COURSE FILE

REFRIGERATION AND AIR CONDITIONING

(Subject Code: A60334)

IIi Year B.TECH. (MECHANICAL ENGINEERING) II SemeSter

Prepared by **U.SREEKANTH, Asst.Proff**

DEPARTMENT OF MECHANICAL ENGINEERING

GEETHANJALI COLLEGE OF ENGINEERING & TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. DIST. - 501 301

(AffiliAted to JNtUH, Approved by AiCte, NeW delHi, ACCREDITED BY NBA)

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GEETHANJALI COLLEGE OF ENGINEERING & TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. DIST. 501 301

DEPARTMENT OF MECHANICAL ENGINEERING

(Name of the Subject /Lab Course): REFRIGERATION AND AIR CONDITIONING

(JNTU CODE: 56018) Programme: UG

Branch: MECHANICAL ENGINEERING **Version No: 01**

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Prepared by:

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2) Sign. : 2) Sign :

3) Design.: Asst. Professor 3) Design:

4) Date : 4) Date :

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4) Date :

Approved by: (HOD)

1) Name : T.SIVA PRASAD

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3) Date :

*** For Q.C Only.**

1) Name:

2) Sign :

3) Design. : Associate

4) Date :

GEETHANJALI COLLEGE OF ENGINEERING & TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. DIST. 501 301

COURSE FILE

Department of: MECHANICAL ENGINEERING

Year and Semester to Whom Subject is offered: III Year B.Tech. II Semester

Name of the Subject: **REFRIGERATION AND AIR CONDITIONING**

Name of the Faculty: U.Sreekanth Designation: Asst. Professor Department: Mech.Engg

INDEX

1.1. INTRODUCTION TO SUBJECT

For specific applications, efficiencies of both living and non-living beings depend to a great extent on the physical environment. The nature keeps conditions in the physical environment in the dynamic state ranging from one extreme to the other. Temperature, humidity, pressure and air motion are some of the important environment variables that at any location keep changing throughout the year. Adaptation to these many a times an unpredictable variation is not possible and thus working efficiently is not feasible either for the living beings or the non-living ones. Thus for any specific purpose, control of the environment is essential. Refrigeration and air-conditioning is the subject which deals with the techniques to control the environments of the living and non-living subjects and thus provide them comforts to enable them to perform better and have longer lives.

1.2 Objectives of the Refrigeration air conditioning.

On completion of this course, students should be able to

1. Understand the basic principles of refrigeration and air conditioning,

2. Analyze air refrigeration systems, vapor compression refrigeration systems, vapour absorption refrigeration systems, and steam jet refrigeration systems

3. Study the psychometric properties of air and utilize the principles of psychometric in the design of air conditioning equipments

4. Finally apply this knowledge for the design of refrigeration equipments and air conditioning equipments

I.3.Outcomes of the subject:

- To describe major design considerations of air-side, water-side, ventilation and refrigeration systems.
- To evaluate applications and design calculations of HVAC&R systems.

1.4. Teaching/Learning Methodology

A mixture of lectures, tutorial exercises, and case studies are used to deliver the various topics. Some of these topics are covered in a problem-based format to enhance learning objectives. Others will be covered through directed study in order to enhance the students' ability of "learning to learn." Some case studies are used to integrate these topics and thereby demonstrate to students how the various techniques are inter-related and how they can be applied to real problems in an industry.

1.5 JNTU Syllabus

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY B.Tech. III-II Sem.

UNIT – I Basic concepts-unit of refrigeration and COP- refrigerants- heat pump- Carnot refrigerator-applications of refrigerator-vapor compression refrigeration system-ideal cycle-effect of sub cooling of liquid- super heating of vapor- deviations of practical from ideal cycle – construction and use of PH chart problems.

UNIT- II compressors- classification –working – advantages and disadvantages

Condenser- classification –working principal

Evaporators - classification –working principal

Expansion devices – types –working principal

UNIT- III Vapor Absorption Refrigeration (VAR) System – Description and Working of NH3 – Water System and Li Br –Water (Two Shell & Four Shell) System -Calculation of Max COP, Principle of Operation of Three Fluid Absorption System. www.jntuaupdates.com || www.jntuaresults.in 81 Steam Jet Refrigeration System: Working Principle and Basic Components-Estimation of Motive Steam Required, Principle and Operation of: (I) Thermo-Electric Refrigerator (Ii) Vortex Tube OrHilsch Tube. Learning Outcome & Suggested Student Activities: After the completion of the

chapter, student can know the purpose and function of each of the basic components of the absorption refrigeration system. Student can have knowledge on latest developments of Electrolux, thermo electric vortex tube methods.

UNIT- IV Introduction to Air Conditioning: Psychometrics Properties & Processes – Characterization of Sensible and Latent Heat Loads — Need For Ventilation, Consideration of Infiltrated Air – Heat Load Concepts of RSHF, ASHF, ESHF and ADP.

Concept of human comfort and effective temperature- comfort air conditioning- industrial air conditioning and requirements- air conditioning load calculations.

UNIT- V Air Conditioning systems: classification of equipments, cooling, heating humidification and dehumidification, filters, grills and registers deodorants, fans and blowers.

Heat pump- heat sources- different heat pump circuits-applications.

TEXT BOOKS:

1. Refrigeration and air conditioning / CP Arora/TMH

2. A course in refrigeration and air conditioning /SC Arora & Domkundwar/ Dhanpatrai

Reference book:

1. Principals of refrigeration / Dossat/ Pearson education

2. Basic refrigeration and air conditioning / Ananthanarayanan/ TMH.

3. Refrigeration and air conditioning? Manohar Prasad? New age.

4. Refrigeration and air conditioning / Ahmadul amen /PHI

1.6. Unit wise Summary

Sl No	Unit No.	Total No. of Periods	Topics to be covered	Reg./ Additional	Teaching aids used LCD. OHP.BB	Remarks
1	**I**	9	Introduction to Refrigeration	Regular	OHP,BB	
2			Necessity and applications	Regular	OHP,BB	
3			Unit of refrigeration and C.O.P.	Regular	OHP,BB	
4			Mechanical Refrigeration–Types of Ideal cycles of refrigeration.	Regular	OHP,BB	
5			Air Refrigeration: Bell Coleman cycle and Brayton Cycle	Regular	OHP, BB	
6			Open and Dense air systems	Regular	OHP, BB	
9			Air refrigeration system problems	Regular	OHP,BB	
10			Refrigeration needs of Air crafts.	Regular	OHP BB	
11			tutorial	Regular	OHP,BB	
12		8	Vapour compression refrigeration – working principle and essential components of the plant	Regular	OHP BB	
13			Simple Vapour compression réfrigération cycle – COP	Regular	OHP BB	
14			Representation of cycle on T-S and p-h charts	Regular	OHP,BB	
15			Effect of sub cooling and super heating – cycle analysis – Actual cycle	Regular	OHP,BB	
			Influence of various parameters on system performance	Regular	OHP,BB	

