GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161406
Food Referigeration and Air Conditioning
VIth SEMESTER

Type of course: Professional Elective Course

Prerequisite: Nil

Rationale: Food refrigeration, air conditioning and ventilation systems provide artificial cooling and refrigeration for the environment and the processing and preservation of food stuffs. Refrigeration is required for the food chain (producers, processors, warehouses, transport, and retailing). A thorough understanding of refrigeration, cooling and freezing processes, refrigerants, equipments and instrumentation and control etc. would be highly desirable for graduating food engineer and technologists. The course is required lead a learner into acquiring all the skills required to work in the industry with an understanding of types of refrigeration components, their operation, safety maintenance, installation and selection of the mechanical and electrical systems which provide temperature control for food processing needs.

Teaching and Examination Scheme

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content

S. No.	Content	Total Hours	% Weightage
1	Refrigerants: Classification & designation of refrigerants. Desirable properties of refrigerant for food preservation applications. Properties, uses and comparison of commonly used refrigerants. Environmental considerations: New non-CFC refrigerants, Green technologies.	**4**	10
2	Vapour Compression Refrigeration System for Food and agro products: Simple vapour compression cycle. Functions of different components of vapour compression system. Representation of vapour compression cycle on (T-S) and (P-h) diagrams. Mathematical analysis of vapour compression refrigeration. Factors affecting the performance of vapour compression system.	**8**	20
3	Vapour Absorption System food and allied materials**:** Vapour absorption cycle. Ammonia-water and Water-Lithium bromide systems adapted to work for food and allied applications. Construction and working of Electrolux refrigerator. Introduction and working of cascade system of refrigeration.	**5**	15
4	Refrigeration and cooling system components: Compressor types: Hermetic sealed compressor, open type compressor, screw compressor centrifugal compressor. Condensers: Air-cooled, water-cooled, evaporative, cooling tower and spray pond. Evaporators: Flooded type, dry expansion, plate surface, finned tube. Thermostatic expansion valve, capillary tube, solenoid valves. Air filters, fans, air washer, radiator and convector.	**9**	15

5	Air-Conditioning controls: Need for controls for food applications. Automatic and s e m i -automatic control systems, humidity control, air movement system, temperature control, limit switches, time switches.	**4**	12
6	Air distribution in food processing facilities**:** Air handling unit, Process air distribution, Requirements of process air distribution, draft, types of supply air inlet/outlets for food processing units, Duct system, Air- distribution system. Basic duct design guidelines and suitable materials.	**4**	13
7	Cold storage and freezing of foods: Design of cold storage for various agro-produce, Storage requirements of plant and animal produce, distinction between refrigeration, chilling and freezing, special food storage requirements, Quick Instant Freezing.	**4**	15

Suggested Specification table with Marks (Theory)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
19	23	17	20	21	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books

1. Suvendu Bhattacharya, Chapter 13, Refrigeration in Food Production and Processing.
2. Fundamentals of Food Process Engg by Romeo T. Toledo. CBS Publishers.
3. Refrigeration and Air-conditioning by CP Arora. TMH
4. Air-conditioning Engineering by Jone WP and Arnold E.
5. Commercial Cooling of Fruits and Vegetables by Thompson Univ. of California ASHRAE Fundamentals, 1997, 2001

List of Open Source Software/learning website: http://foodscience.uark.edu/

a. https://www.ashrae.org/
b. http://www.arpec.org/
c. http://www.irhace.org.nz: Institute of Refrigeration, Heating & Air Conditioning Engineers (IRHACE)
d. www.achrnews.com
e. Refrigeration and Air-Conditioning - ScienceDirect.com
f. www.ishrae.in (ISHRAE)

Course Outcomes

At the end of this module, the student will be able to:

Sr. No.	CO statement	Weightage (%)
CO-1	Demonstrate an understanding of procedures within food industry and the ability to service, repair and start-up air conditioning, refrigeration and ventilation systems including the use and maintenance of equipment and tooling to meet food quality and output requirements, working safety and in an environmentally aware manner.	20

CO-2	Demonstrate an understanding of the need for control of food quality in the manufacturing, installation, maintenance and repair processes relating to air conditioning, refrigeration and ventilation.	25
CO-3	Demonstration an understanding of the application and procedures relating to the operation of various control devices, control systems and programmable logic systems used in food air conditioning, refrigeration and ventilation plants.	20
CO-4	Demonstrate an understanding and application of all the various types of systems used and related to the food air conditioning, refrigeration and ventilation industry.	15
CO-5	Critical Cross-Field Outcomes include Diagnosing operational faults in refrigeration systems, conducting quality checks and explaining the operation of different systems and refrigerants in the air-conditioning, refrigeration and ventilation industry related to food industry.	20

List of Experiments

1. Performance evaluation of VCRS tutor to find out actual and theoretical COP.
2. Performance of VCRS based heat pump to find actual and theoretical COP.
3. To study different types of expansion valves used for refrigeration systems.
4. Performance on ice plant tutor, find COP and compare it with the theoretical value.
5. Performance test on air conditioning tutor for studying sensible heating of foods.
6. Performance test on air conditioning tutor for studying cooling and dehumidification process for foods.
7. Performance test on air conditioning tutor for studying heating and humidification process for foods.
8. To study and acquaint with the tool kit used for the maintenance of the refrigeration systems.
9. To understand different types of reciprocating compressors suitable for food applications.
10. Routine maintenance and audit of refrigeration systems for perishable foods.

Major Equipments & Instruments

a. Vapour Compression Refrigeration System Trainer
b. DX-coil ice bank tank or Mini Ice plant
c. Mechanical VCR Heat Pump Trainer
d. Reciprocating and rotary compressors.
e. Thermostatic expansion valves
f. DX-coil Evaporator
g. Air cooled condenser
h. Water cooled condenser
i. Vapour absorption refrigeration system.
j. Special tool kits