

Curriculum
of
Diploma Programme
in
Food Processing & Preservation



State Board of Technical Education (SBTE)
Bihar

Semester – IV
Teaching & Learning Scheme

Board of Study	Course Codes	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
	2449401	Food Fermentation Technology	3	-	4	2	9	6
	2449402	Flesh Food Technology	3	-	4	2	9	6
	2449403	Dairy Technology	3	-	4	2	9	6
	2449404	Food Hygiene and Sanitation	3	-	4	2	9	6
	2449405	Fruits and Vegetables Technology	3	-	4	2	9	6
Total			15	-	20	10	45	30

Legend:

- CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)
- LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)
- Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.
- TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)
- SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.
- C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - IV
Assessment Scheme

Board of Study	Course Codes	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
	2449401	Food Fermentation Technology	30	70	20	30	20	30	200
	2449402	Flesh Food Technology	30	70	20	30	20	30	200
	2449403	Dairy Technology	30	70	20	30	20	30	200
	2449404	Food Hygiene and Sanitation	30	70	20	30	20	30	200
	2449405	Fruits and Vegetables Technology	30	70	20	30	20	30	200
Total			150	350	100	150	100	150	1000

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

- A) **Course Code** : 2449401(T2449401/P2449401/S2449401)
- B) **Course Title** : Food Fermentation Technology
- C) **Pre-requisite Course(s)** : Food Microbiology
- D) **Rationale** :

Fermentation technology is an important branch of food industry which manufactures alcoholic beverages like Beer, Wine, Whisky, Vodka, gin, Rum, some traditional food products and raw materials for food processing. Students require having basic knowledge of fermentation technology, Principles, Culture, Industrial media, Fermentation processing steps, Parameters, Processing equipment used for these processes. This subject covers major fermentation food products production and the FSSAI quality standards for their production.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- CO-1** Outline process of food fermentation, types and construction industrial fermenter.
- CO-2** Apply the fermentation process and prepare the traditional products as per FSSAI standards.
- CO-3** Produce the beer and wine as per FSSAI standers.
- CO-4** Use control fermentation process to produce good quality yeast and vinegar for food processing.
- CO-5** Outline the manufacturing of distilled alcoholic beverages as per FSSAI standards.

- F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	-	-	2	-	-	3		
CO-2	3	2	2	2	-	-	2		
CO-3	3	2	-	2	2	-	2		
CO-4	3	2	-	2	2	-	2		
CO-5	3	-	-	2	2	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Food Processing and Preservation	2449401	Food Fermentation Technology	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Food Processing and Preservation	2449401	Food Fermentation Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units: T2449401**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 1a.</i> Define the terms in Fermentation Technology. <i>TSO 1b.</i> Draw the sketch of aerobic bioreactor. <i>TSO 1c.</i> Describe the process of typical fermentation. <i>TSO 1d.</i> Prepare the industrial important culture and media. <i>TSO 1e.</i> Select the raw material for industrial fermentation media. <i>TSO 1f.</i> Identify the parameters affected on rate of fermentation process. <i>TSO 1g.</i> State the role of enzymes in food fermentation. <i>TSO 1h.</i> Describe the Upstream and Downstream process in fermentation process.	Unit-1.0 Introduction to Fermentation Technology 1.1 Definition of fermentation, benefits of fermentation in food Processing, importance of Glycolysis in Fermentation process. 1.2 Typical fermentation process, Types of fermentation process, Construction of Industrial fermenter and its accessories. 1.3 Cultures: Uses of microbial food cultures in food: Bacteria, Yeast, Mold, Microbial growth phases, Maintenance and preparation of industrially Important cultures 1.4 Media: Types of media, Media composition and sources, Carbon Sources, Nitrogen Sources, Sources of Growth Factors, Precursors, inhibitors and antifoaming agents. 1.5 Sterilization of fermentation media and air 1.6 Enzymes: Definition of enzyme, role of enzyme in fermentation and enzymes used in food fermentation.	CO1
<i>TSO 2a.</i> State the principle involved in tradition fermented food processing. <i>TSO 2b.</i> Name the raw material and microorganisms involved in Idli and Dhokal processing. <i>TSO 2c.</i> Draw the production process flow sheet of Soya-sauce. <i>TSO 2d.</i> Name the raw material and microorganisms used soya-sauce production. <i>TSO 2e.</i> Draw the production process flow sheet with process parameters required to control in fermented dairy products.	Unit-2.0 Traditional Fermented Products 2.1 Cereal and legume base -Idli, Dosa and Dhokla: Raw materials, microorganism and production process 2.2 Legume base-soya sauce- Raw materials, microorganism, Role of Ingredients, flow diagram of preparation with its control parameters during fermentation process. 2.3 Fermented fruit products: Mango pickle: Raw materials, microorganisms, production process. 2.4 Fermented Dairy Products: Cheese, Curd Yoghurt, and Butter: Raw materials, microorganism mechanism and production process flow diagram with its control parameters during fermentation process.	CO1, CO2
<i>TSO 3a.</i> Name the raw material and their role in brewing. <i>TSO 3b.</i> Give the FSSAI specification for any two	Unit-3.0 Wine and Beer Production 3.1 Brewing: raw materials and its role, Types of beer, Process of Malting of barley.	CO3, CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
types of beer. <i>TSO 3c.</i> Describe the Mashing process in brewing. <i>TSO 3d.</i> State the changes occurred in brew kettle boiling. <i>TSO 3e.</i> Draw the production process of lager beer with process parameters. <i>TSO 3f.</i> Describe the analysis of beer with respect to total acidity and Total solid content. <i>TSO 3g.</i> Classify the wines. <i>TSO 3h.</i> Give the FSSAI specifications of any two types of wine. <i>TSO 3i.</i> Draw the production process of white wine with process parameters. <i>TSO 3j.</i> Describe the Malolatic fermentation and aging of wine. <i>TSO 3k.</i> Describe the wine standardization process. <i>TSO 3l.</i> Draw the production process of Sparkling wine with process parameters.	3.2 Mashing, brew kettle boiling, brewing, carbonation, packaging, Pasteurization, defects and quality control of beer. 3.3 Analysis of Beer- Total acidity, free acidity, Volatile acidity, Alcohol content, total solids and Ash. 3.4 Wine production: Definition, Classification of wine of wine as per FSSAI norms. 3.5 Process technology of white wine grape pre-processing-grape juice treatment, fermentation, malolatic fermentation, clarification, aging, standardization, defects and quality control of wine and packaging process. 3.6 Production Process of Red and Rose. 3.7 Production Process of fortified and sparkling wine. 3.8 Analysis of wine: Acidity, alcohol and Tannins.	
<i>TSO 4a.</i> Enlist the name of yeast cultures and their uses in fermentation process. <i>TSO 4b.</i> Describe the production process of compressed yeast with flow sheet. <i>TSO 4c.</i> Name the equipment's required for yeast cultivation plant. <i>TSO 4d.</i> Compare the compressed yeast and active dry yeast. <i>TSO 4e.</i> Give the FSSAI specification of vinegar. <i>TSO 4f.</i> Describe the mechanism of vinegar production process. <i>TSO 4g.</i> Draw the sketch of quick vinegar production process aerobic bioreactor.	Unit-4.0 Yeast and Vinegar Production 4.1 Yeast Production -Types of yeast and their uses, media and Propagation of yeast. 4.2 Production process of compressed yeast and active dry yeast - media, starter culture, and separation of cells, drying, methods of maintenance, preservation and quality control. 4.3 Types of vinegar, mechanism of acetic acid fermentation. 4.4 Production process- slow process, Orlean's process and quick process, Downstream processing and defects in vinegar	CO3, CO4
<i>TSO 5a.</i> Select suitable raw material and process for distilled alcoholic beverages. <i>TSO 5b.</i> Demonstrate the production process of distilled alcoholic beverages. <i>TSO 5c.</i> Describe the production process of distilled alcoholic beverages.	Unit-5.0 Distilled Alcoholic Beverages 5.1 Whiskey Production process- Malting, milling, cooking, saccharification, fermentation, distillation, aging, standardization and bottling. 5.2 Production process of Rum and Brandy- raw material, production process flow sheet, standardization and FSSAI standers. 5.3 Production process of Gin and Vodka-- raw material, production process flow sheet, standardization and FSSAI standers	CO4, CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449401

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify the raw materials. LSO 1.2. Formulate and prepare the Industrial media.	1.	Prepare one carbon and nitrogen-rich source media by natural resources.	CO1
LSO 2.1. Use aerobic bioreactor. LSO 2.2. Connect all accessories and sterile the fermenter.	2.	Demonstrate and sterilize the laboratory fermenter and its accessories	CO1
LSO 3.1. Select the raw material. LSO 3.2. Formulate and prepare the product. LSO 3.3. Observe natural fermentation process.	3.	Prepare Idli from the required raw material, note the observation, and calculate the approximately cost of idli per pieces.	CO1, CO2
LSO 4.1. Select the raw material. LSO 4.2. Formulate and prepare the product. LSO 4.3. Observe natural fermentation process.	4.	Prepare Dhokla from the required raw material and note the observation and result.	CO1, CO2
LSO 5.1. Select the raw materials. LSO 5.2. Prepare and observe the natural fermentation process.	5.	Prepare the Fruit / Vegetable pickle and calculate the approximately cost per Kg.	CO1, CO2
LSO 6.1. Use the Incubator LSO 6.2. Choose appropriate processing conditions. LSO 6.3. Calculate the app. cost per kg product.	6.	Prepare the Curd and calculate the approximately cost per Kg	CO1, CO2
LSO 7.1. Use incubator and churner. LSO 7.2. Choose appropriate processing conditions LSO 7.3. Calculate the app. cost per kg product	7.	Prepare the white Butter and calculate the approximately cost per Kg.	CO1, CO2
LSO 8.1. Analyze the quality of beer / wine on the basis of acidity.	8.	Determine the total acidity, free acidity and volatile acidity of Beer/wine using the FFSAI analysis manual.	CO3
LSO 9.1. Use the analytical instruments. LSO 9.2. Analyze the quality of wine/beer.	9.	Determine total solids, Suspended solids and dissolved solids in a given sample of Beer/wine by using the FFSAI analysis manual.	CO3
LSO 10.1. Analyze the alcohol content % in sample.	10.	Determine the alcohol content of the beer/wine sample by using the FFSAI analysis manual.	CO3
LSO 11.1. Use the crusher, basket press, fermenter and filtration equipment's. LSO 11.2. Prepare the wine as per FSSAI norms.	11.	Prepare white wine by using suitable raw materials and record the observation and result.	CO1, CO3
LSO 12.1 Prepare the vinegar and observe the changes acidity with respect to time of oxidation.	12	Prepare the Cider/ Wine/ Sprite vinegar and observe the change in acidity with respect to the time of aerobic oxidation.	CO4
LSO 13.1 Identify the activeness of yeast.	13	Evaluate the quality/activity of yeast.	CO4
LSO 14.1 Use distillation apparatus. LOS 14.2 Apply the distillation process on given sample.	14	Prepare the concentrated ethyl alcohol by the distillation process.	CO5