			Use of p-h charts – numerical Problems.	Regular	OHP,BB	
16			Numerical problems	Regular	OHP,BB	
17			Numerical problems	Regular	OHP,BB	
18	**II**	6	Classification–Working Principles of compressors – Types	Regular	OHP,BB	
19			Classification–Working Principles of condensers – Types	Regular	OHP,BB	
20			Classification–Working Principles of evaporators – Types	Regular	OHP,BB	
21			Classification–Working Principles of Evaporator devices – Types.	Regular		
			Advantages and disadvantages			
			tutorial			
22	**III**	7	Vapor Absorption System – Calculation of max COP	Regular	OHP,BB	
23			Description and working of NH3 – water system	Regular	OHP,BB	
24			Li Br –water (Two shell & Four shell) System.	Regular	OHP,BB	
25			Principle of operation Three Fluid absorption system, salient features.	Regular	OHP,BB	
26			Problems	Regular	OHP,BB	
27			Review of the unit	Regular	OHP,BB	
28			tutorial	Regular	OHP,BB	
		6	Steam Jet Refrigeration System – Working Principle	Regular	OHP,BB	
			SJR Basic Components	Regular	OHP,BB	
29			SJR problems	Regular	OHP,BB	

30			Principle and operation of Thermoelectric refrigerator	Regular	OHP,BB	
31			Principle and operation of Vortex tube or Hilsch tube	Regular	OHPBB	
32			Tutorial class	Regular	OHP,BB	
33	**IV**	10	Introduction to air conditioning and Psychometric	Regular	OHP,BB	
			Psychometric properties and processes			
34			Sensible heat and latent heat loads	Regular		
35			Problems on psychrometry.		OHP,BB	
36			Ventilation and ventilation standards	Regular	OHP,BB	
37			Infiltration air ,loads	Regular	OHP,BB	
38			RSHF,GSHF	Regular	OHP,BB	
39			ESHF,ADP	Regular	OHP,BB	
40			Problems	Regular	OHP,BB	
			Review of the unit	Regular	OHP,BB	
			tutorial	Regular		
41		7	Human comfort, various factors	Regular	OHP,BB	
42			Concept of effective temperature, factors	Regular	OHP,BB	
43			Comfort chart	Regular	OHP,BB	
44			Comfort air conditioning	Regular	OHP,BB	
45			Industrial air conditioning		OHP,BB	
46			Air conditioning load calculations	Regular	OHP,BB	
47			problems	Regular		
48	**V**	5	Introduction to air conditioning systems	Regular	OHP,BB	

49			Classification of equipments	Regular	OHP,BB	
50			Heating , humidification equipments	Regular	BB	
51			Cooling and dehumidification equipments	Regular	BB	
52			Filters grills registers	Regular	BB	

1.7. Less ion Plan:-

Sl. No	Unit No.	Total No. of Periods	Date	Topic to be covered in One Lecture	Reg/ Additional	Teaching aids used LCD/OHP /BB	Rem
1	**I**	01	07/12/15	Introduction to Refrigeration	Regular	OHP,BB	
2		01	09/12/15	Necessity and applications	Regular	OHP,BB	
3		01	10/12/15	Unit of refrigeration and C.O.P.	Regular	OHP,BB	
4		01	11/12/15	Mechanical Refrigeration–Types of Ideal cycles of refrigeration.	Regular	OHP,BB	
5		01	14/12/15	Air Refrigeration: Bell Coleman cycle and Brayton Cycle	Regular	BB	
6		01	16/12/15	Open and Dense air systems		BB	
7		01	17/12/15	Air refrigeration system problems	Regular	OHP,BB	
			18/12/15	Refrigeration needs of Air crafts.	Regular	BB	
8		01	21/12/15	tutorial	Regular	OHP,BB	
9		01	23/12/15	Vapour compression refrigeration – working principle and essential components of the plant	Regular	BB	
10		01	28/12/15	Simple Vapour compression réfrigération cycle – COP	Regular	BB	
11		01	30/12/15	Representation of cycle on T-S and p-h charts	Additional	OHP,BB	
12		01	4/1/16	Effect of sub cooling and super heating – cycle analysis – Actual cycle		BB	
13		01	6/1/16	Influence of various parameters on		BB	

				system performance			
14			7/1/16	Use of p-h charts – numerical Problems.			
15		01	8/1/16	Numerical problems	Regular	BB	
		01	11/1/16	Numerical problems	Regular	OHP,BB	
16	**II**	01	13/1/16	Classification–Working Principles of compressors – Types	Regular	OHP,BB	
17		01	14/1/16	Classification–Working Principles of condensers – Types	Regular	BB	
18		01	15/1/16	Classification–Working Principles of evaporators – Types	Regular	BB	
19		01	18/1/16	Classification–Working Principles of Evaporator devices – Types.	Regular	OHP,BB	
20		01	20/1/16	Review of the unit	Regular	OHP,BB	
21		01	21/1/16	tutorial	Regular	OHP,BB	
22	**III**	01	22/1/16	Vapor Absorption System – Calculation of max COP	Regular	BB	
23		01	25/1/16	Description and working of NH3 – water system	Additional	OHP,BB	
24		01	27/1/16	Li Br –water (Two shell & Four shell) System.	Regular	OHP,BB	
25		01	28/1/16	Principle of operation Three Fluid absorption system, salient features.	Regular	OHP,BB	
26		01	29/1/16	Problems	Regular	BB	
27		01	1/2/16	Review of the unit	Regular	OHP,BB	
28			3/2/16	tutorial	Regular	OHP,BB	
29			4/2/16	Steam Jet Refrigeration System – Working Principle	Regular	BB	

30			5/2/16	SJR Basic Components	Regular	OHP,BB	
31		01	8/2/16	SJR problems	Regular	OHP,BB	
32		01	10/2/16	Principle and operation of Thermoelectric refrigerator	Regular	BB	
33		01	11/2/16	Principle and operation of Vortex tube or Hilsch tube	Regular	OHPBB	
34		01	12/2/16	Tutorial class	Regular	OHP,BB	
35	**IV**	01	15/2/16	Introduction to air conditioning and Psychometric	Regular	OHP,BB	
36		01	17/2/16	Psychometric properties and processes	Regular	BB	
37		01	18/2/16	Sensible heat and latent heat loads	Regular	OHP,BB	
38		01	19/2/16	Problems on psychrometry.	Regular	OHP,BB	
39		01	22/2/16	Ventilation and ventilation standards	Regular	OHP,BB	
40		01	24/2/16	Infiltration air ,loads	Regular	BB	
41		01	25/2/16	RSHF,GSHF	Additional	BB	
42		01	29/2/16	ESHF,ADP	Regular	OHP,BB	
43		01	2/3/16	Problems	Regular	OHP,BB	
44		01	3/3/16	Review of the unit	Regular	BB	
45		01	4/3/16	tutorial	Regular	OHP,BB	
46		01	7/3/16	Human comfort, various factors	Regular	OHP,BB	
47		01	9/3/16	Concept of effective temperature, factors	Regular	OHP,BB	
48		01	10/3/16	Comfort chart	Regular	OHP,BB	
49		01	11/3/16	Comfort air conditioning	Regular	BB	
50		01	14/3/16	Industrial air conditioning		BB	
51		01	16/3/16	Air conditioning load calculations	Regular	OHP,BB	
52		01	17/3/16	problems	Regular	BB	

53	**V**	01	18/3/16	Introduction to air conditioning systems	Additional	OHP,BB	
54		01	21/3/16	Classification of equipments	Regular	OHP,BB	
55		01	1/4/16	Heating , humidification equipments	Regular	OHP,BB	
56		01	4/4/16	Cooling and dehumidification equipments	Regular	BB	
57		01	6/4/16	Filters grills registers	Regular	OHP,BB	
58		01	7/4/16		Regular	OHP,BB	
59							

1.7.1. Subject Contents

1.7. 1. Synopsis page for each period (62 pages)

1.7.2. Detailed Lecture notes containing:

1. Ppts
2. Ohp slides
3. Subjective type questions (approximately 5 to 8 in no)
4. Objective type questions (approximately 20 to 30 in no)
5. Any simulation.

