**Semesterwise course curriculum for**

**B.Tech (Dairy Technology)**

**Semester – I**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DE-111</td>
<td>Workshop Practice</td>
<td>1+1</td>
</tr>
<tr>
<td>2</td>
<td>DE-112</td>
<td>Fluid Mechanics</td>
<td>2+1</td>
</tr>
<tr>
<td>3</td>
<td>DE-113</td>
<td>Engineering Drawing</td>
<td>0+1</td>
</tr>
<tr>
<td>4</td>
<td>DM-111</td>
<td>Fundamentals of Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>5</td>
<td>DBM-111</td>
<td>Milk Production Management and Dairy Development</td>
<td>2+1</td>
</tr>
<tr>
<td>6</td>
<td>DBM-112</td>
<td>Communication Skills and Personality Development</td>
<td>1+1</td>
</tr>
<tr>
<td>8</td>
<td>DC-111</td>
<td>Biochemistry</td>
<td>1+1</td>
</tr>
<tr>
<td>9</td>
<td>DBM-113</td>
<td>Environmental Studies And Disaster Management</td>
<td>3+0</td>
</tr>
<tr>
<td>10*</td>
<td>*#EL-111/</td>
<td>Organic Chemistry</td>
<td>2+1/</td>
</tr>
<tr>
<td></td>
<td>*#EL-112</td>
<td>Nutraceuticals and Functional Foods</td>
<td>2+0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>14+7/8</strong></td>
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</table>

*Non credit course (2 credits are S / US)

# Elective Course

**Semester – II**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Credit hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>DE-121</td>
<td>Thermodynamics</td>
<td>1+1</td>
</tr>
<tr>
<td>2</td>
<td>DC-121</td>
<td>Physical Chemistry of Milk</td>
<td>2+1</td>
</tr>
<tr>
<td>3</td>
<td>DE-122</td>
<td>Heat &amp; Mass Transfer</td>
<td>2+1</td>
</tr>
<tr>
<td>4</td>
<td>DE-123</td>
<td>Boilers and Steam Generation</td>
<td>1+1</td>
</tr>
<tr>
<td>5</td>
<td>DE-124</td>
<td>Basic Electrical Engineering</td>
<td>2+1</td>
</tr>
<tr>
<td>6</td>
<td>DM-121</td>
<td>Microbiology of fluid milk</td>
<td>1+1</td>
</tr>
<tr>
<td>7</td>
<td>DBM-121</td>
<td>Economic Analysis, Marketing Management, and International Trade</td>
<td>2+1</td>
</tr>
<tr>
<td>8</td>
<td>DC-122</td>
<td>Chemistry of Milk</td>
<td>2+1</td>
</tr>
<tr>
<td>9</td>
<td>DBM-122</td>
<td>Computer and Application Software Packages</td>
<td>1+1</td>
</tr>
<tr>
<td>10*</td>
<td>*#EL-121/</td>
<td>Food Safety Regulations</td>
<td>2+0/</td>
</tr>
<tr>
<td></td>
<td>*#EL-122</td>
<td>Technology Management</td>
<td>2+0</td>
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<td><strong>Total</strong></td>
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<td><strong>16+9</strong></td>
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**READY-1**

Student READY Rural Dairy Work Experience* Programme-I (Summer Break)

*Non credit course (5 credits are S / US)
### Semester – III

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DT-211</td>
<td>Market Milk</td>
<td>3+1</td>
</tr>
<tr>
<td>2</td>
<td>DT-212</td>
<td>Traditional Indian Dairy Products</td>
<td>2+1</td>
</tr>
<tr>
<td>3</td>
<td>DE-211</td>
<td>Refrigeration &amp; Air-conditioning</td>
<td>2+1</td>
</tr>
<tr>
<td>4</td>
<td>DE-212</td>
<td>Dairy Engineering</td>
<td>2+1</td>
</tr>
<tr>
<td>5</td>
<td>DT-213</td>
<td>Fat Rich Dairy Products</td>
<td>2+1</td>
</tr>
<tr>
<td>6</td>
<td>DT-214</td>
<td>Condensed &amp; Dried Milks</td>
<td>3+1</td>
</tr>
<tr>
<td>7</td>
<td>DC-211</td>
<td>Human Nutrition</td>
<td>1+1</td>
</tr>
<tr>
<td>8</td>
<td>DBM-211</td>
<td>Entrepreneurship Development, Business Management, and Industrial Consultancy</td>
<td>2+1</td>
</tr>
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<td><strong>Total</strong></td>
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<td><strong>17+8</strong></td>
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### Semester – IV

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<th>Title of the Course</th>
<th>Credit hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>DE-221</td>
<td>Dairy Process Engineering</td>
<td>2+1</td>
</tr>
<tr>
<td>2</td>
<td>DM-221</td>
<td>Starter Cultures and Fermented Milk Products</td>
<td>2+1</td>
</tr>
<tr>
<td>3</td>
<td>DM-222</td>
<td>Microbiology of Dairy Products</td>
<td>1+1</td>
</tr>
<tr>
<td>4</td>
<td>DT-221</td>
<td>Cheese Technology</td>
<td>3+2</td>
</tr>
<tr>
<td>5</td>
<td>DT-222</td>
<td>Ice-cream &amp; Frozen Deserts</td>
<td>2+1</td>
</tr>
<tr>
<td>6</td>
<td>DC-221</td>
<td>Chemistry of Dairy Products</td>
<td>2+1</td>
</tr>
<tr>
<td>7</td>
<td>DBM-221</td>
<td>Fundamentals of Dairy Extension</td>
<td>2+1</td>
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READY-II | Student READY Rural Dairy Work Experience* | Programme-II (Summer Break) | 0+5* |

