



**Second Year Curriculum  
Admission Year 2026-27**

**Bachelor of Technology  
Dairy Technology**

**Faculty of Engineering & Technology**

**Parul University**

**Vadodara, Gujarat, India**

## Detailed Syllabus

### Semester 3

- a. **Course Name:** Thermodynamics
- b. **Course Code:** 20104212
- c. **Prerequisite:** Basic knowledge of thermodynamics and practical aspects of different mode of heat transfer. It also makes understanding of the thermodynamic properties of substances in gas and liquid states and working principles of different systems of internal combustion engines.
- d. **Rationale:** Learn about Acquire fundamental understanding of the principles of thermodynamics and heat transfer. It enables the student to understand mathematical and practical aspects of heat transfer by conduction, convection and radiation. It develop understanding of thermodynamic properties of substances in gas and liquid states and learn about the concept, type and working principle of different systems of internal combustion engines and understand the classification, design and operation of steam generators.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	Develop a comprehensive understanding of the fundamental principles and concepts of thermodynamics, including the laws of thermodynamics, thermodynamic properties, and energy transfer mechanisms.
<b>CLOBJ 2</b>	Apply thermodynamic principles to analyse and optimize heat transfer processes, refrigeration systems, and energy utilization within dairy processing units.
<b>CLOBJ 3</b>	Explore the thermodynamics of phase transitions and refrigeration cycles as they relate to dairy product manufacturing and storage.
<b>CLOBJ 4</b>	Apply thermodynamic principles to optimize thermal processing parameters like pasteurization and sterilization to assure dairy product safety and quality.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand and apply the basic concepts of thermodynamics, including systems, properties, processes, and thermodynamic equilibrium.
<b>CLO 2</b>	Analyze the First Law of Thermodynamics to perform energy balance calculations in closed and open systems.
<b>CLO 3</b>	Explain and apply the Second Law of Thermodynamics, entropy, and irreversibility to evaluate the efficiency of thermodynamic processes.
<b>CLO 4</b>	Evaluate the performance of thermodynamic cycles (e.g., Carnot, Rankine, refrigeration cycles) used in engineering applications.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				T	T	P	P	
2	-	2	3.00	40	40	-	20	100

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction to thermodynamics: Importance and applications of thermodynamics in Dairy/Food processing. Basic concepts: Thermodynamic systems, properties, state, processes, cycles, energy, The Zeroth Law of Thermodynamics.	616	5
2	Ideal gases: Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. Analysis of non-flow and flow processes. The second Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, heat engine, entropy, reversibility, availability.	19	6
3	Air Cycles: Otto, Diesel, dual cycles and their efficiencies, Plotting the air cycles on p-V, T-S, p-h diagram etc. I.C. Engines: Concepts, Classification, Working of two stroke and four stroke cycle S.I. engines and C.I. engines. Parts of I.C. engine, Performance of IC engines. Fuels.	18	6
4	Chemical properties: Calorific value and its determination, Fuel Burners, Fuel combustion analysis. Properties of steam: Properties of wet, dry saturated, superheated steam, Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption	19	6
5	Steam generators: Definition, classification, fire tube boilers, water tube boilers, Boiler performance parameters, Boiler mountings and Boiler accessories. Layout of steam pipe-line and expansion joints. Introduction to Indian Boiler Regulation Act. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, Draught analysis.	19	6
6	Air Compressors: Definition, classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis	9	3
<b>Total</b>		<b>100%</b>	<b>48</b>

**i. Text Books and Reference Books**

1. Arora, C.P. 1998. Thermodynamics. Tata McGraw- Hills Publ. Co., New Delhi.
2. Chattopadhyay P. Chattopadhyay 2000 Boiler Operation Engineering: Questions and Answers, McGraw-Hill
3. Steam Plant Operation 2017 Everett B. Woodruff, Herbert B. 2017. Steam Plant Operation. Lammers & Thomas F. Lammers. McGraw-Hill Education
4. Gupta, C.P. and Parkash, R. 1996. Engineering Thermodynamics. New Chand & Bros., Roorkee (UP).
5. Khurmi, R.S. and Gupta, J.K. 2004. A Textbook of Thermal Engineering. S. Chand & Co. Ltd., New Delhi.
6. Nag, P.K. Nag.2005. Engineering Thermodynamics, 3rd Ed. Tata-McGraw-Hill Education, New Delhi
7. Rajput, R.K. Rajput. 2007. Engineering Thermodynamics, 3rd edn. Laxmi Publications (P) Ltd., Beangaluorue.
8. Smith, J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.
9. STEAM/its generation and use 42nd edition. The Babcox and Willcox company.

**j. Experiment List :**

<b>Sr. No.</b>	<b>Experiment List</b>
1	A visit to dairy/ food processing plant showing the thermodynamics applications/ devices;
2	Study of 2-stroke and 4-strokes IC engines working;
3	Study of S.I. and C.I. engines working; Study of modern fuel injection systems of I.C. engines;
4	Study of diesel fuel supply system (pump and fuel injector) of I.C. engine;
5	Study of fuel supply system of a petrol engine;
6	Study of the cooling system of an I.C. engine (air cooling and water cooling);
7	Study of lubrication system of I.C. engine;
8	Study of Solar water heater and biogas plants and appliances;
9	To study different types of boilers with the help of Lab models;
10	To study Boiler mountings and steam-line layout and steam traps; Industrial exposure visit to plant with steam utilization;
11	Study of Fire tube low pressure boiler installed in a dairy processing plant;
12	Study of water softening plant installed with boiler in a dairy processing plant;
13	Study the construction and working of Cochran boiler.
14	Study of Babcock and Wilcox boiler.
15	Study of different Boiler accessories

- a. **Course Name:** Traditional Indian Dairy Products
- b. **Course Code:** 20104213
- c. **Prerequisite:** Students should have completed foundational courses related to market milk. Basic knowledge of milk and its physico-chemical properties. Familiarity with different principles and mechanisms for preparation of milk products is recommended. Understanding the overall operations in preparation of different milk products will enhance comprehension.
- d. **Rationale:** This course is vital for understanding the principles governing different methodology for product preparation. This course aims to bridge the gap between traditional knowledge and modern dairy science by introducing students to standardized processing techniques, quality control, packaging innovations, and regulatory requirements. It also supports the growing demand for value-added ethnic dairy products in both domestic and international markets. By equipping students with technical and entrepreneurial skills.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	Understand the historical and cultural significance of traditional Indian dairy products to preserve their significance in Indian cuisine.
<b>CLOBJ 2</b>	Learn about traditional fermentation, curdling, and preservation procedures used to make indigenous dairy products in different Indian areas and communities.
<b>CLOBJ 3</b>	Discover the variety of traditional Indian dairy products, their regional variants, and the ingredients and procedures that give them their distinct Flavors, textures, and nutritional profiles.
<b>CLOBJ 4</b>	Assess traditional dairy product production quality assurance, including hygiene, safety, and standard compliance, and evaluate ways to adapt and improve to modern practices.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand the types, characteristics, and cultural significance of traditional Indian dairy products such as ghee, paneer, khoa, chhanna, and fermented products.
<b>CLO 2</b>	Explain the manufacturing processes and principles involved in the preparation of various traditional dairy products.
<b>CLO 3</b>	Analyze the quality parameters, defects, and shelf-life factors affecting traditional dairy products.
<b>CLO 4</b>	Apply knowledge of hygiene, packaging, and storage techniques to ensure safety and quality of traditional dairy products.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Lab	Credit	Theory Marks	Practical Marks	Total Marks

