M Eskin, Elsevier, 1971
6. Food Chemistry. O.R. Fennema, CRC Press, 2008
7. Basic food chemistry Frank Lee Springer 1st Edition reprint 1983
8. Food chemistry Meyer LH, CBS publication 2006
9. Food Antioxidants: Technological toxicological and health perspective. D L Madhavi, S S Deshpande, D K Salunkhe, CRC press. 1st Edition
10. Food flavours, Part A B & C. I.D. Marton, A J Macleod, Elsevier science publisher 1990.
11. Natural food additive, ingredients and flavourings D. Baines, woodhead publishing series in Food science, Technology and Nutrition, 1st edition 2012

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/126/104/126104004/
2. https://archive.nptel.ac.in/courses/126/104/126104004/
3. https://www.youtube.com/watch?v=iuW3nk5EADg
4. https://www.digimat.in/nptel/courses/video/126105015/L29.html
5. https://www.youtube.com/watch?v=Ut9uSIK-f-8

Skill Development Activities Suggested

1. Hands on experience in food chemistry practicals: analysis of protein, carbohydrates and lipids and estimation of casein in various milk samples
2. Class Presentations and discussions of research articles from publications.
3. Online tools for surprise quizzes.
4. Collection of case studies via Newspapers/Journal articles, on topics covered.
5. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand and Analyse amino acids, peptides and enzymes for utilization in food processing	L1, L2, L3
CO2	Understand the chemistry carbohydrates, types, importance during food processing	L1, L2, L3
CO3	Understand chemistry of classification and importance of lipids in food processing	L1, L2, L3
CO4	Understand different kinds of nutrient supplements and their chemistry	L1, L2, L3
CO5	Analyse and evaluate levels of food ingredients and addition for the acceptability of food products	L1, L2, L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyse, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			**3**		
CO2			**3**		
CO3			**3**		
CO4			**3**		
CO5			**3**		

Semester- I

Food Packaging and Storage Engineering (PCC)			
Course Code	**22FDT15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- Learn about packaging materials, packaging systems and food storage.
- Apply his understanding to select appropriate packaging.
- Learn to evaluate suitability of appropriate storage system.
- Evaluate bio- films for various food packaging.
- Learn how to test materials for their suitability for packaging

Module-1

INTRODUCTION:

Function of packaging, marketing consideration for a package and types of packaging. Barrier properties of packaging material, gas permeation rates- oxygen transmission rate (OTR), water vapour transmission rate (WVTR), bursting strength, tensile strength, tearing strength, drop test, puncture test, etc

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-2	
PACKAGING MATERIALS: Selection of packaging materials, packaging machines and labeling Packaging materials for foods, Selection criteria of packaging materials for raw and processed food products. Machinery for Packaging: Form fill and seal machines, vacuum packaging machine, shrink wrap packaging machine and multilayer packaging system. Package labeling: functions, nutrition labeling, ingredient characterization handling instruction, and regulations; Shelf life of packaged food: water activity and prediction of shelf life. Packaging logistics.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-3	

STORAGE ENGINEERING-I: FOOD STORAGE: Importance of scientific storage systems, postharvest Physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene biosynthesis. Product damages during storage. Storage structures: Traditional, improved and modern storage. Structures: farm silos. Stored grain management and aeration: moisture and temperature changes in stored grains; conditioning of environment inside. Storage, purposes of aeration, aeration theory and aeration system operation.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-4	
STORAGE ENGINEERING-II: Storage pests and control: Damage due to storage insects, pests, rodents and its control. Storage of perishables: cold storage, controlled and modified atmospheric storage, hypoboric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside perishable storage.	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
BIODEGRADABLE PACKAGING: Types of packaging, classification, advantages and limitations of each type of packaging, economics of various packaging materials; Specifications for packaging various food products, testing standards, testing agencies and biodegradability; Types of natural polymers used for developing food packaging, properties of natural polymers for food packaging applications, chemical modifications of natural polymers for food applications; Methods of manufacturing biodegradable packaging, testing and evaluation; Synthetic biopolymers used for packaging applications. Properties of the polymers and specifications; Methods of manufacturing synthetic polymer films, testing and evaluation.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Food Packaging: Principles and Practice. Gordon L. Robertson, CRC Press, 2012
2. Hand book of Postharvest Technology: Cereals, CRC Press, 2003

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/126/105/126105015/
2. https://archive.nptel.ac.in/courses/126/105/126105015/
3. https://archive.nptel.ac.in/courses/126/105/126105015/
4. https://archive.nptel.ac.in/courses/126/105/126105015/

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Learn about packaging materials, packaging systems and food storage	L1, L2, L3
CO2	Apply his understanding to select appropriate packaging.	L1, L2, L3
CO3	Learn to evaluate suitability of appropriate storage system	L1, L2, L3
CO4	Evaluate bio- films for various food packaging	L1, L2, L3
CO5	Learn how to test materials for their suitability for packaging	L1, L2, L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3		
CO2			3	3	
CO3			3	3	
CO4			3	3	
CO5			3	3	

Semester- I

Research Methodology and IPR (PCC)			
Course Code	**22RMI16**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn research methodology and the technique of defining a research problem
- To learn significance of literature review in research, and to carry out a literature search, develop theoretical and conceptual frameworks and writ a review.
- To learn various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- To learn several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- To learn various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR

Module-1

RESEARCH METHODOLOGY:

Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the

Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve Technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-2	
REVIEWING THE LITERATURE: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-3	
DESIGN OF SAMPLING: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve Technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-4	
TESTING OF HYPOTHESES: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean,	

Hypothesis. Chi- square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve Technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common

Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve Technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 2018
2. Research Methodology a step- by-step guide for beginners(For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE, Publications, 2011.
3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, 2013
4. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications, 2009

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/121/106/121106007/
2. https://onlinecourses.nptel.ac.in/noc22_ge08/preview
3. https://archive.nptel.ac.in/courses/110/105/110105091/
4. https://archive.nptel.ac.in/courses/102/106/102106051/
5. https://www.youtube.com/watch?v=aKohB8lPueg
6. https://archive.nptel.ac.in/courses/110/105/110105091/

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	L1, L2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	L1, L2
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L1, L2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports.	L1, L2
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR	L1, L2

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1	**3**			**2**	
CO2	**3**			**2**	
CO3	**3**			**2**	
CO4	**3**	**2**	**2**	**2**	
CO5	**3**		**3**	**2**	

Semester I

Food Processing Laboratory (PCCL)			
Course Code	**22FDTL17**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	3

Course objectives:

- To learn different methods of food preservation methods.
- To learn the performance of different food processing equipments.
- To learn the physical properties of different food grains.
- To learn the analysis of energy and material balances of food processes

Sl.NO	Experiments
1	Preservation of fruits and vegetables by osmotic dehydration, salting and canning
2	Yield and performance evaluation of juice extraction and processing
3	Studying the effect of chemical preservatives on the shelf life of juices and pastes
4	Determination of physical properties of grains, cereal and spice seeds
5	Determination of coefficient of static friction for grain against different surfaces and angle of repose
6	Energy consumption, yield and performance during size reduction of cereals.
7	Estimation of drying curve of vegetables in a hot air oven
8	Estimation of freezing time in a freezer.
	Demonstration Experiments For CIE

9	Determination of drying rate of vegetables in the freeze dryer
10	Determination of drying rate of vegetables in a microwave oven and hot air oven.
11	Determination of dehydration rate of vegetables in salt and brine
12	Determination of thermal process time for sterilization

Course outcomes (Course Skill Set):

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

- Learn different food preservation methods.
- Evaluate the performance of different food processing equipment.
- Determine the physical properties of different food grains.
- Analyse the energy and material balances of food processes

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

1. Unit Operations of Agricultural Processing. K.M. Sahay and K.K. Singh, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2004.
2. Experimental Methods in Food Engineering, Rizvi, S.S.H. and Mittal, G.S., Springer US, 1st Edition, 1992
3. Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4th Edition, 2009

Semester- I

BOS recommended ONLINE courses (AUD/AEC)			
Course Code	**22AUD18/22AEC18**	CIE Marks	Evaluation procedures are as per the policy of the online course providers.
Teaching Hours/Week (L:P:SDA)	Classes are as per the policy of the online course providers.	SEE Marks	
Total Hours of Pedagogy		Total Marks	
Credits	pp	Exam Hours	

BOS RECOMMENDED ONLINE COURCES

1. Advanced Aquaculture Technology
2. Advanced Chemical Theory
3. Advanced Protein chemistry
4. Advanced Thermodynamics
5. An Introduction to Cardiovascular Fluid Mechanics
6. Animal Physiology
7. Applied Environmental Microbiology
8. Basic Principles and Calculations in Chemical Engineering
9. Bioenergetics of Life Processes
10. Bioenergy
11. Bioengineering : An Interface with Biology and Medicine
12. Biomedical nanotechnology
13. Biomicrofluidics

15.	Cell Culture Technologies
16.	Cellular biophysics: a framework for quantitative biology
17.	Computational Fluid Dynamics
18.	Computational Systems Biology
19.	Computer Aided Applied Single Objective Optimization
20.	Computer Aided Drug Design
21.	Conservation Geography
22.	Current regulatory requirements for conducting clinical trials in India for investigational new
23.	Dairy And Food Process And Products Technology
24.	Data Science for Engineers
25.	Descriptive Statistics with R Software
26.	Design Thinking - A Primer
27.	Design, Technology and Innovation
28.	Diary and food process and products technology
29.	Drug Delivery: Principles and Engineering
30.	drug/new drug (Version 2.0)
31.	Effective Engineering Teaching In Practice
32.	Electrochemical Technology in Pollution Control
33.	Electronic Waste Management - Issues And Challenges
34.	Employment Communication A Lab based course

36.	Entrepreneurship Essentials
37.	Environmental Biotechnology
38.	Environmental Quality Monitoring & Analysis
39.	Environmental Remediation of Contaminated Sites
40.	Equipment Design : Mechanical Aspects
41.	Essentials of Biomolecules : Nucleic Acids and Peptides
42.	Ethics in Engineering Practice
43.	Experimental Biotechnology
44.	Forest Biometry
45.	Forests and their management
46.	Functional Genomics
47.	Fundamentals Of Food Process Engineering
48.	Fundamentals Of Micro And Nanofabrication
49.	Fundamentals of Protein Chemistry
50.	Fundamentals of Spectroscopy
51.	Fuzzy Logic and Neural Networks
52.	General Microbiology
53.	Genetic Engineering: Theory and Application
54.	Genome Editing and Engineering
55.	Geographic Information System

57.	Human Behaviour
58.	Human Molecular Genetics
59.	Immunology
60.	Industrial Biotechnology
61.	Innovation by Design
62.	Instrumentation
63.	Intellectual Property
64.	Interactomics : Basics & Applications
65.	Introduction to Biomedical Imaging Systems
66.	Introduction to Biostatistics
67.	Introduction to Brain & Behaviour
68.	Introduction to Cell Biology
69.	Introduction to Cognitive Psychology
70.	Introduction to Developmental Biology
71.	Introduction to Dynamical Models in Biology
72.	Introduction to Environmental Economics
73.	Introduction to mechanobiology
74.	Introduction To Process Modelling In The Membrane Separation Process
75.	Introduction to Professional Scientific Communication
76.	Introduction to Proteogenomic

78. Introductory Mathematical Methods for Biologists
79. Manage TB
80. Material and Energy Balances
81. Matlab Programming for Numerical Computation
82. Medical Biomaterials
83. Medicinal Chemistry
84. Membrane Technology
85. Multiphase Flows
86. Non-Conventional Energy Resources
87. Offshore Structures Under Special Environmental Loads Including Fire Resistance
88. Optical Spectroscopy and Microscopy : Fundamentals of optical measurements and
89. Optimization in Chemical Engineering
90. Organic farming for sustainable Agricultural production
91. Patent Drafting for Beginners
92. Patent Law for Engineers and Scientists
93. Physics of Biological Systems
94. Physics through Computational Thinking
95. Plant Cell Bioprocessing
96. Plastic Waste Management
97. Post-Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products

99.	Principles Of Downstream Techniques In Bioprocess
100.	Process Control - Design, Analysis and Assessment
101.	Product Design and Innovation
102.	Programming, Data Structures And Algorithms Using Python
103.	Protein folding
104.	Qualitative Research Methods and Research Writing
105.	Quantitative Methods in Chemistry
106.	Regulatory requirements for medical devices including in vitro diagnostics in India (Version
107.	Roadmap for patent creation
108.	Soft Nano Technology
109.	Strategic Performance Management
110.	The Joy of Computing using Python
111.	Thermal Processing of Foods
112.	Thermodynamics for Biological Systems : Classical and Statistical Aspect
113.	Tissue Engineering
114.	Transport Phenomena in Biological Systems
115.	Advanced Chemical Thermodynamics and Kinetics
116.	Ultrafast laser spectroscopy
117.	Understanding Design
118.	Waste to Energy Conversion

Semester II

Fruit, Vegetable, and Milk process technology (PCC)			
Course Code	22FDT21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the importance of fruits, vegetable and milk processing in India.
- To learn different processing and preservation methods for fruits, vegetable and milk.
- To learn different methods of milk processing.
- To apply acquired knowledge to evaluate different processing methods.
- To apply acquired knowledge to select appropriate method for processing of fruits and vegetables.