1.7.2 Course Review (By the concerned Faculty):

(i)Aims (ii) Sample check (iii) End of the course report by the concerned faculty

GUIDELINES:

Distribution of periods:

No. of classes required to cover JNTU syllabus	:	54
No. of classes required to cover Additional topics	:	Nil
No. of classes required to cover Assignment tests (for every 2 units 1 test)	:	4
No. of classes required to cover tutorials	:	2
No. of classes required to cover Mid tests	:	2
No of classes required to solve University Question papers	:	3

Total periods		65

GEETHANJALI COLLEGE OF ENGINEERING & TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. DIST. 501 301

DEPARTMENT OF MECHANICAL ENGINEERING

Ref: TLE/2013/01.07.2013/SADM /CT -1004

PROGRAMME : B.TECH. (MECHANICAL ENGINEERING)

SEMESTER: III Year II- SEMESTER / Bsec

1.8 TIME TABLES

DAY / HOURS	(9.30 AM - 10.20 AM)	(10.20 AM - 11.10 AM)	(11.10 AM - 12.00 PM	(12.00 PM - 12.50 PM)	(12.50 PM - 1.30 PM)	(1.30 PM - 2.20 PM)	(2.20 PM - 3.10 PM)	(3.10 PM - 4.00 PM)
MON							RAC(B)	
TUE								
WED		RAC(B)						
THUR	RAC(B)							
FRI			RAC(B)					
SAT								

GEETHANJALI COLLEGE OF ENGINEERING AND TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. Dist.-501301

DEPARTMENT OF MECHANICAL ENGINEERING

Year/Sem/Sec: III B.Tech II-Sem,Sec: B

ROOM NO :LH 39
CLASS INCHARGE: sreekanth.u

Time	9.30-10.20	10.20-11.10	11.10-12.00	12.00-12.50	12.50-1.30	1.30-2.20	2.20-3.10	3.10-4.00
Period	**1**	**2**	**3**	**4**	**LUNCH**	**5**	**6**	**7**
Monday	**AE**	**ACS /HT LAB**				**HT**	**R&AC**	**HVPE***
Tuesday	**DMM II**	**ACS /HT LAB**				**HVPE**	**FEM**	**R&AC***
Wednesday	**AE**	**R&AC**	**FEM**	**HVPE**		**DMM II**	**DMM II***	**HT**
Thursday	**R&AC**	**HVPE**	**HT**	**HT**		**DMM II**	**AE***	**FEM**
Friday	**FEM**	**DMM II**	**R&AC**	**AE**		**HT***	**HVPE**	**MENTORING**
Saturday	**FEM***	**AE**	**CRT**			**CRT**		**LIBRARY**

S. No.	Subject	Name of the Faculty	Subject Code	Periods/Week
1	Refrigeration & aircondtioning	U.Sreekanth	55015	4+1*+1# Periods
2	Design of machine members	M.Ravindra ghandi	55016	4+1*+1# Periods
3	Heat transfer	Basker	55017	4+1*+1# Periods
4	Automobile engineering	p.srilatha	55018	4+1*+1# Periods
5	Finite element method	V.Rajasekhar	55019	4+1*+1# Periods
6	Industrial management		55020	4+1*+1# Periods
7	HT lab	Basker	55604	3 Periods
8	Aces Lab		55605	3 Periods
9	Mentoring			2 Periods
10	CACHE			4 Periods
11	Library			1 Periods
12	Sports			1 Periods

Time Table Coordinator **HOD** **PRINCIPAL**

GEETHANJALI COLLEGE OF ENGINEERING & TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. DIST. 501 301

DEPARTMENT OF MECHANICAL ENGINEERING

INDIVIDUAL TIME TABLE

Name of the faculty: **U.Sreekanth** Load = 20 **w.e.f**.:

	9.30-10.20	10.20-11.10	11.10-12.00	12.00-12.50	12.50-1.30	1.30-2.20	2.20-3.10	3.10-4.00
MON	**FM/HM lab**				LUNCH		R&AC(B)	
TUE	ECE-D(ED)							
WED		R&AC(B)				**FM/HM lab**		
THU	R&AC(B)					ECE-D(ED)		
FRI			R&AC(B)			ECE-C(WORK SHOP)		
SAT								

EVALUATION SCHEME:

PARTICULAR	WEIGHTAGE	MARKS
End Examinations	75%	75
Three Sessionals	20%	20
Assignment	5%	5
TEACHER'S ASSESSMENT(TA)*	WEIGHTAGE	MARKS

*TA will be based on the Assignments given, Unit test Performances and Attendance in the class for a particular student.

GEETHANJALI COLLEGE OF ENGINEERING & TECHNOLOGY

CHEERYAL (V), KEESARA (M), R.R. DIST. 501 301

DEPARTMENT OF MECHANICAL ENGINEERING

III YEAR IISEMESTER STUDENT LIST/ BSec

S.No	Roll No	Student Name
1	13R11A0361	A RAHUL
2	13R11A0362	AMMULA PRANAY KUMAR
3	13R11A0363	ANKARLA BHARATH
4	13R11A0364	ANNAPAREDDY SATYANARAYANA REDDY
5	13R11A0365	BAIRU RAVIKIRAN REDDY
6	13R11A0366	BANKA JAGADEESH
7	13R11A0367	BEERA KISHORE
8	13R11A0368	BHAVIRI DEVISRIKAR
9	13R11A0369	BODDULA RAM PRASAD
10	13R11A0370	BOMMOJU SATISH KUMAR
11	13R11A0371	MALEGIRI BALRAJ
12	13R11A0372	CHERUKURI SAI SUDEEP
13	13R11A0373	DARMANA RAJESH KUMAR
14	13R11A0374	DESAI VENKATA ANUP REDDY
15	13R11A0375	DHIDIGE SHARATH KUMAR

16	13R11A0376	DOODALA SAIKIRAN
17	13R11A0377	G BIKSHAPATHI
18	13R11A0378	G ELLENDER
19	13R11A0379	GUGULOTH BALAJI
20	13R11A0380	JANAMPET AMIT KUMAR
21	13R11A0381	K BHEEMA SHANKER
22	13R11A0382	KATIKA UPENDER
23	13R11A0383	KHANDAVILLI ANIRUDH
24	13R11A0384	KOMPALLY SUGANDH REDDY
25	13R11A0385	LAKAVATH SADGUNAPRASAD
26	13R11A0386	M SAI SRAVAN
27	13R11A0387	NAGUBOYINA PRAVEEN
28	13R11A0388	NAMPALLY VINOD KUMAR
29	13R11A0389	PALTHIYA VENKATESH
30	13R11A0390	PEDDOLLA PRASHANTH
31	13R11A0391	POLISETTY SURYA BHASKAR
32	13R11A0392	POSHALA SAIRAM
33	13R11A0393	POTHURAJU BHANU KIRAN
34	13R11A0394	P KARTHIK VARMA
35	13R11A0395	PULIGILLA SAI PRATAP
36	13R11A0397	RAGULU VENKATESH
37	13R11A0398	RAHUL RAVIKANTH
38	13R11A0399	TENALI PRADEEP RAJ
39	13R11A03A0	THADEM KRANTHI
40	13R11A03A1	THIPPARTHI SUMANTH
41	13R11A03A2	TUMMETI BALA KRISHNA
42	13R11A03A3	TUNGA VENUGOPAL
43	13R11A03A4	U YASHWANTH KUMAR
44	13R11A03A5	VELDANDA PUSHYA MITHRA
45	13R11A03A6	VENNAPU ROHITH KUMAR
46	13R11A03A7	YANNAM ABHISHEK
47	13R11A03B0	PANIKALA VENKATARAMANA
48	14R15A0301	G KARTHIK KUMAR

