

## **PG COURSE DETAILS FOR M.TECH (DAIRY ENGINEERING)**

### **Activity of the Department:**

Dairy Engineering department is currently engaged in teaching and research in specialized field of Dairy Engineering. Broadly, the research work of the department covers the areas related to process engineering, heat and mass transfer modelling, image analysis technique, etc. Department also offering Ph. D. in Dairy Engineering and faculty of this department are teaching courses for IDD (DT) & (DH), B. Tech (DT), B. Sc. (Hons.) Dairying, B. Sc. (Hons.) Food Tech., M.Tech. (DT) and M. Sc. (Food Tech) programme.

**Total Intake:** 10 Students

**Eligibility Criteria for M.Tech. in Dairy Engineering:** B. Tech. (Dairy Technology)/ B. Tech. (Food Technology)/ B. Tech. (Agriculture Engineering)/ B. Tech. (Mechanical Engineering)/ B. Tech. (Chemical Engineering)

### **COURSE STRUCTURE OF M.TECH. IN DAIRY ENGINEERING**

<b>S.No.</b>	<b>Course code</b>	<b>Title</b>	<b>Credit Hours</b>
<b>Major Courses (25 Credit)</b>			
1.	DE-811	Advances in Heat and Mass Transfer	3
2.	DE-812	Engineering Properties of Dairy & Food Products	3
3.	DE-821	Refrigeration Engineering	3
4.	DE-822	Design of Process Equipment	3
5.	DE-823	Instrumentation and Process Control	3
6.	DE-824	Dairy and Food Engineering	4
7.	DE-831	Industrial Automation & Robotics	3
8.	DE-832	Transport Phenomenon	3
9.	DE-833	Seminar	1
<b>Minor Courses (15 Credit)</b>			
1.	DT-809	Advances in Dairy processing-I	3
2.	DT-812	Advances in Dairy Processing-II	3
3.	DT-813	Advances in Dairy Processing-III	3
4.	DC-810	Advances in Dairy Chemistry	3
5.	DM-810	Advances in Dairy Microbiology	3
<b>Supporting Courses (5 Credit)</b>			
1.	MAS-701	Advanced Engineering Mathematics	4
2.	MAS- 815	Experimental Design	3

### **SEMESTER I**

S.No.	Course Code	Course Title	L-T-P	Credit
1.	MAS-701	Advanced Engineering Mathematics	3-1-0	4
2.	MAS- 815	Experimental Design	2-0-2	3
3.	DE-811	Heat and Mass Transfer	3-0-0	3
4.	DE-812	Engineering Properties of Dairy & Food Products	3-0-0	3
5.	DT-809	Advances in Dairy processing-I	2-0-2	3

### **SEMESTER II**

S.No.	Course Code	Course Title	L-T-P	Credit
1.	DE-821	Refrigeration Engineering	2-0-2	3
2.	DE-822	Design of Process Equipment	3-0-0	3
3.	DT-812	Advances in Dairy Processing-II	2-0-2	3
4.	DE-823	Instrumentation and Process Control	3-0-0	3
5.	DE-824	Dairy and Food Engineering	4-0-0	4

### **SEMESTER III**

S.No.	Course Code	Course Title	L-T-P	Credit
1.	DE-831	Industrial Automation & Robotics	3-0-0	3
2.	DT-813	Advances in Dairy Processing-III	2-0-2	3
3.	DE-832	Transport Phenomenon	3-0-0	3
4.	DC-810	Advances in Dairy Chemistry	2-0-2	3
5.	DM-810	Advances in Dairy Microbiology	2-0-2	3
6.	DE-833	Seminar	0-0-2	1

### **SEMESTER IV**

S.No.	Course Code	Course Title	L-T-P	Credit
1.	DE-841	Dissertation	0-0-60	30

## SYLLABUS OF MASTERS OF TECHNOLOGY IN DAIRY ENGINEERING

### SEMESTER I

#### **MAS-701      ADVANCED ENGINEERING MATHEMATICS      (3-1-0) 4 Credits**

Gamma, Beta and Legendre's functions, Euler's equations, Lang-range equations, the Rix method, the Green's functions. Solzane Woirestrass theorem in finite products.

Laplace transforms, Inverse Laplace Transforms, and application to differential equations. Fourier series, Fourier transforms, Solution of non-linear algebraic and transcendental equation by Regula falsi method. Newton Raphson method.