Module-1

POST-HARVEST HANDLING

Production of Fruits and vegetables in India, Composition of major fruits and vegetables produced in the country, Post-harvest handling, transport and storage practices of fresh fruits and vegetables, Factors effecting for post-harvest losses. Production of milk in India, Composition of milk produced in the country, Post-harvest handling, transport and storage practices of milk, Factors effecting for post-harvest losses in milk during handling, transport and storage.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
FRUITS AND VEGETABLES PROCESSING Canning: Preparation of fruits and vegetables for canning – Washing, peeling, grating, slicing dicing, deseeding, blanching; Common machinery for operations, Juice and pulp extraction – extractors, Hydraulic Press, Hot and Cold Break process, Clarification, Clarification centrifuges, Decanters and desludgers; Fruit juice concentrates-methods of concentration, types of evaporators; Fruit Powders - Preparation of Fruit material for powder production, Process operations.	
Teaching-Learning Process	. Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	

MILK AND MILK PRODUCT PROCESSING: Filtration, milk storage, bulk cooling, stirring and mixing, standardization, pasteurization, sterilization, centrifugation, homogenization, evaporation and condensation. Manufacturing of milk products and principles of processing of cheese, ice- cream, butter, milk powder, casein, whey, curd, butter milk etc.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
ASPETIC AND OTHER PROCESSING METHODS Aseptic processing- Aseptic heat exchangers / homogenizers, Aseptic fillers. Filling systems- Tetra pack for small quantities, Dole system and Scholle system for bulk filling; Hurdle technology with reference to Vegetable, Fruit and Milk processing.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
NOVEL PROCESSING METHODS UV, High pressure processing, Ultrasound, Membrane, High intensity pulsed electric field, ozone, Irradiation, Minimal processing, Storage in Modified Atmosphere, Active Packaging, Freeze concentration, Vacuum frying, Edible coatings, Ohmic heating, Microwave dielectric heating technology.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

2012

2. Hand book of vegetables and vegetable processing. N.K.Sinha, Y. H. Hui,E. O.Evranuz, M. Siddiq, J. Ahmed, Wiley-Blackwell, 1st edition, 2011
3. Hand Book of Vegetable Preservation and Processing. Y. H. Hui, E. ÖzgülEvranuz, CRC Press, 2nd Edition, 2015
4. Fruit and Vegetable Preservation; Principles and Practices. R.P. Srivastava and Sanjeev Kumar, CBS; 3rd Edition, 2014
5. Technological Interventions In The Processing Of Fruits And Vegetables. RachnaSehrawat, Khursheed A. Khan, Megh R. Goyal, Apple Academic Press Inc. 2018
6. Outlines of Dairy Technology. Sukumar De, Oxford University Press, 5th Edition, 2005
7. Dairy Plant System and Layout. Tufail Ahmed, Kitab Mahal, New Delhi, 1996
8. Milk processing and quality management. A.Y.Tamime, Wiley- Blackwell, West Sussex, UK,2009
9. Dairy Technology: Principles of Milk Properties and Processes. P. Walstra, T.J. Geurts, A. Noomen, A. Jellema, M.A.J.S. van Boekel, 1st Edition, Marcel Dekker, New York ,1999
10. Dairy science and technology hand book- Principles and properties. Y.H. Hui, Wiley-VCH, New York, 1993

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/126/105/126105015/
2. https://archive.nptel.ac.in/courses/126/105/126105015/
3. https://archive.nptel.ac.in/courses/126/105/126105015/
4. https://archive.nptel.ac.in/courses/126/105/126105015/

Skill Development Activities Suggested

- Demos on basic fermentation process and separation techniques.
- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes
- Collection of case studies based on research findings
- Model making and Poster presentations on specific case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Learn the importance of fruits, vegetable and milk processing in India.	L1, L2, L3
CO2	Learn different processing and preservation methods for fruits, vegetable and milk.	L1, L2, L3
CO3	Learn advanced methods of fruits, vegetable and milk processing.	L1, L2, L3
CO4	Apply acquired knowledge to evaluate different processing methods.	L1, L2, L3, L4
CO5	Apply acquired knowledge to select appropriate method for processing of fruits and vegetables.	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO 1
2	An ability to write and present a substantial technical report/document.	PO 2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO 3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society.	PO 4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products.	PO 5

Mapping of COS and POs

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

Semester - II

Food process engineering-II (IPCC)			
Course Code	**22FDT22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- To apply and evaluate irradiation and high pressure for food processing
- To apply and evaluate minimal methods for food processing
- To apply and evaluate heat for food processing applications
- To apply and evaluate ohmic and infrared heating for food processing
- To apply and evaluate extraction and hurdle technology for food processing

MODULE-1

FOOD PROCESSING AT AMBIENT-TEMPERATURE

Irradiation- theory-dose distribution; equipment-radiation dose measurement; applications- radappertisation, radicidation, radurisation, ripening control, disinfection, sprouting inhibition; effect on foods- induced radioactivity, radiolytic products, nutritional and sensory qualities; effect on microbes; effect on packaging; detection of irradiated foods- physical, chemical and biological methods. High pressure processing of Foods- theory- effect on food components, mechanism of microbial cell inactivation; equipment- batch operation, semi continuous operation, process developments; effect on parasites and microbes- yeasts, moulds, bacteria, viruses;

effect on enzymes; effect on foods; combinations of high pressure and other minimal processing techniques	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
MODULE-2	
FOOD PROCESSING AT AMBIENT-TEMPERATURE Minimal Food processing methods- Processing by Pulsed electric field (PEF)- theory, equipment, effects on microbes, enzymes and food components, combinations of PEF and other treatments; Processing by electric arc discharges and oscillating magnetic fields; Processing with pulsed light, UV light and pulsed X-rays- theory, equipment, effects on microbes, enzymes and food components; Processing by ultrasound- theory, processing, effects on microorganisms and foods; Microwave processing.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
MODULE-3	
Food Processing by heat application Processing by heat using hot air: Dehydration (Drying)- theory- drying with heated air and heated surfaces, intermediate moisture foods; equipment- hot air driers, heated surface (contact) driers, control of dryers, rehydration; effect on sensory and nutritional properties of food and microbes. Smoking- theory- smoke constituents, liquid smoke; processing equipment; effect on foods and microorganisms. Baking and Roasting- theory; equipment- batch and semi continuous ovens, continuous ovens, control of ovens; effects on sensory and nutritional qualities of foods & microorganisms .Processing by heat using hot oils: Frying- theory-heat and mass transfer, frying time and temperature; equipment- atmospheric fryers, vacuum and pressure fryers, fryer operation control, oil filtration and heat recovery; oils used for frying and effect of frying on oils; effect of frying on foods- oil absorption, changes to texture, colour and flavour & nutritional changes; effect of frying on microbes.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

MODULE-4

FOOD PROCESSING BY HEAT APPLICATION-DIRECT AND RADIATED ENERGY

Heat processing by direct and radiated energy: Dielectric heating- theory, equipment, applications, effect on foods and microbes

Ohmic heating- theory, equipment, applications, effect on foods and microbes; Infrared heating- theory, equipment, applications, effect on foods and microbes

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

MODULE 5

EXTRACTION & HURDLE TECHNOLOGY

Extraction- Solid-liquid extraction (Leaching)- types of extraction processes; extraction principles- counter current extraction, equipment- batch extractor, continuous counter current extractor, multi stage continuous counter current extractor; extraction applications in food processing- extraction of oils & fats, oleoresins, food colours, coffee, flavours and pigments. Hurdle technology-

Basics of hurdle technology – Mechanism, Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plant derived, antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one representative example for each group of chemical and biochemical hurdle)	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Comparative study of the total bacterial count of food exposed to UV and food kept at ambient temperature
2	Comparative study of the organoleptic characteristics of food processed by high temperature and kept at ambient temperature
3	Comparative study of the total bacterial count of food processed in microwave and food kept at ambient temperature
4	Comparative study of the organoleptic characteristics of food processed in microwave oven and food kept at ambient temperature
5	Comparative study of the total bacterial count of food exposed to hot air heater and ambient temperature

6	Comparative study of the organoleptic characteristics of food processed by hot air heater and ambient temperature
7	Comparative study of the total bacterial count of smoke food and food kept at ambient temperature
8	Comparative study of the organoleptic characteristics of smoke food and food kept at ambient temperature
9	Comparative study of the total bacterial count of oil fried food and food kept at ambient temperature (Demonstration Experiments For CIE)
10	Comparative study of the organoleptic characteristics of oil fried food and food kept at ambient temperature (Demonstration Experiments For CIE)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks**

Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**

Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
2. Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4th Edition, 2009
3. Fundamentals of food engineering. D.G. Rao, PHI Leraning Private Limited, New Delhi, 2010
4. Food process engineering and technology. Zeki Berk, 1st edition, 2009, CRC Press, New York
5. Trends in Food Engineering. Jorge E. Lozano, Cristina Anon, Gustavo V. Barbosa-Canovas, Efren Parada-Arias, CRC Press; 1st Edition, 2000
6. Novel Food Processing Technologies (Food Science and Technology Series). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, 1st Edition, 2004
7. Minimal Processing Technologies in the Food Industry. Thomas Ohlsson and Nils Woodhead Publishing Limited, 1st Edition, 2002

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/126/104/126104004/
2. https://archive.nptel.ac.in/courses/126/104/126104004/
3. https://www.youtube.com/watch?v=iuW3nk5EADg
4. https://www.digimat.in/nptel/courses/video/126105015/L29.html
5. https://www.youtube.com/watch?v=Ut9uSlK-f-8

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes
- Collection of case studies based on research findings
- Model making and Poster presentations on specific case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply and evaluate irradiation and high pressure for food processing	L1, L2, L3, L4, L5
CO2	Apply and evaluate minimal methods for food processing	L1, L2, L3, L4, L5
CO3	Apply and evaluate heat for food processing applications	L1, L2, L3, L4, L5
CO4	Apply and evaluate ohmic and infrared heating for food processing	L1, L2, L3, L4, L5
CO5	Apply and evaluate extraction and hurdle technology for food processing	L1, L2, L3, L4, L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

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

Semester II

Grain Processing and Baking Technology (PEC-1)			
Course Code	22FDT231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn structure and proximate composition of grains & physical properties
- To learn different technologies for making bakery products
- To learn roles of different components and technical considerations in different confectionary products
- To learn the strategies for chocolate and vanilla processing
- To learn the strategies for candy and toffee making

Module-1

GRAIN PROCESSING AND MILLING I

Classification of grains, cereal production and factors influencing the economics of production, structure and chemical composition of cereal grains (wheat, rice, corn, barley), Legumes, Oil seeds; Types of storage of cereals, Drying of cereals, Processing scenario of food grains (mortar and pestle, stone mill, French process, gradual reduction system, automatic mill), Dry and Wet milling, Dry milling of wheat- storage, cleaning, conditioning or tempering, milling (breaking, purification and reduction systems), Recent developments in flour milling

Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Learning Process	Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Module-2

GRAIN PROCESSING AND MILLING II

Dry milling of corn or maize (Roller milling), Decortication or Attrition milling-Barley pearling, Sorghum and millet decortication, Dry milling of paddy or rough rice, by products of dry rice milling, further processing of milled rice, Parboiling of rice or wet milling of rice (process, types, advantages and disadvantages), Rice grain quality indicators, Wet milling of maize, Dry and wet milling of pulses, extraction of oil from oilseeds, processing of vegetable oil