49	14R15A0302	MANDAVA POORNA SAI KUMAR
50	14R15A0303	BHUKYA PRABU VINOD
51	14R15A0304	MOHAMMED SHAKEER

1.12 PREVIOUS QUESTION PAPER QUESTIONS & OBJECTIVE BITS

UNIT-1

INTRODUCTION TO REFRIGERATION

Learning Objectives:

At the end of unit – 1, Students will know

- the types of refrigeration systems
- the necessity and applications of refrigeration
- Unit of refrigeration and C.O.P
- the Bell Coleman cycle and Brayton Cycle, Open and Dense air systems
- the Refrigeration needs of Air crafts

DESCRIPTIVE QUESTIONS (UNIT-I)

1) What is the necessity and application of refrigeration systems
2) Define Unit of refrigeration and C.O.P.
3) Explain the principle of working of Bell Coleman cycle
4) Describe the Open and Dense air refrigeration systems
5) Write the Refrigeration needs of Air crafts.

6) Explain the term “Ton of refrigeration”.

Problems

1) A heat quantity is absorbed at 300k and rejecting it at 330k in a Carnot refrigeration Cycle. Calculate COP of the cycle, work required per second in KJ if the cycle is absorbing 1500KJ/Min at 300K.

2) 1.5KW per ton refrigeration is required in a Carnot refrigerator to maintain a temperature of. Calculate the COP of refrigerator, temperature at which heat is 50°C. Calculate the COP of refrigerator, temperature at which heat is rejected, amount of heat rejected and COP if the cycle is used as a heat pump.

3) In refrigerating plant, water at 25 ^{o}C is producing ice at -4 ^{o}C at 4 tones per day. The temperature range in the compressor is 25 ^{o}C and -5 ^{o}C. Calculate the power required to drive the compressor. Latent heat of ice is 340 KJ/kg, specific heat of ice is 2.2KJ/kgK.

4) When the temperature of the brine is -10°C, ice is manufactured at 0oC from water at 10 ^{o}C. Find the kg of ice formed per 1 KWh using the Reversible Carnot cycle. Latent heat of ice is 335KJ/Kg.

(a) A cold storage is to be maintained at -5 ^{o}C while the surroundings are at 35 ^{o}C . The heat leakage from the surroundings into the cold storage is estimated to be 29KW. The actual C.O.P. of the refrigeration plant is one third of an ideal plant working between the same temperatures. Find the power required to drive the plant?

(b) Refrigerator working on Bell-coleman cycle operates between pressure limits of 1.05 bar and 8.5 bar. Air is drawn from the cold chamber at 10 ^{o}C , compressed and, then it is cooled to 30 ^{o}C before entering the expansion cylinder. The expansion and compression follows the law PV1.3 = Constant. Determine the

5) Theoretical C.O.P of the system?

(a) A cold storage is to be maintained at -5 ^{o}C while the surroundings are at 35 ^{o}C . The heat leakage from the surroundings into the cold storage is estimated to be 29KW. The actual C.O.P. of the refrigeration plant is one third of an ideal plant working between the same temperatures. Find the power required to drive the plant?

(b) Refrigerator working on Bell-Coleman cycle operates between pressure limits of1.05 bar and 8.5 bar. Air is drawn from the cold chamber at 10 ^{o}C , compressed and, then it is cooled to 30 ^{o}C before entering the expansion cylinder. The expansion and compression follows the law

6) $PV^{1.3}$ = Constant. Determine the theoretical C.O.P of the system?

7) In an aero-plane simple air refrigeration is used. The main compressor delivers the air at 5 bar and 200 ^{o}C.The bled air taken from compressor is passed through a heat exchanger, cooled with the help of ram air so that the temperature of air leaving the heat exchanger is 45 ^{o}C and the pressure is 4.5 bar. The cooling turbine drives the exhaust fan which is used to force the ram air through the heat exchanger. The air leaving the heat exchanger passes through the cooling turbine and then supplied to cabin at 1 bar. The pressure loss between the cooling turbine and cabin is 0.2 bar. If the rate of flow of air through the cooling turbine is 20kg/min, determine the following:
   (a) The temperature of the air leaving the expander,
   (b) the power delivered to the ram air which is passed through the heat exchanger and
   (c) The refrigeration load in tones when the temperature of the air leaving the cabin is limited to 25°C .

8) Assume that the isentropic efficiency of the cooling turbine is 75% and no loss of heat from air between the cooling turbine and cabin. Take γ = 1.4 and c_p=1kJ/kg.K.

9) An Air refrigerator of 10 ton capacity operates on a Bell-Coleman cycle. The temperature of air entering the compressor is 10°C and that of entering the expander is 32°C. The quantity of air circulated is 50kg/min. The compression and expansion follow the law $PV^{1.3}$= constant. Find COP of the system and the power required to run the system.

Objective questions

1. Reversed carnot cycle comprises

   (a) two isentropic processes and two adiabatic processes

   (b) two isentropic processes and two isothermal processes

   (c) two isentropic processes and two isobaric processes

   (d) two isentropic processes and two isochoric processes [ ]

2. Two Carnot Refrigerators are employed, one for ice making and other for comfort cooling

   (a) The COP of the refrigerator for ice making is higher than that for other

(b) The COP of the refrigerator for ice making is same as that for the other

(c) The COP of the refrigerator for ice making is lower than that for other

(d) The COP of Carnot refrigerator will depend on refrigerant used [ ]

3. A reversed Carnot cycle has a COP of 4. The ratio of higher temperature to lower temperature

will be

(a) 1.25 (b) 1.5 (c) 2 (d) 2.5 [ ]

4. Carnot refrigerator absorbs heat at -13° C and requires 1 kW for each 6.5 kW of heat absorbed, the COP and temperature of heat rejections respectively

(a) COP = 6.5, t = 27° C (b) COP = 7.5, t = 27° C

(c) COP = 6.5, t = 30° C (d) COP = 7.5, t = 37° C [ ]

5. The dense air refrigeration system as compared to open air refrigeration system for same range

of temperatures using Bell- Colemann cycle requires.