*Non credit course (5 credits are S / US)
### Semester – V

<table>
<thead>
<tr>
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<th>Title of the Course</th>
<th>Credit hours</th>
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<tbody>
<tr>
<td>1</td>
<td>DE-311</td>
<td>Instrumentation and Process Control</td>
<td>2+1</td>
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<tr>
<td>2</td>
<td>DM-311</td>
<td>Quality and Safety Monitoring in Dairy Industry</td>
<td>2+1</td>
</tr>
<tr>
<td>3</td>
<td>DT-311</td>
<td>By Products Technology</td>
<td>2+1</td>
</tr>
<tr>
<td>4</td>
<td>DT-312</td>
<td>Packaging of Dairy Products</td>
<td>2+1</td>
</tr>
<tr>
<td>5</td>
<td>DC-311</td>
<td>Chemical Quality Assurance</td>
<td>1+1</td>
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<tr>
<td>6</td>
<td>DBM-311</td>
<td>Information and Communication Technology in dairy Industry and Agri-Informatics</td>
<td>2+1</td>
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<tr>
<td>7</td>
<td>DBM-312</td>
<td>Industrial Statistics</td>
<td>1+1</td>
</tr>
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<td>8</td>
<td>EL-311</td>
<td>Emerging Dairy Processing Technologies</td>
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*Non credit course (2 credits are S / US)

# Elective Course

### Semester – VI

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Credit hours</th>
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<tbody>
<tr>
<td>1</td>
<td>DE-321</td>
<td>Food Engineering</td>
<td>2+1</td>
</tr>
<tr>
<td>2</td>
<td>DE-322</td>
<td>Material Strength &amp; Dairy Machine Design</td>
<td>2+1</td>
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<tr>
<td>3</td>
<td>DE-323</td>
<td>Dairy Plant Design and Layout</td>
<td>1+1</td>
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<tr>
<td>4</td>
<td>DM-321</td>
<td>Food and Industrial Microbiology</td>
<td>2+1</td>
</tr>
<tr>
<td>5</td>
<td>DT-321</td>
<td>Sensory Evaluation of Dairy Products</td>
<td>2+1</td>
</tr>
<tr>
<td>6</td>
<td>DT-322</td>
<td>Food Technology - I</td>
<td>2+1</td>
</tr>
<tr>
<td>7</td>
<td>DC-321</td>
<td>Food Chemistry</td>
<td>2+1</td>
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<td>8</td>
<td>DE-324</td>
<td>Energy Conservation and Management</td>
<td>1+1</td>
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<td>9</td>
<td>DBM-322</td>
<td>Operations Research</td>
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### Semester – VII

<table>
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<th>Credit hours</th>
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<tbody>
<tr>
<td>1</td>
<td><em>DT- 411</em></td>
<td>Student READY In- Plant Training*</td>
<td>0+20*</td>
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*Non credit course (20 credits are S / US)*

### Semester – VIII

<table>
<thead>
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<th>Sl. No</th>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Credits hours</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>DT-421</td>
<td>Dairy Plant Management</td>
<td>1+1</td>
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<tr>
<td>3</td>
<td>DT-422</td>
<td>Waste Disposal and Pollution Abatement</td>
<td>1+1</td>
</tr>
<tr>
<td>4</td>
<td>DT-423</td>
<td>Food Technology -II</td>
<td>2+1</td>
</tr>
<tr>
<td>5</td>
<td>DBM-421</td>
<td>Financial Management &amp; Cost Accounting</td>
<td>3+1</td>
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<td>6*</td>
<td>*DT-424</td>
<td>Student READY Experiential Learning Module*</td>
<td>0+10*</td>
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*Non credit course (10 credits are S / US)*
DAIRY TECHNOLOGY

1. DT-211 Market Milk


2. DT-212 Traditional Indian Dairy Products

processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.


3. **DT-213 Fat-Rich Dairy Products**

Status of fat-rich dairy products in India and abroad. **Cream:** a) Definition & 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. **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. Special butters and related products: a) Manufacture, packaging 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. **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.

**Practical:** Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant.

4. **DT-214 Condensed and Dried Milk**

**Condensed Milks:** History, status and scope in India and abroad, Definition and legal standards; Condensed milk, sweetened condensed milk and evaporated milk, manufacturing techniques; a) Manufacture of evaporated milk including pilot sterilization test, b) Manufacture of sweetened condensed milk, c) Recombined sweetened condensed milk. Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention. Recent advances with reference to freeze concentration and membrane concentration. **Dried Milks:** History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders, Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in
dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk, Manufacture of infant foods, malted milk foods and other formulated dried products, Cheese spread powder, ice cream powder, cream powder, butter powder, whey powder, Management of condensed and dried milk industry.