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Module-3

<table>
<tr><td colspan="2">BAKING TECHNOLOGY I
Leavening (Overview of biological and chemical leavening agents and products), Bread- quality of flour, overview of equipments used in bread making; bread making formulas and systems (straight dough, sponge dough, liquid sponge, short time bread making systems), Detailed process of straight dough bread making system- dough formation, fermentation, molding, proofing and baking; Bread staling, Other types of yeast leavened products (other breads, doughs, rusk-making process),</td></tr>
<tr><td>Teaching-Learning Process</td><td>Include traditional teaching learning process such as Chalk and Talk using writing boards.
Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.
Collaborate with students how tools are applied to solve food technology problems.
Integrate real time case studies in various scientific tools used.
Reflective approaches on analysing how and why the tools are used in self-reflected or published data.
Incorporate Inquiry based approach using demonstration, field study, experiments and project work</td></tr>
<tr><td colspan="2">Module-4</td></tr>
<tr><td colspan="2">BAKING TECHNOLOGY II
Chemical leavening and agents, Chemically Leavened products- Cookie types (rotary mold cookies, cutting machine cookies, wire cut cookies, sugar wafers), cookie flour quality, phenomena during cookie making process; Biscuits; Crackers (Saltine crackers-sponge fermentation, dough fermentation, dough processing, cracker baking; Snack crackers); Cakes (layer cakes-mixing, role of ingredients; angel food cakes; pound cakes)</td></tr>
<tr><td>Teaching-</td><td>Include traditional teaching learning process such as Chalk and Talk using writing boards.</td></tr>
</table>

Process	presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
PASTRY AND CONFECTIONARY Pastry- types (short crust, flaky, puff, choux, phyllo, hot water crust pastries); Confectionary- classification of confectionary, Ingredients used in sugar confectionary, Technical considerations and production principles for confectionary products- TS, TSS, pH and acid content, ERH, sugar solubility, sugar crystallization, aeration, texture, etc.; Confectionary production process; traditional confectionary products; Candies and toffee manufacturing	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

2. Food Technology-II. A. Patel, H.C. Devraja, P. Sharma, R. R. B. Singh, www.agrimoon.com, ICAR
3. Food Technology-I. A.K. Singh, P.N. Raju, A. Jana, www.agrimoon.com, ICAR
4. Bakery Products: science and technology. Y. H. Hui, H. Corke, I.D. Leyn, WK Nip, N. Cross, Blackwell Publishing, 2006
5. Cereal grains for the food and beverage industries. E.K. Arendt, E. Zannini, Woodhead Publishing, 2013.
6. Cereals Processing Technology. G. Owens, CRC Press, Woodhead Publishing, 2001.

Web links and Video Lectures (e-Resources):

6. https://archive.nptel.ac.in/courses/126/104/126104004/
7. https://archive.nptel.ac.in/courses/126/104/126104004/
8. https://www.youtube.com/watch?v=iuW3nk5EADg
9. https://www.digimat.in/nptel/courses/video/126105015/L29.html
10. https://www.youtube.com/watch?v=Ut9uSlK-f-8

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand structure and chemical composition of grains & milling of grains	L1, L2, L3
CO2	Evaluate different milling technologies for selecting appropriate one for different grains	L1, L2, L3,L4,L5
CO3	Create strategies and processes for manufacturing yeast leavened bakery products	L1, L2, L3,L4,L5,L6
CO4	Create strategies and processes for manufacturing chemically leavened bakery products	L1, L2, L3,L4,L5,L6
CO5	Evaluate technical considerations and create strategies for manufacturing confectionary products	L1, L2, L3,L4,L5,L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

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

Semester II

Sugar, Protein and Oil Technology (PEC-1)			
Course Code	22FDT232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn structure, properties and functionality of sugars, proteins and lipids
- To learn the production of sugar and by-products from different sources
- To learn the different methods of processing of proteins
- To learn the different methods of oil processing
- To learn the gained knowledge food processing for extended uses

Module-1

INTRODUCTION

Structure, properties and functionality of sugars Structure, properties and functionality of proteins Structure, properties and functionality of lipids.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
SUGAR TECHNOLOGY, PRODUCTS AND BY-PRODUCTS Sugarcane and sugarbeet as sugar raw materials; Flow charts for manufacture of Granulated and Liquid sugars; Properties of Granulated sucrose and Liquid Sugars; Invert sugar and their characteristics Extraction of sugar juice from beet and cane; Juice purification; Decolorisation, Evaporating, Crystallization; Centrifugation; Sugar handling after centrifugals, Pressed and dried pulp; Bagasse; Molasses; Liquid sugars; Special crystal sugar products	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
PROTEIN PROCESSING Protein extraction- different methods, Protein separation- different methods, Protein concentration- different methods	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
OIL PROCESSING Pressing and Extraction of oils; Chemical, Physical and miscellaneous methods, Inter-esterification; Hydrogenation; Fat crystallization	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
EXTENDED APPLICATIONS OF LIPIDS Food emulsions; Non-aqueous foods; Special food applications- edible coating and film barriers; spray processing of fat containing	

foodstuffs- spray drying and cooling; low calorie fats; food emulsifiers; lipid emulsions for intravenous nutrition and drug delivery, Fats and oils Formulation; Shortenings; Margarine.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

2. Practical Guide to Vegetable Oil Processing. Monoj K. Gupta, AOCS Press, 1st Edition, 2004
3. Bleaching and Purifying Fats and Oils, Gary R. List, AOCS Press and Academic Press, 2nd Edition, 2009
4. Sugar Technology-Beet and Cane Sugar Manufacture. P.W. van der Poel, H. Schiweck, T.K. Schwartz, Publisher: Verlag Dr Albert Bartens KG, 1998
5. Principles of Sugar Technology. P. Honig, Elsevier, 1st Edition, 1953
6. Encyclopedia of Protein Technology. Josie Mehta, Dominant Publishers And Distributors, 1993

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/103107081
2. https://ch402npc.wordpress.com/2020/03/17/sugar-and-fermentation-industry-nptel/
3. https://onlinecourses.nptel.ac.in/noc21_bt48/preview

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements in animal biotechnology and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand structure, properties and functionality of sugars, proteins and lipids	L1, L2, L3
CO2	Create strategies for the production of sugar and by-products from different sources	L1, L2, L3, L4, L6
CO3	Analyze and evaluate the different methods of processing of proteins	L1, L2, L3, L4
CO4	Analyze and evaluate the different methods of oil processing	L1, L2, L3, L4
CO5	Apply lipids for extended uses	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3		
CO2			3	3	
CO3			3	3	
CO4			3	3	
CO5			3	3	

Semester II

Microbial Biotechnology (PEC-1)			
Course Code	22FDT233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the process of industrial Fermentations, Screening Methods and Strain Development
- To learn the process of production of Media, Sterilization and related equipment
- To learn to process of different fermenter designs and control their operation
- To learn the process of microbiological assays for biomolecules and pathogens
- To learn the use of gained knowledge on microbes for industrial uses

Module-1

INTRODUCTION

The era of the discovery of Microbes, Pasteur and fermentation, The discovery of Antibiotics, Production strains, screening techniques, Industrial Fermentations, Screening Methods, Strain Development.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
PRODUCTION MEDIA Characteristics of an Ideal Production Media, Raw materials for production, Different production Media, Principles of Sterilization, Sterilization equipment.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
PRINCIPAL TYPES OF FERMENTOR IN INDUSTRIES Introduction to Fermenters, Factors involved in fermenter Design, Fermenter configurations, Principal operating characteristics of fermenters, Computer control of Fermentation Process.	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
MICROBIOLOGICAL ASSAYS Microbiological assay of Vitamins, Amino Acids, Antibiotics and Trace elements. Advantages and Disadvantages of Microbiological Assay, Automation of Microbiological Assay, Detection methods for pathogens.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
INDUSTRIAL APPLICATIONS OF MICROBES Food sector- Fermented foods, Production of food related metabolites like organic acids, vitamins by microbes; Enzyme Industries-Production of microbial enzymes used in food processing; Sewage treatment methods by using microbes.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

2. Microbiology. Prescott, Joanne Willey and Kathleen Sandman and Dorothy Wood, Harley, Klein, McGraw Hill, 8th Edition, 2010
3. Industrial Microbiology. Samuel C Prescott and Cecil G Dunn, Agro bios (India), 2011
4. Palynology and its applications. Shripad N. Agashe, Oxfor and Ibh publishing Pvt. Ltd. 1st Edition, 2006
5. Biotechnological Applications of Microbes. Ajit Verma, I.K. International Publishing House, 1st Edition, 2005
6. Alcamo's Fundamentals of Microbiology. Jeffery C Pommerville, Jones and Bartlett Publisher, 9th Revised Edition, 2010
7. Microbiology, an Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Publisher: Pearson, 12th Edition, 2016
8. Principles of Microbiology. Ronald M Atlas, McGraw-Hill Inc., US, 1995
9. Microbiology: Principles and Explorations, Jacquelyn G. Black and Laura J. Black, John Wiley & Sons, 8th Edition, 2012

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/102/105/102105058/
2. https://www.youtube.com/watch?v=aHAblZ1pDKY
3. https://www.youtube.com/watch?v=O95HEJ1VoPQ

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand Industrial Fermentations, Screening Methods and Strain Development	L1, L2, L3,
CO2	Understand Different production Media, Principles of Sterilization and related equipment	L1, L2, L3,
CO3	Analyse different fermenter designs and control their operation	L1, L2, L3,
CO4	Analyse and evaluate different microbiological assays for biomolecules and pathogens	L1, L2, L3,
CO5	Apply microbes for industrial uses	L1, L2, L3,

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3		
CO2			3		
CO3			3	3	
CO4			3	3	
CO5			3	3	

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Semester II

Food Product Development (PEC-1)			
Course Code	22FDT234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the new food product development process
- To learn the analysis and formulation of new products
- To lean the Creation of process for product development
- To learn the evaluation of the quality of product and market for new product
- To learn the evaluation cost and economics of the product and creation of strategies for the commercialization of the product

Module-1

INTRODUCTION

Need, importance and objectives of formulation for new product development. Ideas, business philosophy and strategy of new product.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
FORMULATION AND STANDARDIZATION Formulation based on sources availability and cost competitiveness for concept developments of new products. Standardization of various formulation and product design.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
PRODUCT DEVELOPMENT Adaptable technology and sustainable technology for standardized formulation for process development. Process control parameters and scale-up, production trials for new product development at lab and pilot scale.	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Learning Process	Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
QUALITY AND MARKET Quality assessment of newly developed products- nutritional and sensory qualities, shelf-life and safety evaluation as per FSSAI guide lines. Market testing and marketing plan.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
ECONOMICAL ASPECT Costing and economic evaluation. Economics of food plant construction- estimation of economic plant size (breakeven analysis and	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Food Product Development: Maximizing Success. R. Earle and A. Anderson, Woodhead Publishing Series in Food Science, Technology and Nutrition, CRC Press; 1st Edition, 2001
2. New Food Product Development: From Concept to Marketplace, Gordon W. Fuller, CRC Press, 3rd Edition, 2011
3. Food Product Development: From Concept to the Marketplace. E. Graf and I. Saguy, Springer US, 1st Edition, 1991
4. Nutraceuticals Food Processing Technology: Innovative Scientific Research. Ed. R.P. Shukla, R.S. Mishra, Abhishek Dutt Tripathi, Ashok Kumar Yadav, Manju Tiwari, Raghvendra Raman Mishra, Bharti Publications; 1st Edition, 2017
5. Food Science. B. Shrilakshmi, New Age International (P) Limited Publication, 3rd Edition, 2003
6. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
7. Industrial Economics: An Introductory Textbook. R.R. Barthwal, New Age Publication, 1st Edition, 2010

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=oHM1Sr9p60Y
- https://www.youtube.com/watch?v=DKTLA__SC2M
- https://youtu.be/oHM1Sr9p60Y
- https://archive.nptel.ac.in/courses/112/107/112107217/

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Create strategy for new food product development	L1, L2, L3,
CO2	Analyze and formulate new products	L1, L2, L3, L4
CO3	Create process for product development	L1, L2, L3, L4, L5, L6
CO4	Evaluate the quality of product and market for new product	L1, L2, L3, L4, L5
CO5	Evaluate the cost and economics of the product and create strategies for the commercialization of the product	L1, L2, L3, L4, L5,

