

ME 502 – REFRIGERATION AND AIR CONDITIONING

Course Title:	Refrigeration and Air Conditioning	Course Code:	ME-502
Semester:	V	Course group :	Core
Teaching Scheme(L:T:P):	4:1:0	Credits:	3
Methodolgy :	Lecture + Assignment	Total contact periods:	75
CIE:	60 Marks	SEE:	40 Marks

Pre-requisites: Basic knowledge of Thermodynamics .

COURSE OUTCOMES

	On Successful completion of the course, the student will be able to
CO 1	Classify and explain the methods of refrigeration and elaborate air refrigeration cycles
CO 2	Evaluate vapour compression and vapour absorption refrigeration systems, calculate parameters and compare the systems
CO 3	Adapt to eco friendly refrigerants and know the function of equipment used in refrigeration, describe and differentiate them.
CO 4	Outline and determine various psychrometric properties, Analyze psychrometric processes..
CO 5	Explain and Assess working of various air conditioning equipment and draw their layout
CO 6	Make use of recent trends in the field of refrigeration and air conditioning and correlate them with their application in industry

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE

Unit No	Unit Name	Periods	Questions to be set for SEE (Q No)				Remarks
			R		U	A	
1	Introduction to Refrigeration & Air refrigeration systems	12	4	1	9(a)	13(a)	
2	Vapour compression and absorption refrigeration Systems	13					
3	Refrigerants and refrigeration equipment	13		2	10 (a)	14 (a)	
4	Psychrometry & Psychrometric processes	12					
5	Air distribution and Air conditioning equipment	12		3	5, 6	9(b), 11(a), 11(b)	13(b), 15(a), 15(b)
6	Applications of refrigeration and air conditioning – Recent trends in Refrigeration and air conditioning.	13					
				7, 8	10(b), 12(a), 12(b)	14(b), 16(a), 16(b)	

Legend: R: Remembering, U: Understanding A: Applying

COURSE CONTENT

Refrigeration and Air conditioning

Unit – 1 Introduction to Refrigeration & Air refrigeration systems

Duration: 12 Periods (L: 10 – T:2)

Definition of refrigeration, Air conditioning – Heat engine, refrigerator and heat pump. Basic terms involved in refrigeration : Refrigeration effect, Work of compression, COP, Ton of refrigeration, Power required per TR – Natural and Artificial methods of refrigeration : Ice, Dry Ice refrigeration. — Thermodynamic analysis of Reversed Carnot refrigeration cycle – Limitations - Thermodynamic analysis of Bell Coleman refrigeration cycle .

Unit – 2 Vapour compression and absorption refrigeration Systems

Duration: 13 Periods (L: 10 – T: 3)

Vapour compression refrigeration system (VCRS):-Principle –Thermodynamic analysis of VCRS -Factors effecting performance of VCRS - Wet and dry compression –Receiver, Accumulator, strainer , drier and flash chamber.

Vapour absorption refrigeration system(VARS):-Principle – Refrigerant absorbent pairs - Working of Ammonia water vapour absorption refrigeration system – Working of Lithium Bromide Water vapor absorption refrigeration system- Expression for COP of VARS.

Unit – 3 Refrigerants and refrigeration equipment

Duration: 13 Periods (L:10 – T:3)

Refrigerants:- Definition - Primary and secondary refrigerants -- properties of good refrigerants – Commonly used refrigerants – Ozone depletion, phase out of Chloro fluoro carbon refrigerants – Montreal protocol – Global warming and Kyoto protocol.

Refrigeration equipment :-Hermetic compressor – Natural circulation tube and fin air cooled condenser, forced circulation tube and fin air cooled condenser, shell & tube water cooled condensers and evaporative condenser – Capillary tube and thermostatic expansion valve – Difference between direct evaporator and flooded evaporator, and Plate surface evaporator, Bare tube evaporator, finned tube forced circulation evaporator and Shell and tube evaporator , ,.