L) Suggested Term Work and Self Learning: S2449401 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Prepare the model of Bioreactor with all accessories.
2. Prepare the mix-vegetable pickle or lime crush pickle and compare with market products as per FSSAI specifications.
3. Prepare the wine by using local fruit or fruit waste.
4. Prepare pomegranate wine by following standards specification required for wine making.
5. Determine the shelf life with respect to its storage conditions in any one food product which is preserved by vinegar.
6. Prepare any one product by using compress yeast and active dry yeast and compare the textural differences with respect to its fermentation time of the same product.
7. Design a chart for distilled and non-distilled alcoholic beverages which demonstrate its alcohol content, total acidity, free acidity, volatile acidity, specific gravity, residue, total solids etc as per FPO specifications and standards.

c. Other Activities:

1. Seminar Topics:
 - Application of enzymes in Food Processing.
 - Probiotic Food.
 - Nutritional value of fermented Foods.
 - Types of media and its composition.
 - FSSAI norms for alcoholic beverages.
2. Visits: Visit nearby Pickle/Wine/Beer/Dairy Processing Industry
3. Self-learning topics:
 - You-tube video on how it's made- Fermented food products

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	-	-	10%	20%
CO-2	20%	25%	20%	25%	25%	30%	20%
CO-3	25%	25%	25%	25%	25%	30%	20%
CO-4	20%	15%	20%	25%	25%	20%	20%
CO-5	15%	15%	15%	25%	25%	10%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Fermentation Technology	8	CO1	12	4	4	4
Unit-2.0 Traditional Fermented Products	12	CO1, CO2	16	4	4	8
Unit-3.0 Wine and Beer Production	14	CO3, CO4	20	6	6	8
Unit-4.0 Yeast and Vinegar Production	08	CO3, CO4	14	4	6	4
Unit-5.0 Distilled Alcoholic Beverages	06	CO4, CO5	08	2	4	02
Total	48	-	70	20	24	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Prepare one carbon and nitrogen-rich source media by natural resources.	CO1	40	40	20
2.	Demonstrate and sterilize the laboratory fermenter and its accessories	CO1	40	40	20
3.	Prepare Idli from the required raw material, note the observation, and calculate the approximately cost of idli per pieces.	CO1, CO2	30	60	10
4.	Prepare Dhokla from the required raw material and note the observation and result.	CO1, CO2	30	60	10
5.	Prepare the Fruit / Vegetable pickle and calculate the approximately cost per Kg.	CO1, CO2	30	60	10
6.	Prepare the Curd and calculate the approximately cost per Kg	CO1, CO2	30	60	10
7.	Prepare the white Butter and calculate the approximately cost per Kg.	CO1, CO2	30	60	10
8.	Determine the total acidity, free acidity and volatile acidity of Beer/wine using the FFSAI analysis manual.	CO3	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
9.	Determine total solids, Suspended solids and dissolved solids in a given sample of Beer/wine by using the FFSAI analysis manual.	CO3	40	50	10
10.	Determine the alcohol content of the beer/wine sample by using the FFSAI analysis manual.	CO3	40	50	10
11.	Prepare white wine by using suitable raw materials and record the observation and result.	CO1, CO3	30	60	10
12.	Prepare the Cider/ Wine/ Sprite vinegar and observe the change in acidity with respect to the time of aerobic oxidation.	CO4	30	60	10
13.	Evaluate the quality/activity of yeast.	CO4	30	60	10
14.	Prepare the concentrated ethyl alcohol by the distillation process.	CO5	40	40	20

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Analytical weight balance	Capacity 500 GM, Accuracy-0.1mg, with all fittings.	All
2.	Laboratory Fermenter	Capacity 5L, Power Consumption-2-5kw with all accessories and fittings	2,11,12
3.	Wet Grinder	Capacity -120 to 150 liter/hour, Material-STAINLESS STEEL	3,4
4.	Electric Idli Steamer	Capacity -80 Idlies, Material-Stainless Steel	3
5.	Incubator	Size-500*527*821 mm, Chamber Volume-100 Litre, Number Of Shelves-3 Shelves, Temperature Range-75 Degree Celsius, Voltage-230 V, Frequency 50 Hz, Accuracy +/- 0.5 Degree Celsius.	6,13
6.	Stainless Steel Curd Churner	Machine Body Material-Stainless Steel, Design Type-Customized, Equipment-Homogenizer.	7
7.	Hot air oven	Chamber Volume -100L, Body Material-Stainless Steel, Number of Shelves -4, Temperature Range: 50°C to 300°C with automatic control and digital display.	8,9
8.	Hot Water bath	Size-40 x 30 x 18 inch, Temperature controller-PID Temperature Controller, Temp Range-Ambient to 95, S S body C with automatic control and digital display.	8,9

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
9.	Muffle Furness	Voltage 220 to 240 v, Material-Mild Steel, Temp.range-max-1100 degrees, with digital display and automatic control.	9
10.	Fruit crusher	Semi-Automatic Fruit Crushing Machine With 1 Hp Motor, Capacity-100 kg per ,Material-Stainless steel.	11,12
11.	Hand Basket Press	Capacity-10 kg, Material-Contacts parts in SS, remaining in MS Extraction of juice	11,12
12.	Bottle corking machine	Capacity -10 Bottle/min, Material-MS, Automation Grade-Semi Automatic.	11,12
13.	Distillation apparatus	Capacity -2 Liter,Color-Transparent, Material-Borosilicate 3.3 Glass, with heating system and supporting stand.	14

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Industrial Microbiology	L. E. Casida, Jr.	New Age International (P) Ltd., New Delhi, ISBN-10: 0852261012
2.	Principles of Fermentation Technology - 2nd Edition	P. F. Stanbury & A. Whitaker & S. J. Hall	B.H.Publisher ISBN-10: 0750645016
3.	Microbiology of Fermented Foods	Wood, Brian J.B.	Springer US, ISBN 978-1-4613-0309-1
4.	Essentials of Food Microbiology	John Garbutt	CRC Press; 2 edition (March 28, 1997) ISBN-13: 978-0340677018

(b) Online Educational Resources:

- 1) <https://youtu.be/p-9p0eZBqCA> (NPTEL lecturer on Food Fermentation)
- 2) <https://youtu.be/MOo9iJ8RYWM> (Bioreactor)
- 3) https://youtu.be/AQUKdXH_29E (NPTEL lecturer on Tradition fermented foods)
- 4) <https://youtu.be/TY2xTdIJQrg> (Beer production process)
- 5) <https://youtu.be/FAlyzK9cqPY> (Wine production process)
- 6) <https://youtu.be/td1PYbxe7xl> (Fermentor media composition)
- 7) https://youtu.be/s_j0tGe9AdY (Yeast fermentation process)
- 8) <https://youtu.be/5zJZ-JFAdS0> (Ethanol production process)
- 9) <https://youtu.be/auTge8VLZ0U> (Vinegar production process)
- 10) <https://youtu.be/V0BzQQCCwgo> (Industrial Microbiology)

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

- https://swayam.gov.in/nc_details/NPTEL,

- A) **Course Code** : 2449402(T2449402/P2449402/S2449402)
- B) **Course Title** : Flesh Food Technology
- C) **Pre-requisite Course(s)** :
- D) **Rationale** :

Flesh food is one of the highly perishable foods. The knowledge of process technology of flesh foods is required to cater the need of the large portion of the world population. The flesh food technology is an important branch of food industry involving the processing of foods such as meat, fish, poultry and eggs having high nutritive value. Food technologist is required to have the knowledge of the composition and processing of flesh foods as their demand is increasing rapidly.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- CO-1** Describe structure, postmortem changes, processing of meat and their value added products.
- CO-2** Discuss the processing steps of poultry and their value added products.
- CO-3** Classify the types of fish, Surimi fish processing and their value added products.
- CO-4** Describe the chemistry of Egg and their value added.
- CO-5** Apply the principles of preservation techniques

- F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	2	3	2	2	2	3		
CO-2	3	2	3	2	2	2	3		
CO-3	3	2	3	2	2	2	3		
CO-4	3	2	3	2	2	2	3		
CO-5	3	3	-	3	2	2	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
-	2449402	Flesh Food Technology	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
	2449402	Flesh Food Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