(a) Same power/Ton of Refrigeration
(b) Lower power/Ton of Refrigeration
(c) Higher power/Ton of Refrigeration
(d) Unpredictable Results. [ ]

6. For very high speed planes cruising at Mach number 2.5 and above, the air craft refrigeration

system recommended is

(a) Simple evaporative type (b) Boot-strap type

(c) Regenerative type (d) Boot strap evaporative type [ ]

7. The air craft system giving Lowest Dry Air Rated Turbine discharge temperature at supersonic cruising speeds of the plane, is

(a) Reduced ambient system of Refrigeration (b) Boot-strap system of Refrigeration

(c) Regenerative system of Refrigeration (d) Boot strap evaporative system of Refrigeration

[ ]

8. There are two cooling turbines in

(a) Reduced ambient system of Refrigeration (b) Boot-strap system of Refrigeration

(c) Regenerative system of Refrigeration(d) Boot strap evaporative system of Refrigeration

[ ]

9. There are two stages of compression of air in

(a) Reduced ambient system of Refrigeration (b) Boot-strap system of Refrigeration

(c) Regenerative system of Refrigeration(d) Simple evaporative system of Refrigeration

[ ]

10. The amount of heat absorbed by the system at low temperature is

(a) COP

(b) refrigerating effect

(c) work done on the system

(d) refrigeration efficiency [ ]

11. No refrigerator using reversed Carnot cycle has been constructed because

(a) it is less efficient

(b) it is uneconomical

(c) isentropic portions of cycle require low speeds where as isothermal portions require high speeds

(d) isentropic portions of cycle require high speeds where as isothermal portions require low

speeds [ ]

12. A refrigeration cycle is usually a

(a) open cycle (b) closed cycle (c) mixed cycle (d) Hybrid cycle [ ]

13. Co-efficient of performance of a Reversed Carnot cycle refrigerator working between higher [ ]

temperature T2 and lower temperature T1

(a) will increase with increase in T1 keeping T2 fixed
(b) will decrease with increase in T1 keeping T2 fixed
(c) will first increase with increase in T1 and then decrease with increase T1 keeping T2 fixed
(d) None of the above [ ]

14.Bell-Colemann cycle comprises

(a) two isentropic processes and two adiabatic processes

(b) two isentropic processes and two isothermal processes

(c) two isentropic processes and two isobaric processes

(d) two isentropic processes and two isochoric processes [ ]

15.Two Carnot Refrigerators are employed, one for ice making and other for comfort cooling [ ]

(a) The COP of the refrigerator for ice making is higher than that for other

(b) The COP of the refrigerator for ice making is same as that for the other

(c) The COP of the refrigerator for ice making is lower than that for other

(d) The COP of Carnot refrigerator will depend on refrigerant used

16. The COP of Carnot Refrigerator is 3 and it produces 1 TR. The work that will be done is equal to

(a) 70 kJ/min (b) 100 kJ/min (c) 200 kJ/min (d) 210 kJ/min [ ]

17. Carnot refrigerator absorbs heat at -13° C and requires 1 kW for each 6.5 kW of heat absorbed, the COP and temperature of heat rejections respectively

(a) COP = 6.5, t = 27° C (b) COP = 7.5, t = 27° C

(c) COP = 6.5, t = 30° C (d) COP = 7.5, t = 37° C [ ]

18. In Bell – Colemann refrigerator for the same temperature range

(a) COP of dense air system is equal to COP of open air system

(b) COP of dense air system is lower than COP of open air system

(c) COP of dense air system is higher than COP of open air system

(d) COP of dense air system may be higher or lower than COP of open air system depending upon pressure ratio. [ ]

19. For very high speed planes cruising at Mach number 2.5 and above, the air craft refrigeration system recommended is

(a) Simple evaporative type (b) Boot-strap type

(c) Regenerative type (d) Boot strap evaporative type [ ]

20.The air craft system giving Lowest Dry Air Rated Turbine discharge temperature at supersonic cruising speeds of the plane, is [ ]

(a) Reduced ambient system of Refrigeration

(b) Boot-strap system of Refrigeration

(c) Regenerative system of Refrigeration

(d) Boot strap evaporative system of Refrigeration

21. There are two cooling turbines in [ ]

(a) Reduced ambient system of Refrigeration

(b) Boot-strap system of Refrigeration

(c) Regenerative system of Refrigeration

(d) Boot strap evaporative system of Refrigeration

22. There are two stages of compression of air in [ ]

(a) Reduced ambient system of Refrigeration

(b) Boot-strap system of Refrigeration

(c) Regenerative system of Refrigeration

(d) Simple evaporative system of Refrigeration

23. A Bell-Colemann cycle is

(a) reversed Carnot Cycle

(b) reversed Joule Cycle

(c) reversed Rankine cycle

(d) None of the above [ ]

24. In a refrigeration cycle the heat is rejected by refrigerant at

(a) expansion valve

(b) compressor

(c) condenser

(d) all the above [ ]

25. A refrigeration cycle is usually a

(a) open cycle (b) closed cycle (c) mixed cycle (d) Hybrid cycle [ ]

26. A reversible refrigerator working between two fixed temperatures

(a) has the same COP whatever the working substance

(b) has its COP increased for working substance with high enthalpy of evaporation

(c) has its COP increased for working substance with higher specific heats

(d) none of the above [ ]

FILL UP THE BLANKS WITH SUITABLE ANSWERS.

27. The co- efficient of performance of a refrigerator working on reversed Carnot cycle with T1 being lower temperature and T2 being higher temperature is_____.

28. COP of Bell-Colemann refrigerator for pressure ratio(rp) is expressed as _____.

29. The ratio of Net refrigerating effect to work supplied is known as _____.

30. The heat removal capacity of a one ton refrigerator in SI units is _____.

31. The simultaneous control of temperature, humidity, purity and motion of air is known as _____.

32. The solidified form of carbon dioxide is known as _____.

33. In a mechanical refrigeration system the lowest temperature of refrigerant occurs between compressor and heat exchanger. State True/False _____.

34. The relation between $COP_{Refrigerator}$ and $COP_{Heat\ pump}$ for the same range of temperature operation is _____.

35. COP of Bell-Coleman refrigerator for pressure ratio(rp) is expressed as _____.

36. The ratio of Net refrigerating effect to work supplied is known as _____.

37. The heat removal capacity of a one ton refrigerator in SI units is _____.

38. The simultaneous control of temperature, humidity, purity and motion of air is known as _____.

39. The solidified form of carbon dioxide is known as _____.

40. Air for air-conditioning of aircraft cabin is obtained by bleeding from air compressor.

State True/False _____.

Key

1.b 2.c 3.a 4.a 5.b 6.d 7.d 8.a 9.b 10.b 11.d 12.b 13.a 14. c 15. c 16. a 17. a 18. c

19.d 20. d 21.a 22. b 23. b 24. c 25. b 26. a

27.$T_1/(T_2-T_1)$

28.$1/(r_p)^{\gamma-1/\gamma}-1$

29.Coefficient of Performance

30.210 kJ/min

31.Air- Conditioning

32.Dry ice

33.False

34. $(C.O.P)_{Heat\ Pump} = (C.O.P)_{Refrigerator} + 1$

35. $1/(r_p)^{\gamma-1/\gamma} - 1$

36. Coefficient of Performance

37. 210 kJ/min

38. Air- Conditioning

39. Dry ice

40. True

VAPOUR COMPRESSION REFRIGERATION SYSTEM

Learning Objectives:

At the end of Unit – 2 Students will know

- the working principle of simple Vapour compression refrigeration system
- the essential components of the refrigeration plant
- Representation of refrigeration cycle on T-S and p-h charts
- the effects of sub cooling and super heating on COP
- the influence of various parameters on refrigeration system performance

DESCRIPTIVE QUESTIONS(UNIT-II)

1) explain the working principle of simple Vapour compression refrigeration system
2) Describe the essential components of the refrigeration plant
3) Represent refrigeration cycle on T-S and p-h charts for different conditions of refrigerant at the entry into the compressor
4) Write the effects of sub cooling and super heating

5) Explain the influence of various parameters on refrigeration system performance

Problems

1) A vapour compression refrigerator uses methyl chloride (R-40) and operates between pressure limits of 177.4 kPa . At entry to the compressor, the methyl chloride is dry saturated and after compression has a temperature of 102 ^{o}C .The compressor has a bore and stroke of 75mm and runs at 8 rev/s with a volumetric efficiency of 80%. The temperature of the liquid refrigerant as it leaves the condenser is 35 ^{o}C and its specific heat capacity is 1.624 kJ/kg. K. The specific heat capacity of the superheated vapour may be assumed to be constant. Determine:
(a) refrigerator C O P

(b) Mass flow rate of refrigerant and

(c) Cooling water required by the condenser if its temperature rise is limited to

12 ^{o}C.Specific heat capacity of water = 4.187 kJ/kg.K.