Unit – 4 Psychrometry & Psychrometric processes

Duration: 12 Periods (L: 10 – T:2)

Definition of air conditioning - Classification of air conditioning systems - Human comfort conditions – Effective temperature – Factors governing effective temperature – comfort chart. Psychrometry:-Definition– Psychrometric terms – Carrier Equation - Psychrometric chart – Psychrometric processes

Unit – 5 Air distribution and Air conditioning equipment

Duration: 12 Periods (L: 10 – T:2)

General Air distribution (Air flow diagram for an ac system) – Air distribution system in a Room :- Ejection system, Downward system and Upward system. -Ducts: -Definition, Types, material used, Need for insulating a duct and Duct system - Fans and blowers – Supply air outlets – Filters – Heating and cooling coils –AHU (Air handling units). –Chiller

Unit – 6 Applications of refrigeration and air conditioning – Recent trends in Refrigeration and air conditioning.

Duration: 13 Periods (L:10 – T:3)

Applications of refrigeration :- Domestic refrigerator – Water cooler – Desert/air cooler(Evaporative cooling), - Unitary vs Central Air conditioning system - Applications of air conditioning:-Window air conditioner, Summer air conditioning system – Winter air conditioning system – Central air conditioning system

Recent trends in RAC : Ice line refrigerator, chest refrigerator - Clean rooms vs Dry rooms - Variable refrigerant flow (VRF) system - Inverter AC – Smart HVAC controls – Natural ventilation.

REFERENCE BOOKS

1. Refrigeration and Air Conditioning – by C. P Arora
2. Refrigeration and Air Conditioning – by Domakundwar
3. Basic Refrigeration and Air conditioning - by P N Ananthanarayana
4. Refrigeration and Air Conditioning – by Dosatt
5. Refrigeration and Air Conditioning – by Stoecker

SUGGESTED LEARNING OUTCOMES

1. Introduction to refrigeration & air refrigeration systems

- 1.1 Define the terms refrigeration and air conditioning
- 1.2 Know the difference between heat engine, refrigerator and heat pump.
- 1.3 Define the terms Refrigeration effect and Work of compression
- 1.4 Define COP
- 1.5 Expression for COP of refrigerator and heat pump and relation between them.
- 1.6 Define unit of refrigeration (Ton of refrigeration- TR).
- 1.7 Evaluate power required per ton of refrigeration
- 1.8 Numerical problems on COP , unit of refrigeration and power required per TR.
- 1.9 Know different natural methods and mechanical methods of refrigeration.
- 1.10 Explain such as direct ice and indirect ice method of refrigeration
- 1.11 Explain dry ice refrigeration system refrigeration
- 1.12 Introduction to Air refrigeration and list different air refrigeration systems.
- 1.13 Explain reverse Carnot refrigeration cycle with flow diagram, PV and TS diagram.
- 1.14 Know limitations of reverse Carnot refrigeration cycle.
- 1.15 Know expression for COP of reverse Carnot refrigeration cycle (derivation omitted)
- 1.16 Solve numerical problems on COP of reverse Carnot refrigeration cycle.
- 1.17 Explain Bell Coleman air refrigeration cycle with flow diagram, PV and TS diagram
- 1.18 Know expression for COP of Bell Coleman air refrigeration cycle (derivation Omitted)
- 1.19 Solve numerical problems on COP of Bell Coleman air refrigeration cycle

2. Vapour compression and absorption refrigeration Systems

- 2.1 List major components in simple (basic) vapour compression refrigeration system.
- 2.2 Draw flow diagram of simple (basic) vapour compression refrigeration system.
- 2.3 Explain principle and working of simple (basic) vapour compression refrigeration system with the help of T-S and P-h diagrams.
- 2.4 Write the expression for COP of vapour compression system.
- 2.5 Distinguish between wet and dry compression.
- 2.6 Solve simple problems on basic vapor compression refrigeration system
- 2.7 Summarize the effects of evaporator pressure and condenser pressure on COP
- 2.8 Summarize the effects of under cooling and super heating on COP.
- 2.9 State the use of receiver, accumulator, strainer, drier and flash chamber.
- 2.10 Explain principle of simple vapor absorption systems.