- I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units: T2449402**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 1a.</i> Describe the structure of muscles tissues. <i>TSO 1b.</i> List the and amount of composition present in meat <i>TSO 1c.</i> List the classes of meat <i>TSO 1d.</i> Describe the post mortem changes in meat <i>TSO 1e.</i> Use of enzymes to tenderizing meat <i>TSO 1f.</i> Discuss the curing of meat <i>TSO 1g.</i> Define ageing of meat <i>TSO 1h.</i> Define water holding capacity of meat <i>TSO 1i.</i> Objective of ant-mortem examination of meat <i>TSO 1j.</i> List the method of meat slaughtering. <i>TSO 1k.</i> Differentiate between scientific slaughter and ritual slaughter <i>TSO 1l.</i> List the ritual slaughter methods <i>TSO 1m.</i> Describe meat quality parameters <i>TSO 1n.</i> Define freezing and thawing <i>TSO 1o.</i> List the methods of freezing on meat <i>TSO 1p.</i> Outline the effect of freezing and thawing on meat quality. <i>TSO 1q.</i> List the table storage life (months) of meat and meat products at different temperature <i>TSO 1r.</i> List the equipment used for processing of meat <i>TSO 1s.</i> Draw flow diagram manufacturing of meat burger <i>TSO 1t.</i> List the RET meat products <i>TSO 1u.</i> Manufacturing process of Meat pickle <i>TSO 1v.</i> Classify the sausages <i>TSO 1w.</i> Describe manufacturing process of sausage <i>TSO 1x.</i> Outline the principles of various meat preservation	Unit-1.0 Meat and Meat Products 1.1 Chemistry of Meat : Structure of muscle tissues, composition of meat, classes of meat, Post-mortem changes in meat, Tenderizing of meat, curing of meat, Definition- ageing, Meat color, water-holding capacity, marbling, firmness 1.2 Slaughtering methods : definition of Slaughtering ,objective of Ant-mortem examination of meat animals, Methods of slaughter- scientific slaughter, Ritual slaughter, Definition - Halal certification 1.3 Freezing and Thawing: Methods of freezing, Effect of freezing and thawing on meat quality, storage life (months) of meat and meat products at different temperature Principles - Curing, Smoking, canning, Dehydration, Irradiation. 1.4 Value added meat products : Ingredients, manufacture process- Burger, Meat nuggets, meat ball ,Meat pickle, Sausage- Classification, process of sausages	CO1, CO5
<i>TSO 2a.</i> Outline the manufacture process of various potato products <i>TSO 2b.</i> Uses of sweet potato. <i>TSO 2c.</i> Define Poultry with examples <i>TSO 2d.</i> Classify poultry by Indian standards <i>TSO 2e.</i> Outline composition and nutritive value of poultry <i>TSO 2f.</i> Draw flow diagram of processing line of poultry <i>TSO 2g.</i> Describe live birds supply to slaughtering point. <i>TSO 2h.</i> Describe stunning process	Unit-2.0 Poultry and Poultry Products 2.1. Introduction: Poultry industry in India, definition of poultry, Classification of poultry to Indian standards, composition and nutritive value. 2.2. Processing of poultry: Live –bird supply - containers and crates, transport Vehicles, Hanging of live-birds on the processing line, Stunning, Neck cutting and bleeding, Scalding, Plucking/de-feathering, Other killing line activities, Evisceration and giblet harvesting, Chilling -Air chilling, Wet chilling, packaging 2.3. Value added Poultry products : Chicken patties, nuggets, chicken ball,	CO2, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 2i.</i> Discuss scalding in poultry processing <i>TSO 2j.</i> Describe plucking process in poultry <i>TSO 2k.</i> List the poultry processing steps . <i>TSO 2l.</i> Draw flow diagram of chicken patties. <i>TSO 2m.</i> Describe tandoor chicken process <i>TSO 2n.</i> List RTE products of poultry <i>TSO 2o.</i> List preservation techniques of poultry <i>TSO 2p.</i> Manufacture process of poultry canning <i>TSO 2q.</i> Principle of freeze drying in poultry processing <i>TSO 2r.</i> List poultry preservation by chemical <i>TSO 2s.</i> Principle of smoke, spices	2.4. Poultry preservation Techniques: Principles of -canning, frying, Drying- freeze drying, Chemical, irradiation	
<i>TSO 3a.</i> Classify fish on the basis of anatomical differences. <i>TSO 3b.</i> Classify fish on the basis of presence of fat <i>TSO 3c.</i> Illustrate the spoilage of fish <i>TSO 3d.</i> List the preservation methods of fish <i>TSO 3e.</i> Advantages and disadvantages of sun drying of fish. <i>TSO 3f.</i> Principle canning of fish <i>TSO 3g.</i> List the chemical used for fish preservation <i>TSO 3h.</i> Define Surimi <i>TSO 3i.</i> Draw flow chart of Surimi manufacturing <i>TSO 3j.</i> Describe manufacturing sequences of surimi <i>TSO 3k.</i> Objective of thawing frozen surimi block <i>TSO 3l.</i> Objective of salting in comminution process <i>TSO 3m.</i> List the chopping equipment <i>TSO 3n.</i> Outline the process of crabsticks <i>TSO 3o.</i> Manufacture process of fish burger <i>TSO 3p.</i> Outline the process of fish marinades <i>TSO 3q.</i> Types of fish marinades <i>TSO 3r.</i> Describe the process of fish protein concentrate <i>TSO 3s.</i> Outline the process of fish oil and fish meal.	Unit-3.0 Fish and Fish Products 3.1 Introduction: Classification of Fish, Composition and nutritive value, Fish spoilage- microbiological, physiological, chemical 3.2 Preservation of Fish: Principles -Drying, ,freezing, canning, chemicals 3.3 Manufacturing of Surimi : Definition of Surimi, Manufacturing technology of surimi process, Comminution process- objectives of -thawing, salting, continuous chopping, Production flow of Crabsticks Value Added Fishery Products – manufacture process of – fish burgers patty , Fish marinades, Fish sausage, Fish soup powder, fish finger, Fish protein concentrates (FPC) , Fish oil, Fish meal.	CO3, CO5
<i>TSO 4a.</i> Outline the structure of egg <i>TSO 4b.</i> List the composition of egg <i>TSO 4c.</i> Explain the nutritive value of egg <i>TSO 4d.</i> Describe the evaluation of egg quality <i>TSO 4e.</i> List the factors of egg spoilage <i>TSO 4f.</i> Describe the spoilage of egg <i>TSO 4g.</i> Outline the desugarization of egg <i>TSO 4h.</i> Draw the flow diagram of whole egg powder <i>TSO 4i.</i> Describe the effect of heat on egg proteins	Unit-4. Egg 4.1 Chemistry of Egg: Structure, composition, Nutritive value, Egg quality- evaluation of egg quality, Egg grading on weight, Egg storage, spoilage of egg, 4.2 Processing of Egg: Pasteurization, desugarization, freezing, dehydrated products- Egg powder, Whole egg powder, Egg yolk products, their manufacture, packaging and storage. effect of heat on egg proteins	CO2, CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449402

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
<i>LSO 1.1.</i> Use of oven <i>LSO 1.2.</i> Use of meat sample	1.	Calculate the percentage of moisture of given flesh sample	CO1
<i>LSO 2.1.</i> Use of cutter, knife <i>LSO 2.2.</i> Use of chicken sample	2	Demonstrate preparation deboning of meat	CO1
<i>LSO 2.3.</i> Use of deep freezer	3	Prepare frozen meat and observe the changes in meat	CO1
<i>LSO 3.1.</i> Use meat chopper, mincer <i>LSO 3.2.</i> Use all types of spices	4	Demonstrate preparation of meat burger	CO1
<i>LSO 4.1.</i> Use of oil, spice, meat sample <i>LSO 4.2.</i> Use of FSSAI specification	5	Demonstrate preparation of meat pickle	CO1
<i>LSO 5.1.</i> Draw poultry chart <i>LSO 5.2.</i> Use of Indian standard specification	6.	Prepare chart of classify poultry on the basis of Indian standard	CO2
<i>LSO 6.1.</i> Watch the processing video <i>LSO 6.2.</i> Use standard procedure	7.	Demonstrate preparation of slaughtering of poultry at plant	CO2
<i>LSO 7.1.</i> Use of calculation part of dressing weight	8.	Calculate percentage of dressing poultry meat	CO2
<i>LSO 8.1.</i> Use of mincer, spice, molder <i>LSO 8.2.</i> Use of deep fryer	9.	Prepare chicken nuggets	CO2
<i>LSO 10.1.</i> Use of mincer, spice <i>LSO 10.2.</i> Use of deep fryer	10.	Demonstrate preparation of chicken ball	CO2
<i>LSO 11.1.</i> Use of knife, cutting board	11.	Demonstrate preparation of dressing of fish	CO3
<i>LSO 12.1.</i> Draw fish chart	12	Prepare chart of types of fish	CO3
<i>LSO 13.1.</i> Use of oven <i>LSO 13.2.</i> Use of salt, packaging material	13	Demonstrate preparation of drying of fish	CO3
<i>LSO 14.1.</i> Use of deep freezer <i>LSO 14.2.</i> Observe the frozen changes	14	Demonstrate preparation of freezing of fish	CO3
<i>LSO 15.1.</i> Use of deep fryer	15	Demonstrate preparation of frying fish marinades	CO3
<i>LSO 16.1.</i> Use of light, salt	16	Evaluation of egg quality	CO4
<i>LSO 17.1.</i> Observe the changes in egg quality	17	Observe effect of heat on egg quality	CO4
<i>LSO 18.1.</i> Use of laminar flow <i>LSO 18.2.</i> Use of media , autoclave, sample	18	Microbiological testing of meat, fish, poultry and eggs	CO1,CO2,C O3,CO

L) Suggested Term Work and Self Learning: S2449402 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Comparative study on the basis of moisture, meat color, procured from local market
2. Collect the information of poultry processing industry and prepare report on it.
3. Survey and collect information types of fish available in local market
4. Prepare report on meat/fish/poultry value added products available in Indian market
5. Collect the information of egg transportation from poultry form to the local market

c. Other Activities:

1. Seminar Topics:
 - Use of equipment in meat industry
 - Industrial poultry processing
 - Modern surimi technology
 - Evaluation of egg quality
2. Visits: Visit nearby poultry industry /fish processing industry/egg industry/fish drying industry prepare report of visit with respect to processing and preservation of food.
3. Self-learning topics:
 - Structure of meat muscle.
 - Freezing and thawing process.
 - Value added poultry products.
 - Production process of crabsticks
 - Spoilage of egg

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	30%	30%	25%	30%	30%	30%	30%
CO-2	25%	25%	25%	30%	30%	25%	25%
CO-3	25%	25%	25%	30%	30%	25%	25%
CO-4	20%	20%	25%	10%	10%	20%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Meat and Meat Products	14	CO1, CO5	20	4	8	8
Unit-2.0 Poultry and Poultry products	10	CO2, CO5	16	4	6	6
Unit-3.0 Fish and Fish Products	14	CO3, CO5	20	8	4	8
Unit-4. Egg	10	CO2, CO5	14	4	6	4
Total	48	-	70	20	24	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Calculate the percentage of moisture of given flesh sample	CO1	40	50	10
2.	Demonstrate preparation deboning of meat	CO1	40	50	10
3.	Prepare frozen meat and observe the changes in meat	CO1	40	50	10
4.	Demonstrate preparation of meat burger	CO1	30	60	10
5.	Demonstrate preparation of meat pickle	CO1	30	60	10
6.	Prepare chart of classify poultry on the basis of Indian standard	CO2	50	40	10
7.	Demonstrate preparation of slaughtering of poultry at plant	CO2	40	50	10
8.	Calculate percentage of dressing poultry meat	CO2	40	50	10
9.	Prepare chicken nuggets	CO2	40	50	10
10.	Demonstrate preparation of chicken ball	CO2	40	50	10
11.	Demonstrate preparation of dressing of fish	CO3	30	60	10
12.	Prepare chart of types of fish	CO3	40	50	10
13.	Demonstrate preparation of drying of fish	CO3	40	50	10
14.	Demonstrate preparation of freezing of fish	CO3	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
15.	Demonstrate preparation of frying fish marinades	CO3	40	50	10
16.	Evaluation of egg quality	CO4	40	50	10
17.	Observe effect of heat on egg quality	CO4	40	50	10
18.	Microbiological testing of meat, fish, poultry and eggs	CO1, CO2, CO3, CO4	30	60	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Weighing Machine	One digital weight balance up to 20 kg and one digital analytical balance upto 500gm maximum	All
2.	Hot air Oven	Laboratory Hot air oven with standard specification temperature maximum 250 degree Cel.	1,13,15
3.	Physical Inspection table of standard specification	Physical Inspection table of standard specification	1,4,6,7,8,9,16
4.	Cutter of standard specification	Cutter of standard specification	1,2,5,6,10,11,17
5.	Chopping machine of standard specification	Chopping machine of standard specification	1,3,5,6,18
6.	Grinder machine of standard specification	Grinder machine of standard specification	6,12,13,14,15
7.	Forming Machine of standard specification	Forming Machine of standard specification	4,9,10,15
8.	Par frying of standard specification	Par frying of standard specification	4,5,9,10,15,
9.	Deep freezer of standard specification	standard specification	3,14
10.	Retort/ Autoclave of standard specification	standard specification	5