5. **DT-221 Cheese Technology** 3+2


6. **DT-222 Ice-Cream and Frozen Desserts** 2+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, Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant, 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, Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.


7. **DT-311 By Product Technology** 2+1

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems, Physico-chemical characteristics of whey, butter milk
and ghee residue. **By-products from skim milk:** Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. b) Industrial and food uses of caseins c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications d) Manufacture of casein hydrolysates and its industrial application e) Co precipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications. **Whey processing:** a) Fermented products from whey, b) Beverages from whey c) Deproteinized and demineralized whey d) Condensed whey e) Dried whey, types and their specification, manufacturing techniques. F) Utilization of whey products. Application of membrane processing for whey processing. **Whey protein concentrates:** a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates b) Functional properties and food applications of WPC. **Lactose:** methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. **Butter milk processing:** a) Condensed butter milk b) Dried butter milk c) Utilization of butter milk products. **Ghee residue:** Composition, processing and utilization. Nutritional characteristics of by products.


8. **DT-312 Packaging of Dairy Products** 2+1

Introduction, Importance of Packaging, History of Package Development, Packaging materials, a) Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information. Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeades, concentrated and dried milks including baby foods. Packaging of functional dairy/food products. Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials, Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food


9. **DT-321 Sensory Evaluation of Dairy Products** 2+1

Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects. Terminology related to sensory evaluation. Design and


10. DT-322 Food Technology-I

Status of food processing industries in India and abroad, magnitude and inter- dependence of dairy and food industry, prospects for future growth in India. Harvesting, transportation and storage of fruits and vegetables. Post harvest processing of fruits and vegetables: Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables. Juice processing: General steps in juice processing, role of enzymes in fruit. Juice extraction, equipments and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders. Fruit juice processing; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices. Manufacture of Jam, Jelly and Marmalade: Role played by pectin, sugar and acid in jellied fruit products. Fruits and vegetable preserves, Glazed, Crystallized fruits. Tomato based products: Juice, puree,


11. DT-421 Dairy Plant Management 1+1


12. DT-422 Waste Disposal and Pollution Abatement 1+1


13. **DT-423 Food Technology-II**  

**Cereal grains, legumes and oilseeds:** Structure and composition of cereals, legumes and oilseeds, Milling of paddy, quality factors of rice grains, processing of rice bran oil, Instant rice, quick cooking rice, canned rice, Milling technology of wheat, Criteria of wheat flour quality, improvers for wheat flour, Types of wheat flour, Milling technology of maize, wet milling of corn, Milling technology of barley, malting of barley and its utilization in manufacture of value added food products including melted milk foods, Dehulling and processing technology of important pulses, Dehulling and extraction of oil in major oilseed crops like soy bean, mustard, sunflower, ground nut, Vegetable protein concentrates/isolates, Utilization of oil cake in food formulation. **Bakery and Snack technology:** Technology of bread, biscuits, crackers and cakes, Technology of manufacturing process of Pasta foods- Macaroni, Noodles and Spaghetti, Technology of breakfast cereals: corn flakes, puffed, extruded snacks, Potato chips. **Meat, fish and egg technology:** Development of meat, poultry, egg and fish industry in India, Pre-slaughter care, handling and ante-mortem inspection of animal, Stunning and slaughtering techniques, Postmortem inspection, rigor mortis and conversion of muscle to meat Slaughterhouse sanitation, meat hygiene and zoonotic diseases, Processing of poultry meat, Egg and egg products – quality assessment of egg, Types, handling, transportation and marketing of fish, Preservation of fish., Manufacturing process of dehydrated fish and fish pickles. Cleaning and sanitation, Waste management of food processing plants.


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**DAIRY ENGINEERING**

1. **DE-111 Workshop Practice**

**Introduction:** workshop practice, safety, care and precautions in workshop. **Wood working tools and their use, Carpentry. Heat treatment process:** Hardening, tempering, annealing and normalizing etc. **Metal work:** Metal cutting. Soldering, Brazing. **Welding:** Electric arc and Gas welding. **Smithy and forging operations:** tools and equipments. **Bench work:** The bench, flat surface filing, chipping, scrapping, marking out, drilling and screwing. **Introduction to following tool machines:** (a) Lathe Machine (b) Milling Machine (C) Shaper and Planner (d) Drilling and Boring machines (e) Grinder (f) CNC Machines etc.

**Practical:** To study different types of measuring tools used in metrology and determine least counts of vernier calipers, micrometers and vernier height gauges. Job work on filing and chipping. To study different types of fitting tools and marking tools used in fitting practice. To study various types of carpentry tools and prepare simple types of at least two wooden joints. Job work on hand hack and power hack saw. Job work on metal sheet working. Job work on butt and lap welding. To study different types of machine tools ( lathe, milling, drilling machines etc). To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making, threading etc.

