COURSE TITLE : REFRIGERATION AND AIR CONDITIONING
COURSE CODE : 4029
COURSECATEGORY : A
PERIODS/WEEK : 5
PERIODS/SEMESTER : 90
CREDITS : 4

TIME SCHEDULE

MODULE	TOPICS	PERIODS
1	Introduction Principles of Refrigeration, Air Refrigeration system, Vapour compression system	22
2	Vapour Absorption system Refrigeration Equipments Refrigerants, Applications of Refrigeration	21
	TEST I	2
3	Psychrometry, Psychrometric Processes	22
4	Air-conditioning Air conditioning systems Air-conditioning Load Estimation Low temperature Refrigeration	21
	TEST II	2
	Total	**90**

OBJECTIVES

MODULE I

1.1.0 Know the importance of refrigeration, psychrometry and air conditioning.

1.1.1 Review the laws of thermodynamics
1.1.2 State the need for transfer of heat in the working of systems
1.1.3 Outline the importance of refrigeration, psychrometry and air conditioning.

1.2.0 Understand the Principles of Refrigeration

1.2.1 State the purpose of refrigeration
1.2.2 Define saturation temperature, latent heat, sensible heat, critical pressure, enthalpy, entropy and sublimation
1.2.3 Explain the change of state from liquid to vapour and vapour to liquid and solid to liquid and liquid to solid
1.2.4 Define refrigeration
1.2.5 Define COP of a refrigerator
1.2.6 Explain the unit of refrigeration
1.2.7 Analyse the reversed Carnot cycle with the help of P-V and T-S diagrams
1.2.8 State COP of reversed Carnot cycle (no proof)
1.2.9 Compute the COP and capacity of a refrigerating machine from a given data
1.2.10 List the applications of refrigeration
1.2.11 Appreciate the working of Air Refrigeration System

1.2.12 Explain the working of air refrigerator based on Bell-Coleman cycle with the help of f low diagram, P-V and T-S diagrams
1.2.13 State COP of Bell Coleman cycle (no proof)
1.2.14 Compute COP of Bell Coleman cycle from given data
1.2.15 Explain open and closed systems
1.2.16 List the advantages of disadvantages of Air refrigeration system

1.3.0 Appreciate the working of Vapour Compression system

1.3.1 Explain the principle of working of a vapour compression system
1.3.2 Analyse vapour compression system with the help of T-S and P-H diagram
1.3.3 Derive the COP of vapour compression systems
1.3.4 Derive the power required to drive the system
1.3.5 Compute COP and Power required from the given data
1.3.6 Explain the effects of sub-cooling and superheating the refrigerant
1.3.7 State the function of accumulation and flash chamber in a vapour compression system

MODULE II

2.1.0 Understand the working of vapour Absorption system

2.1.1 Explain the working of a simple absorption system with a flow diagram
2.1.2 Explain the working of electrolux refrigerator with the help of a flow diagram
2.1.3 Compare vapour compression system and vapour absorption system

2.2.0 Understand the working of major components in a Refrigeration System

2.2.1 Explain with a simple sketch the working of a reciprocating compressor
2.2.2 Explain with a sketch the working of roller and vane type compressors
2.2.3 Explain with a sketch the working of a centrifugal compressor
2.2.4 Distinguish between hermetically sealed and semi-hermetically sealed compressor
2.2.5 Explain with a sketch the working of a Scroll Compressor
2.2.6 Explain the working of air cooled condensers
2.2.7 Explain the working of water cooled condensers – shell and tube type, shell and coil type and double tube type
2.2.8 Explain the working of dry expansion type evaporator and flooded type evaporator
2.2.9 Distinguish between Natural convection type evaporators and forced convection type evaporators and forced convection type evaporators
2.2.10 Explain with suitable sketches the expansion devices such as capillary tube, automatic expansion valve and thermostatic expansion valve

2.3.0 Understand the Properties and applications of Refrigerants

2.3.1 Define refrigerant
2.3.2 Distinguish between Primary refrigerant and secondary refrigerant, with examples
2.3.3 Classify properties of refrigerants
2.3.4 Outline the desirable properties of refrigerants
2.3.5 Explain ozone depletion potential and global warming potential
2.3.6 list various refrigerants such as , ammonia, carbon dioxide, freon 11, freon 12 and freon 22
2.3.7 Outline the characteristics of environmentally safe refrigerants R123, R134a, R 125
2.3.8 Explain salt brines and glycol.