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Handbook of meat processing	Fidel Toldra	Blackwell Publishing, ISBN 978-0-8138-2182-5
2	Poultry meat processing and quality	G. C Mead	woodhead-publishing, Limited, Abington Hall, Abington, Cambridge
3	Frozen food Technology	C.P Mallett	Chapman & Hall Cambridge, ISBN 0751400726
4	Foods facts and principles	N.Shakuntala Manay, M.Shadaksharaswamy	New Age international (P) Limited Publishers, New Delhi ISBN:978-81-224-2215-3
5	Marine fisheries and sea food processing	Dr. Pramod Kiran R.B.	State Council of Educational Research and Training (SCERT), KERALA
6	Surimi and surimi seafood	JAE W. PARK	CRC Press Taylor & Francis Group, New York, ISBN: 13: 978-1-4398-9858-1

(b) Online Educational Resources:

- 1) <https://www.youtube.com/watch?v=dR0TWe-u98Y> (meat processing)
- 2) <https://www.youtube.com/watch?v=TbeSBo6SRIM> (poultry lecture)
- 3) <https://www.youtube.com/watch?v=ZnRYi2ukzOs> (Poultry processing)
- 4) <https://www.youtube.com/watch?v=DRT1MbcNpQY> (Inspection and pre –slaughter care of poultry)
- 5) <https://www.youtube.com/watch?v=kcGiyWzqZgc> (Value addition of fisheries)
- 6) <https://www.youtube.com/watch?v=0mESabY0NmW> (Surimi Processing)

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

(c) Others:

1. Material Handbook
2. Lab Manuals

- A) **Course Code** : 2449403(T2449403/P2449403/S2449403)
 B) **Course Title** : Dairy Technology
 C) **Pre-requisite Course(s)** :
 D) **Rationale** :

This Course deals with the milk processing, preparation of special milks, milk products and its quality control as per FSSAI standards. It also covers quality analysis of raw milk, detection of adulteration in milk, Milk-pre-processing, Pasteurization and preparation of major dairy products. Understanding of this course helps student to start own entrepreneurship in Ice-cream, frozen dessert, milk and milk product processing.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- CO-1** Analyse the quality of market milk and describe the chemical composition of milk.
CO-2 Apply pasteurization process for milk.
CO-3 Describe the production process of all major special milks.
CO-4 Outline the production process of Ice –Cream and Frozen Dessert.
CO-5 Prepare the Indian dairy products as per FSSAI standards.

- F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	3		2	2	2	2		
CO-2	3	2	2	3	2	2	2		
CO-3	3	-	3	2	2	2	3		
CO-4	3	-	2	3	3	2	3		
CO-5	3	-	3	3	3	2	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
	2449403	Dairy Technology	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
	2449403	Dairy Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units: T2449403**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 1a.</i> Enlist the types of milk and state the milk composition. <i>TSO 1b.</i> Enlist the physico-chemical properties of cow and buffalo milk. <i>TSO 1c.</i> Outline factors affecting composition of milk. <i>TSO 1d.</i> Evaluate the quality of milk.	Unit-1.0 Market Milk. 1.1 Milk: - Current scenario in dairy technology in India, Definition of Milk, FSSAI Standards of different types of milks in India, Composition of milk, Factors affecting composition of milk. 1.2 Physico-chemical properties of milk: Acidity, pH, Density, Specific gravity, Frizzling point, color and flavour of milk. 1.3 Quality analysis of Milk: Physical examination, Alcohol test, COB test, MBRT test, Fat analysis, SNF analysis, Acidity and Detection of Common Adulterants- Sugar, Starch, Urea, Glucose and Water.	CO1
<i>TSO 2a.</i> Illustrate the process of milk collection, cooling and transportation system. <i>TSO 2b.</i> Enlist the types of pasteurization. <i>TSO 2c.</i> Explain the cleaning and sanitation process in dairy. <i>TSO 2d.</i> Outline the working process of pasteurization. <i>TSO 2e.</i> Importance's of FDV in pasteurization.	Unit-2.0 Pasteurization of Milk 2.1 Handling of Milk: - Milk collection systems, Principle and methods of Cooling of milk, Transportation methods of milk, Action of milk on metals. Cleaning and sanitation in dairy process. 2.2 Pasteurization Process: -Pasteurization process flow sheet, Types of pasteurization- LTLT HTHT, UHT, Pre-processing of milk, Chilling and storage of milk, Milk standardization process by Pearson's square method, Homogenisation process, Plate heat exchanger pasteurization process-working, regeneration and importance of FDV, Working of pasteurization plant by heat exchanger, Storage and distribution of pasteurized Milk.	CO2, CO5
<i>TSO 3a.</i> Enlist the FSSAI standards of special milks <i>TSO 3b.</i> Outline the production process of sterilized milk. <i>TSO 3c.</i> Describe the homogenized milk. <i>TSO 3d.</i> Outline the production process of pasteurized and sterilized milk. <i>TSO 3e.</i> Explain standardized milk. <i>TSO 3f.</i> FSSAI standards of toned and double toned	Unit-3.0 Special Milks 3.1 Define as per FSSAI norms, Production process flow sheet– • Sterilized milk, • Homogenized milk, • Pasteurized and Sterilized Flavoured milk, • Vitaminized / irradiated milk • Standardized milk, • Reconstituted / rehydrated milk	CO3, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
milk.	- Recombined milk - Toned milk - Double toned milk	
<i>TSO 4a.</i> Enlist the name of ingredients and their role in Ice-cream. <i>TSO 4b.</i> Outline the production process of Ice-cream. <i>TSO 4c.</i> Define the frozen dessert and its types as per FSSAI norms	Unit-4. Ice -Cream and Frozen Dessert 4.1 Ice cream: Define Ice cream, Classification of ice cream, Role of constituents in Ice cream, Name of dairy and non-dairy ingredients, Name stabilizers and emulsifier's agents and its role in Ice Cream. 4..2 Production Process of Ice Cream: Manufacture process flow sheet of Ice cream, preparation of mix, Pasteurisation and homogenisation of mix, Aging and freezing the mix, define overrun and its calculation, packaging, hardening and storage of Ice cream, Ice cream defects and its causes. 4.3 Frozen dessert: - Define Frozen dessert Ices, Sherbets, Sorbets, Frozen Yoghurt, Kulfi and Ice Milk as per FSSAI.	CO2, CO3, CO4
<i>TSO 5a.</i> Outline the production process of khoa and basundi. <i>TSO 5b.</i> Draw the production process flow sheet of curd, Shrikhand and lassi. <i>TSO 5c.</i> State the principle of paneer production and its process. <i>TSO 5d.</i> Describe the production process of Butter and Ghee. <i>TSO 5e.</i> Outline the production process of sweetened condensed milk. <i>TSO 5f.</i> Compare the whole and Skim milk powder.	Unit-5.0 Indian Dairy & Dried milks products. 5.1 Khoa and Basundi:- Define as per FSSAI norms, classification, Production process and Storage 5.2 Curd, Shrikhand and Lassi: - Define as per FSSAI norms, Classification, Production process and Storage. 5.3 Chhana or Paneer: Define as per FSSAI norms, Production process of Panner, Factors affecting quality and Yield of Paneer. 5.4 Butter and Ghee: - Define as per FSSAI norms and Production process 5.5 Condensed Milk: Define the sweetened condensed milk and unsweetened condensed milk, Production process of sweetened condensed milk 5.6 Whole and Skim milk Powder: Define WMP and SMP as per FSSAI norms, Production process flow sheet by Spray dried system	CO2, CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449403

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1. Use of lactometer, thermometer LSO 1.2. Use of market milk sample	1.	Analyse the milk at platform level- Organoleptic test- color, Smell, Test Appearance, and Temperature by touch of cans and COB.	CO1
LSO 2.1. Use of MBRT, alcohol chemical LSO 2.2. Use of glass ware, test tube	2	Analyse the milk by MBRT and alcohol test.	CO1
LSO 2.3. Use of centrifuge, test tube	3	Estimate of fat content in Milk.	CO1
LSO 3.1. Use of glass ware, SG bottle LSO 3.2. Use of pH meter	4	Estimate the pH, acidity and specific gravity of Milk.	CO1
LSO 4.1. Use of glass ware, chemicals etc. LSO 4.2. Use of FSSAI procedure for adulteration	5	Detect the adulteration in Milk- Water, Starch, Urea, Soda and Detergent.	CO1
LSO 5.1. Use of Ultrasonic milk analyser LSO 5.2. Use of market milk sample.	6.	Analyse the quality of milk through Ultrasonic milk analyser by collecting sample in local market.	CO2
LSO 6.1. Use chemicals, glass ware , pasteurized milk LSO 6.2. Use of FSSAI specification	7.	Determine the adequacy of pasteurisation process by Alkaline Phosphatase test.	CO2
LSO 6.3. Use chemicals, glass ware , pasteurized milk LSO 7.1. Use of FSSAI specification.	8.	Prepare the pasteurised flavoured milk (any two types of flavours)	CO3
LSO 8.1. Use steam kettle	9.	Prepare the soya milk and tofu.	CO3
LSO 9.1. Use of deep freezer LSO 9.2. Use of ingredients	10.	Prepare the ice cream as per FSSAI standards	CO4
LSO 10.1. Use of milk sample , culture LSO 10.2. Use of FSSAI standards	11.	Prepare the Curd as per FSSAI standards.	CO5
LSO 11.1. Use of steam kettle LSO 11.2. Use of FSSAI standards	12	Prepare the Shrikhand or Amrkhand or Fruitkhand as per FSSAI standards.	CO5
LSO 11.3. Use of curd, sugar, flavor LSO 11.4. Use of FSSAI standards.	13	Prepare the Lussi as per FSSAI standards.	CO5
LSO 11.5. Use of milk sample, culture , muslin cloth. LSO 11.6. Use of FSSAI standards	14	Prepare the Paneer as per FSSAI standards.	CO5
LSO 11.7. Use of steam kettle LSO 11.8. Use of FSSAI standards	15	Prepare the Butter from culture cream milk.	CO5
LSO 11.9. Use of steam kettle LSO 11.10. Use of FSSAI standards	16	Prepare the Ghee as per FSSAI standards.	CO5
LSO 11.1. Use of Khoa making machine LSO 11.2. Use of FSSAI standards	17	Prepare the khoa as per FSSAI standards.	CO5
LSO 11.3. Prepare chart of list of equipment in condensed and dried mils.	18	Prepare the List of equipment's required for production of condensed and dried milks.	CO5