2. **DE-112 Fluid Mechanics**

Units and dimensions, Properties of fluids. **Static pressure of liquids:** Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular surfaces. Compressible and non compressible fluids. Surface tension, capillarity. Pressure
measuring devices, simple, differential, micro, inclined manometer, mechanical gauges, Piezometer. **Fluid flow:** Classification, steady uniform and non uniform flow, Laminar and turbulent, continuity equation, Bernolli’s theorem and its applications. **Flow through pipes:** Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge. **Dimensional analysis:** Buckingham’s theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude. **Pumps:** Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Pump selection and sizing.


3. **DE-113 Engineering Drawing**  0+1


4. **DE-121 Thermodynamics**  1+1

Importance and applications of thermodynamics in Dairy/Food processing. **Basic concepts:** Thermodynamic systems, properties, state, processes, cycles, energy, The Zeroth Law of Thermodynamics. **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. **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.

5. **DE-122 Heat & Mass Transfer** 2+1

**Basic heat transfer process:** thermal conductivity, convective film co-efficient, Stefan Boltzman’s constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature. **One-dimensional steady state conduction:** Theory of heat conduction, Fourier’s law, Derivation of Fourier’s equation in Cartesian coordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines. **Steady-state heat conduction with heat dissipation to environment:** Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction. **Convection:** Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, Some important empirical relations used for determination of heat transfer coefficient. **Heat Exchangers:** General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry. **Mass transfer:** Fick’s Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolal diffusion. Mass transfer co-efficient and problems on mass transfer.


6. **DE-123 Boilers and Steam Generation** 1+1

**Fuels:** Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. **Renewable energy sources:** Concepts, classification, Types and description of of renewable energy sources. **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. **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. **Air Compressors:** Definition, classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis.

**Practical:** To study different types of boilers with the help of Lab models. To study Boiler mountings and steam-line layout and steam traps. Industrial exposure visit to plant with steam utilization. Study of Fire tube low pressure boiler installed in a dairy processing plant. Study of water softening plant installed with boiler in a dairy processing plant. Study the construction and working of Cochran boiler. Study of Babcock & Wilcox boiler. Study of different Boiler accessories.

8. **DE-211 Refrigeration and Air-Conditioning**

**Basic refrigeration cycles and concepts:** 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. **Refrigerants:** 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. **Refrigeration Equipments and Controls:** 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. **Design and Balancing of Refrigeration System:** 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. **Cryogenic Freezing:** 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. **Air-conditioning Systems:** 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 storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.

**Practical:** Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools. Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler. Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant. Estimation of installed cooling capacity with the help of observed working pressures. Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT). Study of specifications, components, operation, control and maintenance of a Cold Storage. Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air-Washer or Room air-cooler etc. Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications. 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). Experimental study of an year-round air-conditioning system on an air-conditioning tutor or an experimental set-up. Determination of SHF and By-pass factor etc. Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor. Measurement of psychrometric properties using psychrometric meters/gadgets Industrial exposure visit to refrigeration/air-conditioning plant.
9. DE-212 Dairy Engineering 2+1

Sanitization: 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 & 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. Mechanical Separation: 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. Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.


10. DE-221 Dairy Process Engineering 2+1

Evaporation: Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators. Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization. Fluidized bed
dryers. **Processing equipments:** Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. **Packaging equipments:** Packaging machines for milk & milk products. **Membrane Processing:** Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

**Practical:** Constructional details, operation and maintenance of Vacuum pan. Constructional details, operation and maintenance of multiple effect evaporator. Constructional details, operation and maintenance of spray drier. Constructional details, operation and maintenance of butter making equipment. Constructional details, operation and maintenance of equipment related to ghee production. Constructional details, operation and maintenance of ice-cream making equipment. Constructional details, operation and maintenance of cheese making equipment. Constructional details, operation and maintenance of reverse osmosis and ultra filtration system. Design problems on double effect evaporator and vacuum pan. Visit to a milk product plant.

11. **DE-311 Instrumentation and Process Control** 2+1

**Instrumentation scheme & characteristics:** Measurands. Some basic discussion about electric field, potential, capacitance, resistance etc. Definition, Application and types of measurements, instrument classification, Functional elements of an instrument, standards, calibration, introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems.


**Automation:** Introduction to plant automation, automation hierarchy, PLC, SCADA

**Practical:** Strain gauge characteristics and weight measurement. Measurement of pressure using bellows and diaphragm. Preparation and calibration of thermocouple. Study the construction and working of Bourden pressure gauge. Test and calibration of pressure gauges using dead weight tester. Study the mechanism of pH meter and its electrodes. Study a Proximity sensor. Study the different parts and working of pressure switch. Study the different parts of an indicating instrument. Study of RTD and Thermister. Study of different speed measurement sensor/ instruments. Study of LVDT. Study of level/flow controller. Study of PLC. Visit to a automatic controlled dairy plant.

12. **DE-321 Food Engineering** 2+1

**Rheology:** Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of solids foods, Viscoelastic models. Measurement of food texture. **Food Freezing:** Thermal properties of frozen foods. Prediction of freezing rates. Plank’s equation, Design of food freezing equipment, Air blast freezers, Plate freezers, spiral freezers, and immersion freezers, IQF, storage of frozen foods. Freeze concentration. **Food dehydration:** Estimation of drying time for food products, constant rate period and falling
rate period dehydration. Diffusion controlled falling rate period. Use of heat and mass balanced in analysis of continuous dryers. Classification of dryers, tray, vacuum, vacuum band, tunnel, bin, solar, drying, freeze drying, spin flash. **Freeze dehydration:** Heat and mass transfer, Calculation of drying time, Industrial freeze drying. **Other food processing operations and equipments:** Equipment for pulping, fruit juice extraction, blanching, dehulling, size reduction, milling, extrusion and distillation.