				<b>T</b>	<b>T</b>	<b>P</b>	<b>P</b>	
2	-	2	3.00	40	40	-	20	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; **MSE**- Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE**- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Status &amp; Significance of Traditional Indian Milk Products:</b> Status, availability and utilization of traditional Indian dairy products in India and Abroad. Associated economic and pollution problems	3	1
2	<b>Khoa :</b> Classification of types, standards methods of manufacture and preservation, Factors affecting yield of khoa	5	1
3	<b>Mechanization of Khoa Manufacture:</b> Mechanized methods, design and working of khoa making machines, process parameters and control, energy efficiency, quality evaluation, hygiene and safety standards, and recent advancements in mechanized khoa production.	5	1
4	<b>Khoa-based Sweets:</b> Production of Burfi, Peda, Milkcake, etc and process description, factors affecting yield, physico-chemical changes during manufacture.	10	3
5	<b>Rabri and Basundi:</b> Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.	5	2
6	<b>Chhana:</b> Product description, standards method of manufacture, packaging and preservation.	15	3
7	<b>Chhana-based Sweets:</b> Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process and advances in preservation and packaging of Chhana	15	5
8	<b>Paneer:</b> Product description, standards, method of manufacture	10	3
9	<b>Mechanization of Paneer Processing:</b> The mechanized (advancement) of paneer processing	10	3
10	<b>Chakka/Maska &amp; Shrikhand:</b> Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects.	5	1
11	<b>Misti Dahi:</b> Product description method of manufacture and packaging process	5	2
12	<b>Kheer and Payasam :</b> Product description methods of manufacture, innovations in manufacturing and packaging processes	8	4
13	<b>Biopreservatives &amp; Active Packaging:</b> Principles in enhancing the self-life of indigenous milk products including active packaging	4	3
<b>Total</b>		<b>100%</b>	<b>32</b>

**i. Text Book and Reference Book:**

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. (2002). Technology of Indian Milk Products. A Dairy India Publ., Delhi, India
2. Agarwala, S.P. (2006). Equipment for paneer making, Lecture compendium on developments in traditional dairy products. Short course organized by CAS from Dec. 10-30, 2006: pp-132-137.
3. Dharam Pal and Narender Raju, P. (Eds). (2006). Developments in Traditional Dairy Products, Lecture Compendium of the 21st Short Course, CAS in Dairy Technology, NDRI, Karnal.
4. Pal, D. (1997). Technology of the manufacture of rabri and basundi. In Advances in Traditional Dairy Products. Short course, CAS in Dairy Technology, NDRI Deemed University, Karnal.

**j. Experiment List :**

Sr. No.	Experiment List
1	Preparation of Khoa from cow, buffalo and concentrated milk
2	Preparation of Burfi, Peda, Kalakand, Milk cake and Gulabjamun
3	Preparation of Paneer from cow, buffalo and mixed milk
4	Preparation of Chhana from cow and buffalo milk and mixed milk
5	Preparation of Sandesh and Rasogolla
6	Preparation of kheer
7	Preparation of Rabri, Misti Dahi, Chhana and Shrikhand
8	Visit to industry.

- a. **Course Name:** Dairy Engineering
- b. **Course Code:** 20104214
- c. **Prerequisite:** Basic knowledge of designing and equipment operation use in the food Industry, it including general principles of sanitary pipes, cleaning operation and mechanical separation and mixing method and other related operation at Industrial level.
- d. **Rationale:** Learn about sanitary pipes and fittings and systems used for cleaning operations in dairy plants. It make the better understanding of design and operation of various mechanical separations systems and devices used in the dairy industry and acquire knowledge of design and operation of thermal processing systems such as pasteurizer, sterilizer and UHT processing plants and learn about pouch filling and aseptic packaging machines for packaging of processed liquid milk.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	Acquire in-depth knowledge of various dairy processing equipment, their design principles, and functionality to effectively optimize and troubleshoot processing systems.
<b>CLOBJ 2</b>	Develop skills in analysing and improving dairy processing workflows, with a focus on enhancing efficiency, quality control, and resource utilization for sustainable and economical production.
<b>CLOBJ 3</b>	Learn how to use dairy engineering to create high-quality, safe, and creative dairy products that satisfy market expectations.
<b>CLOBJ 4</b>	Understand and apply dairy processing regulatory standards, quality control measures, and safety processes to ensure industry compliance and the delivery of high-quality dairy products.

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Understand the fundamental principles of engineering operations applied in dairy processing, including fluid flow, heat transfer, and mass transfer.
<b>CLO 2</b>	Analyze and perform calculations related to dairy equipment such as heat exchangers, evaporators, dryers, and refrigeration systems.
<b>CLO 3</b>	Evaluate the design, working, and performance of various dairy machinery used in milk processing and product manufacturing.
<b>CLO 4</b>	Apply engineering concepts for efficient plant layout, energy utilization, and maintenance of dairy processing systems.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				T	T	P	P	
2	-	2	3.00	40	40	-	20	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

#### h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Sanitization:</b> Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes and fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system.	22	7
2	<b>Mechanical Separation:</b> Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers.	23	7
3	<b>Homogenization:</b> Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers.	7	2
4	<b>Thermal Processing:</b> (a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, Arrhenius equation, D value, Z value, F value, Q10 value. (b) Factors affecting thermal destruction of microorganisms.	15	5
5	<b>Pasteurization:</b> Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers..	6	2
	<b>Sterilization:</b> Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers.	9	3
<b>Total</b>		<b>100%</b>	<b>30</b>

#### i. Text Book and Reference Book:

- i. Ahmad, T. 1985. Dairy Plant Systems Engineering. Kitab Mahal Publ., Allahabad.
- ii. Dairy Processing Handbook. 1995. Tetra Pak Processing Systems AB, Sweden.
- iii. Kessler. 1981. Food Engineering and Dairy Technology. V.A. Kessler Publ., Freising, Germany.

- iv. McCabe, W., Smith, J. and Harriott, P. 1993. Unit operations of Chemical Engineering. Mc.Graw Hill Inc. New York.
- v. Towler, G. and Sinnott, R. 2008. Chemical Engineering Design. Elsevier, New York.

**j. Experiment List:**

<b>Sr. No.</b>	<b>Experiment List</b>
1	Study of S. S. pipes, fitting and gaskets;
2	Study and selection of pump;
3	Study of different types of milk filter;
4	Study of equipment at raw milk reception dock;
5	Constructional details, operation and maintenance of straight through can washer;
6	Constructional details, operation and maintenance of C.I.P. system;
7	Constructional details, operation and maintenance of homogenizers;
8	Constructional details, operation and maintenance of batch pasteurizer;
9	Constructional details, operation and maintenance of HTST pasteurizer;
10	Comparison of conventional and modern pasteurizer;
11	Constructional details, operation and maintenance of cream separators;
12	Constructional details, operation and maintenance of sterilization systems;
13	Constructional details, operation and maintenance of pouch filling machine;
14	Constructional details, operation and maintenance of different types of agitators
15	Constructional details, operation and maintenance of bottle filling and capping machine;
16	Visit to a dairy processing plant.



2	-	2	3.00	40	40	-	20	100
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L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Basic refrigeration cycles and concepts:</b> Standard rating refrigerating machines; Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors; Theoretical vapour compression cycle; Departure from theoretical vapour compression cycle, representation on T-S and p-h diagrams; Mathematical analysis of vapour compression refrigeration system.	19	6
2	<b>Refrigerants:</b> Primary and secondary refrigerants; common refrigerants (Ammonia, Freon, HFC, HCFC etc.); Brine, their properties and comparison. Multi-Pressure Refrigeration Systems: Applications; Multi-evaporators with single stage and multi-stage compression and expansion systems; Working, Control and mathematical analysis of above systems.	18	6
3	<b>Refrigeration Equipment and Controls:</b> Introduction to the types, construction, operation and maintenance of Refrigeration Components, Controls and Safety Devices as used in different refrigeration applications. Capacity control methods, Refrigeration Piping: Purpose, Types, Materials, Fittings and Insulation.	19	6
4	<b>Design and Balancing of Refrigeration System:</b> Basic elements of design of individual components and a complete refrigeration system. Input and Output design parameters, Balancing of components of refrigeration system for optimum performance. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Actual Vapour absorption refrigeration system, Refrigerant absorbent pairs, Absorption cycle analysis.	18	6
5	<b>Cryogenic Freezing:</b> Cryogenics, cryogens, properties, applications, cryogenic freezers. Psychrometry: Definition, properties of moist air, psychrometric charts, psychrometric processes; Cooling/ Heating coils, humidifiers and dehumidifiers, Temperature and humidity measurements and controls.	16	5
6	<b>Air-conditioning Systems:</b> Types of cooling loads and their calculation, Design conditions for Human and Industrial air conditioning systems, Analysis of different air-conditioning systems with the help of psychrometric chart. Cold Storage: Types of cold	10	3

	storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.		
<b>Total</b>		<b>100</b>	<b>32</b>

**i. Text Book and Reference Book:**

1. Arora, S. C. and Domkundwar, S. 2018. A Course in Refrigeration and air conditioning. 5th ed. Dhanpat Rai and Sons, Delhi.
2. Arora, C. P. 2000. Refrigeration and air conditioning. Tata McGraw-Hill, New Delhi.
3. Ballaney, P. L. 1992. Refrigeration and air conditioning. Khanna Publ., New Delhi. Jorden, R. C. and Priester, G. B. 1957. Refrigeration and air conditioning. Prentice-Hall, New Delhi.
4. Prashad, M. 2007. Refrigeration and air conditioning. New Age International, New Delhi.