2.4.0 Appreciate the various applications of Refrigeration

2.4.1 List various fields of applications of refrigeration
2.4.2 Explain with a layout, working of domestic refrigerator

2.4.2 Explain with a layout, working of ice plants
2.4.3 Explain the working of water coolers – pressure type and storage type
2.4.4 Explain the working of a cold storage
2.4.5 Explain Dairy refrigeration – Pasteurization
2.4.6 Explain freeze drying
2.4.7 Explain Ice cream making process

MODULE III

3.1.0 Understand the Principle of Psychrometry

3.1.1 Define Psychrometry
3.1.2 Define dry air, moist air, saturated, unsaturated and super saturated air, degree of saturation, dry bulb temperature, wet bulb temperature and dew point temperature
3.1.3 State Dalton's law of partial pressure
3.1.4 Distinguish between absolute humidity and specific humidity
3.1.5 Explain degree of saturation
3.1.6 Explain relative humidity
3.1.7 Explain enthalpy of moist air
3.1.8 Solve numerical problems relating the above parameters
3.1.9 Explain the construction and use of psychrometer
3.1.10 Explain the use of psychrometric chart (Simple problems using tables and charts.)

3.2.0 Understand the various Psychrometric processes

3.2.1 Explain and represent psychrometric process such as sensible heating, sensible cooling, humidifying,dehumidifying, heating and humidifying, cooling and dehumidifying and adiabatic mixing of air streams on psychrometric charts
3.2.2 Explain by-pass factor of heating and cooling coil
3.2.3 Explain the concept of sensible heat factor
3.2.4 Derive efficiency of heating and cooling coils
3.2.5 Solve simple problems using psychrometric chart.

MODULE IV

4.1.0 Understand the principles of Air conditioning

4.1.1 Define air conditioning
4.1.2 Explain the factors affecting human comfort
4.1.3 Explain the concept of effective temperature
4.1.4 Explain the use of comfort chart in air conditioning

4.2.0 Understand the types of Air conditioning systems

4.2.1 Classify air conditioning systems on the basis of major function, season of the year and equipment arrangement
4.2.2 Explain industrial air conditioning, comfort air conditioning
4.2.3 Explain the working of summer, winter and year round air conditioning with line sketches
4.2.4 Explain the construction and working of window type air conditioner
4.2.5 Explain the construction and working of packaged type air conditioner
4.2.6 Explain the central plant system with suitable layout

4.3.0 Estimate the load and design Air conditioning systems

4.3.1 Explain the sources of heat gain or loss

4.3.2 Estimate heat gain from various sources such as conduction heat load, radiation load of sun, occupants load, infiltration air load, equipment load, fresh air load, miscellaneous heat sources.
4.3.3.Explain sensible, latent and total heat load.
4.3.3 Compute total cooling load .

4.4.0 Understand the principles and working of low temperature refrigeration system

4.4.1 Define Cryogenic
4.4.2 List Advantages and applications of cryogenic refrigeration
4.4.3 Explain Cascade refrigeration
4.4.4 Explain Joule –Thomson effect
4.4.5 Explain Liquefaction of Nitrogen and Hydrogen.

CONTENT OUTLINE

MODULE I

Introduction

Introduction to heat transfer – importance of refrigeration, psychrometry and air conditioning.