**Practical:** To determine physical properties of food product. To determine viscosity of food product. To study food freezers. To study freeze drier. To determine drying characteristics of food product. To compare various dying methods. To determination juice yield. To compare hot water and steam blanching. To study construction and working of distillation system. To study various size reduction equipments. Visit to cold storage. Visit to food processing plant.


14. **DE-323 Dairy Plant Design And Layout**  

**Introduction of Dairy Plant design and layout:** Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site. Hygienic design considerations for dairy processing plants. **Planning:** Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout. Space requirements for dairy plants, estimation of service requirements including peak load consideration. **Dairy plant design aspects:** General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design. Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop. Arrangement of
equipment, milk piping, material handling in dairies. Common problems, office layout-flexibility. Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout. **Building construction materials:** Floors, general requirement of dairy floor finishes, floors for different section of dairy. Foundations, walls doors and windows. **Other design aspects:** Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants. **Computer aided Design:** Introduction to CAD software. **Practical:** Building symbols and convention. Symbols for equipments. Study of process schedule. To draw layout of collection/chilling centre. Visit to dairy processing plant for understanding of layout of different sections. To draw layout of small dairy plant. To draw layout of small dairy plant using CAD. To draw layout of medium dairy plant. To draw layout of large dairy plant. To draw layout of cheese plant. To draw layout of ice-cream plant. To draw layout of butter manufacturing unit. To draw layout of ghee plant. To draw layout of composite dairy plant

15. **DE-324 Energy Conservation and Management**  

benefits. Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries. Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practicals:

**DAIRY CHEMISTRY**

1. **DC-111 Biochemistry 1+1**


2. **DC-121 Physical Chemistry of Milk 2+1**


3. DC-122 Chemistry of Milk


Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

4. DC-211 Human Nutrition 1+1


5. DC-221 Chemistry of Dairy Products 2+1


6. DC-311 Chemical Quality Assurance 1+1
Importance of chemical quality control, quality assurance and total quality management in dairy industry. Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc., Application of food safety management system (ISO: 22000). Hazard analysis and critical control points (HACCP) system and its application in dairy industry with respect to chemical quality. Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories. Preparation and standardization of reagents required in the analysis of milk and milk products. Sampling procedures; labeling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis. Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer. Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products. Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products and their chemical testing methods. Importance of milk contact surfaces, metallic contamination in dairy industry. Chemical quality of water in dairy industry. Prediction of shelf life behavior of milk and milk products.

Practical: Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, Fehlings, EDTA solutions etc. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Detection of vegetable oils and animal body fat adulteration in ghee. Analysis of market samples of milk and milk products. Determination of available chlorine from bleaching powder.

7. DC-321 Food Chemistry 2+1

Practical: Determination of the order of hydrolysis of an ester/carbohydrate and measurement of activation energy; determination of the progress curve obtained during the hydrolysis of P-nitrophenyl phosphate by milk alkaline phosphatase; determination of the Michaelis constant for the digestion of casein by trypsin; Measurement of pH and buffering capacity of different types of milk; To study the gel formation and gel stability of milk proteins; preparation of a Tris/phosphate/citrate buffer of a given molarity/ionic strength and pH; determination of pH of the buffer; measuring the stability of an oil-in-water emulsion stabilised by milk proteins; foaming capacity and foam stability of caseins/whey proteins; drawing of an adsorption isotherm of water on casein.

DAIRY MICROBIOLOGY

1. DM-111 Fundamentals of Microbiology

Overview of history and scope of microbiology: Discovery of Microorganisms and Microscopy (types, working principles and applications); Theories of Biogenesis and abiogenesis; Contributions of Leeuwenhoek, Pasteur, Tyndal, Joseph Lister, Robert Koch, Edward Jenner and Alexander Fleming; Scope and application of microbiology in fields like Dairy, Food, Pharmaceutical, Industrial, Medical and agriculture. Classification of Microbes: Microbial classification systems, numerical taxonomy, General properties and principles of microbial classification, Whittaker’s five kingdom and Carl Woese’s three domain classification system; Systematics of bacteria and Bergey’s manual of systematic bacteriology, Phylogenetic tree. Prokaryotic and Eucaryotic microorganisms: Structure and functions of prokaryotic cells; Differences between prokaryotes and eukaryotes; Differences between cell wall of Gram positive and Gram negative bacteria; Structure of Archeal cell wall. Microbial growth and nutrition: Bacterial growth curve; factors affecting growth of bacteria, direct and indirect methods of measurement of bacterial growth; Bacteriostatic and bactericidal agents; Common nutrient requirements and nutritional types of microorganisms. Diversity of Microorganisms: Viruses: Structure and Classification; Bacteriophages; Differences between viruses and bacteria; Fungi: Classification of Fungi; Reproduction in Fungi; Protozoa and algae. Microbial Ecology and Environmental Microbiology: Microflora of air, soil and water and Microbes of Extreme environment like Archea. Basics of Microbial Genetics and Host-Microbe interactions: DNA as the genetic material, Structure of DNA/RNA, DNA replication, transcription and translation; Basic concepts of immunology; Role of immune system in governing host-microbe interactions, Microbial Commensalism, Colonization, Infection, Disease and Vaccines.