The relevant properties of methyl chloride are as follows:

Sat.temp. ^{o}C	Pressure kPa	Specific Volume m3/kg		Specific enthalpy kJ/kg		Specific entropy kJ/kg.K	
		Liquid	Vapour	Liquid	Vapour	Liquid	Vapour
-10	177.4	0.00102	0.233	45.38	460.76	0.183	1.762
45	967.5	0.00115	0.046	132.98	483.6	0.485	1.587

2) A simple saturation cycle using F12 is designed for taking a load of 10 tons. The refrigerator and ambient temperatures are 0°C and 30°C respectively. A minimum temperature difference of 5 ^{o}C is required in evaporator and condenser for heat transfer.

Find: (a) mass flow rate through the system

(b) Power required in kw.

(c) Cylinder dimensions assuming L/D = 1.2 for single cylinder, single acting

compressor if it runs at 300 r.p.m. with volumetric efficiency = 0.9.

3) A 5 ton Freon-12 refrigeration plant has saturated section temperature of -5 ^{o}C . The condensation takes place at 32 ^{o}C and there is no under cooling of refrigerant liquid. Assuming isentropic compression, find,
   i. C.O.P. of the plant.
   ii. Mass flow rate of refrigerant.
   iii. Power required to run the compressor in kw.
   Take L_P (Super heated vapour) = 0.615 kj/kg-k.

4) A food storage requires a refrigeration system of 12 tons capacity at an evaporator temperature of -10 ^{o}C and condenser temperature 25 ^{o}C . The refrigerant NH_3 is sub-cooled by 5 ^{o}C before passing through throttle valve. The vapour leaving the evaporator coil is 0.97 dry. Find the C.O.P. and power required to run the plant. Neglect all losses.

5) A vapor compression refrigerator plant uses methyl chloride as refrigerant and operates between pressure limits of 119Kpa and 567Kpa. The refrigerant vapour with dryness fraction of 0.96 is charged into the compressor and at the end of the isentropic compression it has a temperature of 328K. Saturated liquid enters the throttle valve. If the refrigerant flow is 100 Kg/h.

   Determine i) theoretical COP ii) Power required to run the machine.

   Properties of MethylChloride

Pressure Kpa	Temp K	Enthalpy kJ/kg		Entropy kJ/kg-k	
		Liquid	Vapour	Liquid	Vapour
119	253	30.1	455.2	0.124	1.803
567	298	100.5	476.8	0.379	1.642

Objective questions

1. Heat is absorbed by the refrigerant, during vapour compression refrigeration cycle in

   (a) Compressor (b) Condenser (c) Evaporator

   (d) Throttle valve [ ]

2. In a simple saturated vapour compression cycle, the refrigerant is in

   superheated condition

(a) before entering compressor (b) before entering condenser

(c) before entering throttle valve (d) before entering evaporator [ ]

3. Sub-cooling is a process of cooling the refrigerant in vapour compression refrigeration system

(a) after compression (b) before compression (c) before Throttling
(d) none of the above [ ]

4. The order in which main components of vapour compression refrigeration system are used is

(a) compressor-evaporator-condenser-throttle valve

(b) compressor-condenser-evaporator-throttle valve

(c) compressor-throttle valve- evaporator-condenser

(d) compressor-condenser- throttle valve- evaporator [ ]

5. The oil separator is incorporated in vapour compression refrigeration system

(a) between evaporator and compressor

(b) between compressor and condenser

(c) between condenser and Throttle valve

(d) between throttle valve and evaporator [ ]

6. In vapour compression refrigeration cycle the following data is available

Heat rejected in condenser = 65 KW

Work done in compressor = 10 kw, then COP(refrigerator) is

(a) 4.5 (b) 5.5 (c) 6.5 (d) not possible to find with the given data [ ]

7. Following results are tabulated for vapour compression refrigeration cycle.

Enthalpy at suction = 190 kJ/kg

Enthalpy at discharge from compressor = 210 kJ/kg

Enthalpy at exit from condenser = 80 kJ/kg

COP of cycle would be

(a)3.5 (b) 4.5 (c) 5.5 (d) 6.5 [ ]

8. For simple saturated vapour compression refrigeration cycle operating between 5°C and 40°C, and the refrigerants being R-11, R-12, R-717 and R-22, the evaporator pressure is lowest for

(a) R-11 (b) R-12 (c) R-717 (d) R-22 [ ]

9. For simple saturated vapour compression refrigeration cycle operating between 5°C and 40°C, and the refrigerants being R-11, R-12, R-717 and R-22, the compressor displacement per min per ton of refrigeration is highest for

(a) R-11 (b) R-12 (c) R-717 (d) R-22 [ ]

10. With reciprocating compressor in vapour compression refrigeration system, wet compression is not desirable because

(a) liquid trapped up in the head of cylinder may damage the compressor valves
(b) COP of the cycle decreases
(c) volumetric efficiency of compressor decreases
(d) mass flow rate per ton of refrigerant increases [ ]

11. An ideal refrigerant should have

(a) low latent heat of vaporization

(b) high critical temperature

(c) high boiling point

(d) high specific volume of vapour [ ]

12. The refrigerant leaving throttle valve is

(a) saturated liquid

(b) saturated vapour

(c) superheated vapour

(d) fraction as saturated vapour and remainder as liquid [ ]

13. Freon group of refrigerants

(a) toxic (b) inflammable (c) non-toxic and non-inflammable

(d) highly toxic and inflammable [ ]

14. The leaks of refrigerant from a cycle may be detected by

(a) halide torch test

(b) sulphur candle test

(c) soap and water test

(d) any of the above

(e) none of the above [ ]

15. During compression in a vapour compression cycle the refrigerant is super heated

(a) work done is increased
(b) C.O.P is increased
(c) Work done is reduced
(d) Refrigerating effect is reduced [ ]
(e)

16. Heat is rejected by the refrigerant, during vapour compression refrigeration cycle in

(a) Compressor (b) Condenser (c) Evaporator

(d) Throttle valve [ ]

17. In a simple saturated vapour compression cycle, the refrigerant is in superheated condition

(a) before entering compressor (b) before entering condenser

(c) before entering throttle valve (d) before entering evaporator [ ]

18. Sub-cooling is a process of cooling the refrigerant in vapour compression refrigeration system

(a)after compression (b) before compression (c) before Throttling

(d) none of the above [ ]

19. Wet compression vapour compression refrigeration cycle means

(a) Vapour compression takes place in wet region

(b) Vapour compression in dry region, but evaporation in wet region

(c) vapour compression in wet region, but leaves in superheated region

(d) None of the above [ ]