**j. Experiment List:**

<b>Sr. NO.</b>	<b>Experiment List</b>
1	Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools;
2	Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator;
3	Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler;
4	Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler;
5	Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler;
6	Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant;
7	Estimation of installed cooling capacity with the help of observed working pressures;
8	Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT);
9	Study of specifications, components, operation, control and maintenance of a Cold Storage;
10	Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air Washer or Room air-cooler etc.;
11	Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications;

12	Study of different types of capacity control devices used with compressors in a refrigeration plant; Experimental study of a simple refrigeration system on refrigeration tutor or an experimental set-up (Comparison of actual and theoretical performance);
13	Experimental study of a year-round air-conditioning system on an air-conditioning tutor or an experimental set-up; Determination of SHF and Bypass factor etc;
14	Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor; Measurement of psychrometric

a. **Course Name: Starter Culture and Fermented Dairy Products**

b. **Course Code:** 20104216

c. **Prerequisite:** Knowledge of chemistry and biology up to 12<sup>th</sup> science level.

d. **Rationale:** Starter Cultures and Fermented Milk Products hold crucial significance in B Tech Dairy Technology as it explores the pivotal role of microbial cultures in the production and quality enhancement of diverse fermented milk products

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	Understand the principles behind microbial cultures and their role in initiating and controlling fermentation in various milk products.
<b>CLOBJ 2</b>	Identify and evaluate different types of starter cultures used in dairy fermentation, considering their impact on product characteristics and quality.
<b>CLOBJ 3</b>	Demonstrate proficiency in the techniques involved in the isolation, maintenance, and propagation of starter cultures for specific dairy applications.
<b>CLOBJ 4</b>	Analyse and assess the factors influencing the fermentation process, including environmental conditions, microbial interactions, and substrate composition.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Learn the basics of starter cultures, their classification and propagation of starter cultures
<b>CLO 2</b>	Study the metabolism of starters, biochemistry of fermentation, quality and activity of starters
<b>CLO 3</b>	Acquire the knowledge in brief about the fermented milk products, probiotics, acidophilus and Bifidus milk products
<b>CLO 4</b>	Evaluate the associative growth of Starter cultures in milk.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				T	T	P	P	
2	-	2	3.00	40	40	-	20	100

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

## h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	<b>History and Characterization</b> Types, metabolism and propagation of starter cultures: History, classification and importance of starter Cultures in dairy industry; Single, multiple, defined and mixed strain starters	10	3
2	<b>Probiotics</b> Probiotics and Special cultures like exopolysaccharide production; Propagation of starter cultures- concentrates- direct bulk and direct vat starter cultures, factors affecting propagation	10	3
3	<b>Metabolism</b> Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits.	10	3
4	<b>Activity and Preservation</b> Activity, Purity, Preservation of Starters and Starter Failure: Quality and activity tests for dairy starters and their preservation-methods (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures), merits and demerits; factors affecting the survival of cultures during preservation.	14	4
5	<b>Defects</b> Defects in starters and their control; Starter failures- effect of antibiotic residues, sanitizers and bacteriophages. Phages-life cycle, sources, prevention, chemical and mechanically protected systems.	10	3
6	<b>Role of Starters in fermented milks</b> Role of starters in the preparation of various fermented milks; Types of fermented milks-dahi, yoghurt, acidophilus milk; different types of dahi and yoghurt; preparation; defects and their control	14	4
7	<b>Kefir and koumiss</b> Origin and characteristics; microbiology of kefir grains; Other fermented milks such as Bulgarian milk, cultured buttermilk, Leben, Villi and Yakult; Microbiology of fermented milk products; their nutritional and therapeutic significance.	13	4
8	<b>Cheese Starters</b> Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; Rennet: rennet substitutes, microbial rennet and recombinant	13	4

	chymosin		
<b>9</b>	<b>Bacterial and mold ripened cheeses</b> soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; Rennet: rennet substitutes, microbial rennet and recombinant chymosin.	6	2
<b>Total</b>		<b>100</b>	<b>32</b>

**i. Text Book and Reference Book:**

1. Advanced Dairy Science and Technology (Textbook) By Britz, T.J. and Robinson, R.K
2. Applied Dairy Microbiology (Textbook) By Marth, E.H. and Steele, J
3. Dairy Bacteriology (Textbook) By De. S
4. E-course of ICAR. Cited from: [www.agrimoon.com](http://www.agrimoon.com)

**j. Experiment List:**

Sr. No.	Experiment List
1	Testing purity of starter cultures by gram's staining, catalase test; creatine test.
2	Testing starter activity by dye reduction tests, Horrall-Elliker, White Head & Cox test
3	Preparation of single and mixed starter cultures. Evaluation of homo-fermentation and hetero-fermentation separately and in combination
4	Preparation of single and mixed starter cultures. Evaluation of homo-fermentation and hetero-fermentation separately and in combination
5	Preservation of starter cultures by freeze- drying techniques.
6	Preparation of concentrated starter (DVS)
7	Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters
8	Testing milk for presence of inhibitory substances using <i>B. stearothermophilus</i> and <i>S. thermophilus</i> as indicator organisms.
9	Effect of presence of antibiotic residues in milk on starter activity.
10	Effect of presence of antibiotic residues in milk on starter activity.
11	Evaluation of associative growth of Starter cultures in milk.
12	Detection of Bacteriophages in cheese whey by plaque assay method.
13	Preparation and microbial examination of dahi, yoghurt, cultured buttermilk, acidophilus milk and kefir.
14	Preparation and microbial examination of dahi, yoghurt, cultured buttermilk, acidophilus milk and kefir.
15	Analysis of cheese for total spore and anaerobic spore count.

16	Microbiological analysis of cheddar cheese at different stages of manufacture of (storage and ripening).
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**a. Course Name: Physical Education, First Aid, Yoga Practice and meditation**

**b. Course Code:** 20104217

**c. Prerequisite:** Basic knowledge of human anatomy, common sports activities, and an introductory understanding of yoga and meditation practices.

**d. Rationale:** It equips students with the knowledge and skills to maintain physical fitness, manage emergencies through first aid, and enhance mental well-being through yoga and meditation. The course fosters an understanding of the physiological and psychological benefits of exercise, the role of sports in personality development, and the importance of safety in physical activities

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	Understand the principles of physical education, including training methods, physiological effects of exercise on body systems, and the role of sports in personality development.
<b>CLOBJ 2</b>	Develop practical skills in administering first aid for common sports injuries, handling emergency situations, and ensuring safe transport of injured individuals.
<b>CLOBJ 3</b>	Master the techniques of yoga asanas, pranayama, and meditation, and analyze their role in enhancing physical fitness, mental focus, and stress management.
<b>CLOBJ 4</b>	Evaluate the importance of posture correction, balanced nutrition, and regular exercise in managing adolescent issues, ageing, and overall well-being.

