

GUJARAT TECHNOLOGICAL UNIVERSITY

FOOD PROCESSING & TECHNOLOGY (14) FOOD REFRIGERATION & AIR – CONDITIONING SUBJECT CODE: 2161406 B.E. 6th SEMESTER

Type of course: Food Processing Technology

Prerequisite: Nil

Rationale:

Food refrigeration, air conditioning and ventilation systems provide artificial cooling 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, air properties, refrigerants, equipments and instrumentation and control etc. would be highly desirable for a graduating food engineer and technologists. The course is required lead to a learner into acquiring all the skills required to work in the industry with an understanding of types of refrigeration components their repair, safety maintenance, installation, manufacture and selection of the mechanical and electrical systems which provide temperature control for food process needs.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Refrigerants: Classification & Designation of refrigerants. Desirable properties of an ideal refrigerant. Properties & uses of common refrigerants like R-12, R-22, R 134-A, NH ₃ . Comparison of refrigerants, Non CFC refrigerants, Green House effect.	5	13
2	Simple Vapour Compression System : Vapour compression cycle. Functions of parts of vapour compression system. Representation of vapour compression cycle on (T-S) and (P-h) diagram. Factors affecting the performance of vapour compression system. Mathematical analysis of vapour compression refrigeration.	10	20
3	Vapour Absorption System : Simple vapour absorption cycle. Functions of parts of vapour absorption system. Electrolux refrigerator construction and working. Temperature concentration diagram and enthalpy concentration diagram for ammonia and lithium bromide absorption system. Cascade system of refrigeration: Introduction and working.	9	14
4	Refrigeration Components And Controls: Compressor: Hermetic sealed compressor, open type compressor, screw compressor centrifugal compressor. Condensers: Air-cooled, water-cooled, evaporative, cooling tower and spray	9	14

	pond. Evaporators: Flooded type, dry expansion, bare tube, plate surface, finned tube. Refrigeration controls: Thermostatic expansion valve, capillary tube, solenoid valves.		
5	Air-Conditioning Components: Air-conditioning components: Filters, fans, air washer, radiator and convector. Air- conditioning controls: Manual, automatic and semiautomatic control system, automatic humidity control, air movement system, automatic temperature control, limit switches, time switches.	6	12
6	Air Distribution: Air handling unit, Room air distribution, Requirements of good room air distribution, draft, types of supply air outlets, Duct system, Air-distribution system. Duct design guidelines.	5	13
7	Cold Storage And Freezing of Foods: Design of cold storage, Storage requirements of plant and animal produce, distinction between refrigeration, chilling and freezing, keeping quality and special storage requirements, Quick Instant Freezing.	5	14

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. Refrigeration and Air-conditioning by CP Arora. TMH
2. Refrigeration and Air-conditioning by Manohar Prasad. New Age pub.
3. Air-conditioning Engineering by Jone WP and Arnold E.
4. Principles of Refrigeration by Dossat RJ. John Wiely
5. Fundamentals of Food Process Engg by Romeo T. Toledo. CBS Publishers.
6. Commercial Cooling of Fruits and Vegetables by Thompson Univ. of California ASHRAE Fundamentals, 1997, 2001

Course Outcome:

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

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.
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.
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.
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.

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

List of Experiments:

1. Performance evaluation of VCR tutor to find out actual and theoretical COPS
2. Performance of Mechanical 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 the sensible heat process.
6. Performance test on air conditioning tutor for studying the cooling and dehumidification process.
7. Performance test on air conditioning tutor for studying the heating and humidification process.
8. To study the Tool kit used for the maintenance of the Refrigeration system.
9. To understand different types of reciprocating compressors.

Design based Problems (DP)/Open Ended Problem:

1. Design of a CFC-Free, Energy-Efficient Refrigeration system for long distance transportation and handling of fresh fruits and vegetables.
2. Design and performance evaluation of Refrigeration and Air Conditioning System problems by using Engineering Equation Solver (EES).
3. Design and analysis of heating and cooling load for a space to be conditioned for specific food products by ANN.
4. Simulation of humid air heating and cooling processes for long term food stuff storage.

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

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](http://www.sciencedirect.com)
- f. www.ishrae.in (ISHRAE)

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.