Newton's forward and backward interpolation formula divided differences. Trapezoidal Rule, Simpson's 1/3 rule, Numerical Solution of Ordinary differential equations by Runge Kutta Method, Picard's equations.

#### **MAS-815                              EXPERIMENTAL DESIGN                              (2-0-2) 3 Cr.**

Analysis of variance techniques, Definitions and assumptions, One way classification, two way classification with more than one observation per cell.

Designs of experiment, principles of experimental design, randomized block design (R.B.D), Latin square design (L.S.D.), Missing plot technique in R.B.D. and L.S.D., critical difference (C.D.), split plot design

All type of Factorial experiment, Sampling techniques, simple random sampling, stratified random sampling and systematic sampling.

#### **DE-811      ADVANCES IN HEAT AND MASS TRANSFER                              (3-0-0) 3Cr.**

One-dimensional steady state heat conduction through fins (Extended surfaces): actual and approximate solution. Efficiency, effectiveness and design of profile area of fins.

Two-dimensional steady state heat conduction: analytical and numerical solution.

Unsteady state heat conduction: analytical solution.

Forced convection heat transfer in flow over a flat surface: hydrodynamic and thermal boundary layer, continuity equation, momentum equation and energy equation, heat transfer coefficient/ Nusselt number in laminar and turbulent region of boundary layer. Stanton number; Coulburn Analogy; Empirical co-relations.

Forced convection heat transfer in flow through tubes: Nusselt number in the entrance region and

Condensation and Boiling Heat transfer: Film wise condensation on vertical surface; Nusselt equation, Boiling liquids

Heat Exchangers: classification, overall heat transfer coefficient. Performance analysis of parallel flows and counter flow heat exchangers: LMTD and effectiveness-NTU approach. Use of computer software for process heat transfer applications.

Mass transfer - Fick's law of diffusion, diffusion of gases and liquids through solids, equimodal diffusion, isothermal evaporation of water into air, mass transfer coefficients.

**DE-812 ENGINEERING PROPERTIES OF DAIRY AND FOOD PRODUCTS (3-0-0) 3 Cr.**

Shape, size, volume, density, porosity, surface areas, friction, rolling resistance, angle of repose, specific surface area, mean diameter, sphericity, particle size analysis.

Aerodynamics properties, drag coefficient and terminal velocity. Pressure drop through packed beds.

Specific heat, thermal conductivity, thermal diffusivity, enthalpy, surface heat transfer coefficient freezing point. Measurement of thermal properties and prediction techniques.

Electrical conductivity, capacitance, inductance, Dielectric properties *viz.* dielectric and microwave, dielectric constant, Dielectric loss factor, loss tangent, energy absorption, heating, Optical properties, colorimetry, transmittance and reflectance.

Non-destructive quality evaluation techniques, Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation, UV VIS NIR spectroscopy, X-ray, CT, NMR, machine vision system.

Application of engineering properties in equipment design, processing and handling of dairy and food products.

**DT-809 ADVANCES IN DAIRY PROCESSING-I (2-0-2) 3 Cr.**

1. Preservation of raw milk
2. Thermal processing of milk
3. Bactofugation/Bacto therm processes.
4. Cream separation cream products
5. Butter & dairy spreads.
6. Current trends in cleaning & sanitization of dairy equipments
7. Frozen dairy products

**SEMESTER II**

**DE-821 REFRIGERATION ENGINEERING (2-0-2) 3Cr.**

Methods of refrigeration: Ice and dry ice refrigeration, evaporative and steam jet refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas and by using liquid gases

Vapour compression refrigeration system, absorption refrigeration systems, heat pump.

Non-conventional Refrigeration Systems: Thermo-electric refrigeration, vortex-tube, refrigerant-mixtures, cooling by adiabatic demagnetization.

Design elements of Refrigeration Equipment: Design elements of compressor, condenser, evaporator, cooling tower, spray pond; balancing of different components of the system

Design of cold storage and air conditioning systems: types of loads in cold storage and their calculations, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapour barriers, care and maintenance of cold storage.

### **Practical**

To study the working of absorption refrigeration plant; the working of heat pump; to design refrigeration equipment for a milk chilling center and to balance the different components; design a cooling tower and spray pond for a small dairy plant; design problems on cold storage for different food products; visit to food cold storage and non-conventional refrigeration plants.

