DAIRY AND FOOD ENGINEERING

ENAE 353

Lecture	**: 3**	**Year : III**
Tutorial	**: 1**	**Part : II**
Practical	**: 2**	

Course Objectives:

The objective of this course is to provide the fundamental principles of unit operations in dairy and food industries, including forms of moisture, water activity, and their relationship to food safety. At the end of the course, students will be able to apply appropriate preservation and processing techniques to maintain the quality, safety, and storage stability of dairy and food products.

1 Introduction to Dairy Processing (6 hours)

1.1 Physio-chemical and thermal properties of milk and milk products
1.2 Dairy processing systems in Nepal
1.3 Unit operation and process flow charts for product manufacture
1.4 Equipment used for receiving, pasteurization, sterilization, homogenization, filling and packaging of milk and milk products
1.5 Dairy plant location, design and layout

2 Thermal Sterilization (5 hours)

2.1 Methods of heat application
2.2 Sterilization process (Batch and continuous) and their working principle
2.3 Concept of TDR and TDT curve, D-value, z-value and F-value
2.4 Heat penetration curve, processing time
2.5 Canning and aseptic processing

3 Deterioration Controls (4 hours)

3.1 Composition and proximate analysis of food products
3.2 Types of food deterioration
3.3 Methods of food preservation
3.4 Effect of processing on physical, chemical and sensory quality of butter

4 Evaporation (7 hours)

4.1 Basic concepts of evaporation
4.2 Types of heat exchangers and its capacity
4.3 Surface and overall heat transfers co-efficient
4.4 Types of evaporators (Design and working principles)
4.5 Factors affecting the rate of heat transfer in evaporator: Operating variables

4.6 Single and multiple effect evaporation system (Working principle, material and heat balance, steam economy)
4.7 Feed flow methods in triple effect system and their principle

5 Dehydration and Drying (7 hours)

5.1 Free, equilibrium and total moisture content; Bound and unbound water
5.2 Sorption Isotherm, BET equation, water activity and its estimation
5.3 Mechanism of drying (Material and heat balance); Drying rate curve; Moisture migration during drying
5.4 Types of dryers: Heated surface, mechanical driers (Tray, cabinet, spray, tunnel drier and others)
5.5 Vacuum, fluidized bed, osmotic drying process (Mechanism and working principles)

6 Freezing (7 hours)

6.1 Theory and principle of freezing for food preservation
6.2 Mechanism of ice crystal formation and growth
6.3 Calculation of freezing time by Plank's equation
6.4 IQF, effect of freezing on product quality
6.5 Factors affecting the freezing rate and process
6.6 Design and working principle of freezers and frozen storage chamber
6.7 Refrigerant: Cryogens (CO_2, liquid N_2)

7 Freeze Drying (5 hours)

7.1 Phase diagram of water
7.2 Theory of lyophilization; Working principle of freeze drying
7.3 Heat and mass transfer; Material and heat balance
7.4 Calculation of freeze-drying time
7.5 Factors affecting the freeze-drying process
7.6 Quality of freeze-dried foods; Freeze burn

8 Concentration (1 hours)

8.1 Theory and principle of concentration
8.2 Concentration by freezing
8.3 Membrane concentration: Reverse osmosis and ultra-filtration

9 Irradiation (3 hours)

9.1 Theory, principle and mechanism of action of irradiation on food preservation
9.2 Factors affecting the irradiation process
9.3 Microwave heating; Dielectric heating of foods
9.4 Effect of Irradiation on the quality of food
9.5 Sources of Irradiation; Method of Irradiation

Tutorial **(15 hours)**

1. Analysis of physio-chemical and thermal properties of milk and milk products and their significance in dairy processing
2. Numerical examples on TDT curve, D-value, z-value, and F-value in thermal sterilization
3. Numerical examples on material balance, heat balance, and steam economy in single and multiple effect evaporation systems
4. Determination and interpretation of free, equilibrium, and total moisture content, including bound and unbound water
5. Numerical examples on calculation of freezing time using Plank's equation
6. Design of commercial freezers and frozen storage chambers
7. Analysis of heat and mass transfer in freeze-drying processes
8. Estimation of freeze-drying time and influencing parameters
9. Analysis of microwave and dielectric heating in food processing

Practical **(30 hours)**

1. Layout of dairy processing plant and equipment
2. Examination of the process and equipment used for pasteurization and sterilization of milk
3. Analysis of the process and equipment used for homogenization of milk
4. Observation of process and equipment used for cream separation from milk
5. Observation of process and equipment used for butter churning
6. Evaluation of process and equipment used for evaporation of milk
7. Investigation of process and equipment used for spray drying of milk
8. Examination of process, equipment used for the manufacture of ice-cream
9. Estimation of refrigeration requirements in dairy and food plant

Visit to a nearby multiproduct dairy or food industry and submit a detail report including working principle, equipment drawing and procedure and efficiency of the available equipment if moderate dairy or food factory is available in the vicinity.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	6	6
2	5	6
3	4	6
4	7	10
5	7	10
6	7	10
7	5	8
8 and 9	4	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Ahmad, T. (2003). Dairy plant engineering and management. Kitab Mahal.
2. Singh, R. P., Heldman, D. R. (2014). Introduction to food engineering. Academic Press.
3. Fellows, P. J. (2017). Food processing technology: Principles and practice. Woodhead Publishing.
4. Toledo, R. T. (2007). Fundamentals of food process engineering. Springer.
5. Rao, M. A., Rizvi, S. S. H., Datta, A. K. (2014). Engineering properties of foods. CRC Press.
6. Suresh, R. (2017). Food and dairy engineering principles. Standard Publishers Distributors.
7. Sharma, P. C. (2003). Dairy plant engineering and milk processing. Agrobios.