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3	3	
CO2			3	3	
CO3			3	3	
CO4			3	3	
CO5			3	3	

Semester II

Water and Beverage Technology (PEC-1)			
Course Code	22FDT235	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand manufacturing technology for juice-based beverages and synthetic beverages.
- To evaluate the manufacturing and quality of non-alcoholic beverages
- To evaluate the manufacturing and quality of alcoholic beverages
- To analyze impurities in water for its purification and treatment
- To evaluate the manufacturing and quality of packaged drinking water

Module-1

INTRODUCTION

Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; synthetic beverages.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
NON-ALCOHOLIC BEVERAGES Ingredients for beverage preparations, role of various ingredients of soft drinks, carbonation of soft drinks. Technology of still, carbonated, low-calorie and dry beverages; isotonic and sports drinks. Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and limitation of dairy-based beverages.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
ALCOHOLIC BEVERAGES Brewing technology; Alcoholic beverages- types- fermented beverages (beer and wines) & distilled beverages (Cane sugar, sugar beet, honey, fruit, grain based, herbal, plant, seed, tree, vegetable distillations & complex/multiple distillations), manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, equipment used for brewing and	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
WATER Water chemistry, water activity, water purification and treatment, Impurities in water and its analysis.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
WATER – PACKAGING AND QUALITY Packaged drinking water- definition, types, manufacturing processes, quality evaluation and raw and processed water, methods of	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

8. Food Product Development: Maximizing Success. R. Earle and A. Anderson, Woodhead Publishing Series in Food Science, Technology and Nutrition, CRC Press; 1st Edition, 2001
9. New Food Product Development: From Concept to Marketplace, Gordon W. Fuller, CRC Press, 3rd Edition, 2011
10. Food Product Development: From Concept to the Marketplace. E. Graf and I. Saguy, Springer US, 1st Edition, 1991
11. Nutraceuticals Food Processing Technology: Innovative Scientific Research. Ed. R.P. Shukla, R.S. Mishra, Abhishek Dutt Tripathi, Ashok Kumar Yadav, Manju Tiwari, Raghvendra Raman Mishra, Bharti Publications; 1st Edition, 2017
12. Food Science. B. Shrilakshmi, New Age International (P) Limited Publication, 3rd Edition, 2003
13. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
14. Industrial Economics: An Introductory Textbook. R.R. Barthwal, New Age Publication, 1st Edition, 2010

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=O-MRC0dskHg
- https://www.youtube.com/watch?v=rKn0NuUpRf0
- https://www.youtube.com/watch?v=UhwjbPprwX0
- https://www.youtube.com/watch?v=Q_MZkOCdUzc

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand manufacturing technology for juice-based beverages and synthetic beverages.	L1, L2, L3,
CO2	Evaluate the manufacturing and quality of non-alcoholic beverages	L1, L2, L3, L4
CO3	Evaluate the manufacturing and quality of alcoholic beverages	L1, L2, L3, L4, L5
CO4	Analyze impurities in water for its purification and treatment	L1, L2, L3, L4
CO5	Evaluate the manufacturing and quality of packaged drinking water	L1, L2, L3, L4, L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3		
CO2				3	
CO3				3	
CO4				3	
CO5				3	

Semester II

Functional Foods and Nutraceuticals (PEC-2)			
Course Code	22FDT241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand various food ingredients and their functional properties.
- To apply his understanding to select appropriate food for particular disease control.
- To understand and evaluate functional foods with respect to different regulations.
- To analyze the functional claims with respect to packaging and labelling.
- To apply various regulations and laws imposed for functional food.

Module-1

I**NTRODUCTION**

Functional foods- concept and definition; nutraceutical-concept and definition. Probiotics, prebiotics and dietary fibres – their functional properties Functional foods-the link between nutrition and medicine, sources and bioavailability of nutraceuticals, chemistry and structure of nutraceuticals

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
FUNCTIONAL FOOD COMPONENTS AND THEIR ROLES IN DISEASE PREVENTION Micronutrients, Vitamins, Isoflavones; Flavanoids, Carotenoids and Lycopene; Nutraceuticals – Garlic, Grape, Wine, Tea; Omega 3 Fatty Acids, Antioxidant, Chemoprevention & Functional Food; Single Cell Proteins. Functional foods for treatment of gastrointestinal disorders, Functional Food and Nutraceuticals for the treatment of Coronary Heart Disease, Role of Functional Food and Nutraceuticals in Tumor. Nutraceuticals and Functional Foods from Marine: Marine Macroalgae, Microalgae, Bacteria, Fungi, Cyanobacteria and their Therapeutic Applications. Marine-Derived Nutraceuticals for Prevention and Development of Atherosclerosis	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Module-3	
NUTRACEUTICALS OF PLANT AND ANIMAL ORIGIN Plant secondary metabolites: Role of Plant Sterols and Phytoestrogens in Functional Foods, Phenolics in Herbal and Nutraceutical Products. Animal metabolites: Fat rich functional food and their applications - Functional Fats and Spreads, modified fats and oils. Functional Meat as Functional Foods, Functional Confectionery and other functional Products	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
FUNCTIONAL FOOD HEALTH CLAIMS Functional claims; packaging and labeling; nutrient modification and specific nutrient claims; disease-specific claims; Dietary Supplement Health and Education Act (DSHEA).	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
MARKETING AND REGULATION OF FUNCTIONAL FOODS Market for Functional Food Products: Functional foods and consumers; the role of health in food choice; functional foods market; Regulations and laws for functional food. Regulations in USA, EU and India.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Functional Foods: Principles and Technology. M. Guo, Woodhead Publishing, 1st Edition
2. Functional foods-Concept to product. Gibson G.R., Williams G.M. Woodhead Publishing Ltd, 2000
3. Handbook of Nutraceuticals and Functional Foods. Wildman R.E.C., Second Edition, CRC Press, 2007
4. Handbook of fermented functional foods. Farnworth E.R., CRC Press, 2003
5. Phytochemical functional foods. Johnson I., Williamson G. Woodhead Publishing Ltd, 2000
6. Phytosterol as functional food components and nutraceuticals. Dutta P.C., Marcel Dekker, 2004
7. Functional food ingredients and nutraceuticals. Shi J., Taylor and Francis, 2007
8. Biotechnology in functional foods and nutraceuticals. Bagchi D., Lau F.C., Ghsh, D.K., Taylor and Francis, 2010
9. Dietary supplements and functional foods. Webb, G.P., Blackwell Publishing, 2006

Web links and Video Lectures (e-Resources):

1. https://www.classcentral.com/course/swayam
2. https://www.functionalfoodscenter.net/OnlineCourses.html
3. https://academy.nutrifytoday.com/
4. https://www.youtube.com/watch?v=gCeSLR5PFIc

Skill Development Activities Suggested

- Preparation of a functional food (Snack)
- Phytochemical screening of any functional ingredient
- Antioxidant, Antimicrobial activity of functional ingredients/herbal extract
- Preparation of Probiotic Beverage

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand various food ingredients and their functional properties	L1, L2,
CO2	Apply his understanding to select appropriate food for particular disease control.	L3, L4, L5
CO3	Understand and evaluate functional foods with respect to different regulations.	L3, L4, L5
CO4	Analyze the functional claims with respect to packaging and labelling	L3, L4, L5
CO5	Apply various regulations and laws imposed for functional food.	L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1.	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2.	An ability to write and present a substantial technical report/document	PO2
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4.	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5.	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

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

Semester II

Enzyme and Fermentation Technology (PEC-2)			
Course Code	22FDT242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the basics , process and scope understand enzyme kinetics
- To learn the application of enzymes for food processing
- To learn different methods for enzyme purification
- To learn the production of enzymes by fermentation technology
- To learn the different fermentor designs relevant for food processing

Module-1

INTRODUCTION AND ENZYME KINETICS

Nature, Function, classification & nomenclature of enzymes, Specificity, Michaeli's Menton equation, Km, Lineweaver Berk Plot, Different inhibitors.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
FOOD RELATED ENZYMES AND APPLICATIONS Amylases, Pectic Enzymes, Proteases, Rennet; Oxidoreductases- Phenolases, Glucose Oxidases, Catalases, Peroxidases, Lipoxygenases, Xanthine Oxidases, Immobilized enzyme, Application of enzymes in food processing; Application of immobilized enzymes and cells.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	

ENZYME PURIFICATION Ammonium sulphate precipitation, Gel exclusion chromatography, Ion exchange chromatography, Affinity chromatography- GST, His tag, Native PAGE, SDS-PAGE, Zymogram, Coomassie blue and Silver staining.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
FERMENTATION TECHNOLOGY Sterilization methods of Fermentors; Scale up and scale down; Biomass Production; Enzyme Production; Downstream processing.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data.

	Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
FERMENTORS Fermentor design and analysis; Aeration and Heat Transfer; Instrumentation and Control; Batch, Fed batch and continuous bioreactors.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Downstream Process Technology: A New Horizon In Biotechnology, Nooralabettu Krishna Prasad, PHI, 2012.
2. Enzyme technology: Pacemaker of Biotechnology, Nooralabettu Krishna Prasad, PHI, 2011
3. Biochemical Engineering Fundamentals. J.E. Baily and D.F. Ollis, Mcgraw Hill Chemical Engineering Series, 1st Edition, 1986
4. Industrial Microbiology. Samuel C Prescott and Cecil G Dunn, Agro bios (India), 2011
5. Principles of Fermentation Technology. P.F. Stanbury and A. Whitaker, Elsevier; 2nd Edition, 2008

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=ie9GIae--HU
2. https://www.digimat.in/nptel/courses/video/102102033/L01.html
3. http://www.digimat.in/nptel/courses/video/102105064/L29.html
4. https://archive.nptel.ac.in/courses/104/105/104105102/

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand enzyme kinetics	L1, L2, L3,
CO2	Evaluate the enzymes for food processing applications	L1, L2, L3, L4, L5
CO3	Analyze and evaluate different methods for enzyme purification	L1, L2, L3, L4
CO4	Create strategies for the production of enzymes by fermentation technology	L1, L2, L3, L4, L5, L6
CO5	Analyze and evaluate different fermentor designs	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for the acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			**3**		
CO2				**3**	
CO3				**3**	
CO4				**3**	
CO5				**3**	

Semester II

Livestock, Fish and Marine Products Processing (PEC-2)			
Course Code	22FDT243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn different methods of meat preservation
- To learn the evaluation on quality of meat
- To learn the abattoir design and poultry processing methods
- To learn the evaluation of unit operations for poultry and fish products
- To learn the evaluation of different methods of processing of marine products

Module-1

INTRODUCTION

Production, Economics, and processing scenario of meat, fish and poultry. Preservation of meat- dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meats using- antibiotics and chemical preservatives.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
QUALITY OF THE PROCUCT Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; texture and tenderness-definition and measurement, factors affecting texture and tenderness, artificial tenderizing	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
PROCESSING Abattoir design and layout, meat plant sanitation and safety, by-products utilization. Processing and preservation of eggs, production of egg yolk and egg yellow powder. Poultry processing.	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Learning Process	Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
UNIT OPERATIONS Unit operations for various poultry products; Fish processing: Unit operations for various fish products.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
ADVANCED PROCESSING Different sea food resources and their postharvest quality changes; bulk handling and chilling; quick freezing; cook-chill processing; modified-atmosphere packaging; retort pouch packaging.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Lawrie's Meat Science. Fidel Toldra, Woodhead Publishing, 8th Edition, 2007
2. Egg Science and Technology. W.J. Stadelmen and O.J. Cotterill, CRC Press, 4th Edition, 1995
3. Handbook of Meat Processing. Ed. Fidel Toldrá, Blackwell Publishing, 1st Edition, 2010
4. Marine and Freshwater Products Handbook, Roy E. Martin, Emily Paine Carter, George J. Flick, Jr., Lynn M. Davis, CRC Press, 1st Edition, 2000
5. Meat Handbook. A. Lavie, AVI, Westport, 4th Edition, 1980
6. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
7. Meat Products Handbook. G Feiner, Woodhead Publishing, 1st Edition, 2006
8. Muscle as Food. P.J. Bechtel, Academic Press, 1st Edition, 1986

