

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19) REFRIGERATION AND AIRCONDITIONING SUBJECT CODE: 2161908 B.E. 6th SEMESTER

Type of course: Core course

Prerequisite: Thermodynamics

Rationale: The course is designed to give fundamental knowledge of types of refrigeration, refrigeration cycles, refrigerants and behavior under various conditions, different air conditioning terms and load calculation, designing of components of air distribution system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
	PA	ALA		ESE	OEP					
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weight age
1	Introduction: Brief history and need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems.	2	3
2	Refrigerants: Classification, nomenclature, desirable properties, secondary refrigerants, future industrial refrigerants	2	4
3	Air refrigeration: Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of Simple; Bootstrap; Reduced ambient and Regenerative air refrigeration systems	4	8
4	Vapour Compression system: Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle Compound Compression System: Compound compression with intercooler, flash gas removal and flash intercooler, multiple evaporators with back pressure valves and with multiple expansion valves without flash inter cooling, analysis of two evaporators with flash intercooler and individual expansion valve and multiple expansion valve, cascade refrigeration system	7	16
5	Absorption refrigeration system: Desirable characteristics of refrigerant, selection of pair, practical H ₂ O -NH ₃ cycle, LiBr – H ₂ O system and its working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer, throttling, Electrolux refrigeration system*	3	8
6	Refrigeration system components: Types; construction; working; comparison and selection of compressors*; condensers; expansion devices; and evaporators, refrigeration piping accessories*, evacuation and charging of refrigerant*, properties and classification of thermal insulation	5	12
7	Psychrometry: Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychrometric chart, psychrometric processes such as sensible heating and cooling, heating and humidification cooling and dehumidification, chemical dehumidification, adiabatic saturation	5	13
8	Human comfort: Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions	1	3
9	Load analysis: Site survey, outdoor and indoor design conditions, classification	6	15

	of loads, flywheel effect of building material and its use in design, effect of wall construction on cooling load, instantaneous heat gain (IHG) and instantaneous cooling load (ICL) heat transmission through sunlit and shaded glass using tables, method of reduction of solar heat gain through glass, calculations of cooling load TETD due to sunlit and shaded roof and walls using tables, ventilation and air infiltration, load due to outside air, heat gain from occupants; electric lights; product; electric motor and appliances, load calculations for automobiles, use of load estimation sheet*, introduction of CLTD method		
10	Duct design and air distribution: Function; classification and economic factors influencing duct layout, equal friction method of duct design, use of friction chart, dynamic losses and its determination, Requirements of air distribution system, air distribution, grills, outlets, application, location	4	10
11	Air-conditioning systems: Classification, system components, all air; all water; and air-water systems, room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems	3	8

* To be covered in practical sessions only.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	15	10	10	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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 C P Arora, McGraw-Hill India Publishing Ltd.
2. Refrigeration and Air-conditioning by Ramesh Arora , Prentice Hall of India
3. Refrigeration and Air Conditioning by Manohar Prasad, New Age International Publisher
4. Principles of Refrigeration by Roy. J Dossat, Pearson Education
5. Refrigeration and Air Conditioning by Jordon and Prister, Prentice Hall of India Pvt. Ltd.
6. Refrigeration and Air Conditioning by W.F. Stocker and J. W. Jones, McGraw-Hill
7. Refrigeration and Air Conditioning by Ameen Ahmadul, PHI India
8. Automobile Air conditioning by Crouse and Anglin, McGraw Hill Publications

Course Outcome:

After learning the course the students should be able to:

- Understand the basic concepts of refrigeration and air conditioning systems
- Understand and analysis of various refrigeration cycles
- Make basic calculation of psychometric properties and process
- Do basic calculations of heating and cooling load requirements of a room.
- Apply scientific and engineering principles to analyze and design aspects of engineering systems that relate to refrigeration and air conditioning.

List of laboratory experiments: (Any 10 of the following experiments to be performed)

1. To understand different components of VCR system and to determine its COP
2. To understand working of Electrolux refrigerator and to determine its COP.
3. To understand construction and working of reciprocating, rotary and centrifugal compressor used for R&AC.
4. To understand various tools used for refrigeration tubing and and to perform various operations like flaring, swaging, bending, brazing etc.
5. To perform different psychometric processes and analyze the same using psychrometric chart.
6. To understand construction and working of window air-conditioner/ split air-conditioner and to determine its capacity.
7. To determine COP and apparatus dew point of an air conditioning test rig.
8. To calculate cooling load of a confined space using table and compare the same with load estimation sheet.
9. Study of domestic refrigerator and to determine % running time at different thermostat settings.

10. To determine $(COP)_C$ and $(COP)_H$ of heat pump
11. To determine saturation efficiency of air cooler/air washer
12. Study of packaged plant

Design based Problems (DP)/Open Ended Problem:

- Calculation of cooling load for a shopping mall or a large building.
- Make calculation of thermal insulation for a small cabin to prevent heat loss.
- Design and construction of a personal cooler.
- Determine evaporative cooling capacity of a desert cooler.
- Prepare duct layout for a shopping mall or a large building using any one method. (Different groups can take one method for same building and discuss the results).
- Thermal design of condenser used for R&AC

Major Equipment:

- Vapor compression test rig
- Vapor absorption test rig
- Sectional models of various type of compressors
- Air conditioning test rig
- Air cooler apparatus
- Apparatus to perform various psychrometric processes
- Tools for refrigeration tubing
- Mechanical heat pump

List of Open Source Software/learning website:

1. <http://nptel.ac.in/>
2. www.learnerstv.com

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.