2. DM-121 Microbiology of Fluid Milk

Microbes associated with raw milk: Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermoduric and thermophillic bacteria - their
morphological and biochemical characteristics and classification. Microbial contaminants in raw milk, their sources during various stages of production - milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms; Microbiological changes in bulk refrigerated raw milk. **Sources of contamination and microbial spoilage of raw milk:** Microbial contaminants of raw milk supplies, their sources during various stages of production i.e. milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms and preventive measures. Types of microbial spoilage - souring, curdling, bitty cream, proteolysis, lipolysis, abnormal flavors and discolouration. Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health. **Concept of clean milk production:** Hygienic milk production system; Cleaning and sanitation of udder, animal, utensils, equipments and dairy farm environment; Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world; Microflora of aseptically drawn milk and its natural antimicrobial systems - immunoglobulins, lactoferrin, lysozyme and lactoperoxidase (LP) system. **Microbiological aspects of fluid milk:** Pasteurization, boiling, sterilization, ultra high temperature (UHT), non thermal (pulsed field) micro-filteration, bactofugation, standardization and homogenization. Significance of heat resistant and post processing contaminants in fluid milk with special reference to proteases and lipase enzymes and their role in spoilage of processed milk. Bio-film formation during processing and their control measures. **Public health aspects of fluid milk:** Microbial zoonotic diseases transmitted through fluid milk; Milk borne diseases - food infection, intoxication and toxification caused *E. coli, Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes, Shigella species, Campylobacter* etc. Microbiological grading and legal standards of raw and processed milk.


3. **DM-221 Starter Cultures and Fermented Milk Products**

**Types, metabolism and propagation of starter cultures:** History, classification and importance of starter Cultures in dairy industry; Single, multiple, defined and mixed strain starters; Probiotics and Special cultures like exopolysaccharide production; Propagation of starter cultures-concentrates - direct bulk and direct vat starter cultures, factors affecting propagation; Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits.

**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; 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. **Role of Starters in fermented milks:** 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. Kefir and koumiss : 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. **Cheese Starters:** 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 chymosin


4. **DM-222 Microbiology of Dairy Products**

**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/unripened 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. **Microbiology of Condensed, Evaporated and Dried products:** Type of microorganisms associated with condensed, evaporated and dried products, 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; Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards. **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. **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, kulfietc.; Factors affecting the microbiological quality in reference to production, processing, storage and distribution; Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards; Active packaging concepts and role in bio-preservation.
Practical: Microbiological examination of raw, pasteurized, sterilized and UHT cream for Standard plate count (SPC) as well as lipolytic and coliform counts, direct microscopic count (DMC), dye reduction tests and sterility test. Microbiological examination of salted and unsalted butter for SPC, psychrotrophic, lipolytic, coliforms and yeast and mold count; K.Q test. Microbiological examination of concentrated milk for SPC, coliforms, spores, yeast and mold, thermoduric and therophilic counts. Microbiological examination of dried milks for SPC, coliforms, *Staph. aureus*, *B. cereus*, *E. coli*, *Salmonella*, Sulphite reducing clostridia and Staphylococcal enterotoxins. Microbiological examination of ice-cream and other frozen desserts for SPC, coliforms and Staphylococcal counts besides yeast and mold counts. Microbiological examination of paneer and shrikhand for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts. Microbiological examination of packaging materials for SPC, Spores and Yeast and mold counts.

5. DM-311 Quality and Safety Monitoring in Dairy Industry 2+1

Consumer Awareness about Microbiological Quality and Safety of Dairy Foods: Changing scenario; Concepts of quality control, quality assurance and food safety; Global quality and food safety standards, Integrated food law, its main features and functions.

**Introduction to Food Safety Management System:** Concepts of Quality Management System (QMS)–ISO: 9000:2000; Principles of QMS; Standard requirements for QMS; HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools and techniques. **Microbiological Risk Analysis Concepts:** Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria and two and three class sampling plan / guidelines; Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant. **Rapid Enumeration Techniques:** Enumeration principles and procedure for rapid detection of predominant hygiene indicator organisms and pathogens like *E. coli* (*E. coli* 0157:H7), *Salmonella*, *Shigella*, *Staphylococcus aureus*, *Bacillus cereus* and *Listeria monocytogenes*. **Role of Biosensors for monitoring hygiene and safety of dairy foods:** Detection of antibiotic residues in milk –Delvo SP, MDR test, penzyme test, charm assay, lateral flow assay (ROSA test) etc. Detection of aflatoxins, pesticides other inhibitors etc. and their public health importance in dairy foods. **Plant and equipment hygiene:** Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of waste water and effluents.