L) Suggested Term Work and Self Learning: S2449403 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Collect the list of equipment's need to start small milk processing unit with details of specifications.
2. Estimate the production cost per kg of any five dairy products.
3. Collect the information regarding storage room, refrigerated transport vans, packed milk distribution process.
4. Prepare the chart of milk and milk products FSSAI standards. (Eight products)
5. Collect the milk sample from local market at different area, detect the adulteration test and prepared the report.
6. Collect the different types of special milk sample by market survey and prepared the comparative chart on the basis of types, specifications, colour code on package, price and shelf life.
7. Prepare the model of small scale dairy plant with proper lay out.
8. Prepare the dairy base instant pre-mix like- Gulab Jamun Mix, Instant Ice Cream Mix and Instant Basundi mix.

c. Other Activities:

1. Seminar Topics:
 - Current scenario in dairy technology in India,
 - FSSAI Standards of different types of milks in India,
 - Types of pasteurization- LTLT HTHT, UHT,
 - Differentiate between Ice cream and frozen dessert.
 - Indian Dairy Products
 -
2. Visits: Visit nearby Dairy industry /Dairy products manufacture industry/Dairy equipment Manufacture industry prepare report of visit with respect to processing and preservation of food.
3. Self-learning topics:
 - Milk sample
 - Prepare different types of dairy products
 - List the equipment's use in dairy industry
 - FSSAI standards of dairy products.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	10%	10%	10%	10%	10%
CO-2	15%	15%	15%	15%	15%	20%	15%
CO-3	20%	15%	25%	25%	25%	20%	15%
CO-4	25%	25%	20%	20%	25%	25%	30%
CO-5	25%	30%	30%	30%	25%	25%	30%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

** : Mentioned under point- (N)

: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Market Milk	08	CO1	08	4	4	-
Unit-2.0 Pasteurization of Milk	08	CO2	12	4	4	4
Unit-3.0 Special Milks	08	CO3	14	4	4	6
Unit-4. Ice -Cream and Frozen Dessert	12	CO4	18	4	6	8
Unit-5.0 Indian Dairy & Dried Milks Products	12	CO5	18	4	6	8
Total	48	-	70	20	24	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Analyse the milk at platform level- Organoleptic test- color, Smell, Test Appearance, and Temperature by touch of cans and COB.	CO2	40	50	10
2.	Analyse the milk by MBRT and alcohol test.	CO2	40	50	10
3.	Estimate of fat content in Milk.	CO3	30	60	10
4.	Estimate the pH, acidity and specific gravity of Milk.	CO3	30	60	10
5.	Detect the adulteration in Milk- Water, Starch, Urea, Soda and Detergent.	CO4	40	50	10
6.	Analyse the quality of milk through Ultrasonic milk analyser by collecting sample in local market.	CO5	40	50	10
7.	Determine the adequacy of pasteurisation process by Alkaline Phosphatase test.	CO5	40	50	10
8.	Prepare the pasteurised flavoured milk (any two types of flavours)	CO5	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
9.	Prepare the soya milk and tofu.	CO5	30	60	10
10.	Prepare the ice cream as per FSSAI standards	CO5	40	50	10
11.	Prepare the Curd as per FSSAI standards.	CO5	40	50	10
12.	Prepare the Shrikhand or Amrkhand or Fruitkhand as per FSSAI standards.	CO5	30	60	10
13.	Prepare the Lussi as per FSSAI standards.	CO5	40	50	10
14.	Prepare the Paneer as per FSSAI standards.	CO2	40	50	10
15.	Prepare the Butter from culture cream milk.	CO2	40	50	10
16.	Prepare the Ghee as per FSSAI standards.	CO3	40	50	10
17.	Prepare the khoa as per FSSAI standards.	CO3	40	50	10
18.	Prepare the List of equipment's required for production of condensed and dried milks.	CO4	50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Weighing Machine	One digital weight balance up to 20 kg and one digital analytical balance upto 500gm maximum	All
2.	Hot air Oven	Laboratory Hot air oven with standard specification temperature maximum 250 degree Cel.	1
3.	Steam Jacketed Kettles	Both jacket and pan are fabricated with S.S.-304 grade stainless steel of heavy gauge. The pan is 2/3 jacketed which provides Maximum steam utilization and efficiency. It is available in the following capacities:25 gallons	8,9,10,11,12
4.	Infrared Thermometer	Infrared Thermometer laboratory standards	All
5.	Analytical balance	Analytical balance laboratory standards	4,5

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
6.	Gerber centrifuge	Gerber centrifuge laboratory standards	3
7.	Water bath	Water bath laboratory standards	2,5,8
8.	Ultrasonic milk analyser	Ultrasonic milk analyser laboratory standards	7
9.	Bottle Filling Machine	This machine is suitable for accurate filling of liquids like medicines, syrups, ketchup, solutions etc. In bottles, machine consists of two/four filling heads with vacuum pump and 1/2 H.P. motor. All contact parts are of stainless steel	8,9
10.	Hand Blender	Hand Blender laboratory standards	14,15
11.	Incubator -35 to 40 degree C temperature	Incubator -35 to 40 degree C temperature	11,12,13
12.	Plastic pouch packaging machine	Plastic pouch packaging machine laboratory standards	8,9,10,13,14,15,16,17
13.	Paneer molds and Stainless still small Tank	Paneer molds and Stainless still small Tank	14
14.	Deep Freezer	Deep Freezer capacity 100 Lit.	10,11,12,13
15.	pH meter	pH meter laboratory	04
16.	Small milk separator	Small milk separator	15
17.	Khoa making machine	Khoa making machine capacity 50 Lit.	17
18.	Cup packaging machine (aluminium lid to cup)	Cup packaging machine (aluminium lid to cup)	12,13

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Outlines of Dairy: Technology	De Sukumar	Oxford; 1st edition (28 March 2001) ISBN-10 : 9780195611946 ISBN-13 : 978-0195611946
2.	Dairy Technology Principles of Milk Properties and Processes	P. Walstra T. J. Geurts A. Noomen A. Jellema M. A. J. S. van Boekel	Marcel Dekker, Inc. 270 Madison Avenue, New York ISBN-10-0824746414, ISBN-13-9780824746414
3.	Dairy Science And Technology Handbook: Principles And Properties	Hui Y.H	John Wiley (WSE & Exclusive Indian Spl. Price Titles); 1 st edition (1 January 2014) ISBN-10 : 9788126547241 ISBN-13 : 978-8126547241
4.	Dairy Product Technology Recent Advances	Subrota & Mandal, Surjit & Mishra, Birendra	Daya Publishing House, ISBN13:9789351243687 ISBN10:9351243680
5	Handbook of Quality Analysis and Quality Control of Fruit & Vegetable Products	Ranganna	Tata McGraw Hill Publishing Co. Ltd., New Delhi ISBN-10 : 9780074518519 ISBN-13 : 978-0074518519

(b) Online Educational Resources:

1. <https://youtu.be/Lk2shU-DYBU>, <https://youtu.be/-CyatR1o9s4> (Plat form test)
2. <https://youtu.be/7Cu7spK6vco> (MBRT test)
3. <https://youtu.be/v7yFSrISK4s> (Acidity measurement of Milk)
4. <https://youtu.be/agdFb9qPYQs> (Specific gravity of Milk)
5. <https://youtu.be/muswKsqvGnM> (Analysis of Milk fat)
6. <https://youtu.be/Lt9cY0KLW1Y> (Analysis of SNF of Milk)
7. <https://youtu.be/xQ4FVBn63FA> (Milk Adulteration test)
8. <https://youtu.be/doc3Uunddlw> (<https://youtu.be/qOiTm7Y5r-o> (Flavoured milk)
9. <https://youtu.be/IFZ82cNxjk8>, <https://youtu.be/yV9wTbvGjHs> (Panner processing)
10. <https://youtu.be/bu6S3BAsCos> (Table butter production process)
11. <https://youtu.be/wUPhfRCWOTA> (Ghee making process)
12. <https://youtu.be/vJERkHxCd48> (Soya Milk production process)
13. <https://youtu.be/dAdMq9qgEWY> , <https://youtu.be/-AQchVaHR1I> (NPTEL lecture on Fermented Dairy Product)
14. <http://localhost:8101/moodle/mod/resource/view.php?id=717>, <https://youtu.be/RjjvLkIQcO8> (NPTEL lecture on Ice-cream and frozen desserts)
15. <https://youtu.be/1PZgCquYl6E> (NPTEL lecture on Starter Cultures and Nutritional Importance of Fermented Milks)
16. Website www.iaritoppers.com for Agri. Study Material on Dairy Technology.

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Material Handbook
2. Lab Manuals

- A) **Course Code** : 2449404(T2449404/P2449404/S2449404)
- B) **Course Title** : Food Hygiene and Sanitation
- C) **Pre-requisite Course(s)** : Food Microbiology
- D) **Rationale** :

Food hygiene & sanitation is one the core course of food technology. It deals with different processes & methods used to maintain good hygiene and sanitation in the food industry. This course essentially imparts the knowledge about the importance of Food safety hazard, good hygienic practices (GHPs), Good Manufacturing Practices (GMPs), personal hygiene and safety, Cleaning and Sanitizing operations, factors to be considered in designing layouts and facilities requirements in the food industry. This knowledge shall be used for ensuring the safe and hygienic manufacturing of food.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO 1: Identify and Control the major types of potentially food hazardous.

CO 2: Apply good hygienic practices in the food industry.

CO 3: Describe the different processes used to clean and sanitize the food processing area and equipments.

CO 4: Outline the facilities to be given to food handlers and factors to be considered while designing the layout of food industry.