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Apply training methods such as interval, Fartlek, and circuit training to design a fitness program, and explain their effects on the muscular, respiratory, circulatory, and digestive systems.
<b>CLO 2</b>	Demonstrate first aid techniques for sports injuries (e.g., muscle strains, burns, and fractures), including proper bandaging, CPR, and safe handling of injured persons.
<b>CLO 3</b>	Perform a sequence of yoga asanas (e.g., Sarvangasan, Bhujangasan), pranayama (e.g., Anulom Vilom, Bhastrika), and meditation with correct techniques, and assess their benefits in sports performance and mental health.
<b>CLO 4</b>	Analyze postural deformities, create a plan for corrective exercises (e.g., Tadasan, Parvatasan), and develop a balanced diet plan to support physical performance and healthy ageing.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				T	T	P	P	
-	-	2	2.00	-	-	-	100	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<p><b>Physical education</b></p> <p>Training and Coaching - Meaning and Concept                      Methods of Training; aerobic and aerobic exercises                      Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems                      Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process                      Personality, its dimensions and types                      Role of sports in personality development                      Motivation and Achievements in Sports: Learning and Theories of learning                      Adolescent Problems and its Management                      Posture: Postural Deformities, Exercises for good posture.</p>	25	4
2	<p><b>Yoga; History of Yoga, Types of Yoga, Introduction to Yoga.</b></p> <p>Asanas (Denition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg - right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhhdhanurasan, Sawasan                      Suryanamskar Pranayama (Denition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari                      Meditation (Denition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh                      Mudras (Denition and Importance) Gyanmudra, Dhyamudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra,</p>	32	6

	Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. Role of yoga in sports. Teaching of Asanas – demonstration, practice, correction and practice		
<b>3</b>	<b>III History of sports and ancient games</b> Governance of sports in India Important national sporting events Awards in Sports History, latest rules, measurements of playeld, specications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.	<b>18</b>	<b>3</b>
<b>4</b>	<b>First AID</b> First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.	<b>25</b>	<b>5</b>

**a. Course Name: Agriculture Marketing & Trade**

**b. Course Code:** 20104218

**c. Prerequisite:** Completion of foundational courses in dairy technology, agricultural economics, and basic management principles is typically required. Students should have a basic understanding of dairy production systems and supply chain dynamics. Familiarity with statistical tools and data analysis is beneficial for market studies. Knowledge of agricultural policies and trade regulations is also advantageous.

**d. Rationale:** This course equips students with skills to navigate the marketing and trade of dairy products in a competitive global market. It addresses the economic and logistical aspects of moving dairy products from farm to consumer, enhancing profitability. Understanding market trends and trade policies is crucial for dairy professionals to ensure sustainable business practices. The course fosters expertise in pricing, distribution, and regulatory compliance, vital for career success in the dairy industry.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	To understand the fundamentals of agricultural marketing and trade
<b>CLOBJ 2</b>	To analyze the factors influencing supply and demand in agricultural markets
<b>CLOBJ 3</b>	To explore different marketing channels and strategies in agriculture
<b>CLOBJ 4</b>	To examine the role of government policies and regulations in agricultural markets

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Understand the structure, functions, and importance of agricultural markets and trade systems.
<b>CLO 2</b>	Analyze pricing mechanisms, demand–supply dynamics, and market trends for agricultural commodities.
<b>CLO 3</b>	Evaluate different marketing channels, government policies, and regulations related to agricultural trade.
<b>CLO 4</b>	Apply knowledge of market information systems, grading, standardization, and export-import procedures in agricultural marketing.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				T	T	P	P	
2	-	2	3.00	40	40	-	20	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Agricultural Marketing:</b> Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets	10%	2
2	<b>Demand, supply and producer's surplus of agri commodities:</b> nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri commodities;	19%	8

	pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits		
3	<b>Marketing process and functions:</b> Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark)	15%	4
4	<b>Market functionaries and marketing channels:</b> Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs	19%	8
5	<b>Role of Govt. in agricultural marketing:</b> Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading	12%	3
6	<b>Agricultural prices and policy:</b> Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO	15%	5
7	Agreement on Agriculture (AoA), and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.	10%	2
<b>Total</b>		<b>100</b>	<b>32</b>

**i. Text Book and Reference Book:**

1. Acharya, S.S. and Agarwal, N.L. 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna, S.S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory.

**j. Experiment List:**

<b>Sr. No.</b>	<b>Experiment List</b>
1	Plotting and study of demand and supply curves and calculation of elasticities.
2	Study of relationship between market arrivals and prices of some selected commodities.
3	Computation of marketable and marketed surplus of important commodities.
4	Study of price behaviour over time for some selected commodities.
5	Construction of index numbers.
6	Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodities, collection of data regarding marketing costs, margins and price spread, and presentation of report in the class.
7	Visit to market institutions (NAFED, SWC, CWC, cooperative marketing society, etc.) to study their organization and functioning
8	Application of principles of comparative advantage in international trade.

## Semester 4

**a. Course Name:** Cheese Technology

**b. Course Code:** 20104261

**c. Prerequisite:** Students should have completed foundational courses in Dairy Chemistry, Dairy Microbiology, Fundamentals of Dairy Processing, and Dairy Engineering to understand milk composition, microbial roles, and basic processing techniques.

**d. Rationale:** This subject provides in-depth knowledge of cheese classification, manufacturing varieties (e.g., Cheddar, Mozzarella), ripening processes, and modern technologies like membrane processing, essential for developing skilled professionals in dairy product innovation and quality assurance in the industry.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	Learn about history of cheese making and evolution of different varieties of cheeses with distinctly different attributes
<b>CLOBJ 2</b>	Understand how quality of milk and various additives play critical role in good cheese making
<b>CLOBJ 3</b>	Acquire knowledge about the role of rennet and starter cultures in progression of chemical and biochemical processes responsible for desirable cheese quality attributes
<b>CLOBJ 4</b>	Develop skills to manufacture good quality cheeses of both fresh and ripened varieties

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Apply scientific principles of milk quality, starter cultures, rennet action, and ripening to produce high-quality fresh, ripened, and processed cheeses.
<b>CLO 2</b>	Operate and optimize cheese manufacturing processes, including mechanization, membrane technologies, and accelerated ripening to enhance yield, quality, and efficiency.
<b>CLO 3</b>	Evaluate and ensure quality and safety of cheese through understanding biochemical changes, additives, packaging, storage, and distribution systems.
<b>CLO 4</b>	Study the role of rennet and starter cultures in cheese quality development.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				T	CE	P	T	P	
3	0	4	5	20	20	20	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation,

**CE- Continuous Evaluation, ESE- End Semester Examination**

**h. Course Content:**

<b>Course Content</b>		<b>W - Weightage (%) , T - Teaching hours</b>	
<b>Sr.</b>	<b>Topics</b>	<b>W</b>	<b>T</b>
<b>1</b>	Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese.	<b>10</b>	<b>05</b>
<b>2</b>	Milk quality in relation to cheese making. Pre-treatment of milk for cheese making; Physical and chemical additives and preservatives for cheese making. Rennet preparation and properties, milk clotting enzymes as rennet substitutes: plant, animal and microbial origin. Action of rennet on milk in relation to cheese making. Biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi soft, semi hard, hard, acid coagulated cheese.	<b>30</b>	<b>15</b>
<b>3</b>	Cheese starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; Manufacture of different choice-based varieties of cheese: Cheddar, Gouda, Swiss Mozzarella, Cottage, Cream and Quarg. Enzyme modified cheese (EMC), flavourings, Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.	<b>30</b>	<b>15</b>
<b>4</b>	Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.	<b>30</b>	<b>13</b>
<b>Total</b>		<b>100</b>	<b>48</b>

**a. Text Book and Reference Book:**

1. Cheese. (2010). A global strategic business report. Global Industry Analysts, Inc
2. Banks, J.M. (1998). The Technology of Dairy Products. 2nd edn. R. Early (Ed.), Chapman and Hall, Blackie Academic and Professional, London,
3. Kapoor, R. and Metzger, L. E. (2008). Process Cheese: Scientific and Technological Aspects—A Review. Comprehensive Reviews in Food Science and Food Safety. 7, 194-214.
4. Singh, S. (2011). Production and Marketing of Cheese – A Global Perspective. Lecture Compendium on Advances in Cheese and Fermented Products (Centre of Advanced Faculty Training), [8http://www.strategyr.com/Cheese\\_Market\\_Report.asp](http://www.strategyr.com/Cheese_Market_Report.asp)
5. Cheese (2017) Chemistry, Physics and Microbiology 4th ed Paul McSweeney, Paul Cotter, David Everett (Ed) Elsevier Publications, USA.
6. Patrick F. Fox, Timothy P. Guinee, Timothy M. Cogan, Paul L. H. McSweeney, (2018) Fundamentals of Cheese Science. Springer New York, NY.