20. The oil separator is incorporated in vapour compression refrigeration system

(a) between evaporator and compressor

(b) between compressor and condenser

(c) between condenser and Throttle valve

(d) between throttle valve and evaporator [ ]

21. In vapour compression refrigeration cycle the following data is available

Heat rejected in condenser = 65 KW

Work done in compressor = 10 kw, then COP(refrigerator) is

(a) 4.5 (b) 5.5 (c) 6.5 (d) not possible to find with the given data [ ]

22. Following results are tabulated for vapour compression refrigeration cycle.

Enthalpy at suction = 190 kJ/kg

Enthalpy at discharge from compressor = 210 kJ/kg

Enthalpy at exit from condenser = 80 kJ/kg

COP of cycle would be

(a)3.5 (b) 4.5 (c) 5.5 (d) 6.5 [ ]

23. For simple saturated vapour compression refrigeration cycle operating between 5°C and 40°C, and the refrigerants being R-11, R-12, R-717 and R-22, the

evaporator pressure is highest for

(a) R-11 (b) R-12 (c) R-717 (d) R-22 [ ]

24. For simple saturated vapour compression refrigeration cycle operating between

5°C and 40°C, and the refrigerants being R-11, R-12, R-717 and R-22, the

compressor displacement per min per ton of refrigeration is highest for

(a) R-11 (b) R-12 (c) R-717 (d) R-22 [ ]

25. With reciprocating compressor in vapour compression refrigeration system, wet

compression is not desirable because

(a) liquid trapped up in the head of cylinder may damage the compressor valves

(b) COP of the cycle decreases
(c) volumetric efficiency of compressor decreases
(d) mass flow rate per ton of refrigerant increases [ ]

26. An ideal refrigerant should have

(a) low latent heat of vaporization

(b) lower critical temperature

(c) lower boiling point

(d) high specific volume of vapour [ ]

27. The refrigerant leaving throttle valve is

(a) saturated liquid

(b) saturated vapour

(c) superheated vapour

(d) fraction as saturated vapour and remainder as liquid [ ]

28. Freon group of refrigerants

(a) toxic (b) inflammable (c) non-toxic and non-inflammable

(d) highly toxic and inflammable [ ]

29. The leaks of refrigerant from a cycle may be detected by

(a) halide torch test

(b) sulphur candle test

(c) soap and water test

(d) any of the above

(e) none of the above [ ]

30. During compression in a vapour compression cycle the refrigerant is super heated

(a) C.O.P is reduced
(b) C.O.P is increased
(c) Work done is reduced
(d) Refrigerating effect is reduced [ ]

Fill in the Blanks

31. The widely used refrigerant in domestic refrigerator ,is_____

32.Out of all the refrigeration systems , the _____ system is the most important system from the stand point of commercial and domestic utility.

33. The function of a _____ is to remove the vapour from the evaporator and to raise its saturation temperature and pressure to a point such that it(vapour) can be condensed with normally available condensing medium.

34.If the vapour is not superheated after compression, the operation is called _____ compression.

35.When the suction pressure decreases the refrigeration effect and COP are _____

36._____ results in increase of COP provided that no further energy has to be spent to obtain the extra cold coolant required.

37. Vertical line on p-h diagram represents _____ process.

38. Low boiling point refrigerants are preferably suited for _____Compressors.

39. The refrigerant R-717 stands for _____.

40. In a domestic vapour compression refrigerator the refrigerant used is _____.

41. Refrigerant number of CO_2 _____.

Key

1. c 2. b 3. c 4. d 5. b 6. b 7. c 8. a 9. a 10. a 11. b 12. d 13. c 14. d 15. a

16. b 17. b 18. c 19. a 20. b 21. b 22. c 23. d 24. a 25. a 26. c 27. d 28. c 29. d 30. a

31.freon-12

32.vapour compression

33.compressor

34.wet

35.reduced

36.subcooling

37. Throttling

38. reciprocating

39. Ammonia

40. R-12

41. R-744

UNIT – 3

PRINCIPLES OF evaporators, condensers, compressor, expansion devices

Learning Objectives:

- the working principle of expansion devices and its classification

- the working principle of evaporators and its classification
- Types of refrigerants
- Understand the required properties of refrigerants
- The causes of Ozone Depletion and global Warming.

DESCRIPTIVE QUESTIONS (UNIT-III)

1) Write and explain the important components of refrigeration system
2) Write the working principle of various types of evaporators,
3) Write the working principle of various types of and expansion devices
4) Write the types of refrigerants
5) What are the required properties of refrigerants
6) Describe the causes of Ozone Depletion and global Warming.

Objective Questions

1.. Heat is absorbed by a refrigerant, during a refrigeration cycle in a [ ]

a) condenser b)evaporator c)compressor d)throttle valve

2. Which of the following statements are TRUE? [ ]

a) In conventional refrigerators, the evaporators are kept at the top as these are natural convection type

b) Natural convection type coils are useful when the latent loads are very high

c) Defrosting of evaporators has to be done more frequently in natural convection type coils compared to forced convection evaporator coils

d) Provision of sufficient free space is very important in natural convection type evaporator coils

3. Which of the following statements are TRUE? [ ]

a) Flooded type evaporators are very efficient as the heat transfer coefficient on refrigerant side is very large

b) In flooded type evaporators, the refrigerant evaporation rate is equal to the refrigerant mass flow rate

c) An oil separator is always required in flooded evaporators as refrigerant tends to get collected in the evaporator

d) All of the above

4. Which of the following statements are TRUE? [ ]

a) Shell-and-tube evaporators are available in small to very large capacities

b) In dry expansion type evaporator, refrigerant flows through the shell while the external fluid flows through the tubes

c) Normally float valves are used expansion devices for flooded type evaporators

d) In shell-and-coil type evaporators, thermal storage can be obtained by having refrigerant on the shell side

5. Which of the following statements are TRUE? [ ]

a) In direct expansion, fin-and-tube type evaporators, the oil return to compressor is better if refrigerant enters at the bottom of the evaporator and leaves from the top

b) For low temperature applications, the fin spacing of evaporator is kept larger to take care of the frost formation

c) Double pipe type evaporators are used when close temperature approach is required

d) Plate type evaporators are used when close temperature approach is required

6. Which of the following statements are TRUE? [ ]

a) In evaporators using air as an external fluid, fins are frequently required on the refrigerant side

b) In evaporators using water as an external fluid, fins may be required on the refrigerant side to enhance heat transfer

c) Flooded type evaporators yield higher heat transfer coefficients compared to direct expansion type evaporators

d) In general heat transfer enhancement techniques yield more compact heat exchangers, but may also increase pressure drop

7.What is the effect of frost on the cooling coils of the evaporator

of refrigeration system [ ]

a) It reduces the life of cooling coils

b)It increases the compressor pressure

c)It makes the compressor run for comparatively short runs

d)It acts as the insulator and decreases the heat transfer rate

8.The widely used refrigerant in domestic refrigerators is [ ]

a) Carbon-dioxide b)Sulphur dioxide c)Freon-12 d) Ammonia

9.Freon group refrigerants are [ ]

a)toxic b)inflammable c)nontoxic and inflammable d)non-toxic & non-inflammable

10.Latent heat of vaporization of a refrigerant ,at lower temperatures and pressures[ ]

a)increases b)decreases c)remains constant d)unpredictable

11.The refrigerant with highest critical pressure is [ ]

a) Carbon dioxide b)Ammonia c)Freon-11 d) Freon-22

12.The Refrigerant commonly used in commercial ice plants is [ ]

a)Carbon-dioxide b)Air c)Ammonia d)Freon-12

13.Which of the following refrigerants has the lowest boiling point? [ ]

a)Freon-12 b)Carbon-dioxide c)Ammonia d)Sulphur dioxide

14.In a flooded type of Evaporator which of the following types of expansion device is

utilized [ ]

a)Float Valve b)Thermostatic device c)Capillary tube
d)Self actuated expansion valve