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=9h7Q62thXGg
- https://www.youtube.com/watch?v=At8iNR38rfo
- https://www.youtube.com/watch?v=irnVa3Bn7_w
- https://www.youtube.com/watch?v=l8AT48eIFQw

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Evaluate different methods of meat preservation	L1, L2, L3, L4, L5
CO2	Evaluate quality of meat	L1, L2, L3, L4, L5
CO3	Analyze abattoir design and evaluate poultry processing methods	L1, L2, L3, L4
CO4	Evaluate unit operations for poultry and fish products	L1, L2, L3, , L4, L5
CO5	Evaluate different methods of processing of marine products	L1, L2, L3, , L4, L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				**3**	
CO2				**2**	**3**
CO3				**3**	
CO4				**3**	
CO5				**3**	

Semester II

Food Industry Byproduct and Waste Management (PEC-2)			
Course Code	22FDT244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the uses of by products of dairy, fruit and vegetables related processing industries
- To lean the uses of by products of meat and fish processing units and agro based industries
- To learn the various laws and regulations of waste management and apply them for food processing industries.
- To learn different waste treatment methods for food processing industries
- To learn the strategies for the zero-discharge and zero-emission of waste

Module-1

BYPRODUCTS I

Various byproducts from Food Processing Industry: By products of cereals, legumes, oil seeds, dairy, fruit and vegetables processing industries and their uses.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
BYPRODUCTS II By products of meat and fish processing units and their uses. Uses of byproducts of agro based industries in various sectors.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
LAWS AND REGULATIONS Various laws and regulations for waste management in food processing industries.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
WASTE TREATMENT METHODS Food industry wastes, Waste treatment methods for Cereals, Fruits, vegetables, Meat, Fish, Dairy processing and Brewery Industries.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
WASTE WATER TREATMENT Preliminary treatment, primary, secondary, advanced and final treatment; zero-discharge and zero-emission ystem.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Handbook of Waste Management and Co-Product Recovery in Food Processing. K. Waldron, Woodhead Publishing Limited, 1st Edition, 2007
2. Waste Management for the Food Industries. I.S. Arvanitoyannis, Academic Press, 2008
3. Utilization of By-Products and Treatment of Waste in the Food Industry. Vasso Oreopoulou and Winfried Russ, Springer US, 1st Edition, 2007
4. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
5. Food Processing By-Products and their Utilization, Ed. Anil K Anal, Willey Publication, 1st Edition, 2017

Web links and Video Lectures (e-Resources):

1. https://www.coursera.org/lecture/meat-we-eat/by-products-P51Cd
2. https://www.youtube.com/watch?v=bf-XC8Ko42I
3. https://www.youtube.com/watch?v=ikKFMgmqjOo

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Evaluate the uses of by products of dairy, fruit and vegetables related processing industries	L1, L2, L3, L4, L5
CO2	Evaluate the uses of by products of meat and fish processing units and agro based industries	L1, L2, L3, L4, L5
CO3	Analyze various laws and regulations of waste management and apply them for food processing industries.	L1, L2, L3, L4
CO4	Evaluate different waste treatment methods for food processing industries	L1, L2, L3, L4
CO5	Create strategies for the zero-discharge and zero-emission of waste	L1, L2, L3, L4, L5, L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				**3**	
CO2				**3**	
CO3				**3**	**3**
CO4				**3**	
CO5				**3**	

Semester II

Food Separation Engineering (PEC-2)			
Course Code	22FDT245	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand various separation processes
- To apply concepts of phase equilibrium in food processing
- To evaluate applications of membrane technology in food industry
- To evaluate applications of powder technology in food industry
- To evaluate applications of super critical fluid extraction in food and pharmaceutical sectors

Module-1

INTRODUCTION

Introduction to various separation processes; Gas-Liquid, Gas-Solid, Liquid-Liquid, Liquid-Solid separation

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
PHASE EQUILIBRIUM Concept of phase equilibrium; Impingement separator; Electrostatic precipitation; Distillation-Application of distillation in food processing.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
MEMBRANE SEPARATION TECHNOLOGY Introduction to microfiltration, ultra-filtration, nano-filtration, reverse osmosis, electro dialysis; Physical characteristics of membrane separation; Factor affecting reverse osmosis process; Concentration of polarization; Design of reverse osmosis and ultra-filtration system; Operation layout of the modules; Electrodialysis; Pervaporization; Fabrication of membrane; Application of membrane technology in food industry.	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
POWDER TECHNOLOGY Classification of powder; Separation of powder; Sieving; Air classification; Factor affecting air classification; Cyclone application; Air separation; Particle size distribution.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
SUPER CRITICAL FLUID (SCF) EXTRACTION Introduction; Properties of SCF; Food application of SCF; Application of SCFE during analysis and pharmaceutical applications.	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Mechanical Operations for Chemical Engineers (Incorporating Computer Aided Analysis). C.M. Narayanan and B.C. Bhattacharya, Khanna Publishers, 3rd Edition, 1990
2. Membrane Technology and Applications. Richard W. Baker, John Wiley & Sons, 2nd Edition, 2004
3. Membranes and Membrane Separation Processes, 1. Principles. Heinrich Strathmann, Wiley VCH Verlag GmbH & Co. KGaA., 2011
4. Powder Technology Handbook. Hiroaki Masuda, Ko Higashitani and Hideto Yoshida, CRC Press Taylor and Francis, 3rd Edition, 2006
5. Transport Processes and Separation Process. Chistie John Geankoplis, Pearson Education India; 4th Edition, 2015

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/103103163
2. https://archive.org/details/NPTEL-ChemEngr-Novel_Separation_Processes
3. https://www.digimat.in/nptel/courses/video/103105061/L22.html

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand various separation processes	L1, L2, L3, L4, L5
CO2	apply concepts of phase equilibrium in food processing	L1, L2, L3, L4, L5
CO3	Analyze various laws and regulations of waste management and apply them for food processing industries.	L1, L2, L3, L4
CO4	Evaluate different waste treatment methods for food processing industries	L1, L2, L3, L4
CO5	Create strategies for the zero-discharge and zero-emission of waste	L1, L2, L3, L4, L5, L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				**3**	
CO2				**3**	
CO3				**3**	**3**
CO4				**3**	
CO5				**3**	

Semester II

Food Analysis and Quality Control Laboratory (PCCL)			
Course Code	**22FDTL26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	3

Course objectives:

- To learn the evaluation of food samples for organoleptic quality.
- To learn the evaluation of food samples for chemical and microbial safety.
- To determine physical properties of different food grains.
- To learn the Analysis of the data for the acceptability of food samples.
- To understand the usage of sophisticated instruments for various food applications.

Sl.NO	Experiments
1	Sensory evaluation of fruit juice and analysis of data by fuzzy logic.
2	Determination of protein concentration in food samples
3	Determination of total dietary fibre and total fat concentration in food samples
4	Determination of ascorbic acid content in fruit juices
5	Qualitative analysis of oils and fats
6	Determination of microbial counts in milk samples and analysis of milk quality
7	Analysis of milk for detection of adulterant
8	Determination of antioxidant activity in food/ beverages

	Demonstration Experiments For CIE
9	Determination of BAR (Brix acid ratio) in beverages
10	Determination of lactose in milk-based sweets by colorimetric/ spectrophotometric method
11	Identification of food additives by using FTIR or GC or HPLC
12	Verification of packaging material by FTIR method

Course outcomes (Course Skill Set):

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

- Learn different food preservation methods.
- Evaluate the performance of different food processing equipment.
- Determine physical properties of different food grains.
- Analyse the energy and material balances of food processes

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

1. Food Quality Control. M. Kalia, Agrotech Publishing Academy, 2010
2. Biochemical Methods. S. Sadasivamand A. Manickam, New Age International, 3rd Edition, 1996
3. Pearson's Composition and Analysis of Foods. Ronald S. Kirk and Ronald Sawyer, Addison-Wesley Longman Ltd, 1991
4. Quality Control for Food Industry. A Krammer, Vol. I and II, Avi Pub. Co., 3rd Edition, 1970
5. Handbook of Analysis and Quality Control of fruits & Vegetables Products. S Ranganna, Tata Mc Grow Hill Publications, 2nd Edition, 1986

Semester- II

BOS recommended ONLINE courses (AUD/AEC)			
Course Code	**22AUD27**	CIE Marks	Evaluation procedures are as per the policy of the online course providers.
Teaching Hours/Week (L:P:SDA)	Classes are as per the policy of the online course providers.	SEE Marks	
Total Hours of Pedagogy		Total Marks	
Credits	pp	Exam Hours	

BOS RECOMMENDED ONLINE COURCES

1. Advanced Aquaculture Technology
2. Advanced Chemical Theory
3. Advanced Protein chemistry
4. Advanced Thermodynamics
5. An Introduction to Cardiovascular Fluid Mechanics
6. Animal Physiology
7. Applied Environmental Microbiology
8. Basic Principles and Calculations in Chemical Engineering
9. Bioenergetics of Life Processes
10. Bioenergy
11. Bioengineering : An Interface with Biology and Medicine
12. Biomedical nanotechnology
13. Biomicrofluidics

15.	Cell Culture Technologies
16.	Cellular biophysics: a framework for quantitative biology
17.	Computational Fluid Dynamics
18.	Computational Systems Biology
19.	Computer Aided Applied Single Objective Optimization
20.	Computer Aided Drug Design
21.	Conservation Geography
22.	Current regulatory requirements for conducting clinical trials in India for investigational new
23.	Dairy And Food Process And Products Technology
24.	Data Science for Engineers
25.	Descriptive Statistics with R Software
26.	Design Thinking - A Primer
27.	Design, Technology and Innovation
28.	Diary and food process and products technology
29.	Drug Delivery: Principles and Engineering
30.	drug/new drug (Version 2.0)
31.	Effective Engineering Teaching In Practice
32.	Electrochemical Technology in Pollution Control
33.	Electronic Waste Management - Issues And Challenges
34.	Employment Communication A Lab based course

36.	Entrepreneurship Essentials
37.	Environmental Biotechnology
38.	Environmental Quality Monitoring & Analysis
39.	Environmental Remediation of Contaminated Sites
40.	Equipment Design : Mechanical Aspects
41.	Essentials of Biomolecules : Nucleic Acids and Peptides
42.	Ethics in Engineering Practice
43.	Experimental Biotechnology
44.	Forest Biometry
45.	Forests and their management
46.	Functional Genomics
47.	Fundamentals Of Food Process Engineering
48.	Fundamentals Of Micro And Nanofabrication
49.	Fundamentals of Protein Chemistry
50.	Fundamentals of Spectroscopy
51.	Fuzzy Logic and Neural Networks
52.	General Microbiology
53.	Genetic Engineering: Theory and Application
54.	Genome Editing and Engineering
55.	Geographic Information System

57. Human Behaviour
58. Human Molecular Genetics
59. Immunology
60. Industrial Biotechnology
61. Innovation by Design
62. Instrumentation
63. Intellectual Property
64. Interactomics : Basics & Applications
65. Introduction to Biomedical Imaging Systems
66. Introduction to Biostatistics
67. Introduction to Brain & Behaviour
68. Introduction to Cell Biology
69. Introduction to Cognitive Psychology
70. Introduction to Developmental Biology
71. Introduction to Dynamical Models in Biology
72. Introduction to Environmental Economics
73. Introduction to mechanobiology
74. Introduction To Process Modelling In The Membrane Separation Process
75. Introduction to Professional Scientific Communication
76. Introduction to Proteogenomic

78.	Introductory Mathematical Methods for Biologists
79.	Manage TB
80.	Material and Energy Balances
81.	Matlab Programming for Numerical Computation
82.	Medical Biomaterials
83.	Medicinal Chemistry
84.	Membrane Technology
85.	Multiphase Flows
86.	Non-Conventional Energy Resources
87.	Offshore Structures Under Special Environmental Loads Including Fire Resistance
88.	Optical Spectroscopy and Microscopy : Fundamentals of optical measurements and
89.	Optimization in Chemical Engineering
90.	Organic farming for sustainable Agricultural production
91.	Patent Drafting for Beginners
92.	Patent Law for Engineers and Scientists
93.	Physics of Biological Systems
94.	Physics through Computational Thinking
95.	Plant Cell Bioprocessing
96.	Plastic Waste Management
97.	Post-Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products