Principles of Refrigeration

Review of thermodynamic principles – saturation temperatures; change of state; latent heat; sensible heat; critical pressure; enthalpy; entropy; sublimation. Definition of refrigeration, concept of C.O.P, unit of Refrigeration. reversed carnot cycle- COP, simple problems,Application of refrigeration, Laws of refrigeration simple problems.

Air Refrigeration systems

Working of Air refrigerator based on Bell-Coleman cycle,flow,PV and TS diagram of Bell Coleman cycle.Simple problems. Open and closed systems of Air refrigeration. Advantages and limitations

Vapour Compression Refrigeration systems

Principles and working of a vapour compression system with the help of flow diagram. Analysis of vapour compression system with the help of TS and PH diagrams. C.O.P of vapour compression systems. Power required to drive the system. Simple problems. Effect of sub-cooling and super heating, use of accumulator and flash chamber.

MODULE II

Vapour Absorption system

Simple absorption system, Electrolux system, comparison with vapour compression system

Refrigeration Equipments

Compressors: Principle of working of reciprocating compressors, rotary compressor – roller and vane type – centrifugal compressor (Explanation with simple diagram only)-hermetically sealed and semi hermetically sealed compressors-scroll compressors.

Condensers: Air cooled condensers, water cooled condensers – shell and tube ,shell and coil and double tube type (Explanation with line diagram)

Evaporators: Types, Dry and flooded type, Natural and forced convection type

Expansion Devices: Capillary tube, Thermostatic expansion valve, automatic expansion valve

Refrigerants

Definition: Primary and secondary refrigerants, desirable properties of refrigerants, Physical – chemical – thermodynamic – ozone depletion potential, global warming potential. properties of

ammonia, carbon dioxide, R-11, R-12 and R-22, environmentally safe refrigerants such as R123, R 134a ,R125, secondary refrigerants salt brine, glycol..

Application of refrigeration

Domestic refrigerator,Ice plants, water coolers- pressure type and storage type, cold storage, dairy refrigeration, freeze drying, ice cream cabinets.

MODULE III

Psychrometry

Definition, Dry air, moist air, saturated, unsaturated and super saturated air, degree of saturation, dry bulb temperature, wet bulb temperature, dew point temperature. Dalton's law of partial pressures absolute humidity,relative humidity, specific humidity., Enthalpy of moist air, psychrometer, psychrometric chart and tables. (Simple problems using tables and charts).

Psychrometric Processes

Sensible heating, sensible cooling – by pass factor, humidifying, dehumidifying – sensible heat factor, heating and humidifying, cooling and dehumidifying, efficiency of heating and cooling coil. Simple problems using psychrometric chart and tables.

MODULE IV

Air Conditioning

Definition, factors affecting human comfort, effective temperature, comfort chart

Air conditioning systems

Classification – industrial, comfort air conditioning, working of summer air conditioning, winter and year round air conditioning, construction and working of window type, package type, and central plant systems.

Design and Load estimation of Air Conditioning systems

Introduction – Heat source – External and Internal source, solar radiation through window – conduction of heat due to temperature difference. Heat addition by the occupants and equipments. Infiltration of air – ventilating estimation. Procedure of sensible heat load – latent heat load – total load –.Estimation of total cooling load .

Low temperature refrigeration (Cryogenics)

Definition for the term cryogenics.-advantages, –field of application ,Cascade refrigeration system– Joule Thomson effect – (definition only) - liquefaction of Nitrogen and Hydrogen.

TEXT BOOK

1. Refrigeration & Air conditioning – R.S. Khurmi & J.K. Gupta
2. Refrigeration & Air Conditioning – A.S. Sarao & P.S. Gabi.

REFERENCE BOOKS

1. A course in Refrigeration & Air Conditioning – S.C. Arora & S. Domkudwar
2. Basic Refrigeration & Air Conditioning – P.N.Ananthanarayanan
3. Cryogenic Systems - Randll Darron
4. Cryogenic engineering - R. D. Scott
5. Principles of refrigeration - ROY.J. Dossat.