6. DM-321 Food and Industrial Microbiology 2+1
Scope of food microbiology: Basic aspects, history and scope of food microbiology. Intrinsic and extrinsic factors that affect microbial growth in different foods. Microbial Spoilage of foods: Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; Sources of contamination; Control of spoilage. Food preservation: Principles of food preservation: physical methods viz. low temperature and high temperature preservation (D, Z and F Values); Drying Methods; Chemical preservatives, Natural antimicrobial compounds and bio-preservation; Mode of action of various preservation methods on microbes. Fermentation processes: Fermentation processes: Historical development, the range, components and types (i.e. submerged, surface and solid state fermentation); criteria for selection of industrially important microorganisms; preservation and improvement of industrially important microorganisms using metabolic engineering/genetic engineering; media for industrial process; upstream and downstream processing. Types of fermenters: Fermenters: types (batch, fed batch and continuous), functions, design and control; sterilization; growth rate analysis, estimation of biomass; difference in chemostat and turbidostat. Microbial production of industrial products: Immobilization of enzymes/cells; Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine; organic acids (citric and lactic), enzymes (protease, lipase and rennet), vitamin (B₁₂), antibiotics and bacteriocins; and fermented whey beverages.

Practical: Microbiological examination of: 1) fresh and canned fruits, vegetables and juices; 2) flour and bread; and 3) eggs and meat. Isolation of psychrophilic, salt and sugar tolerant microorganisms from foods. Isolation of industrially important microorganisms from environment. Determination of Z, D and F values. Production and assaying of microbial enzymes (protease/ lipase). Production of lactic acid from whey. Production of nisin and assaying the antimicrobial activity of the culture. Design and control of a tabletop and 10 liter lab fermenter (Demonstration). Production of ethyl alcohol from molasses and whey by yeasts. Production of fermented whey beverages. Educational tour to food processing/fermentation industries.

**DAIRY BUSINESS MANAGEMENT**

1. **DBM-111 Milk Production Management and Dairy Development 2+1**


buffalo population and its distribution; trends in population growth, annual milk production and per capita availability.


2. **DBM-112 Communication Skills and Personality Development** 1+1

**Communication Process:** The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Communication Skills: meaning and process of communication, listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; Style of technical communication Curriculum vitaé/resumé writing; Innovative methods to enhance vocabulary, analogy questions. Individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

**Structural and Functional Grammar:** Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults;

**Practical:** Listening and note taking, writing skills, oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; Individual and group presentations. Micro-presentations and Impromptu Presentations: Feedback on presentations ; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises ; Interview Techniques;Organization of events

3. **DBM-113 Environmental Studies and Disaster management** 3+0

Unit I: The Multidisciplinary nature of environmental studies Definition, scope and importance, Need for public awareness

Unit 2: Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems, Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people, Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture fertilizerpesticide problems, water logging, salinity, case studies, Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies, Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.
Unit 3: Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).


Unit 8: Field work: Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban / Rural / Industrial / Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc.

Disaster Management

UNIT-1 : Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

UNIT-2 : Man made disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, field fires-burning of straw, stables and residues oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT-3: Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

4. DBM-121 Economic Analysis, Marketing Management and International Trade

Economics: Terms and definitions. Consumption, Demand and Supply: Consumer behaviour- law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer behaviour. Theory of demand-law of demand,
demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer’s surplus.; Factors of production: Role of factors of production, production function for a single product, nature of production function, laws of returns, Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale. Gross Domestic Product: GDP, GNP, NNP, disposable personal Income, per capita income, inflation, Role of Dairy Sector in National GDP
Salient features of International Marketing. Composition & direction of Indian exports; Trends on International Dairy Trade, International marketing environment; Deciding which & how to enter international market; World Trade Organisation (WTO)

5. DBM-122 Computer and Application Software Packages 1 + 1
History, features, classification and organization and I/O peripheral devices for computers; Features of modern operating systems; number systems and coding schemes; Basics of networking and communications; Internet, email concepts and application, Word-processing and desktop publishing, Electronic spreadsheet basics and operations, Database management system basics and operations; Fundamental of presentation-graphic packages. Recent strides in computing.
Practical: Windows Operating System, Word Processing software operations, Presentation Graphics software operations, Internet Surfing/Email usage, RDBMS software package basic operations, Spreadsheet software package basic operations.

6. DBM-211 Entrepreneurship Development, Business Management, and Industrial Consultancy 2+1

**Practical:** Assessment of entrepreneurial skills and characteristics for successful entrepreneur. Consumer opinion surveys. Pricing of milk and milk products. Preparation of feasibility reports for setting up of dairy farms, composite milk plants, collection centers, chilling units and processing units. Guidelines for obtaining ISO/HACCP certification for dairy plants

7. **DBM-221 Fundamentals of Dairy Extension** 2+1


**Practical:** Acquiring skill in use of audio-visual and other aids: Hands-on training on use of LCD projector, PA system, camera. Skills in preparation of documents including script writing, Preparation and use of audio-visual aids including animation for dairy stakeholders Group discussion technique, Hands on learning of field problems in dairy and animal husbandry.