- 2.11 State the desirable properties of refrigerants -absorbers
- 2.12 List commonly used refrigerant – absorber pairs.
- 2.13 Explain the construction and working of Ammonia-Water VARS
- 2.14 Explain the construction and working of Water-Lithium Bromide VARS.
- 2.15 Know expression of COP of VARS (without derivation)
- 2.16 Solve simple problems on COP of VARS.

3. Refrigerants and refrigeration equipment

- 3.1 Distinguish between primary and secondary refrigerants.
- 3.2 List the desirable properties of refrigerants and Classify refrigerants.
- 3.3 Know the difference between chloro fluoro carbon refrigerants, hydro chloro fluoro refrigerants and hydro carbon refrigerants.
- 3.4 Write chemical formula, designation name and application of the following refrigerants – R 12, R 22, R 134 a, R 290a, R 600a, R 401a, R 410 a, R 717, R 718, R 729, R 744.
- 3.5 Know the impact of refrigerants on Ozone depletion – Need to phase out of Chloro fluoro carbons and hydro Chloro fluoro carbons –
- 3.6 Understand Montreal protocol (Statement of protocol)
- 3.7 Know the effect of refrigerants on Global warming .
- 3.8 Understand Kyoto protocol. (Statement of protocol).
- 3.9 Know the application of reciprocating, scroll, screw and centrifugal compressors.
- 3.10 Explain construction and working of hermetic reciprocating compressor.
- 3.11 State the function of condenser, know difference between air cooled condenser and water cooled condenser – know difference between natural circulation and forced circulation condenser.
- 3.12 Explain the working of natural circulation tube and fin air cooled condenser used in domestic refrigerator.
- 3.12 Explain the working of forced circulation tube and fin air cooled condenser used in window air conditioner/water cooler.
- 3.13 Explain the working of shell & tube water cooled condensers used in big capacity refrigeration/air conditioning systems.
- 3.14 Explain the working of evaporative condensers used in ice making plants..
- 3.15 Explain the working of capillary tube.
- 3.16 Know the difference between direct evaporator and flooded evaporator.
- 3.17 Explain the working plate surface evaporator used in domestic refrigerator/ display panel in bakeries..
- 3.18 Explain the working of bare tube evaporator used in water cooler.
- 3.19 Explain the working of finned tube forced circulation evaporator used in window air conditioner.
- 3.20 Explain the working of shell and tube evaporator used in big capacity refrigeration/air conditioning plants.

4.Air conditioning & Psychrometry

- 4.1 Define air conditioning and classify air conditioning systems
- 4.2 Know the following terms: human comfort, effective temperature
- 4.3 Know about comfort chart.
- 4.4 Define the terms: Psychrometry, dry air and moist air, DBT, WBT, DPT and adiabatic saturation temperature
- 4.5 Define the terms humidity, absolute humidity, relative humidity, specific humidity.
- 4.6 Know carrier's equation and solve problems involving psychrometry.
- 4.7 Construction and working of different psychrometers- Laboratory, continuous recording, sling, aspirating psychrometers.
- 4.8 Explain the features of psychrometric chart, plot all psychrometric processes on the chart.
- 4.9 Simple problems on psychrometric processes using psychrometric chart only.
- 4.10 Know the concept of mixing of air streams and solve problems.