## **DE-822                      DESIGN OF PROCESS EQUIPMENT                      (3-0-0) 3Cr.**

Codes and regulation, materials of construction, design of pressure vessel, cylindrical and spherical shells; formed heads; re-enforcement openings; fabrication requirements; inspection; tests and non-destructive examination, pressure tests; design and stress evaluation

Design of storage tank, milk coolers, pasteurizing plants, flavor treating equipment, evaporation systems - evaporator; milk dryers; spray dryer and roller dryer; ice cream freezers. Design of material handling system and equipment. Design and evaluation of packages and packaging systems; methods and equipment for packaging.

## **DT-812                      ADVANCES IN DAIRY PROCESSING-II                      (2-0-2) 3Cr.**

1. Non- thermal process
2. Extrusion processing
3. Food emulsions/ Foams/Gels
4. Membrane processing
5. Rheology of dairy products
6. Hurdle Technology & its application
7. Fermented Dairy Products

## **DE-823                      INSTRUMENTATION AND PROCESS CONTROL                      (3-0-0) 3Cr.**

Instrument terminology and performance system accuracy; flow sheet symbols

Instrument evaluation: electrical, mechanical, magnetic and optical transducers for measurement of process variables like temperature, pressure, flow, level, consistency and humidity

Indicating and re-cording devices: direct acting and servo operated systems; digital indicators, strip and circular chart recorders, electronic data loggers

Principles of automatic process control : process characteristics; controller characteristics; closed loop system; pneumatic and electric controllers; final controlling elements : control valves; valve sizing; electronic actuators; motor drives and controls

Introduction to programmable logic controllers (PLCs) : internal structure; inter facing with sensors and actuators; binary logic diagrams and ladder diagrams; choosing a PLC system.

**DE-824**

**DAIRY AND FOOD ENGINEERING**

**(4-0-0) 4Cr.**

Concept of rheology: ideal elastic, plastic and viscous behavior, viscoelasticity, rheological models and constitutive equations, viscoelastic characterization of materials, stress-strain behavior, creep, stress relaxation, non-Newtonian fluids and viscometry.

Rheology and texture of food materials: methods of texture evaluation, subjective and objective measurements, mechanical tests, firmness, hardness, dynamic hardness, objective methods of measuring texture, rheological properties of dairy products, strength of food materials.

Water activity and states: a thermodynamic quantity, water sorption isotherms, hysteresis, theories of sorption hysteresis, water activity measurement methods, water binding, control of water activity and moisture, principles of IMF and their application.

Freezing, freezing curves, freezing time calculations, design of freezing equipment, freeze drying, freeze concentration

Unit Operation in dairy and food processing: Grading, cleaning, washing, sorting, shelling, dehusking, decortication, milling, polishing, pearling, drying (evaporative, osmotic and freeze drying), Mixing, clarification, coagulation, mechanical separation, sedimentation

Handling of food product: construction of conveyors and elevators, mechanical cleaning and size reduction, crystallization and distillation process

Design of single and multi-effect evaporators: design of spray dryer and its components, separation and recovery of dried product, design of recovery system, selection and design of auxiliary equipment.

Permeability and shelf-life: theoretical considerations, permeability to gases and vapours, measurement methods, permeability of multilayer materials, permeability in relation to packaging requirements of food products.

Novel processing methods and equipment: high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano encapsulation, microwave

### SEMESTER III

#### **DE-831                    INDUSTRIAL AUTOMATION AND ROBOTICS                    (3-0-0) 3Cr.**

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.

Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.

Automated Manufacturing Systems: Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies.

Control Technologies in Automation: Industrial Control Systems, Process Industries Versus Discrete - Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms.

Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Systems & RTU. Monitoring of plant parameters through Internet. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. Industrial Control Applications in dairy and food processing industry.

Basic principles of robotic technology, configurations, control. Application of Machine Vision System, Image Processing and Analysis. Typical Pick & place, loading & unloading, packaging and palletizing applications.