99.	Principles Of Downstream Techniques In Bioprocess
100.	Process Control - Design, Analysis and Assessment
101.	Product Design and Innovation
102.	Programming, Data Structures And Algorithms Using Python
103.	Protein folding
104.	Qualitative Research Methods and Research Writing
105.	Quantitative Methods in Chemistry
106.	Regulatory requirements for medical devices including in vitro diagnostics in India (Version
107.	Roadmap for patent creation
108.	Soft Nano Technology
109.	Strategic Performance Management
110.	The Joy of Computing using Python
111.	Thermal Processing of Foods
112.	Thermodynamics for Biological Systems : Classical and Statistical Aspect
113.	Tissue Engineering
114.	Transport Phenomena in Biological Systems
115.	Advanced Chemical Thermodynamics and Kinetics
116.	Ultrafast laser spectroscopy
117.	Understanding Design
118.	Waste to Energy Conversion

Semester III

Food Laws, Regulations and Certifications (PCC)			
Course Code	22FDT31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	4	Exam Hours	3

Course Learning objectives:

- To understand implications of food adulteration and food safety management system
- To understand various laws for smooth running of food industries
- To understand and apply FSSAI in food industries
- To understand about other Indian food regulatory bodies
- To apply various international laws and practices for smooth running of food industries

Module-1

FOOD ADULTERATION AND FOOD SAFETY MANAGEMENT

Food Adulteration, Food Safety Management System, Mandatory and voluntary food laws.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
DIFFERENT FOOD LAWS Various food laws for food processing, Essential Commodity Act, Prevention of Food Adulteration Act (PFA), Fruit Products Order (FPO) and Meat Food Products Order (MFPO), FSSAI - Introduction.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
FSSAI Food Safety and Standards Authority of India (FSSAI), Structure and Function, Food Safety and Standards Act	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
OTHER RELEVANT NATIONAL BODIES Bureau of Indian Standards (BIS), Agricultural and Processed Food Products Export Development Authority (APEDA), Marine Products Export Development Authority (MPEDA), Spice Board India and Agricultural Marketing and Grading Standards (AGMARK).	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
International food laws and practices Food Codex laws, Food and Drug Administration (FDA), International Organization for Standardization (ISO), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), Hazard Analysis and Critical Control Point (HACCP).	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:

Books

1. A Practical Guide to Food Laws and Regulations. Kiron Prabhakar, Bloomsbury Professional India, 1st Edition, 2016
2. International Food Law and Policy. Gabriela Steier and Kiran Patel, Springer International Publishing, 1st Edition, 2016
3. Food Regulation: Law, Science, Policy and Practice, N.D. Fortin, Wiley Publication, 2nd Edition, 2016
4. Food Safety and Standards Act and Regulations, Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2006
5. International Food Law and Policy. Gabriela Steier & Kiran K. Patel (Eds.) Springer Nature; 1st Edition. 2016

Web links and Video Lectures (e-Resources):

- https://onlinecourses.swayam2.ac.in/nou19_ag07/course
- https://vimeo.com/343624655
- https://foodsafetyhelpline.com/introduction-to-food-safety-and-standards-act-2006/
- https://vimeo.com/345007583
- https://www.youtube.com/watch?v=YlTtVcQgVaU

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the implications of food adulteration and the food safety management system	L1, L2, L3, L4
CO2	Understand various laws for smooth running of food industries	L1, L2, L3, L4
CO3	Understand and apply FSSAI in food industries	L1, L2, L3, L4
CO4	Understand about other Indian food regulatory bodies	L1, L2, L3, L4
CO5	Apply various international laws and practices for smooth running of food industries	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

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

Semester III

Plantation Products and Spices Technology (PEC-3)			
Course Code	22FDT321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand different types of spices and their importance.
- To understand the methods of processing of different spices & dry fruits.
- To understand and create strategies for processing of tea leaves to obtain different kinds of tea
- To understand the processing of coffee to obtain different kinds of coffee
- To understand and create strategies for processing of cocoa bean to obtain different products of cocoa

Module-1

INTRODUCTION

Classification, composition, structure and characteristics. Production status of spices in India: major spice producing area in India and worldwide, export potential of processed and raw spice product

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
SPICE AND DRY FRUIT PROCESSING Processing of major and minor spices: Preservation and processing of major and minor spices of India; Processing of whole spice, spice powder, paste and extracts; production and processing of spice mixtures; spice oils and oleoresins, functional role of spices, quality specification for spices Composition, Structure, characteristics & processing of cashew nut and other dry fruits.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
TEA PROCESSING Composition and production of tea leaves; processing of tea leaves; CTC tea, black tea, green tea and Oolong tea, grading and packaging; processing of instant tea, Iced Tea	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
COFFEE PROCESSING Production and processing of coffee cherries by wet and dry method; processing technology for coffee; preparation of brew; processing technology for instant coffee and decaffeinated coffee; Nitrous coffee; Specialty coffee, Introduction to coffee cupping/tasting.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
COCOA PROCESSING Cocoa bean-introduction, history and composition; processing of cocoa bean; processed products of cocoa such as cocoa powder,	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. The complete book on cultivation and manufacture of tea. Panda H, 2nd revised edition, Asia Pacific Business Press Inc., NIIR
2. Coffee-growing, processing, sustainable production. Wintgens J.N., Wiley- VCH, 2004.
3. Cocoa production and processing technology. Afoakwa EO. Taylor and Francis group, 2014
4. Handbook on Spices and Condiments (Cultivation, Processing and Extraction).Panda H. Asia Pacific Business Press Inc., NIIR, 2010
5. Small-scale cashew nut processing. Azam-Ali S.H. and Judge E.C. FAO, 2001
6. Vanilla-post harvest operations. InPho-Post harvest compendium. Javier De La Cruz Medina , Guadalupe C. Rodriguez Jiménes, and Hugo S. García. FAO, 2009

Web links and Video Lectures (e-Resources):

1. http://ecoursesonline.iasri.res.in/course/view.php?id=156
2. https://onlinecourses.nptel.ac.in/noc22_ag13/preview
3. https://www.youtube.com/watch?v=x-m3SnyURa8
4. https://www.youtube.com/watch?v=0eBEmkB3tyE

@# 03112023

Skill Development Activities Suggested

1. Coffee Brewing via different methods/machines
2. Coffee cupping/Tasting
3. Preparation of Tea variants
4. Spice powder/paste/sauce preparation

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand different types of spices and their importance	L1, L2
CO2	Understand the methods of processing of different spices & dry fruits	L3, L4
CO3	Understand and create strategies for processing of tea leaves to obtain different kinds of tea	L3, L4, L5, L6
CO4	Understand the processing of coffee to obtain different kinds of coffee	L3, L4, L5, L6
CO5	Understand and create strategies for processing of cocoa bean to obtain different products of cocoa	L3, L4, L5, L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

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

Semester III

Process Control and Instrumentation In Food Industry (PEC-3)			
Course Code	22FDT322	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To apply pressure and humidity related equipments for food related measurements
- To apply and analyze gravimetric methods for food related measurements
- To apply chromatographic and MS methods for food analysis
- To evaluate different spectroscopic methods for food analysis
- To evaluate different analytical, electron microscopic methods and sensors for food analysis

Module-1

INTRODUCTION

Instruments for temperature, pressure, humidity measurements - types, calibration. Pressure gauge, basic concept of pneumatic pressure transmitter, pressure current and pressure resistance transducers.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
PROPERTIES AND PROCESS CONTROL Positive displacement meter, Weight measurement- mechanical scale, electronic tank scale, conveyor scale, measurement of specific gravity, measurement of humidity, measurement of viscosity, measurement of density, automatic valves. Definition of process control, simple system analysis, dynamic behavior of simple process, Laplace transform.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
INSTRUMENTATION AND ANALYTICAL METHODS Ionization techniques, scanning technique, application of GC/MS, LC/MS and Linked scan techniques. Basic principles of chromatography. Paper chromatography, thin layer chromatography, HPLC (High performance liquid chromatography), Gas chromatography, Application in food analysis.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
SPECTROSCOPY AND SPECTRAL ANALYTICAL METHODS Introduction and principles of Spectrophotometry and Atomic absorption spectroscopy. Electromagnetic spectrum – The NMR Phenomenon – Types of information provided by NMR spectra, application of NMR to Food analysis.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
INSTRUMENTAL ANALYSIS OF FOOD QUALITY	

analyzer, e–sensors, biosensors, Nitrogen analyzers.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Introduction to Analytical Chemistry: Instrumental methods of chemical analysis. B.K Sharma, Goel Publishing House, 23rd Edition, 2004
2. Process System Analysis and Control. Donald R Coughanowr and Steven E. LeBlanc, Mc-Graw Hill's, 3rd Edition, 2009Cocoa production and processing technology. Afoakwa EO. Taylor and Francis group, 2014
3. Principles of Industrial Instrumentation. D. Patranabis, Tata Mc-Graw Hill, 1976
4. Transducers and Instrumentation. D.V.S. Murty, Prentice Hall India, 2nd Edition, 2008
5. Food Processing Handbook. James G. Brennan and Alistair S. Grandison, Wiley-VCH Verlag GmbH & Co. KGaA, 2011

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=mfaNvvcTrt4
2. https://www.youtube.com/watch?v=sj0PsMFpTKY
3. https://www.youtube.com/watch?v=lhTJRFU6og4
4. https://archive.nptel.ac.in/courses/103/105/103105064/

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply pressure and humidity related equipments for food related measurements	L1, L2, L3
CO2	Apply and analyze gravimetric methods for food related measurements	L1, L2, L3, L4
CO3	Apply chromatographic and MS methods for food analysis	L1, L2, L3
CO4	Evaluate different spectroscopic methods for food analysis	L1, L2, L3, L4, L5
CO5	Evaluate different analytical, electron microscopic methods and sensors for food analysis	L3, L4, L5, L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				3	
CO2				3	
CO3				3	
CO4				3	
CO5				3	

Semester III

Agricultural Biotechnology (PEC-3)			
Course Code	22FDT323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand conventional crop improvement programs and the role agricultural biotechnology in food security and national economy
- To apply biotechnological approaches for crop improvement
- To apply plant tissue cultural methods for crop improvement
- To evaluate uses of antisense RNA technology and biotechnology in agriculture
- To evaluate legal and socioeconomic impacts of biotechnology

Module-1

INTRODUCTION

Staple food, fiber, fuel and fruit crops of India and abroad, Agro-climatic zones and cropping pattern of India. Conventional crop improvement programs- Introduction, Selection and Hybridization, Mutation, Haploidy and Polyploidy Breeding. Modern agriculture biotechnology for food security and national economy. Green-revolution.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
APPLICATIONS OF BIOTECHNOLOGY IN AGRICULTURE Productivity and performance, disease resistance, genes and gene constructs used for viral resistance by coat protein mediated production, bacterial resistance by lysozyme gene and fungal resistance by chitinase and beta glucanase genes. Agrobacterium mediated tranformation. Crop improvement to resist adverse soil conditions. Salinity tolerance, drought resistance. Herbicide resistance in commercially important plants. Insecticide resistance through BT-gene.Integrated pest management. current status of BT crops in the world. Effect of transgenic crops on environment.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	

<table>
<tr><td colspan="2">PLANT TISSUE CULTURE
Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; plant regeneration-organogenesis, somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Role of tissue culture in rapid clonal propagation, production of pathogen free plants and "synthetic seeds"; haploid production: advantages and methods. Protoplast technology.</td></tr>
<tr><td>Teaching-Learning Process</td><td>Include traditional teaching learning process such as Chalk and Talk using writing boards.
Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.
Collaborate with students how tools are applied to solve biological problems.
Integrate real time case studies in various scientific tools used.
Reflective approaches on analysing how and why the tools are used in self-reflected or published data.
Incorporate Inquiry based approach using demonstration, field study, experiments and project work</td></tr>
<tr><td colspan="2">Module-4</td></tr>
<tr><td colspan="2">ANTISENSE RNA TECHNOLOGY AND BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE
Antisense RNA technology (ACC synthase gene and polygalacturonase): Delay of softening and ripening of fleshy fruits by antisense RNA for ACC synthase gene in tomato and banana. Use of antisense RNA technology for extending shelf life of fruits and flowers. Protection of cereals, millets and pulses following harvest using biotechnology. Biotechnology for fortification of agricultural products-Golden rice, transgenic sweet potatoes. Importance of biofertlilizers in agriculture:(Rhizobium azatobacter, Mycorrhiza, Frankia and Blue green algae) current practices and production of biofertilizers.</td></tr>
<tr><td>Teaching-</td><td>Include traditional teaching learning process such as Chalk and Talk using writing boards.</td></tr>
</table>