**b. Experiment List:**

<b>List of Practical</b>	
<b>1.</b>	Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters.
<b>2.</b>	Testing milk for presence of inhibitory substances using <i>B. stearothermophilus</i> and <i>S. thermophilus</i> as indicator organisms.
<b>3.</b>	Effect of presence of antibiotic residues in milk on cheese starter activity.
<b>4.</b>	Evaluation of associative growth of Starter cultures in milk.
<b>5.</b>	Detection of Bacteriophages in cheese whey by plaque assay method.
<b>6.</b>	Familiarization with equipments, accessories and standardization numericals.
<b>7.</b>	Study of factors affecting rennet action.
<b>8.</b>	Determination of Rennet Coagulation Time (RCT) of milk.
<b>9.</b>	Manufacture of Cheddar cheese.
<b>10.</b>	Manufacture of Gouda cheese.
<b>11.</b>	Manufacture of Mozzarella cheese.
<b>12.</b>	Manufacture of Swiss cheese.
<b>13.</b>	Manufacture of Cottage cheese.
<b>14.</b>	Manufacture of Processed cheese.
<b>15.</b>	Manufacture of Processed cheese spread.
<b>16.</b>	Manufacture of Processed cheese food.

- a. **Course Name:** Fat Rich Dairy Products
- b. **Course Code:** 20104262
- c. **Prerequisite:** Foundational knowledge in dairy science and technology with emphasis on lipid chemistry and dairy processing methods.
- d. **Rationale:** Fat Rich Dairy Products in B.Tech. Dairy Technology equips students with specialized skills to formulate, process, and optimize the quality of high-fat dairy products, meeting consumer preferences and industry standards.

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	Understand manufacture of different types of creams, its packaging, marketing and quality control
<b>CLOBJ 2</b>	Learn about the processes involved in making butter and spreads using batch and continuous methods, their packaging and quality
<b>CLOBJ 3</b>	Learn ghee making methods, factors affecting its quality, packaging and legal standards required for marketing
<b>CLOBJ 4</b>	Develop skills to produce value-added items (e.g., butter milk, ghee residue utilization) and low-fat spreads.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Demonstrate knowledge of processing technologies for cream, butter, ghee, and related fat-rich dairy products, including standardization, pasteurization, churning, and ghee-making methods.
<b>CLO 2</b>	Evaluate and control product quality by understanding factors affecting texture, flavor, stability, packaging, defects, and legal standards of fat-rich dairy products.
<b>CLO 3</b>	Operate and manage dairy equipment and processes for efficient production, storage, and distribution of creams, butters, spreads, and ghee at both batch and industrial scales
<b>CLO 4</b>	Explore packaging materials, storage techniques, and defects prevention in high-fat products

g. **Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/Week	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
2	-	2	-	3	20	20	20	40	-	100

**SEE** - Semester End Examination, **T** - Theory, **P** – Practical

## h. Course Content:

Course Content		W - Weightage (%), T - Teaching hours	
Sr.NO.	Topics	W	T
1	Status of fat-rich dairy products in India and abroad. Cream: (a) Definition and Legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream. (b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. (c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT processing of cream. (d) factors affecting quality of cream; ripening of cream. (e) Packaging, storage and distribution, defects (non-microbial) in cream and their prevention.	25%	9
2	Butter: (a) Introduction to the butter making process; theory of churning, Legal standards. (b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat loses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine.	25%	9
3	Special butters and related products: (a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter/fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. (b) Manufacture, packaging, storage and characteristics of margarine of different types	25%	7
4	Ghee and butter oil: (a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. (b) Ghee: Composition and changes during manufacture fat constants. (c) Butteroil: Manufacture of butteroil, packaging and storage.	25%	7
<b>Total</b>		<b>100</b>	<b>32</b>

### i. Text Book and Reference Book:

1. Anantkrishnan, C.P. and Srinivasan, M.R.1964. Milk Products of India. ICAR Publications, New Delhi.
2. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. 2002. Technology of Indian Milk Products. A Dairy India Publication, Delhi.
3. De, S.1980. Outlines of Dairy Technology. Oxford University Press, Delhi.
4. Rangappa, K.S. and Acharya, K.T. 1974. Indian Dairy Products. Asia Publishing House, New Delhi

**j. Experiment List:**

<b>List of Practical</b>	
<b>1.</b>	Standardization, neutralization, pasteurization and cooling of cream.
<b>2.</b>	Preparation of sterilized cream.
<b>3.</b>	Study of construction and cooperation of the power operated butter churn and butter packaging machine.
<b>4.</b>	Preparation of cooking butter by the hand operated churn.
<b>5.</b>	Preparation of desi butter.
<b>6.</b>	Manufacture of table butter using the power-driven churn.
<b>7.</b>	Preparation of ghee from cream and butter.
<b>8.</b>	Study and operation of continuous ghee plant.

- a. **Course Name:** Ice Cream & Frozen Deserts
  - b. **Course Code:** 20104263
  - c. **Prerequisite:** Basic understanding of dairy chemistry, food processing principles, and refrigeration fundamentals is required to comprehend mix formulation, freezing behaviour, and processing operations in ice-cream manufacture.
  - d. **Rationale:** This course equips students with technical, processing, and quality control knowledge essential for producing safe, high-quality ice-cream and frozen desserts, while familiarizing them with industrial practices, advanced technologies, and product innovation in the frozen dessert sector.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	Understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
<b>CLOBJ 2</b>	Learn about design and working of Ice cream freezers including cleaning and sanitization
<b>CLOBJ 3</b>	Acquire knowledge about the physic-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
<b>CLOBJ 4</b>	Learn about the defects that appear in ice cream, causative factors and measures to control them

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Apply scientific and technological principles of mix formulation, freezing, stabilizer-emulsifier functionality, and equipment operation to manufacture high-quality ice cream and frozen desserts.
<b>CLO 2</b>	Evaluate and control product quality by understanding physico-chemical properties, process variables, defects, standards, hygiene, and sanitation in ice-cream production.
<b>CLO 3</b>	Utilize modern innovations and industrial practices such as fat replacers, flavour systems, continuous freezing, and plant management to optimize product quality, safety, and processing efficiency.
<b>CLO 4</b>	Identify defects in ice cream and methods to control them.

g. **Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/Week	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
2	-	2	-	3	20	20	20	40	-	100

SEE - Semester End Examination, T - Theory, P - Practical

## h. Course Content:

Course Content		W - Weightage (%), T - Teaching hours	
Sr.NO.	Topics	W	T
1	History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts.	20%	7
2	Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture.	20%	6
3	Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant.	20%	6
4	Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention.	20%	7
5	Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.	20%	6
<b>Total</b>		<b>100</b>	<b>32</b>

### i. Text Book and Reference Book:

1. Arbuckle, W.S. 1991. Ice Cream. AVI Publ., Co. Inc., West Port, Connecticut
2. Hall, C.W. and Hedric, T.T. 1975. Drying of Milk and Milk Products. AVI Publ. Co. Inc., West Port, Connecticut. p-338.
3. Hui, Y.H. 1993. Dairy Science and Technology Handbook 2- Product Manufacturing. Wiley VCH Inc., USA.
4. Ice Cream Alliance and Ice Cream Federation. 1992. Code of Practice for the Hygienic manufacture of Ice Cream.
5. NDRI. 1998. Advances in Ice Cream and Frozen Desserts. Lecture compendium, Sixth short course, Dec15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson, R.K. 1986. Modern Dairy Technology. Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.
7. Robinson, R.K. 2002. Dairy Microbiology Handbook. 3rd edn. John Willey and sons, New York, USA.
8. Sommer, H. H. 1951. The Theory and Practice of Ice Cream Making. 6th edn. Madison, Wisconsin,

**j. Experiment List:**

**List of Practical**

<b>1.</b>	Calculation of standardization of ice-cream mixes
<b>2.</b>	Manufacture of plain and fruit flavoured icecream
<b>3.</b>	Manufacture of chocolate, fruit and nut ice cream
<b>4.</b>	Preparation of sherbets/ices
<b>5.</b>	Preparation of soft served and filled ice-cream
<b>6.</b>	Manufacture of kulfi
<b>7.</b>	Study of continuous and batch type freezers
<b>8.</b>	Manufacture of ice-cream by continuous process
<b>9.</b>	Determination of overrun in ice cream
<b>10.</b>	Visit to an Ice Cream Plant

- a. **Course Name:** Chemistry of Dairy Products  
 b. **Course Code:** 20104264  
 c. **Prerequisite:** Basic knowledge of milk composition, dairy processing principles, and food chemistry is required to understand the physicochemical behaviour and analytical aspects of dairy products  
 d. **Rationale:** This course provides students with a scientific understanding of chemical changes, quality attributes, and deterioration mechanisms in dairy products, enabling effective processing, quality evaluation, and storage management across the dairy industry.