5.Air distribution and Air conditioning equipment

- 5.1 Draw the general air flow diagram for AC system and explain flow of air.
- 5.2 Explain different air distribution systems in a room like ejection system, downward system and upward system.
- 5.3 Air distribution system in a Room :- Ejection system,
- 5.4 Air distribution system in a Room :- Downward system
- 5.5 Air distribution system in a Room: Upward system.
- 5.6 Explain the need of duct- Know duct materials, shapes and classify ducts
- 5.7 Explain need of insulating a duct and material used for insulation.
- 5.8 Explain the duct system based on arrangement of supply ducts loop perimeter system
- 5.9 Explain the duct system based on arrangement of supply : radial perimeter system
- 5.10 Explain the duct system based on arrangement of supply ducts : extended plenum system.
- 5.11 Explain duct system based upon number of ducts used like: single duct system, dual duct system and dual duct with induction system.
- 5.12 Differentiate fan and blower.
- 5.13 Know the factors governing selection of fans.
- 5.14 Classify fans according to direction of air flow.
- 5.15 Know about grill outlets, slot diffusers, ceiling diffusers, perforated ceiling panels and their applications.
- 5.16 Know different types of filters (Dry, Viscous, Wet, Electronic and

HEPA filters)-

- 5.17 Explain heating and cooling coils.
- 5.18 Know about air handling unit (AHU).
- 5.19 Know the function of chillers in air conditioning.

6. Applications of refrigeration and air conditioning – Recent trends in Refrigeration and air conditioning

- 6.1 Explain construction and working of domestic refrigerator.
- 6.2 Explain construction and working of storage type water cooler.
- 6.3 Know about ice line refrigerator and chest freezer.
- 6.4 Explain the working of desert type air cooler.
- 6.5 Explain difference between unitary and central ac system.
- 6.6 Explain working of window air conditioner.
- 6.7 Know the difference between unitary air conditioner, split air conditioner and cassette air conditioning system.
- 6.8 Explain summer air conditioning system for hot & humid out door conditions and hot & dry conditions.
- 6.9 Explain winter air conditioning system for cold & dry out door conditions
- 6.10 Explain central air conditioning system
- 6.11 Know the difference between clean room and dry room.
- 6.12 Know about variable refrigerant flow (VRF) system.
- 6.13 Know about inverter ac system.
- 6.14 Explain briefly smart HVAC system.
- 6.15 Explain briefly about Natural ventilation system.

CO – PO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1.50	1.50	3.00	3.00	1.50	1.50	3.00
CO2	1.50	3.00	3.00	3.00	1.50	3.00	3.00
CO3	3.00	3.00	1.50	1.50	3.00	3.00	1.50
CO4	3.00	3.00	1.50	1.50	3.00	3.00	1.50
CO5	3.00	1.50	1.50	3.00	3.00	3.00	1.50
CO6	3.00	1.50	1.50	1.50	3.00	3.00	1.50
AVERAGE	2.50	2.25	2.00	2.25	2.50	2.75	2.00

BOARD DIPLOMA EXAMINATIONS (C 24)
MID SEM I EXAMINATION
DME V SEMESTER
REFRIGERATION AND AIR CONDITIONING

Time : 1 Hour

Total Marks : 20 M

PART – A

Marks: 4 X 1M = 4 M

*NOTE: 1) Answer **all** questions and each question carries **one** mark.*

*2) Answers should be brief and straight to the point and shall not exceed **three** simple sentences*

1. Define the term Ton of refrigeration.?
2. Find COP of a heat pump working on Reverse Carnot cycle operating between -10° C and 40° C?
3. What is function of accumulator in VCRS?
4. In Water- Lithium bromide VARS which Refrigerant is used?

PART – B

Marks: 2 X 3M= 6 M

*NOTE: 1) Answer **all** questions and each question carries **three** marks*

2) The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer.

5.(a). Explain about ice refrigeration

OR

5. (b). Draw PV and TS diagram of refrigerator of reverse Carnot air refrigeration cycle.

6 a). Draw the layout of Ammonia – water VARS..

OR

6 (b). Why is water Lithium bromide VARS is limited to be used only for air conditioning?

PART – C

Marks : 2 X 5 M = 10 M

NOTE :

1. Answer **all** questions and each question carries **five** marks.
2. The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer

7(a) Explain Bell Coleman refrigeration cycle with a layout.