- F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	-	-	-	2	-	1		
CO-2	3	-	2	2	3	-	2		
CO-3	3	3	2	2	3	3	2		
CO-4	3	3	3	2	3	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Food Processing and Preservation	2449404	Food Hygiene and Sanitation)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Food Processing and Preservation	2449404	Food Hygiene and Sanitation	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

- I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units: T2449404**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 1a.</i> Define Contamination & Hazard. <i>TSO 1b.</i> Enlist the chemical, physical and biological hazards. <i>TSO 1c.</i> Describe the food borne hazards <i>TSO 1d.</i> Name the common food borne microorganisms <i>TSO 1e.</i> Enlist the Physical hazards examples. <i>TSO 1f.</i> Enlist the sources of toxic metals and its causes. <i>TSO 1g.</i> Describe the naturally occurring chemical and its preventive measures. <i>TSO 1h.</i> Give the labeling guidelines for allergens foods. <i>TSO 1i.</i> Describe the Good Manufacturing Practices with example. <i>TSO 1j.</i> State the procedure use for Sanitation Standard Operating Procedure. <i>TSO 1k.</i> Draw the flow sheet of HACCP steps. <i>TSO 1l.</i> Enlist the principles of HACCP <i>TSO 1m.</i> Define the terms in HACCP.	Unit-1.0 Food Safety Hazard 1.1 Definition of Contamination & Hazard, Source of food Contamination, Types of hazards. 1.2 Definition of Biological hazard & their examples. 1.3 Definition of Food Infection & Intoxication and their examples. 1.4 Definition of Physical hazards, their examples and Precaution measures. 1.5 Definition of Chemical hazards and their examples. 1.6 Names of naturally occurring toxic substance in Kesari dal, Soybean, Green potato, Argemone seeds, Cereals, Ground nuts and Shell fish. 1.7 Names of toxic metals & chemicals commonly found in foods 1.8 Name of allergens foods. 1.9 Definition, Principles, and Process- Good Manufacturing Practices (GMPs), Sanitation Standard Operating Procedure (SSOP), Good Hygiene Practices (GHPs), and Hazard Analysis of Critical Control Points (HACCP). 1.10 HACCP Implementation Steps	CO1
<i>TSO 2a.</i> Enlist the good and bad habits of food handler. <i>TSO 2b.</i> Identify potential problems, related to a food workers poor personal hygiene <i>TSO 2c.</i> Write the health status examination parameters. <i>TSO 2d.</i> Outline the process of hand washing. <i>TSO 2e.</i> Write the GHPs with respect to hair, eye, mouth, hands, fingernails, jewelry. <i>TSO 2f.</i> State the importance of rest, exercise and recreation. <i>TSO 2g.</i> Enlist parameters for safe working habits. <i>TSO 2h.</i> State the precaution taken for food storage room desing. <i>TSO 2i.</i> Describe the management and supervision in food processing section. <i>TSO 2j.</i> Name the types of common accidents that occur in the Food processing Industry . <i>TSO 2k.</i> What are the precautions required to taken to prevent accidents in food industry. <i>TSO 2l.</i> Classify the fire extinguishers. <i>TSO 2m.</i> What are the Safety measures that required to	Unit-2.0 Personal Hygiene and Safety 2.1 Importance of maintaining personal hygiene, Guideline to maintain good health for employees, Good and bad habits of employee. 2.2 GHPs with respect to Personal hygiene -skin, hair, eye, mouth, hands, fingernails, jewelry, feet, footwear and health status, 2.3 Importance of Protective clothing, Procedure and Guidelines for hand washing. 2.4 Importance of rest, exercise and recreation for employees. 2.5 Procurement of raw materials, Storage of raw materials, Time and temperature control, Food Distribution / Service, Management and Supervision, Food testing facility, Audit documentation and record. 2.6 Safety at work place- Common types of injuries-falls, cuts, burns, and poisoning, Parameters for safe working habits; 2.7 Types of fire extinguishers, Safety measures to prevent accidents.	CO1, CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
be taken to prevent fire accidents?		
<i>TSO 3a.</i> Define cleaning and sanitizing. <i>TSO 3b.</i> Describe food soil characteristics. <i>TSO 3c.</i> Describe the cleaning methods. <i>TSO 3d.</i> How to improve the food cleaning efficiency. <i>TSO 3e.</i> Select proper cleaning and sanitizing agent with proper concentration and conditions. <i>TSO 3f.</i> Describe the different methods of food equipment cleaning. <i>TSO 3g.</i> Describe the emulsification and wetting ability of cleaning agent. <i>TSO 3h.</i> Identify the different processes that can be used to clean and sanitize equipments. <i>TSO 3i.</i> Define the CIP and COP. <i>TSO 3j.</i> Describe the typical Clean in Place sequence. <i>TSO 3k.</i> Describe the single tank CIP system with sketch. <i>TSO 3l.</i> Describe the COP system with sketch. <i>TSO 3m.</i> Outline the CIP system in the dairy industry. <i>TSO 3n.</i> Name the factors affecting cleaning and sanitizing efficiency <i>TSO 3o.</i> Describe Chlorine as a sanitizer in the food industry. <i>TSO 3p.</i> State the advantage and disadvantages of chemical sanitizers. <i>TSO 3q.</i> State the properties of hypochlorites.	Unit-3.0 Cleaning and Sanitizing Operations 3.1 Cleaning – Definition of cleaning, Characteristic of food soil, Types of soils, Energies involved in cleaning, Role of cleaning media-air and water. 3.2 Properties of cleaning agents-chelating, risibility, emulsification, peptizing and wetting. 3.3 Methods of cleaning- foam, spray and machine, Factors affecting cleaning. 3.4 Types of detergents used in cleaning performance, Names of acid, alkali, solvents and formulated detergents used for cleaning with their concentration, temperature, frequency of cleaning. 3.5 CIP and COP- Definition of CIP and COP, Typical CIP sequence, Process of single stage and multi stage CIP system 3.6 CIP treatment for Dairy plant, fruits and vegetable plant with process parameters. 3.7 Sanitizing - Definition of sanitizing, Comparison of heat sanitizing and chemical sanitizing, Names of sanitizers used for cleaning with their concentration, temperature and frequency. 3.8 Factors affecting action of chemical sanitizers, properties. 3.9 Advantages and disadvantages of chlorine and hypochlorite's, Iodine, quaternary ammonium compound and Hydrogen peroxide.	CO1, CO3, CO4
<i>TSO 4a.</i> Name the factors required to consider while site selection. <i>TSO 4b.</i> State the principles of effective layout. <i>TSO 4c.</i> Describe the guidelines for building interior construction requirements. <i>TSO 4d.</i> Describe the proper role of lighting and ventilation. <i>TSO 4e.</i> Select proper material for equipment and containers. <i>TSO 4f.</i> Enlist facilities required for staff and their importance. <i>TSO 4g.</i> State the procedure of raw material procurement. <i>TSO 4h.</i> Give the guidelines for Visitor management. <i>TSO 4i.</i> Describe the GMPs guidelines for the raw material storage room. <i>TSO 4j.</i> Give examples of cross-contamination. <i>TSO 4k.</i> Describe the sources of pests and their control. <i>TSO 4l.</i> Enlist the sources of water contamination. <i>TSO 4m.</i> Describe water purification processing steps with a flow sheet. <i>TSO 4n.</i> Describe the sedimentation and chlorination process.	Unit-4.0 Location, Layout and Facilities 4.1 Factors to be consider while selecting location for food industry. 4.2 GHPs for building construction consideration- Floors, Walls, windows, doors, roof floor , Ceilings and construction material for processing equipment, 4.3 GHPs guidelines for facility-Water Supply, Drainage, Washing of raw material, Ice and Steam, waste disposal, ventilation, lighting, rest room and personnel facility, 4.4 GMPs guidelines' for raw material procurement, storage room, visitor management, avoiding cross-contamination 4.5 Pest Control design – Source of pest entrance in food processing area, Name the major pest found in food industry, Pest control methods for -Cockroaches, Rodents, Flies and stored product pest 4.6 Proper Water supply-Source of water contamination, Process of raw water purification-Oxidation, Sedimentation, filtration & chlorination.	CO3, CO4

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449404

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.1.</i> Visit to food Industry. <i>LSO 1.2.</i> Observe major precautions taken in the food industry to control hazards.	1.	Identify the possible sources of food contamination and control measures taken in a food processing area by visiting the nearest food industry.	CO1
<i>LSO 2.1.</i> Prepare the chart separate chart of chemical, physical, and biological hazard sources and precautions.	2.	Prepare the chart of chemical, physical, and biological hazard sources, and possible measure control with examples of each type.	CO1
<i>LSO 3.1.</i> Draw the flow sheet of implementations steps. <i>LSO 3.2.</i> Identify the possible hazards, critical control point, corrective action plan and documentation process.	3.	Prepare the detailed action plan for HACCP implementation in Milk Pasteurization/Mango pulp Canning/Fruit Jam etc. (one food processing plant)	CO1
<i>LSO 4.1.</i> Prepare the detail chart of personal hygiene and hand wash process.	4.	Prepare the chart of do and don't personal habits, proper hand wash technique, and hand wash guidelines of food handlers.	CO2
<i>LSO 5.1.</i> Use the fire extinguisher. <i>LSO 5.2.</i> Select and apply the fire extinguisher.	5.	Demonstrate the fire extinguisher on the fire.	CO2
<i>LSO 6.1.</i> Prepare the separate chart with respect to personal procurement of raw materials, storage room and visitor management	6.	Prepare the checklist with respect to procurement of raw materials, storage room and visitor management.	CO1, CO2
<i>LSO 7.1.</i> Use pH meter <i>LSO 7.2.</i> Calibration of pH meter. <i>LSO 7.3.</i> Detect the pH value of given detergent sample.	7.	Evaluate the pH of given cleaning agents.	CO3
<i>LSO 8.1.</i> Calculate the amount of solution required for a specific ppm concentration. <i>LSO 8.2.</i> Prepare the hypochlorite solution.	8.	Prepare the 5/10/ 50/100 PPM sodium hypochlorite solutions.	CO2. CO3
<i>LSO 9.1.</i> Use analytical balance <i>LSO 9.2.</i> Calculate the alkalin and water amount for specific % solution. <i>LSO 9.3.</i> Prepare the alkalin detergent.	9.	Prepare caustic soda solution of 0.5/ 1.25/1.5 % strength at temperature 75°C.	CO2. CO3
<i>LSO 10.1.</i> Calculate the acid and water amount for specific % solution. <i>LSO 10.2.</i> Prepare the acid detergent	10.	Prepare Nitric acid, Phosphoric acid and Peracetic acid solution of 0.5% / 1.25 % strength at temperature 70°C.	CO2. CO3
<i>LSO 11.1.</i> Prepare the CIP process flow sheet with all processing parameters in Dairy Industry.	11.	Prepare chart mentioning different cleaning & sanitizing solutions used in CIP of Dairy plant, mentioning their concentration, ideal temperature, and pressure, contact time, and CIP flow sheet.	CO2. CO3
<i>LSO 11.2.</i> Prepare the separate GHPs check list waste disposal, pest control, employee's facilities, water supply and construction consideration and plumbing.	12	Enlist the GHPs checklist with respect to waste disposal, pest control, employee's facilities, water supply and construction consideration and plumbing.	CO3. CO4
<i>LSO 11.3.</i> Prepare the buffer and EDTA solution.	13	Estimate the total hardness of the water.	CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 11.4.</i> Determine the % total hardness in a given water sample.			
<i>LSO 11.5.</i> Visit to nearest water treatment plant. <i>LSO 11.6.</i> Prepare the flow sheet of raw water treatment process.	14	Prepare the raw water treatment processing steps and parameters used by visit to nearest raw water treatment plant.	CO4

L) Suggested Term Work and Self Learning: S2449404 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Design the hand wash procedure and process chart.
2. Design the good hygienic practices chart.
3. Implement pest control process in food processing laboratory.
4. Identify the food safety points by visit nearest food industry.
5. Prepare the model of water purifier.
6. Prepare hand wash station in food processing laboratory
7. Design change room for worker's chart.
8. Identify the allergens in market products.

c. Other Activities:

1. Seminar Topics:

- Hygiene Rating
- Hygienic requirements in Dairy Industry.
- Hygienic requirements in the Fish-Processing Industry.
- Hygienic requirements in food service.
- Food Hygienic training.