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
AN OVERVIEW OF LEGAL AND SOCIOECONOMIC IMPACT OF BIOTECHNOLOGY Biotechnology & hunger. Ethical issues associated with labeling and consumption of GM foods. Public perception of GM technology. Biosafety management. Cartagena protocol on biosafety. Ethical implication of BT products, public education, Biosafety regulations, experimental protocol approvals, guidelines for research, environmental aspects of BT applications.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Biotechnology- Expanding Horizons. B.D. Singh, Kalyani Publishers, 4th Edition, 2012
2. Crop Biotechnology. K. Rajashekaran, T.J. Jacks and J.W. Finley, American Chemical Society, 1st Edition, 2002 \
3. Textbook of Agricultural Biotechnology. Ahindra Nag, PHI learning publication, 1st Edition, 2008
4. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani and M.K. Razdan, Elsevier Science, 1996
5. Plant biotechnology in Agriculture. K. Lindsey and M.G.K. Jones, Prentice Hall, 1990
6. Plant Biotechnology and Agriculture- Prospects for the 21st Century. Arie Altman and Paul Hasegawa, Academic Press, 1st Edition, 2011
7. Agricultural Biotechnology in Developing Countries: Towards Optimizing the Benefits for the Poor. Ed: Matin Qaim, Anatole F. Krattiger, Joachim von Braun, Springer, 1st Edition, 2000

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=z6x1HZDQtKQ
2. https://www.youtube.com/watch?v=VsYax7b09GU
3. https://www.digimat.in/nptel/courses/video/102104069/L32.html
4. https://www.digimat.in/nptel/courses/video/102106080/L01.html
5. https://www.digimat.in/nptel/courses/video/102104088/L29.html

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand conventional crop improvement programs and the role agricultural biotechnology in food security and national economy	L1, L2, L3
CO2	Apply biotechnological approaches for crop improvement	L1, L2, L3, L4
CO3	Apply plant tissue cultural methods for crop improvement	L1, L2, L3
CO4	Evaluate uses of antisense RNA technology and biotechnology in agriculture	L1, L2, L3, L4, L5
CO5	Evaluate legal and socioeconomic impacts of biotechnology	L3, L4, L5, L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3		
CO2			3		
CO3			3	3	
CO4			3	3	
CO5			3		

Semester III

Biosafety and Bioethics (PEC-3)			
Course Code	22FDT324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand public issues, benefits and challenges with respect to biotechnology
- To evaluate legal, institutional,bioethical and socioeconomic impacts of biotechnology
- To evaluate and manage biosafety concerns at the level of individuals, institutions, society, region, country and the world
- To evaluate biosafety regulations and national and international guidelines with respect to biotechnology products
- To evaluate the impact of biotechnology products and practices on the environment

Module-1

BIOTECHNOLOGY AND SOCIETY

Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology, Biotechnology and hunger, Challenges for the Indian Biotechnological research and industries.

Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.
Learning	Construct graphical and pictorial representation of the subject in the form of Chart, hand outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
LEGAL ISSUES & BIOETHICS Legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies. Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR,technology transfer and other global biotech issues.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	

Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship among risk,hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques. Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
REGULATIONS Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
BIOTECHNOLGY IMPACT ON THE ENVIRONMENT The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers' rights. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in clinical trials.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Biotechnology and Safety Assessment. John A. Thomas and Roy L. Fuchs, Academic Press, 3rd Edition, 2002
2. Biological safety Principles and practices. D.O. Fleming and D.L. Hunt, ASM Press, 3rd Edition, 2000
3. Biotechnology: A Multi-Volume Comprehensive Treatise Legal Economic and Ethical Dimensions. H.J.Rehm and G. Reed, Vch Verlagsgesellschaft Mbh, 1995
4. Bioethics: An Introduction for the Biosciences. Ben Mepham, Oxford University Press, 2nd Edition, 2008
5. Bioethics & Biosafety. R. Rallapalli & Geetha Bali, APH Publication, 2007
6. Bioethics & Biosafety. M.K. Sateesh, I. K. International, 2008
7. Biotechnologies and Development. Albert Sasson, UNESCO Publications, 1988
8. Biotechnologies in Developing Countries: Present and Future Regional and Sub-regional Co-operation and Joint Ventures. Albert Sasson, UNESCO Publishing, 1993

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=gxm5ZLRGsoE
2. https://www.youtube.com/watch?v=R0s-Y8ugXSk
3. https://archive.nptel.ac.in/courses/109/106/109106092/
4. https://www.youtube.com/watch?v=APq3g7WYs6k
5. https://www.youtube.com/watch?v=4GviNafYdS4

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand public issues, benefits and challenges with respect to biotechnology	L1, L2, L3
CO2	Evaluate legal, institutional, bioethical and socioeconomic impacts of biotechnology	L1, L2, L3, L4
CO3	Evaluate and manage biosafety concerns at the level of individuals, institutions, society, region, country and the world	L1, L2, L3
CO4	Evaluate biosafety regulations and national and international guidelines with respect to biotechnology products	L1, L2, L3, L4, L5
CO5	Evaluate the impact of biotechnology products and practices on the environment	L3, L4, L5, L6

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			**3**	2	
CO2				3	
CO3				3	
CO4				3	
CO5				3	

Semester III

Biochemistry and Human Nutrition (PEC-3)			
Course Code	22FDT325	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To evaluate nutritional requirements of individuals
- To understand enzyme kinetics
- To understand metabolism of carbohydrates, lipids and proteins
- To evaluate and correlate the ill-effects of deficiency of different micro nutrients
- To analyze and learn how to restore deficient nutrients by fortification and supplementation

Module-1

INTRODUCTION TO NUTRITION

Nutrition, malnutrition, functions of food, basic food groups, nutritional needs, requirements and recommended allowances of foods.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
ENZYMOLOGY Mechanism of enzyme action, coenzymes, enzyme kinetics, Derivation of Michaelis-Menten Equation.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
METABOLISM Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings. Metabolism of carbohydrates: Respiration, Metabolism of lipids, Metabolism of proteins.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
MINERALS, VITAMINS AND HORMONES Functions, sources, factors affecting absorption of minerals, absorption promoters and inhibitors, effect of deficiency of Calcium, phosphorus, iron, zinc, iodine, fluorine and copper. Vitamins and hormones.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
NUTRITIONAL DEFICIENCY AND FOOD PROCESSING Classification, functions, sources, effects of deficiency. Changes during food processing operations, restoration, enrichment, fortification and supplementation of foods.	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Textbook of Nutrition and Dietetics. Kumud Khanna, Sharda Gupta, Santosh Jain Passi, Rama Seth, Ranjana Mahna and Seema Puri, Elite Publishing House Pvt. Ltd., 2nd Edition, 2016
2. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson and M.M. Cox, W. H. Freeman, 4th Edition, 1993
3. Textbook of Biochemistry. E. S. West, W. R. Todd, H. S. Mason, and J. T. Van Bruggen, MacMillan, 4th Edition, 1966
4. Nutrition and Dietetics. Shubhangini A. Joshi, Tata Mc Grow- Hill publishing Company Ltd, 1992
5. Biochemistry of Foods. N.A.M Eskin, Academic Press, 1st Edition, 1971
6. Food Chemistry. O.R. Fennema, Marcel Dekkar Inc, 3rd Edition, 1996
7. Essentials of Food and Nutrition. M. S. Swaminathan, Ganesh and Co, 1st Edition, 1974
8. Outlines of Biochemistry. Eric E. Conn and P.K. Stumpf, John Wiley and Sons, 3rd Edition, 1972

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=HLzB3miHWM8
2. https://www.youtube.com/watch?v=CU3J9UGzRL0
3. https://www.youtube.com/watch?v=zLZwbOZMesY
4. https://www.youtube.com/watch?v=XzCGonFs0k0
5. https://www.digimat.in/nptel/courses/video/102105034/L01.html
6. https://www.youtube.com/watch?v=BbKi6ExQdxo

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.● Model making and Poster presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Evaluate nutritional requirements of individuals	L1, L2, L3
CO2	Understand enzyme kinetics	L1, L2, L3
CO3	Understand metabolism of carbohydrates, lipids and proteins	L1, L2, L3
CO4	Evaluate and correlate the ill-effects of deficiency of different micro nutrients	L1, L2, L3, L4, L5
CO5	Analyze and learn how to restore deficient nutrients by fortification and supplementation	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	PO4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	PO5

Mapping of COS and POs

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

Semester III

Food Business Management and Entrepreneurship Development (PEC-4)			
Course Code	22FDT331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the fundamentals of project management and entrepreneurship development
- To learn the project formulation and market survey techniques
- To learn the network and project schedules
- To learn the project costs
- To learn the Learn launching and organizing of an enterprise

Module-1

INTRODUCTION
Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development.

Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
PROJECT FORMULATION: Market survey techniques, project identification, project selection, project proposal, work breakdown structure	
Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
Network scheduling: Activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources	
Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
BUSINESS Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector. Government policies for promotion of entrepreneurship in food processing	
Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
ENTERPRISE Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis, resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. An Introduction to Business (v.1). Collins K. creativecommons.org, 2012 2.Economics and Management of the Food Industry. Jeffrey H. Dorfman, Routledge, 1st Edition, 2013
2. Food and Beverage Management. Partho Pratim Seal, Oxford University Press; 1st Edition, 2017
3. Food Industry: Food Processing and Management. Lisa Jordan, Callisto Reference, 2015
4. Fundamentals of Entrepreneurship. Nandan H., Prentice Hall India Learning Private Limited; 3rd Edition, 2013
5. Management in Engineering: Principles and Practice. Gail Freeman-Bell and James Balkwill, Prentice Hall, 1993
6. Operations Research: An Introduction. Hamdy A. Taha, Pearson Publication, 9th Edition, 2010
7. Project Management. K. Nagarajan, New Age International Pvt Ltd; 8th Edition, 2017

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=MO6EOMd-CkA
2. https://www.youtube.com/watch?v=eZgv1BW1lCU
3. https://www.youtube.com/watch?v=n6YIXmUEoYA
4. https://www.youtube.com/watch?v=64Z__faxcr0

Skill Development Activities Suggested

- Class Presentations and discussions of research articles from publications.
- Online tools for surprise quizzes.
- Collection of case studies via Newspapers/Journal articles, on topics covered.
- Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Le
CO1	Understand fundamentals of project management and entrepreneurship development	L1, L2, L3,
CO2	Understand project formulation and market survey techniques	L1, L2, L3,
CO3	Create network and project schedules	L1, L2, L3,
CO4	Evaluate project costs	L1, L2, L3,
CO5	Learn launching and organizing of an enterprise	L1, L2, L3,

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO 1
2	An ability to write and present a substantial technical report/document.	PO 2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO 3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society.	PO 4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products.	PO 5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			3	3	
CO2			3	3	
CO3			3	3	
CO4			3	3	
CO5			3	3	

Semester III

Nanotechnology in food industry (PEC-4)			
Course Code	22FDT332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand nanotechnology for improving food quality and detection of contaminants
- To understand nano ingredients and additives
- To apply Nanotechnology in Agriculture and Food Technology fields
- To apply Nano technology in packaging
- To evaluate the risks associated with nanotechnology

Module-1

Introduction

Definition of nanotechnology, development, application of nanoscale materials, AFM, natural food nano substances and nanostructure – carbohydrate, protein, emulsion. Nanotechnology fo improving food quality, detection of contaminants

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
Nano Ingredients and additives Nano Ingredients and additives: Nano materials for food applications- metal oxides, functionalized nanomaterials, nano additives, relation to digestion	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
Nanotechnology in Agriculture and Food Technology Nanotechnology in Agriculture and Food Technology Nanotechnology in Agriculture - Precision farming, Smart delivery system Nanofertilizers: Nanourea and mixed fertilizers, Nanofertigation Nanopesticides, Nanoseed Science. Nanotechnology in Food industry Nanopackaging for enhanced shelf life - Smart/Intelligent packaging - Food processing and food safety and bio-security – Electrochemical sensors for food analysis and contaminant detection.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
Nano technology in packaging Nano technology in packaging: Nano technology in food packaging, nano composites, nano coatings. Role in active packaging, intelligent packaging. Nano sensor. Nano membrane Potential Benefits and hazards. Industrial benefits, consumer benefits, Detection and characterization of nanoparticles in food, exposure, potential hazards	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	

Risks associated with nanotechnology Risks associated ENP, health risks- toxins, metabolism action etc. Risk governance- principle Regulations. General regulations, safety aspects in different regions, Regulation aspects of nano scale food ingredients, additives, FCMS.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve food technology problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

The question paper will have ten full questions carrying equal marks.

Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1.P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006.

2. J. Altmann, Routledge, Military Nanotechnology: Potential Applications and Preventive Arms Control, Taylor and Francis Group, 2006.

3. Introduction to nanotechnology - Charles P. Poole; Frank J. Owens – 2008 – Wiley.

4. Nanotechnologies in Food – Qasim Chaudhary, Laurence Castle, Richard Watkins - 2010- RSC Publishing

5. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).

6. Q. Huang -Nanotechnology in the Food, Beverage and Nutraceutical Industries. Woodhead Publishing 2. Limited - 2010

7. Lestie prey, "Nanotech in food products", Wiley publications 2010.

8. Pandua W., "Nanotech research methods for foods and bioproducts", Wiley publications 2012.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/111107113
2. https://archive.nptel.ac.in/courses/102/106/102106051/ https://onlinecourses.nptel.ac.in/noc22_ma20/preview
3. https://archive.nptel.ac.in/courses/126/105/126105015/
4. https://onlinecourses.nptel.ac.in/noc22_ma33/preview

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand nanotechnology for improving food quality and detection of contaminants	L1, L2, L3,
CO2	Understand nano ingredients and additives	L1, L2, L3,
CO3	Apply Nanotechnology in Agriculture and Food Technology fields	L1, L2, L3,
CO4	Apply Nano technology in packaging	L1, L2, L3,
CO5	Evaluate the risks associated with nanotechnology	L1, L2, L3,L4,L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				**3**	**2**
CO2				**3**	
CO3				**3**	
CO4				**3**	
CO5			**2**	**3**	

Semester III

Food Allergies and Allergens (PEC-4)			
Course Code	22FDT333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand food allergies and allergens
- To understand Factors affecting food allergenicity
- To analyze Characteristics of food allergenictiy
- To Manage food allergenicity
- To evaluate Preventive measures for food allergies and Regulatory and labelling procedures

Module-1

INTRODUCTION

Introduction to food allergies and allergens: Overview of food allergies, allergens, immune system, antigen antibody interactions; sign & symptoms of food allergy; global prevalence of food allergies; classification of hypersensitivity reactions, use of bioinformatics in understanding and identification of potential cross allergens.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
Factors: food allergies and allergens Factors affecting food allergenicity, issues related to food additives and ingredients, genetic inheritance of food allergy, Immunological response, Oral allergy syndrome, GM foods and risk of allergy.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
Characteristics of food allergenicity Natural sources and chemistry of food allergens, handling of food allergies; Detection & Diagnostic techniques for allergy, limitations of food allergy diagnostic techniques; Characterization of allergens, food sensitivities (anaphylactic reactions, metabolic food	

disorders and idiosyncratic reactions).	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
Management of food allergenicity Principles of management of food allergens including detailed knowledge of avoidance measures; Application of Genetic modification to reduce allergenicity; Methods used in safety evaluation-risk assessments	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data.

Module-5	
Preventive measures for food allergies and Regulatory and labelling procedures: Prevention of allergic disease by primary, secondary and tertiary methods including aspects of epidemiology, hygiene and allergic march hypotheses; Case studies of reported food allergies and related food recalls. Hypoallergenic foods and dietary management of allergy, effect of processing treatments on food allergenicity; Regulatory procedures for food allergens at national and international level; Labelling guidelines.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

. The question paper will have ten full questions carrying equal marks.

. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1.Judy Owen, Jenni Punt, Sharon Stranford. (2013). Immunology by Kuby. 7th edition

2. S Flanagan. (2014). Handbook of Food Allergen Detection and Control, Simon Flanagan. 1st edition Woodhead publishing .

3. Scott H. Sicherer. (2013). Food Allergy: Practical Diagnosis and Management. 1st edition CRC Press.

4. Ebisawa M. Sagamihara, Ballmer-Weber B.K. Zurich, Vieths S. Langen and Wood.

5. R.A. Baltimore, Md. (2015). Food Allergy: Molecular Basis and Clinical Practice. Karger Publishing.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/111107113
2. https://archive.nptel.ac.in/courses/102/106/102106051/ https://onlinecourses.nptel.ac.in/noc22_ma20/preview
3. https://archive.nptel.ac.in/courses/126/105/126105015/
4. https://onlinecourses.nptel.ac.in/noc22_ma33/preview

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	understand food allergies and allergens	L1, L2, L3,
CO2	understand Factors affecting food allergenicity	L1, L2, L3,
CO3	analyze Characteristics of food allergenictiy	L1, L2, L3,L4
CO4	Manage food allergenicity	L1, L2, L3,L4,L5
CO5	evaluate Preventive measures for food allergies and Regulatory and labelling procedures	L1, L2, L3,L4,L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

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

Semester III

Biomaterials and Applications (PEC-4)			
Course Code	22FDT334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

1. To understand structure of biomaterials and biocompatibility
2. To understand metalic and ceramic materials
3. To understand synthetic and biopolymers
4. To apply biomaterials for the synthesis of artificial organs
5. To apply biomaterials in medical field

Module-1

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY

Definition and classification of bio-materials, mechanical properties, composite materials, Nanomaterials and nanocomposites, Tissue-biomaterial interactions, biomaterial characterization, medical devices, Testing of biomaterials: In-vitro, invivo pre-clinical tests, safety and biocompatibility evaluation

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
METALIC AND CERAMIC MATERIALS Metallic implant materials, stainless steels, Co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydro-apatite, glass ceramics, carbons.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
SYNTHETIC AND BIOPOLYMERS Polymerization, poly amides, Acrylic polymers, rubbers, high strength thermoplastics, Bio polymers: Collagen, Hyaluronic acid, chitosan and Elastin.	
Teaching-	Include traditional teaching learning process such as Chalk and Talk using writing boards.

Learning Process	Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
ARTIFICIAL ORGANS Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally powered limb prosthesis, Dental Implants, Artificial cornea, Artificial liver and pancreas, artificial skin.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
APPLICATIONS Medical applications of biomaterials, Drug delivery, Bioinspired Materials and Biomimetics, Tissue engineering, Regenerative	

engineering and organ printing, global regulatory requirements, technology transfer and ethical issues	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

. The question paper will have ten full questions carrying equal marks.

. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1.VasifHasirci, NesrinHasirci, Fundamentals of Biomaterials, Springer, 2018

2. Shayne Cox Gad, Samantha GadMcDonal, Biomaterials, Medical Devices, and Combination Products - Biocompatibility Testing, CRC press, 2015

3. Joon B. Park, Roderic S. Lakes, Biomaterials – An Introduction, Springer, 2010

4. Hench L. Larry and Jones J. Biomaterials, Artificial organs and Tissue Engineering, Woodhead Publishing Limited, 2005

5. Marek J. Los, AndrzejHudecki, Emilia Wiechec, Associated press, 2018

Web links and Video Lectures (e-Resources):

5. https://nptel.ac.in/courses/111107113
6. https://archive.nptel.ac.in/courses/102/106/102106051/ https://onlinecourses.nptel.ac.in/noc22_ma20/preview
7. https://archive.nptel.ac.in/courses/126/105/126105015/
8. https://onlinecourses.nptel.ac.in/noc22_ma33/preview

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	understand structure of biomaterials and biocompatibility	L1, L2, L3,
CO2	understand metalic and ceramic materials	L1, L2, L3,
CO3	understand synthetic and biopolymers	L1, L2, L3,
CO4	apply biomaterials for the synthesis of artificial organs	L1, L2, L3,
CO5	apply biomaterials in medical field	L1, L2, L3,

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
2	An ability to write and present a substantial technical report/document	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	3
4	Students should be able to acquire technical, research, managerial and entrepreneurial skills related to food technology so that they can analyze, evaluate and solve problems related to food and adapt to changing needs of industry and society	4
5	Students should be able to evaluate food quality and safety & apply food laws and regulations for acceptability of food products	5

Mapping of COS and POs

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

Semester III

Biosensors and applications (PEC-4)			
Course Code	22FDT335	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

1. To understand characteristics of biosensors
2. To understand transducers
3. To analyze biochemical recognition problems
4. To evaluate integrated biosensors
5. To apply biosensors in various fields

Module-1

BIOSENSOR CHARACTERISTICS

Definition and components of biosensor, Basic measurement system, Measurement, Measureand, Errors in Measurements, Signal and Noise, Calibration, Method validation, Surface chemistry, Mass transport, Static characteristics- accuracy, precision, linearity, hysteresis, threshold; dynamic range, Dynamic Characteristics – response time, damping, calibration, standards and AC/DC bridges, Biocompatibility and surface fouling, sensor integration and systems fabrication.

Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
TRANSDUCERS Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminescence - based Biosensors, Quantum dots, Fluorescence, Raman Spectroscopy and Fluorescence Enhancement and DNA microarrays	
Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	
BIOCHEMICAL RECOGNITION Chemical reactions: history of gravimetric and colorimetric reactions. Problems of specificity.Enzymes: biological catalysts, specificity, activity, storage/shelf life. Enzyme kinetics in solution and on a surface. Chemical equilibrium- forcing an unfavorable reaction. Cells: Signal transduction through chemoreception, membrane potential, cell metabolism, cytotoxicity,	

Nucleic Acids (RNA and DNA): Basic biochemistry, hybridization; Amplification/self-replication; Secondary Structure and folding Aptamer (oligonucleotide) based recognition and molecularly imprinted polymers. Common assaying formats i) Labels: Radioisotopes, fluorophores, dyes, enzymes/substrates, liposomes, electroactive compounds. ii) ELISAs and nucleotide capture assays.	
Teaching - Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
MODERN INTEGRATED BIOSENSORS Bioelectronic sensors (Fundamentals of microelectronics and CMOS based sensors) Biophotonic sensors (Fundamentals of photonic sensors, Resonant optical sensors, Plasmonic sensors) Biomechanical sensors (Principles of micro-electromechanical (MEM) resonators and sensors) Microfluidic devices for Lab-on-a-chip (Fabrication, Devices and techniques) Application of nanotechnology in bio sensing (Nanoparticles, Active nanochannels, Nanoelectronic, Nanophotonic and Nanomechanical sensors). Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly, Assembly of photonic biomolecular memory store; Information processing; commercial prospects for biomolecular computing systems Chemometrics, Biosensor arrays;	

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Module-5

APPLICATIONS

Biosensor applications in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food, Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment, Mobile/Point of Care biosensors

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

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. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. F.-G. Bănică, Chemical Sensors and Bios ensors: Fundamentals and Applications, wiley, 2012
2. B.D. Malhotra, A.P.F.Turner, Advances in Biosensors, Elsevier, 2003
3. I.Willner, E.Katz, Bioelectronics: From Theory to Applications, Wiley-VCH Verlag GmbH, 2006
4. Bilitewski, U.Turner, Biosensors for environmental monitoring, A.P.F. Harwood, Amsterdam, 2000

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/111107113
2. https://archive.nptel.ac.in/courses/102/106/102106051/ https://onlinecourses.nptel.ac.in/noc22_ma20/preview
3. https://archive.nptel.ac.in/courses/126/105/126105015/
4. https://onlinecourses.nptel.ac.in/noc22_ma33/preview

Skill Development Activities Suggested

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2. Online tools for surprise quizzes.
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4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Le
CO1	understand characteristics of biosensors	L1, L2, L3,
CO2	understand transducers	L1, L2, L3,
CO3	analyze biochemical recognition problems	L1, L2, L3,L4
CO4	evaluate integrated biosensors	L1, L2, L3,L4, L5
CO5	apply biosensors in various fields	L1, L2, L3,L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	1
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Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1				**2**	
CO2				**2**	
CO3	**2**		**2**	**2**	
CO4	**2**		**2**	**2**	
CO5	**2**		**2**	**3**	