4265 -FOOD ENGINEERING - I

Teaching Schedule Per Week			Progressive Assessment		Examination Schedule (Marks)			
					Theory		Practical Ex.	Total
Lectures	Practical	Credits						
3	1	4	25	25	3Hrs	100	-	150

Pre-requisite	Source	Semester	Theory	Test	Total	TW	PR	Gr Total
Nil	FOD		75	25	100	50	-	150

Rationale: This part of Food Engineering course deals with unit operations involving heat transfer. Design and mathematical aspects have been minimised. On the other hand, adequate emphasis has been given to maintenance aspect and factors to be considered in choosing appropriate equipment. Unit operations such as heat transfer, dehydration, concentration, freezing, etc. have been extensively dealt with. The course is supplemented by factory visits for study on the various equipments.

COURSE CONTENTS	Hrs	Mk
1. HEAT TRANSFER	6	10
Conduction- Thermal conductivity, conduction through plane homogeneous and composite walls. Concept of thermal resistance. Conduction through a hollow cylinder. Conduction through pipes, heat transfer coefficients, overall heat transfer coefficient, empirical correlations. Heat transfer with boiling liquids. Convection- free and forced. Radiation: Stefan Boltman law, emissvity and absorptivity.		
2. HEAT EXCHANGERS	7	2(
Tube and plate heat exchangers: Characteristics and uses. Relative merits and demerits. Tube heat exchangers: Counter and parallel flow, log mean temperature difference. Mechanically aided heat exchangers: Votators, film, scraped surface, etc. Heat exchangers for gases: Extended surface, radiators.		
3. PSYCHROMETRY	4	8
Principles and definitions: Humidity, dry and wet bulb. Temperature, relative humidity, humid heat. Humidity measurement instruments. Humidity charts. Cooling by evaporation.		
4. CONCENTRATION AND DEHYDRATION	15	3
Moisture calculations: Dry and wet basis. Drying rate behaviour: Free and bound-moisture, critical and equilibrium moisture content. Drying curves: Materials characteristics, constant and falling rate periods. Factors affecting drying rate. Types of airflow and basis of material balance in drying and concentration. Concentration and dehydration equipment. Vacuum and atmospheric concentration – production of vacuum. Evaporators: Tubular, Flash, forced circulation, etc. Multi- effect evaporators. Vacuum and atmospheric dehydration. Dryers: Batch and continuous, drum, spray, tray, fluidised bed, roller. Freeze drying - Principles and equipment.		
5. REFRIGERATION PRINCIPLES	6	
Simple vapour compression refrigeration system: Thermodynamics and system components. Effect of sub cooling liquid, super-heating suction vapour, pressure losses, etc. Unit of refrigeration. Properties of common refrigerants, comparison, classification, basis of selection. Principle of absorption refrigeration.		
6. FREEZING	7	
Principles of freezing: rate, heat, transfer, storage of frozen foods. Freezing equipment: plate, fluidised bed, blow continuous, etc.		

7. DISTILLATION Outlines of batch distillation, flash vaporisation, fractionation and steam distillation. Stripping of flavour / essence.	3	8
Total	48	100

PRACTICALS

Measurement of humidity by wet and dry bulb thermometers
Study experiments of the following, with drawings on sketchbook / journal
Heat exchanger: Tube, plate, and scraped surface.
Refrigeration system.
Dehydration equipment: Spray dryer, shell dryer, drum dryer.
Evaporators: Flashed, forced circulation, tubular, long tube, short tube external heating.
Freezers: Plate, tunnel, cryogenic.

FIELD VISITS

Goa Meat Complex, Sugar Factory, Freezing Plant.

REFERENCE BOOKS

1. Food Process Engineering by D. R. Heldman AVI Publications
2. Fundamentals of Food Engineering by S. E. Charm AVI Publications
3. Elements of Food Engineering by J. C. Harper AVI Publications
4. Unit Operations in Chemistry Engineering McCabe & Smith
5. Food Process Engineering by H. A. Leniger & W. A. Beverloo, D. Reidel Publishing Co.