2. Visits: Visit nearby Fish/Meat/Milk/Fruit Juice Processing Industry.

3. Self-learning topics:

- FSSAI schedule -4
- FSSAI Pink book.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	25%	25%	25%	25%	20%	25%
CO-2	20%	20%	25%	25%	25%	30%	25%
CO-3	30%	30%	30%	25%	25%	30%	30%
CO-4	30%	25%	20%	25%	25%	20%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Food Safety Hazard	8	CO1	18	6	6	6
Unit-2.0 Personal Hygiene and Safety	8	CO1, CO2	16	6	4	6
Unit-3.0 Cleaning and Sanitizing Operations	8	CO3, CO4	20	4	8	8
Unit-4.0 Location, Layout and Facilities	12	CO3, CO4	16	4	6	6
Total	48	-	70	20	24	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identify the possible sources of food contamination and control measures taken in a food processing area by visiting the nearest food industry.	CO1	40	40	20
2.	Prepare the chart of chemical, physical, and biological hazard sources, and possible measure control with examples of each type.	CO1	40	40	20
3.	Prepare the detailed action plan for HACCP implementation in Milk Pasteurization/Mango pulp Canning/Fruit Jam etc. (one food processing plant)	CO1	40	40	20
4.	Prepare the chart of do and don't personal habits, proper hand wash technique, and hand wash guidelines of food handlers.	CO2	30	60	10
5.	Demonstrate the fire extinguisher on the fire.	CO2	30	60	10
6.	Prepare the checklist with respect to the procurement of raw materials, storage room and visitor management.	CO1, CO2	30	60	10
7.	Evaluate the pH of given cleaning agents.	CO3	30	60	10
8.	Prepare the 5/10/ 50/100 PPM sodium hypochlorite solutions.	CO2. CO3	40	50	10
9.	Prepare a caustic soda solution of 0.5/ 1.25/1.5 % strength at temperature 75°C.	CO2. CO3	40	50	10
10.	Prepare Nitric acid, Phosphoric acid and Peracetic acid solution of 0.5% / 1.25 % strength at temperature 70°C.	CO2. CO3	40	50	10
11.	Prepare chart mentioning different cleaning & sanitizing solutions used in CIP of Dairy plant, mentioning their concentration, ideal temperature, and pressure, contact time, and CIP flow sheet.	CO2. CO3	30	60	10
12.	Enlist the GHPs checklist with respect to waste disposal, pest control, employee's facilities, water supply and construction consideration and plumbing.	CO3. CO4	40	50	10
13.	Estimate the total hardness of the water.	CO4	40	50	10
14.	Prepare the raw water treatment processing steps and parameters used by visit to nearest raw water treatment plant.	CO4	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	pH Meter	Type-Digital ,Range- 0.0-14.00 or better, Resolution (pH)- 0.01 pH or better, Resolution (Temp) -0.1 Deg C, curacy (pH) +/-0.01 pH or better	07
2.	Digital Analytical Balance	Capacity 220g, Accuracy-1 mg , Calibration-External, Type of Weighing Scale-Digital	08,09,10,13

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Food Hygiene & sanitation second edition	Sunetra Roday	Tata McGraw-Hill ISBN-9780070700208
2	Food safety and sanitation	David McSwane	Prentice Hall ISBN-0130648442
3	Principles and Practices for the Safe Processing of Foods	David A. Shapton, Norah F. Shapton	Butterworth-Heinemann Ltd., Oxford
4	Water Supply and Sanitary Engineering [Environmental Engineering]	S.C.Rangwala	Pradeep Publications, Anand 388 001
5	David McSwan, Nancy Rue, Richard Linton	Essential of Food Safety and Sanitation	Prentice-Hall Inc., New Jersey
6	Principles of Food sanitation 5th edition	Norman G.Marriot Robert B.Gravni	Springer

(b) Online Educational Resources:

1. https://www.spxflow.com/en/assets/pdf/CIP_Systems_22003_05_02_2013_GB_tcm11-7665.pdf (Cleaning in place system)
2. www.fssai.gov.in (Training Manual Food Safety Supervisor Course advance (level 2) manufacturing)
3. www.fssai.gov.in (Food safety and good hygienic practices handbook for Gambian youth entrepreneurs)
4. www.mhlw.go.jp (CAC/RCP 1-1969, Rev.4- 2003 Page 1 of 31)
5. <https://youtu.be/-Wn3Fwt8QrY> (Lecture on Food Hazards)
6. https://youtu.be/kSwA9pT_LyY (Lecture on Food Hygiene and sanitation)
7. <https://old.fssai.gov.in/FOSTAC/advance-level.html> (Lecture on food safety)
8. https://youtu.be/_pSz7G_hV8k (Lecture on Food Hygiene and sanitation)
9. <http://www.safefood360.com/resources/Cleaning.pdf> (pdf file regarding cleaning and sanitation)

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others: FSSAI schedule -4 guidelines

- A) **Course Code** : 2449405(T2449405/P2449405/S2449405)
- B) **Course Title** : Fruits and Vegetables Technology
- C) **Pre-requisite Course(s)** : Food Processing and Preservation
- D) **Rationale** :

The rationale behind fruits and vegetables technology lies in addressing various challenges and opportunities associated with the production, processing, preservation, and consumption of these Fruits and vegetables are seasonal in nature, highly perishable commodities and having shortest shelf life. Fruits and vegetables are essential components of a healthy diet and contribute to overall human nutrition and well-being. This technology aims to improve efficiency, increase yield, enhance quality, extend shelf life, and minimize post-harvest losses.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- CO-1** Identify ripening changes and control ripening process.
- CO-2** Outline the manufacture process of Vegetable products as per the FSSAI standards.
- CO-3** Outline the manufacture process of fruit products as per the FSSAI standards.
- CO-4** Describe canning process and drying/dehydration of fruit and vegetable.
- CO-5** Classify the spices based on economic, origin and climatic condition.

- F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	-		2	2	-	2		
CO-2	3	3	3	3	2	2	2		
CO-3	3	3	3	3	2	2	2		
CO-4	3	3	3	3	2	2	2		
CO-5	3	-	-	2	2	2	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Fruits and Vegetables Technology	2449405	Fundamentals of Food Sciences and Technology)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Food Processing and Preservation	2449405	Fruits and Vegetables Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units: T2449405**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 1a.</i> Outline the maturity indices of fruit and vegetables by physical, chemical, and physiological. <i>TSO 1b.</i> Explain the current scenario of fruits and vegetables in India <i>TSO 1c.</i> Identify the factors affecting ripening of fruit and vegetable.. <i>TSO 1d.</i> Enlist the climacteric and non-climacteric fruit <i>TSO 1e.</i> Describe maturity Indices of fruits and vegetables. <i>TSO 1f.</i> Describe the uses of ethylene and its mechanism <i>TSO 1g.</i> Explain the preprocessing of fresh fruits and vegetables. <i>TSO 1h.</i> Differentiate between MAS and CAS <i>TSO 1i.</i> Describe the hypobaric storage and , cool storage	Unit-1.0 Maturity Indices and Ripening 1.1 Current scenario of fruits and vegetables in India. 1.2 Climacteric and non-climacteric fruits 1.3 Physiology of maturity, ripening, and senescence in fruits, and vegetables. 1.4 Maturity indices and harvesting of fruits and vegetables (physical & chemical, Physiological, etc.). 1.5 Ripening of fruits & vegetables - Respiratory changes during ripening, Physiology of ripening, 1.6 Use of ethylene and its mechanism, Use of plant growth regulators and hormones 1.7 Preservation, handling, packing and transport of fresh fruits and vegetables processing, grading, cleaning 1.8 Storage of fresh fruits and vegetables - MAS, CAS, Hypobaric storage, cool storage.	CO1
<i>TSO 2a.</i> Outline the manufacture process of various potato products <i>TSO 2b.</i> Uses of sweet potato. <i>TSO 2c.</i> Describe the manufacture process of carrot and mushroom products. <i>TSO 2d.</i> Describe the freeze drying mushroom <i>TSO 2e.</i> Explain canning of carrot <i>TSO 2f.</i> Outline the manufacture process of various tomato products. <i>TSO 2g.</i> Differentiate between tomato puree and tomato paste.	Unit-2.0 Vegetable Processing 2.1 Potato and Sweet potato Processing: Potato-Chips, Frozen patties, French fries processing, Flours and Granules Sweet potato - Chips, Flakes, Uses of sweet potato 2.2 Carrot and mushroom Processing: Carrot Processing- Toffee and Canning, Mushroom processing - Freeze drying, Pickles, Dehydration and Canning 2.3 Tomato Processing: Selection of tomatoes, pulping & processing of tomato juice, tomato puree, paste, chutney, ketchup, sauce.,	CO2
<i>TSO 3a.</i> Uses of equipment's for fruit juice processing. <i>TSO 3b.</i> Outline the manufacture process and preservation of various fruit juice products <i>TSO 3c.</i> Describe the straining ,filtration and clarification process <i>TSO 3d.</i> Describes the chemicals use in fruit product	Unit-3.0 Fruit Processing 3.1 Fruit beverages: - Types of Fruit beverages, Equipment's used for fruit juice processing, Preparation of fruit Juice- selection of fruit, preprocessing, extraction of juice, de-aeration, straining, filtration, and clarification. 3.2 Preservation of fruit juices-Pasteurization, use	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
as a preservatives <i>TSO 3e.</i> Explain the mechanism of sulphur dioxide as a preservatives. <i>TSO 3f.</i> Outline the manufacture process of squash/ cordials/ nectars. <i>TSO 3g.</i> Outline the manufacture process of jam, jelly, and marmalades and yield calculation. <i>TSO 3h.</i> Explain fruit bars and fruit leathers	of chemical preservatives, Preservation by sugars, Freezing, Drying, irradiation, Aseptic processing, carbonation, Production process of Fruit Juice, RTS, squash, cordials, nectars, concentrates and powder. 3.3 Jam, Jellies, Marmalades and Fruit preserves: role of ingredient sugar, pectin, acid, Production process of Jam, Jelly and Marmalades, Fruit preserves, Candies, Fruit leathers, bars & toffees. Calculation of jam yield from different combination of fruit and sugar.	
<i>TSO 4a.</i> Principles of canning for fruits and vegetables <i>TSO 4b.</i> Draw flow diagram of canning process. <i>TSO 4c.</i> Identify spoilage of canned foods. <i>TSO 4d.</i> Explain the types of cans use in canning process. <i>TSO 4e.</i> Principles of drying and dehydration of fruits and vegetables. <i>TSO 4f.</i> Outline the production process of drying and dehydration of fruit and vegetables <i>TSO 4g.</i> Differentiate between drying and dehydration	Unit-4. Canning and Dehydration 4.1 Canning: Principles of canning, Types of can, lacquering of can, Syrups and brines for canning, 4.2 Canning process of fruits and vegetables, 4.3 spoilage of canned food. 4.4 Drying & dehydration of fruits & vegetables : Principles of drying and dehydration, 4.5 Production process of -Raisin, Anardana, Mango bar, onion slice, Jackfruit bar, dried fig and leafy vegetables	CO2, CO3, CO4
<i>TSO 5a.</i> Describe curing techniques. <i>TSO 5b.</i> Identify defect and their causes. <i>TSO 5c.</i> Classify the spices based on economic, origin and climatic condition. <i>TSO 5d.</i> Uses and value added products of spices <i>TSO 5e.</i> Differentiate between essential oil and oleoresins. <i>TSO 5f.</i> Outline the production process of essential oil and oleoresins. <i>TSO 5g.</i> Application of essential oils and oleoresins.	Unit-5.0 Pickles, Chutneys and Spices 5.1 Pickles & Chutneys : Methods of preparation, Curing techniques, Defects, their causes and prevention 5.1 Spices: Definition of spices and condiments, Classification of spices (based on economic importance, Based on origin & flavor, climatic requirement), 5.2 Uses and value added products of spices (Turmeric, Ginger, Black Pepper, Cardamom, Cloves, Cinnamon, coriander and Cumin Fenugreek, Chillies) 5.3 Essential oil and oleoresins: Definition of essential oil & oleoresins, Production process of Essential oils and oleoresins.	CO2, CO3, CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449405