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	Acquire knowledge about composition and legal standards for different types of dairy products
<b>CLOBJ 2</b>	Understand about the physico-chemical changes that take place during manufacture of dairy products as a function of processing variables
<b>CLOBJ 3</b>	Learn about various deteriorative reactions that occur during storage of dairy products and measures to control them
<b>CLOBJ 4</b>	Understand the chemistry involved in manufacturing products like cream, butter, ghee, and cheese

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand the chemical composition, legal standards, and physicochemical changes occurring during the processing of major dairy products such as butter, ghee, khoa, paneer, dahi, cheese, and ice cream.
<b>CLO 2</b>	Analyze deteriorative reactions (hydrolytic, oxidative, enzymatic, and microbial) during storage of dairy products and apply appropriate control measures to maintain quality and stability.
<b>CLO 3</b>	Perform essential chemical analyses of dairy products to evaluate quality attributes such as fat, moisture, acidity, protein, lactose, and functional properties relevant to product safety and shelf life.
<b>CLO 4</b>	Apply analytical techniques for testing chemical quality, assessing safety parameters, and detecting adulterants in dairy products

g. **Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/Week	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
1	-	2	-	2	20	20	20	40	-	100

SEE - Semester End Examination, T - Theory, P - Practical

## h. Course Content:

Course Content		W - Weightage (%) , T - Teaching hours	
Sr. No.	Topics	W	T
1.	Chemical composition and legal standards of milk products. Chemistry of creaming and factors affecting the same. Ripening and neutralization of cream. Theories of churning and factors affecting the same. Butter colour. Ghee: Physico-chemical changes during manufacture. Hydrolytic and oxidative deterioration, their causes, prevention and role of antioxidants.	25%	5
2.	Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa, Paneer, Dahi, Channa, Lassi, Chakka, Shrikhand.	25%	3
3.	Chemistry of cheese: milk clotting enzymes, enzymatic coagulation of milk, biochemical changes during ripening. Physico-chemical changes during preparation and storage of concentrated and dried milk products	25%	4
4.	Physico-chemical changes during processing and storage of ice cream and frozen desserts. Role and mechanism of stabilizers and emulsifiers in ice cream.	25%	4
<b>Total</b>		<b>100</b>	<b>16</b>

## i. Text Book and Reference Book:

1. Fox, P. F. (Ed). (2006). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
2. Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi.
3. Mathur, M. P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Pubs., ICAR, New Delhi.
4. Megh R. Goyal, Suvartan G. Ranvir, Junaid Ahmad Malik. (2023). The Chemistry of Milk and Milk Products-Physicochemical Properties, Therapeutic Characteristics, And Processing Methods. AAP, CRC Press (Taylor & Francis Group).
5. Varnam, Jane and Sutherland, P. (2001) Milk and Milk Products: Technology, Chemistry and Microbiology. Springer Science & Business Media
6. Webb, B. H., Johanson, A. H., and Alford, J. A. (Eds). (2008). Fundamentals of Dairy Chemistry. CBS Publ. and Distributors Pvt. Ltd., New Delhi.

## j. Experiment List:

### List of Practical

1.	Cream: estimation of fat and acidity;
2.	Butter: estimation of fat moisture, curd and salt content
3.	Ghee: estimation of moisture, acid value
4.	Butyro refractive reading and Reichert Meissl value / Polanske value
5.	Determination of lactose and sucrose in sweetened condensed milk
6.	Milk powder: moisture, fat, ash, solubility, acidity and bulk density
7.	Ice cream: estimation of fat and total solids; Estimation of moisture, fat and salt content in cheese
8.	Khoa/paneer: estimation of moisture and fat
9.	Estimation of protein content in milk products and protein rich dairy products using Kjeldahl method

- a. **Course Name:** Microbiology of Dairy Products
- b. **Course Code:** 20104265
- c. **Prerequisite:** Basic understanding of general microbiology, dairy processing, and food hygiene is needed to study microbial behaviour, spoilage mechanisms, and safety concerns in dairy products.
- d. **Rationale:** This course helps students understand microbial ecology, spoilage pathways, and pathogen risks across diverse dairy products, enabling them to implement effective control, preventive measures, and safety standards essential for quality assurance in the dairy industry.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	To learn about entry of spoilage and pathogenic microorganisms vis-à-vis microenvironment of processed dairy products, their spoilage mechanism and preventive measures
<b>CLOBJ 2</b>	Understand the type of microorganisms that could enter fat rich dairy products, condensed or dried milk, frozen and traditional dairy products
<b>CLOBJ 3</b>	Learn about microenvironment of each of the dairy products and how they influence growth of these microorganisms which in turn cause spoilage
<b>CLOBJ 4</b>	Understand critical processing factors that impact presence of different types of microorganisms and control measures to prevent spoilage and health hazards

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Understand the microbial ecology, spoilage mechanisms, and pathogen entry routes across cream, butter, milk powders, frozen desserts, and indigenous dairy products, along with their preventive and control measures.
<b>CLO 2</b>	Assess the influence of product microenvironment and processing conditions on microbial growth, survival, deterioration, and safety, including regulatory microbiological standards.
<b>CLO 3</b>	Apply microbiological principles to ensure safety and quality of dairy products by identifying defects, evaluating risks of pathogens, and implementing suitable hygiene and processing interventions.
<b>CLO 4</b>	Understand the role of probiotics and bioactive compounds in fermented milk products for human health

**g. Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/Week	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
1	-	2	-	2	20	20	20	40	-	100

SEE - Semester End Examination, T - Theory, P - Practical

## h. Course Content:

Course Content		W - Weightage (%), T - Teaching hours	
Sr. No.	Topics	W	T
1	Microbiology of Cream and Butter - Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in cream and butter; Microbiological aspects including defects in pasteurized (ripened/un-ripened cream), sterilized and UHT cream; Factors influencing the microbial growth during batch/continuous butter making process; Microbial Defects in butter - Bacterial/mold discoloration, enzymatic deterioration and their control measures; Regulatory microbiological standards. Fungal spoilage of Ghee.	20%	5
2	Microbiology of Condensed, Evaporated and Dried products: Type of microorganisms associated with condensed and evaporated milk, their growth/survival during manufacture and storage; Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/ bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavor in evaporated milk; pre heating/DSI temperature and their impact on microflora of dried products.	20%	3
3	Microbiological aspects of milk powder with respect to manufacturing steps and types of powder (heat classification of powders), Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards. Microbiology of Infant Milk Formula (IMF).	20%	2
4	Microbiology of Ice Cream and Frozen desserts: Microenvironment in ice cream, microbiological quality of ingredients, critical process factors and their impact on entry of pathogens in ice cream and frozen desserts, their survival during storage, food poisoning out breaks and legal standards.	20%	3
5	Microbiology of Indigenous Milk Products: Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfi etc.; Factors affecting the microbiological quality in reference to production, processing, storage and distribution; Comparison of dairy sweets made at sweet shops vs. commercially manufactured sweets. Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards	20%	3
<b>Total</b>		<b>100</b>	<b>16</b>

## i. Text Book and Reference Book:

1. Marth, E.M. and Steele, J.L. (1998). Applied Dairy Microbiology. Marcel Dekker, New York.
2. Marth, Elmer H. Marth and Steele, James Steele (2001) Applied Dairy Microbiology CRC Press Palmiro,
3. Poltronieri (2017) Microbiology in Dairy Processing: Challenges and Opportunities. John Wiley & Sons.
4. Prajapati, J.B and Behare, P.V. 2018. Textbook on Dairy Microbiology. Directorate of

Knowledge Management in Agriculture (DKMA), ICAR, NewDelhi. ISBN:978-81-7164-182-6.