OR

7(b) A refrigeration plant works between -15°C and 30°C . The refrigerant is dry and saturated at the end of compression. Calculate Refrigerating effect, Carnot COP and COP of VARS, if enthalpy values before and after compression are 1280 kJ/kg and 1470 kJ/kg, fluid enthalpy at 30°C is 320 kJ/kg.

8 (a) Explain with help of Pressure-Enthalpy (P-H) diagram the effect of increase in condenser pressure on refrigeration system performance.

OR

8 (b) Differentiate between wet compression and dry compression refrigeration system.

BOARD DIPLOMA EXAMINATIONS (C 24)
MID SEM II EXAMINATION
DME V SEMESTER
REFRIGERATION AND AIR CONDITIONING

Time : 1 Hour

Total Marks : 20 M

PART – A

Marks: 4 X 1M = 4 M

*NOTE: 1) Answer **all** questions and each question carries **one** mark.*

*2) Answers should be brief and straight to the point and shall not exceed **three** simple sentences*

1. What is a secondary refrigerant. Give an example.
2. What is chemical name of R- 290.
3. Define air conditioning ?
4. Define the term relative humidity.

PART – B

Marks : 2 X 3M= 6 M

*NOTE: 1) Answer **all** questions and each question carries **three** marks*

2) The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer.

5. (a) Write short notes on KYTO protocol

OR

- 5 (b) When are forced circulation water cooled condensers used in air conditioning systems.

6. (a) How does Dry bulb temperature change in sensible cooling and sensible heating.

OR

- 6 (b) Write carrier's equation used in air conditioning and indicate the terms used in it?.

PART – C

Marks : 2 X 5 M = 10 M

NOTE :

3. Answer **all** questions and each question carries **five** marks.
4. The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer

7(a) Explain working of Hermetic compressor.

OR

7(b) Explain working of capillary.

8 (a) A air conditioning system requires air which is at DBT 35C . Without changing its specific humidity, its temperature should change to 15 C. Indicate the process on Psychrometric chart and name the process?

OR

8 (b) Explain the difference between humidification and dehumidification.

BOARD DIPLOMA EXAMINATIONS (C 24)
MODEL PAPER (SEE)
DME V SEMESTER
REFRIGERATION AND AIR CONDITIONING

TIME : 2 Hours

Max. Marks: 40

PART – A

Marks: 8 X 1 M = 8 M

*NOTE : 1) Answer **all** questions and each question carries **one** marks.*

*2) Answers should be brief and straight to the point and shall not exceeding **three** simple sentences*

1. Define the term refrigeration.
2. What is the function of flash chamber in VCRS.
3. Why is an air conditioning duct need to be insulated.
4. Write equation to find humidity of air.
5. What is function of a duct in conditioning systems..
6. What is approximate value of relative humidity of Vishakapatnam?.
7. What are main components in out door unit of split air conditioner?
8. What psychrometric process does air under go in air cooler ?

PART – B

*Answer **all** questions . Each question carries **three** marks*

4x 3 M = 12M

9(a) COP of refrigerator working on reverse Carnot cycle is 5. What is the value of ratio of high temperature and low temperature of the cycle.

OR

9(b) What does HEPA stands for? Why it is used.

10(a) What are primary refrigerants give two examples.

OR

10 (b) Draw layout of components in window air conditioner?

11 (a) Differentiate slot diffuser and ceiling diffuser.

OR

11(b) Differentiate radiation and convection heat transfer

12(a) Draw the layout of summer air conditioning system.

OR

12(b) Draw the layout for domestic refrigerator.

PART – C

*Answer **all** questions. Each question carries **five** marks*

4x 5 M = 20 M

13 (a) Explain reverse Carnot air refrigeration cycle?

OR

13 (b) Explain loop perimeter duct system with a neat sketch.

14 (a) Explain working of thermostatic expansion valve.

OR

14 (b) Explain working of window air conditioner.

15 (a) Explain general air distribution system.

OR

15 (b) Explain dual duct air conditioning system.

16 (a) Explain winter air conditioning system ?

OR

16 (b) Write short notes on clean rooms and dry rooms?