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
<i>LSO 1.1.</i> Use of plant growth regulator <i>LSO 1.2.</i> Use of Penetrometer,	1.	Demonstrate the ripening of fruits by natural and artificial - Texture - Color	CO1
<i>LSO 2.1.</i> Use of color meter, Penetrometer <i>LSO 2.2.</i> Use of refractometer.	2	Determine the maturity indices by physical and chemical method	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 2.3. Select best quality of potato LSO 2.4. Use of deep fryer	3	Prepare potato chips	CO2
LSO 3.1. Use stem jacketed kettle LSO 3.2. Use of refractometer.	4	Demonstrate preparation of carrot toffee	CO2
LSO 4.1. Use of pupler, refractometer, steam kettle LSO 4.2. Use of FSSAI specification	5	Demonstrate preparation of tomato ketchup and sauce by using preservative.	CO2
LSO 5.1. Select of juicer, refractometer LSO 5.2. Use of FSSAI specification	6.	Demonstrate preparation of orange/ mango squash.	CO3
LSO 6.1. Use of Juicer , peeler ,stem jacketed kettle, refractometer. LSO 6.2. Use of FSSAI specification	7.	Prepare the apple jam or mix fruit jam	CO3
LSO 7.1. Use of Juicer , peeler ,stem jacketed kettle, refractometer LSO 7.2. Use of FSSAI specification.	8.	Prepare the guava Jelly as per FSSAI standards	CO3
LSO 8.1. Use of refractometer	9.	Demonstrate the preparation of amla candy.	CO3
LSO 9.1. Use of filler, exhaust LSO 9.2. Calculate the strength of brine and sugar syrup	10.	Demonstrate the canning process	CO2,CO3, CO4
LSO 10.1. Use of try dryer LSO 10.2. Observe the color changes	11.	Prepare raisin from grapes by using drying	CO3,CO4
LSO 11.1. Use of cutter, spices, oil LSO 11.2. Check the quality of pickles and chutneys.	12	Prepare of different types of pickles & chutneys. .	CO2,CO3, CO4
LSO 11.3. Outline the chart of value added spices.	13	Prepare chart of value-added products of spices	CO5
LSO 11.4. Use of solvent extractor LSO 11.5. Observe the extraction of oleoresins from spices	14	Demonstrate the extraction of oleoresins from spices	CO5

L) Suggested Term Work and Self Learning: S2449405 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Comparative study of natural and artificial ripening of fruits and vegetables.
2. Prepare different types of fruits and vegetables products as per FSSAI standards.
3. Survey and collect information types of fruits and vegetables products available in local market.
4. Prepare chart or model of canning process of fruits and vegetables industry.
5. Collect the information of spices/pickles/chutneys available in local market.

c. Other Activities:

1. Seminar Topics:

- Uses of ethylene and its mechanism.
- FSSAI Standards of Vegetables products.
- Fruit juice preparation and methods of juice extraction.
- Spoilage of canned food and its prevention.
- Classification of spices.

2. Visits: Visit nearby vegetables industry/fruits processing industry/canning industry/drying industry prepare report of visit with respect to processing and preservation of food.

3. Self-learning topics:

- Fruit ripening
- Prepare different types of vegetables product.
- Prepare different types of fruit product.
- Canning and drying process of fruit and vegetables
- Uses of different varieties of spices.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	10%	10%	10%	10%
CO-2	25%	25%	25%	30%	25%	25%	30%
CO-3	30%	25%	30%	30%	25%	25%	30%
CO-4	15%	15%	15%	15%	20%	20%	15%
CO-5	15%	20%	15%	15%	20%	20%	15%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Maturity Indices and Ripening.	8	CO1	08	2	4	2
Unit-2.0 Vegetable Processing	10	CO2	16	4	6	6
Unit-3.0 Fruit Processing	12	CO3	18	4	6	8
Unit-4. Canning and Dehydration	8	CO2,CO3,CO4	14	4	4	6
Unit-5.0 Pickles, Chutneys and Spices	10	CO2, CO3,CO5	14	6	4	4
Total	48	-	70	20	24	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Demonstrate the ripening of fruits by natural and artificial - Texture - Color	CO1	40	50	10
2.	Determine the maturity indices by physical and chemical method	CO1	40	50	10
3.	Prepare potato chips	CO2	30	60	10
4.	Demonstrate preparation of carrot toffee	CO2	30	60	10
5.	Demonstrate preparation of tomato ketchup and sauce by using preservative.	CO2	40	50	10
6.	Demonstrate preparation of orange/ mango squash.	CO3	40	50	10
7.	Prepare the apple jam or mix fruit jam	CO3	40	50	10
8.	Prepare the guava Jelly as per FSSAI standards	CO3	40	50	10
9.	Demonstrate the preparation of amla candy.	CO3	30	60	10
10.	Demonstrate the canning process	CO2, CO3, CO4	40	50	10
11.	Prepare raisin from grapes by using drying	CO3, CO4	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
12.	Prepare of different types of pickles & chutneys. .	CO2, CO3, CO4	30	60	10
13.	Prepare chart of value-added products of spices	CO5	40	50	10
14.	Demonstrate the extraction of oleoresins from spices	CO5	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Weighing Machine	One digital weight balance up to 20 kg and one digital analytical balance upto 500gm maximum	All
2.	Hot air Oven	Laboratory Hot air oven with standard specification temperature maximum 250 degree Cel.	2,3,4,11,
3.	Steam Jacketed Kettles	Both jacket and pan are fabricated with S.S.-304 grade stainless steel of heavy gauge. The pan is 2/3 jacketed which provides Maximum steam utilization and efficiency. It is available in the following capacities:25 gallons	4,5,6,7,8,9,10,
4.	FRUIT CRUSHER (CRUSHING MACHINE)	This fruit Crusher is ideal for various fruits and vegetables processing. It can be used to crush a variety of fruits and vegetables, such as berry, pear, apple, carrot, tomato, etc. Technical Parameters: • Production Capacity: 1-2T/hr • Cutter Rotational Speed: 310 rpm • Motor Power: 2.2 kW • Dimensions: 910x600x1175 (mm)	4,5,6,7,8,10,
5.	Bottle Filling Machine	This machine is suitable for accurate filling of liquids like medicines, syrups, ketchup, solutions etc. In bottles, machine consists of two/four filling heads with vacuum pump and 1/2 H.P. motor. All contact parts are of stainless steel	5,6,7,8,10,12,

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Fruit & Vegetable Preservation	Giridharilal Sidappa and Tandon	ICAR New Delhi, ISBN-10: 9788171640904 ISBN-13: 978-8171640904
2.	Fruit & Vegetable Preservation Principles & Practices	R.P. Srivastava & Sanjeev Kumar	International Book distributing Co., Lucknow ISBN-10: 8123924372 ISBN-13: 978-8123924373
3.	Handbook of Vegetable Science & Technology	D.K. Salunkhe & S.S. Kadam	Marcel Dekker Inc., New York, ASIN: 0824701054 ISBN-10 : 8126525665 ISBN-13 : 978-0824701055
4.	Food Processing and Preservation	G. Subbulakshmi	New Age International Publishers, New Delhi, ISBN-10 : 8122412831 ISBN-13 : 978-8122412833
5	Handbook of Quality Analysis and Quality Control of Fruit & Vegetable Products	Ranganna	Tata McGraw Hill Publishing Co. Ltd., New Delhi ISBN-10 : 9780074518519 ISBN-13 : 978-0074518519

(b) Online Educational Resources:

- 1) <https://youtu.be/Mq3fVA083L0> (Ripening of fruit)
- 2) <https://youtu.be/xCxUjdAmQak> (Maturity Index)
- 3) <https://youtu.be/7ksooSp2Fys> (Tomato ketchup)
- 4) <https://youtu.be/ZozA1gHNoDA> (Jam)
- 5) https://youtu.be/ggA7F_L-1D8 (Canning processing)
- 6) <https://youtu.be/paDdBQYdjLU> (Drying process)
- 7) https://youtu.be/bLw4NbJa_Rs (Spices)
- 8) <https://youtu.be/UQk955IljA> (Oleoresins)

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

(c) Others:

1. Material Handbook
2. Lab Manuals