#### **DT-813                    ADVANCES IN DAIRY PROCESSING-III                    (2-0-2) 3Cr.**

1. Functional Foods
2. Food value addition
3. Food Biotechnology
4. Advances in dairy/ food packaging
5. Dairy By-products
6. Imitation dairy products
7. Condensing & Drying of milk

#### **DE-832                    TRANSPORT PHENOMENON                    (3-0-0) 3Cr.**

Introduction to transport phenomena – Molecular transport mechanism, transport properties and their proportionality constants in momentum, energy and mass transfer.

Steady-state equations - Momentum transport equations for Newtonian and non-Newtonian fluids, continuity equation in different co-ordinates.

Equations of motion - Navier–Stokes equations and their application in viscous fluid flow between parallel plates and through pipes.

Turbulent transport mechanism -- Mathematical analysis; eddy viscosity and eddy diffusivity; velocity, temperature and concentration distribution; time smoothing equations. Inter-phase transport in isothermal system -friction factors for various geometries.

Dimensional analysis – Buckingham Pi-theorem and matrix method, application to transport phenomena, analysis among mass, heat and momentum transfer, Reynolds' analogy

Boundary layer concept - Theoretical and exact solutions for heat, mass and momentum transfer.

**DC-810                      ADVANCES IN DAIRY CHEMISTRY                      (2-0-2) 3Cr.**

Nomenclature of milk proteins; major milk proteins: caseins (acids and micellar), fractionation of casein; primary and secondary structure of different fractions; casein models; alpha-lactalbumin and beta-lactoglobulin-distribution, whey protein concentrates and their functional properties; minor milk proteins: proteose-peptone, non-protein nitrogen constituents, immunoglobulins, lactotransferrin (lactoferrin), lipoprotein and fat globule membrane proteins; milk enzymes: properties and their significance with particular reference to lipases; Milk lipids: classification, gross composition and physical properties; neutral and polar lipids and their role in milk and milk products; fatty acids profile: composition, properties and factors affecting them; unsaponifiable matter: composition with special reference to sterols and fat soluble vitamins and carotenoids, chemistry, physiological functions and levels in milk.. Lactose: occurrence, isomers; molecular structure; physical properties:- crystalline habits; hydrate; lactose glass; equilibrium of different isomers in solution; solubility; density sweetness; chemical properties:- hydrolysis; pyrolysis; oxidation; reduction; degradation with strong bases; derivatives; dehydration and fragmentation browning reaction; oligosaccharides in milk. Major and minor minerals; factors associated with variation in salt composition; partitioning of salt constituents and factors affecting it; effect of various treatments on salt equilibrium; protein mineral interactions; distribution and importance of trace elements in milk. Water soluble vitamins: thiamin; riboflavin; niacin; pantothenic acid; pyridoxine; biotin; folacin and cyanocobalamin; molecular structure; levels in milk and milk products.

**Practical**

Instrumental measurements of colour, viscosity tenderness, specific gravity, size and size distribution, firmness, texture etc. of various milk products. Analysis of major constituents, such as moisture, fat, protein and carbohydrates of milk and milk products, pH and acidity measurements

**DM- 810                      ADVANCES IN DAIRY MICROBIOLOGY                      (2-0-2) 3 Cr.**

Microflora associated with milk and milk products and their importance. Food poisoning, food infection, emerging food borne pathogens associated with milk and other milk borne diseases.



Lactic Acid bacteria and food fermentations. Current status of metabolism of starter cultures. Novel starter preservation techniques. Quality control tests of starter culture.

Naturally occurring preservative systems in milk like LP system, Immunoglobulins, Lysozyme, Lactoferrin etc. Food grade bio-preservative. Bacteriocin of lactic acid bacteria, structure, functions, transport and mode of action. Application of bacteriocin in food bio preservation.

Unit-IV Bacteriological aspects of processing techniques like bactofugation, thermisation, pasteurization, sterilization, boiling, UHT, Pulse field treatment and membrane filtration of milk. Types of spoilages of heat treated milk. Bacteriological grading of raw and heat treated milk.

### **Practical**

1. Isolation and identification of common microflora in dairy products 2. Isolation and identification of pathogenic microbes from dairy products by using selective media 3. Preparation and propagation of starters 4. Quality evaluation of starter cultures. 5. Antimicrobial activity of LAB isolated from foods. 6. Antibiotic susceptibility of pathogenic bacteria from dairy products. 7. Isolation of bacteriocin producing LAB.

## **SEMESTER IV**

**DE-841**

**DISSERTATION**

**(0-0-60) 30Cr.**