8. **DBM-311 Information and Communication Technology in Dairy Industry and Agri-Informatics** 2+1

IT and its importance. IT tools, IT-enabled services and their impact on society, Importance of Computerization and IT in Dairy Industries; Computers, Operating Environments and Information Systems for various types of Dairy Industries; Automation, Inventory Control, Expert Systems and Artificial Intelligence; Concepts of System Analysis and Designing, SDLC, MIS, Decision Support Systems, Development of case studies; Databases: Characteristics of Databases, Different, Approaches to Database Management, Database Normalization, Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP, Introduction to MS Office: Word, Excel, Power Point.

Agriculture, World Wide Web (www): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations; e-Agriculture, concepts and applications. Use of ICT in Agriculture; Smartphone Apps in Agriculture for farm advisory, e-banking markets market price, postharvest management etc; Geospatial technology for generating valuable agri-information.

**Practical:** Use of MS Word and MS Power Point for creating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, art tool, graphics, template and designs; MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Dairy-information System; MS-EXCEL: Creating a spreadsheet, use of
statistical tools, writing Expressions, creating graphs, analysis of scientific data; Internet applications: Web Browsing, Creation and operation of Email account; Familiarization with the application of computer in dairy industries: Milk plant, Dairy units, Fruit & Vegetable processing unit; Familiarization with software related to dairy industry; Introduction of Geospatial Technology for generating valuable information for Agriculture.

9. **DBM-312 Industrial Statistics** 1+1


10. **DBM-322 Operations Research** 1+1


**Practical:** LP problems, Inventory Control problems, Replacement model problems, problems on queuing theory, sequencing, transportation, assignment, PERT/CPM.

11. **DBM-421 Financial Management and Cost Accounting** 3+1


ELECTIVES / NON CREDIT COURSES

1. **EL-111 Organic Chemistry** 2+1


Practical

2. EL-112 Nutraceuticals and Functional Foods 2+0

Introduction The definition of Functional Foods will be outlined. Students will explore both the industry and the consumer roles involved in this growing field. Antioxidants Students will learn the chemical makeup, free radicals and biochemical functions of antioxidants. Foods explored in this unit will include cranberries, tomatoes, garlic, pomegranate and different ice teas. Dietary Fiber Students will learn about soluble and insoluble fiber, resistant starch, and how important these are to human health. The biochemical functions of dietary fiber will be explored, and oats and oats products will be the main example used in the classroom. Prebiotics and Probiotics Students will learn the definition of both pre-and probiotics, and their biological functions. How to develop prebiotics and probiotics. Pre-and probiotics will be used together as symbiotics. Lipids and health Students will learn the structure and function of essential fatty acids. Chemistry and health benefits of W-3 fatty acids, phytosterols, and CLA, Olive oil. Functions and sources of vitamins and minerals with proposed functional claims.Sports Drink – functional qualities of sports drinks. Electrolytes and sugar level will be a large part of the discussion. Infant Formula - ingredients and formulation techniques of infant formula, and all aspects of the product that make it a functional food. Consumer trends surrounding infant formula will also be outlined.

3. EL-121 Food Safety Regulations 2+0


4. EL-122 Technology Management 2+0

Introduction to Technology Management: Concept and Meaning of Technology and Technology Management- Technology; Technology management, Evolution and Growth of Technology, Role and Significance of Technology Management, Impact of Technology on Society and Business- Technology and competition; Key issues in managing technological innovation, Forms of Technology- Process technology; Product technology. Technology Forecasting Process, Need and Role of Technology Forecasting, Forecasting Methods and
Techniques, Planning and Forecasting. Technology Adoption, Technology Diffusion- of technology diffusion; Perspectives of innovation diffusion process; Activities necessary for diffusion process, Technology Absorption- Role of technology absorption; Benefits of technology absorption; Constraints in technology absorption. Integration of People and Technology, Factors Considered in Technology Management- Organisational factors; Psychological factors, Organizational Structure and Technology

5. EL-311 Emerging Dairy Processing Technologies 2+0

High Pressure Processing: Principles of high pressure processing, use of high pressure to improve food safety and stability. Effects of high pressure on food quality: Pressure effects on microorganisms, enzyme, texture and nutrients of food. Modelling HP processes. Other applications of high pressure processing. Pulsed electric fields processing: Historical background, PEF treatment systems, main processing parameters. Mechanisms of action: mechanisms of microbial and enzyme inactivation. PEF for processing of liquid foods and beverages, PEF Processing for solid foods. Food safety aspects of pulsed electric fields. Pulsed electric field and high pressure processing. A thermal membrane concentration of liquid foods and colours: osmotic membrane distillation, direct osmosis, membrane modules, Applications of membrane concentration. Processing by radio frequency electric fields: radio frequency electric fields equipments, RFEF non-thermal inactivation of yeasts, bacteria and spores, electrical costs. Ultrasound processing: fundamentals of ultrasound, ultrasound as a food preservation and processing aid, effects of ultrasound on food properties. Alternate thermal processing: Microwave heating: dielectric properties of foods, heat and mass transfer in microwave processing, application of microwave processing for foods; Radio frequency processing: dielectric heating, material properties, radio-frequency heating and drying applications; Ohmic heating: Fundamentals of ohmic heating, electrical conductivity, modeling, treatment of products. Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes, equipment for microwave vacuum drying, product quality degradation during dehydration.