5. Prajapati, J.B. (1995). Fundamental Dairy Microbiology, EktaPrakashan, Nadiad, India.

6. Robinson, R.K. (2002). Dairy Microbiology Handbook. John Wiley and Sons, Inc., New York.

7. Salminen, S. and Wright, A.V. (1998). Lactic Acid Bacteria. Marcel Dekker, New York.

8. Yadav, J.S., Grover, S. and Batish, V.K. (1993). A Comprehensive Dairy Microbiology. Metropolitan Publishers, New Delhi.

#### **j. Experiment List:**

##### **List of Practical**

<b>1.</b>	Calculation of standardization of ice-cream mixes
<b>2.</b>	Manufacture of plain and fruit flavoured ice cream
<b>3.</b>	Manufacture of chocolate, fruit and nut ice cream
<b>4.</b>	Preparation of sherbets/ices
<b>5.</b>	Preparation of soft served and filled ice-cream
<b>6.</b>	Manufacture of kulfi
<b>7.</b>	Study of continuous and batch type freezers
<b>8.</b>	Manufacture of ice-cream by continuous process
<b>9.</b>	Determination of overrun in ice cream
<b>10.</b>	Visit to an Ice Cream Plant

- a. **Course Name:** ICT in Dairy Industry
- b. **Course Code:** 20104266
- c. **Prerequisite:** Basic knowledge of computer fundamentals, mathematics, and dairy processing operations is required to understand digital tools, modelling, and automation used in the dairy industry
- d. **Rationale:** This course develops students' ability to use ICT, automation, AI, and process simulation to optimize dairy operations, enhance productivity, support decision-making, and ensure efficient, technology-driven dairy plant management.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	Learn about computers and its operating environment for organizing, storage and retrieval of data
<b>CLOBJ 2</b>	Understand application of computer as dairy management tools to describe, document and control all processes in the dairy industry
<b>CLOBJ 3</b>	Learn about project management tools for project scheduling and monitoring for timely completion and implementation of information system
<b>CLOBJ 4</b>	Develop competence in process modelling and simulation for product design and manufacturing to deliver good quality dairy products

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Apply ICT tools, computer applications, and process modelling techniques to optimize dairy operations, manage information systems, and support efficient plant decision-making.
<b>CLO 2</b>	Understand and utilize automation technologies such as SCADA, instrumentation, robotics, AI, and CAD/CAM for improved control, productivity, and quality in dairy processing.
<b>CLO 3</b>	Use computational methods and project management tools (e.g., queuing models, PERT/CPM, optimization algorithms) to enhance workflow efficiency, scheduling, and system performance in the dairy industry.
<b>CLO 4</b>	Develop skills in process modelling, AI, and robotics in dairy processing.

**g. Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/Week	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
1	-	2	-	2	20	20	20	40	-	100

SEE - Semester End Examination, T - Theory, P - Practical

## h. Course Content:

Course Content		W - Weightage (%) , T - Teaching hours	
Sr. No.	Topics	W	T
1	Importance of Computerization and IT in dairy industries. Computers, Operating. Environments and Information Systems for various types of dairy Industries.	25%	4
2	Principles of communication. Role of Computer in Optimization; Introduction to Operation. Research.	25%	4
3	A Computer Oriented Algorithmic approach: Queuing systems and waiting models, PERT CPS and CPM. Dairy Process Modelling and Simulation.	25%	4
4	Introduction to SCADA and INTELUTION. CAD and CAM in Dairy Industries: Instrumentation, Process control, Inventory control, Automation, Robotics, Expert Systems and Artificial Intelligence, Instrumentation	25%	4
<b>Total</b>		<b>100</b>	<b>16</b>

## i. Text Book and Reference Book:

1. Balagurusamy, E. 2009. Fundamentals of Computers. Tata Mcgraw-Hill, New Delhi.
2. Britz, T. J. and Robinson, R. K. 2008. Advanced Dairy Science and Technology. Blackwell Publication, UK.
3. Elmasri, R. and Navathe, S. B. 2008. Fundamentals of Database Systems. 5th ed. Pearson Education, New Delhi.
4. Forouzan, B. A. 2012. Data Communication and Networking. 4th ed. Tata McGraw-Hill, India.
5. Goyal, D.P. 2000. Management Information Systems. 2nd ed. Macmillan Publishers, India.
6. Mishra, T.N. and Kirmani, M.M. 2004. System Analysis and Design. CyberTech Publishers, India.
7. Obrien, J. A., and Marakas, G. M. 2006. Management Information System. 7th ed. Tata McGraw-Hill, New Delhi.
8. Patterson, D.W. 2007. Introduction to Artificial Intelligence and Expert Systems. Prentice Hall, India.
9. Rajan, E.G. 2003. Information Technology. BS Publication, Hyderabad.
10. Rajaraman, V. 2002. Fundamentals of Computers. 3rd ed. Prentice Hall of India, New Delhi.
11. Shmulei, G., Patel, N. R. and Bruce, P. C. 2008. Data Mining for Business Intelligence. Wiley Interscience, New Delhi.

**j. Experiment List:**

**List of Practical**

1.	Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food
2.	Chemical kinetics in dairy processing
3.	Use of word processing software for creating reports and presentation.
4.	Familiarization with the application of computer in dairy industries: Milk plant, Dairy units, Fruit and Vegetable processing unit
5.	Familiarization with software related to dairy industry

- a. **Course Name:** Entrepreneurship Development and Business Management
- b. **Course Code:** 20104267
- c. **Prerequisite:** Basic understanding of business fundamentals, economics, and agricultural/dairy sector operations is needed to grasp entrepreneurial processes and enterprise management concepts.
- d. **Rationale:** This course prepares students to create, manage, and sustain small agribusiness ventures by developing entrepreneurial competencies, financial planning skills, and the ability to design viable, fund-worthy business proposals.

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To expose the student to various aspects of establishment and management of a small business unit
<b>CLOBJ 2</b>	To enable the student to develop financially viable agribusiness proposal
<b>CLOBJ 3</b>	Acquire knowledge on mobilizing human resources and capital, and formulating growth strategies
<b>CLOBJ 4</b>	Understand legal requirements, government industrial policies, and the regulatory environment for small industries

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Develop entrepreneurial competencies by understanding opportunity identification, motivation, environmental scanning, and the process of establishing and managing small agribusiness or dairy-based enterprises.
<b>CLO 2</b>	Prepare viable business and project proposals through knowledge of financial planning, marketing, production management, and support systems required for enterprise development.
<b>CLO 3</b>	Apply managerial skills in areas such as operations, finance, personnel, and crisis management to effectively run and sustain small-scale agribusiness ventures.
<b>CLO 4</b>	Apply creative thinking to develop new products/services while assessing and mitigating financial and operational risks

g. **Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
2	-	2	-	3	20	20	20	40	-	100

**SEE** - Semester End Examination, **T** - Theory, **P** - Practical

## h. Course Content:

Course Content		W - Weightage (%), T - Teaching hours	
Sr.	Topics	W	T
1	Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development.	25%	7
2	Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning-spotting of opportunity-scanning of environment- identification of product / service - starting a project; factors influencing sensing the opportunities.	25%	9
3	Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.	25%	7
4	Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management - product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management - raw material costing, inventory control. Personal management - manpower planning, labour turn over, wages / salaries. Financial management /accounting - funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.	25%	9
<b>Total</b>		<b>100</b>	<b>32</b>

## i. Text Book and Reference Book:

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Grover, Indu. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
4. Gupta C.B., 2001, Management Theory and Practice. Sultan Chand & Sons.
5. Khanka S.S., 1999, Entrepreneurial Development. S. Chand & Co.
6. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.

7. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh D., 1995, Effective Managerial Leadership. Deep & Deep Publ.
9. Singhal R.K., 2013, Entrepreneurship Development & Management, Katson Books
10. Tripathi P. C. and Reddy P. N., 1991, Principles of Management. Tata McGraw Hill.
11. Vasant Desai, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

**j. Experiment List:**

**List of Practical**

<b>1.</b>	Visit to small scale industries/agro-industries
<b>2.</b>	Interaction with successful entrepreneurs/ agric entrepreneurs
<b>3.</b>	Visit to financial institutions and support agencies
<b>4.</b>	Preparation of project proposal for funding by different agencies.

