Semester	**:**	**V**		
Course No.	**:**	**PFE-354**	**Credit Hrs.** **:**	**4(3+1)**
Course Title	**:**	**Food and Dairy Engineering**		

SYLLABUS

Objectives : (i) To make the students acquainted with the different unit operations in processing and value addition of different dairy and food products,
(ii) To make them understand the different types of equipment and their working principles used for the same.

THEORY

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; Mass and energy balance; Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression; Thermal processing: Thermo-bacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing;

Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods *viz*. ohmic, infrared and dielectric heating;

Mixing: theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes *viz.,* tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge; Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nano-filtration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders.

Unit operations in milk processing: engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice-cream;

Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles; Nanotechnology and its applications in food industry; Basics of food plant design and layout; Plant utilities.

PRACTICAL

Preparation of flow-charts for different food processing industries; Study of different parts of retort and canning process; Study of different types of evaporators and multiple effect evaporation system; Study of drum dryer and spray dryer, and comparison of product qualities; Study of different types of mixers for solids and liquids; determination of mixing effectiveness and mixing index; Study of settling and sedimentation process in a tank; Study of different types of filters; Study of membrane modules and different types of membranes; Study of measurement of different properties of milk and milk products; Study of milk pasteurizer, sterilizer and homogenizer; Study on preparation of cream and butter; Study of preparation of cheese, paneer and ice-cream; Study of different types of packaging materials; Study of different types of filling machines for liquids and powder/ granules; Study of layout of a food processing plant; Visit to food processing industries and dairy plants to study the plant layout and unit operations.

TEACHING SCHEDULE

THEORY [PFE-354]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Introduction	Different unit operations in food processing; Process flow-charts for preparation of various food products.	20
3	Mass and Energy Balance	Mass and Energy Balance-	
4 - 9	Dehydration of Foods	Dryers for solid foods, Construction and Operation of direct and indirect-type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer etc.; Dryers for liquid foods, Construction and Operation of drum dryer, spray dryer and vacuum band dryer.	
10 - 14	Evaporation of Food Products	Principle, Different types of evaporators, Factors affecting steam economy, Multiple effect evaporation, Vapour recompression.	15
15 - 19	Thermal Processing	Thermo-bacteriology, D value, Z value, Reaction quotient, Process time, Different types of retorts and continuous sterilizers, Canning process, Aseptic processing.	
20 - 24	Non-Thermal Processing	Principles and Applications of different non-thermal processing methods as- Vacuum processing, High pressure processing, PEF processing, Ultrasonication, Radiation processing.	10
25 - 27	Novel Heating Methods	Principles and Applications of Novel heating methods- ohmic, infrared and dielectric heating.	

Continued…

28 - 31	Mixing	Theory of mixing of solids and pastes, Mixing index, Mixers for solids, liquid foods and pastes, *viz.* tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator.	25
32 - 34	Separation Processes	Principle and Equipment for sedimentation of solids in liquid and solids in air; Principle and Operation of tubular bowl centrifuge and disc bowl centrifuge.	
35 - 36	Filtration	Principle, Construction and Working principles of different types of filters as- plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter.	
37 - 38	Membrane Separation	Principle, Characteristics and Applications of reverse osmosis, nano-filtration, ultra-filtration and macro-filtration; Membrane modules.	
39 - 40	Extrusion Cooking	Principle, Factors affecting extrusion cooking, Single and twin-screw extruders.	15
41	Unit Operations in Milk Processing	Engineering, thermal and chemical properties of milk and milk products.	
42 - 43	Principles and Equipment	Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream.	
44	Filling and Packaging	Selection of different types of packaging materials for different types of food products;	15
45 - 46	Equipment	Equipment for filling and packaging of liquid foods, such as- gravity filler, filling by metering FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; Aseptic filling of pouches and bottles.	
47	Nanotechnology	Nanotechnology and its applications in food industry.	
48	Food Plant Design and Layout	Basics of Food Plant Design and Layout; Plant utilities.	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PFE-354]

Exercise No.	Exercise Title
1.	Preparation of flow charts for different food processing industries.
2.	Study of different parts of retort and canning process.
3.	Study of different types of evaporators and multiple effect evaporation system.
4.	Study of drum dryer and spray dryer and comparison of product qualities.
5.	Study of different types of mixers for solids and liquids and determine the mixing effectiveness and mixing index.
6.	Study of settling and sedimentation process in a tank.
7.	Study of different types of filters.
8.	Study of membrane modules and different types of membranes.
9.	Study of measurement of different properties of milk and milk products.
10.	Study of milk pasteurizer, sterilizer and homogenizer.
11.	Study on preparation of cream and butter.
12.	Study of preparation of cheese, paneer and ice-cream.
13.	Study of different types of packaging materials.
14.	Study of different types of filling machines for liquids and powder/ granules.
15.	Study of layout of a food processing plant.
16.	Visit to food processing industries and dairy plants to study the plant layout and unit operations.

Suggested Readings [PFE-354]:

1. Ahmed T. 1997. Dairy Plant Engineering and Management. Kitab Mahal.
2. Dash, S.K., Chandra P. and Kar A. 2024. Food Engineering Principles and Practice. CRC Press, Boca Raton, USA.
3. McCabe W.L., Smith J.C. and Harriott. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
4. Rao D.G. 2009. Fundamentals of Food Engineering. PHI Learning Pvt. Ltd., New Delhi.
5. Singh R.P. and Heldman D.R. 1993. Introduction to Food Engineering. Academic Press.
6. Toledo R.T. 1997. Fundamentals of Food Process Engineering. CBS Publishers.
7. Earle R.L. Unit Operations in Food Processing. Pergamon Press, New York. USA.