- a. **Course Name:** Extrusion Processing in Dairy and Food Industry
- b. **Course Code:** 20104280
- c. **Prerequisite:** Basic understanding of food chemistry, dairy processing, and unit operations is required to comprehend extrusion equipment, process variables, and quality evaluation of extruded foods.
- d. **Rationale:** This course equips students with the skills to operate extrusion systems, optimize processing conditions, and develop innovative cereal-, pulse-, and dairy-based extruded products, along with quality analysis and industrial application for value addition and by-product utilization.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	Understand extrusion equipment and principles, including single-screw and twin-screw extruders and their components.
<b>CLOBJ 2</b>	Learn the effect of key process variables such as moisture, temperature, and screw speed on product quality and expansion.
<b>CLOBJ 3</b>	Develop skills to formulate and process extruded products from cereals, pulses, and dairy-based ingredients.
<b>CLOBJ 4</b>	Gain proficiency in quality evaluation of extruded foods using physical, functional, and sensory parameters.

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Operate and optimize extrusion systems by understanding equipment design, processing conditions, and their effect on product characteristics.
<b>CLO 2</b>	Develop cereal-, pulse-, and dairy-based extruded products and assess their quality through functional, textural, and sensory analysis.
<b>CLO 3</b>	Apply extrusion technology for innovation and industrial value addition, including use of by-products and formulation of functional, nutritious extruded foods.
<b>CLO 4</b>	Understand the effect of incorporating diverse ingredients (fiber, fats, dairy) on the structural and functional properties of extrudates.

**g. Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
0	-	4	-	2	-	-	100	-	-	100

**SEE** - Semester End Examination, **T** - Theory, **P** – Practical

#### **h. Text Book and Reference Book:**

1. Extrusion Processing Technology: Food and Non-Food Biomaterials – Jean-Marie Bouvier and Osvaldo H. Campanella, Wiley-Blackwell Publication, 2014.
2. Extrusion Cooking: Cereal Grains Processing – Edited by Girish M. Ganjyal, Elsevier/Woodhead Publishing, 2020.
3. Extruders and Expanders in Pet Food, Aquatic and Livestock Feeds – Mian N. Riaz, Agrimedia GmbH Publication, 2007.
4. Extrusion and Size Change Processes in the Food Industry – Edited by Seid Mahdi Jafari, Elsevier Publication, 2022.
5. Dairy Ingredients for Food Processing – Ramesh C. Chandan and Arun Kilara, Wiley-Blackwell Publication, 2011.
6. Dairy Processing and Quality Assurance – Ramesh C. Chandan, Arun Kilara and Nagendra P. Shah, Wiley-Blackwell Publication, 2015.

#### **i. Experiment List:**

##### **List of Practical**

1.	Development of High-Protein Extruded Snacks Utilizing Whey Protein Concentrate
2.	Texturization of Casein/Caseinate Blends using Twin-Screw Extrusion for Meat Analogs
3.	Optimization of Extrusion Parameters for Producing Processed Cheese Analogs
4.	Application of Cold Extrusion for the Production of Functional Dairy-Based Confectionery
5.	Effect of Extrusion Cooking on the Functional Properties of Milk Protein Concentrates
6.	Development of Nutrient-Dense Dairy-Cereal Blends via Extrusion for Infant Nutrition
7.	Encapsulation of Probiotics in Dairy Matrices using Hot-Melt Extrusion
8.	Modification of Whey Proteins via Extrusion to Mimic Fat Globules in Low-Fat Foods
9.	High Moisture Extrusion (HME) of Soy-Wheat Gluten Blends for Whole-Cut Meat Analogs
10.	Effect of Screw Configuration on the Fibrous Structure of Pea Protein Meat Alternatives
11.	Utilization of Pulse Proteins (Lentils/Chickpeas) in Extruded Snack Foods
12.	Improving the Nutritional Profile of Extruded Products by Incorporating Food By-products
13.	Optimizing Moisture Content and Die Temperature for Texturized Vegetable Protein (TVP) Production
14.	Development of Gluten-Free Expanded Snacks from Corn and Millet Blends
15.	Extrusion Processing for Increasing Soluble Dietary Fiber in Cereal-Based Foods

16.	Impact of Screw Speed and Feed Rate on the Expansion Ratio of Ready-to-Eat (RTE) Breakfast Cereals
17.	Production of Precooked Instant Flours and Soups using Twin-Screw Extrusion
18.	Functional Modification of Starch using Extrusion for Improved Viscosity
19.	Extrusion-Based 3D Printing of Personalized Nutritional Snacks for Specialized Diets
20.	Supercritical $(CO_2)$ Assisted Extrusion for Producing Low-Density Health Foods
21.	Using Hot-Melt Extrusion (HME) for Taste-Masking of Functional Ingredients in Food
22.	Real-time Quality Monitoring of Extruded Products Using Near-Infrared Spectroscopy

- a. Course Name:** NABL Accreditation of Laboratory
- b. Course Code:** 20104281
- c. Prerequisite:** Basic understanding of laboratory practices, analytical techniques, microbiology, chemistry, and quality control concepts is required to comprehend NABL accreditation requirements, laboratory documentation, calibration procedures, and quality management systems.
- d. Rationale:** This course equips students with the knowledge and practical skills required for implementation of NABL accreditation systems in testing laboratories, including documentation, quality assurance, calibration, method validation, internal auditing, and compliance with ISO/IEC 17025 standards for reliable laboratory operations in dairy and food industries.

**e. Course Learning Objective:**

<b>CLOBJ 1</b>	To understand the principles, structure, and importance of NABL accreditation and ISO/IEC 17025 standards in testing laboratories.
<b>CLOBJ 2</b>	To develop competency in laboratory quality management systems, documentation practices, and record control procedures.
<b>CLOBJ 3</b>	To train students in method validation, calibration practices, internal auditing, and uncertainty estimation in laboratory operations.
<b>CLOBJ 4</b>	To provide practical exposure to accreditation procedures, corrective actions, proficiency testing, and laboratory assessment systems.

**f. Course Learning Outcomes:**

<b>CLO 1</b>	Explain the requirements and procedures involved in NABL accreditation of laboratories.
<b>CLO 2</b>	Prepare and maintain laboratory quality documents, SOPs, calibration records, and audit reports.
<b>CLO 3</b>	Perform laboratory quality assurance activities including method validation, uncertainty analysis, and internal audits.
<b>CLO 4</b>	Apply NABL and ISO/IEC 17025 guidelines for improving laboratory competence and regulatory compliance in dairy and food industries..

**g. Teaching & Examination Scheme:**

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/	Lab Hrs/	Seminar Hrs/	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
0	-	4	-	2	-	-	100	-	-	100

**h. Text Book and Reference Book:**

1. Ramteke, S. and Moghe, C.A. – Manual on Laboratory Quality Management
2. Panneerselvam, R. – Quality Assurance and Management
3. ISO/IEC 17025:2017 – General Requirements for the Competence of Testing and Calibration

## Laboratories

4. NABL Publication 100 – General Information Brochure
5. David Hoyle – ISO 9000 Quality Systems Handbook
6. Kaushik, V.K. – Total Quality Management in Laboratory Systems

### i. Experiment List:

List of Practical	
1.	Study of organizational structure of NABL accredited laboratories.
2.	Preparation of laboratory quality manual.
3.	Preparation and documentation of Standard Operating Procedures (SOPs).
4.	Study of ISO/IEC 17025 clauses and documentation requirements.
5.	Calibration of laboratory glassware and measuring instruments.
6.	Verification and calibration of weighing balances.
7.	Preparation and maintenance of laboratory record registers.
8.	Study of laboratory safety practices and risk assessment procedures.
9.	Demonstration of internal quality control practices in laboratories.
10.	Preparation of corrective and preventive action (CAPA) reports.
11.	Study of proficiency testing and inter-laboratory comparison procedures.
12.	Validation of analytical test methods.
13.	Estimation of measurement uncertainty in laboratory analysis.
14.	Preparation of sample handling and sample traceability records.
15.	Study of equipment qualification and maintenance procedures.
16.	Conduct of internal laboratory audit.
17.	Preparation of non-conformance and audit observation reports.
18.	Study of document control and revision procedures.
19.	Demonstration of root cause analysis for laboratory errors.
20.	Study of accreditation application and assessment procedures of NABL.
21.	Preparation of laboratory audit checklist based on ISO/IEC 17025.
22.	Visit to an NABL accredited laboratory and submission of practical report.