15**.** Which of the following statements are TRUE? [ ]

a) A capillary tube is a variable opening area type expansion device

b) In a capillary tube pressure drop takes place due to fluid friction

c) In a capillary tube pressure drop takes place due to fluid acceleration

d) In a capillary tube pressure drop takes place due to fluid friction and acceleration

16**.** Which of the following statements are TRUE? [ ]

a) The refrigerant mass flow rate through a capillary tube increases as condenser pressure decreases and evaporator pressure increases

b) The refrigerant mass flow rate through a capillary tube increases as condenser pressure increases and evaporator pressure decreases

c) A capillary tube tends to supply more mass flow rate as refrigeration load increases

c) A capillary tube tends to supply more mass flow rate as refrigeration load decreases

17**.** Which of the following statements are TRUE? [ ]

a) A capillary tube based refrigeration system is a critically charged system

b) A capillary tube based refrigeration system does not use a receiver

c) Capillary tube based refrigeration systems employ open type compressors

d) In capillary tube based systems, pressure equalization takes place when compressor is off

18.. Which of the following statements are TRUE? [ ]

a) The mass flow rate through a capillary is maximum under choked flow conditions

b) The mass flow rate through a capillary is minimum under choked flow conditions

c) The enthalpy of refrigerant remains constant as it flows through a capillary tube

d) The enthalpy of refrigerant in a capillary tube decreases in the flow direction

19. For a given refrigerant mass flow rate, the required length of a capillary tube increases as: [ ]

a) The degree of subcooling at the inlet decreases

b) The diameter of the capillary tube increases

c) The diameter of capillary tube decreases

d) Inlet pressure increases

20. Which of the following statements are TRUE? [ ]

a) An automatic expansion valve maintains a constant pressure in the condenser

b) An automatic expansion valve maintains a constant pressure in the evaporator

c) In an automatic expansion valve, the mass flow rate of refrigerant increases as the refrigeration load increases

d) Automatic expansion valve based systems are critically charged

21. A thermostatic expansion valve: [ ]

a) Maintains constant evaporator temperature

b) Maintains a constant degree of superheat

c) Increases the mass flow rate of refrigerant as the refrigeration load increases

d) Prevents slugging of compressor

22**.** Which of the following statements are TRUE? [ ]

a) A float valve maintains a constant level of liquid in the float chamber

b) A float valve maintains a constant pressure in the float chamber

c) Low-side float valves are used with direct expansion type evaporators

d) High-side float valves are used in flooded type evaporators

23**.** Which of the following statements are TRUE? [ ]

a) An electronic expansion valve is bi-directional

b) In an electronic expansion valve, the refrigerant mass

flow rate increases as the amount of liquid at evaporator exit increases

c) In an electronic expansion valve, the refrigerant mass flow rate increases as the temperature of refrigerant at evaporator exit increases

d) Electronic expansion valves are used in all-year air conditioning systems

Fill in the Blanks

24._____provides a heat transfer surface through which heat can pass from the refrigerated space or product into the vapourizing refrigerant.

25._____ is a substance that absorbs heat through expansion or vapourisation.

26._____ should be as large as possible to reduce the weight of the refrigerant to be circulated in the system.

27_____ is the cheapest refrigerant.

28. The boiling point of Freon-22 is_____ .

29. The refrigerant should have the freezing temperature_____

30. The refrigerant with lowest specific volume is_____

31. The widely used refrigerant in domestic refrigerator is_____

Key

1.b 2.a,d 3.a,c 4.a,c 5.b,d 6.b,c,d 7.d 8.c 9.d 10.a 11.b 12.c 13.b 14.a 15.d 16. b, d 17. a, b, d 18. a ,d 19. b, d 20. b, d 21.b,c,d

22. b, c, d 23.a,c,d 24.Evaporator 25.Refrigerant 26.Latent heat
27.Ammonia 28. -41°C 29. Lowest 30. Freon-12 31. Freon-12

UNIT – 3

VAPOUR ABSORPTION REFRIGERATION SYSTEM

Learning Objectives:

At the end of Unit – 4 Students will know

- The Vapor Absorption System
- max COP
- the working principles of NH3 – water system
- The working principles of Li Br –water (Two shell & Four shell) System.
- The principle of operation of Three Fluid absorption system, salient features.
- Electrolux refrigerator

DESCRIPTIVE QUESTIONS(UNIT-IV)

1) Explain the working principle of Vapor Absorption System
2) Write how to calculate max COP
3) Describe the working of NH_3 – water system
4) Describe the working of Li Br –water (Two shell & Four shell) System.
5) Describe the principle of operation of Three Fluid absorption system, salient features.

Problems

1) Determine the HCOP of a vapor absorption refrigeration system when the generator, the condenser and the evaporator temperature are $115^{O}C$, $35^{O}C$, and $-25^{O}C$ respectively.

Objective Questions

1. Co-efficient of performance of vapour absorption refrigeration system as

compared to that for vapour compression refrigeration system is

(a) more (b) less (c) may be more or less (d) un - predictable [ ]

2. The function of compressor in vapour compression refrigeration system is performed in vapour absorption system by

(a) generator (b) absorber (c) generator, absorber and liquid pump

(d) absorber and liquid pump [ ]

3. In vapour absorption refrigeration system heating in generator is done at 100°C, refrigeration in evaporator at 10°C and cooling by cooling water in condenser at 30°C. The (COP)max is

(a) 0.5 (b) 0.35 (c) 2 (d) in sufficient data [ ]

4. Electrolux system of refrigeration has

(a) only one liquid pump (b) only two liquid pumps (c) no liquid pump

(d) none of the above [ ]

5. Electrolux refrigerators has the following working substances

(a) Hydrogen (b) Ammonia and Hydrogen (c) Ammonia and water

(d) Ammonia, hydrogen and water [ ]

6. Which of the following system can be called as mechanical system of refrigeration

(a) Vapour absorption system (b) Vapour compression system

(c) Steam jet refrigeration system (d) None of the above [ ]

7. The vapour absorption refrigeration system using Ammonia – water has cycle operating pressures

(a) higher than that using Lithium Bromide – water

(b) lower than that using Lithium Bromide – water

(c) may be higher or lower depending upon application

(d) higher for sub-zero application and lower for above zero application [ ]

8. Shaft work required for vapour absorption system to produce 1 ton refrigeration may be only

(a) 50 to 60% of that required for vapour compression system

(b) 20 to 30% of that required for vapour compression system

(c) 1 to 2% of that required for vapour compression system

(d) none of the above [ ]

9. Work of compression of the fluid in vapour absorption refrigeration system as compared to that for vapour compression refrigeration system is

(a) less (b) more (c) may be more or less (d) un - predictable [ ]

10. The function of compressor in vapour compression refrigeration system is performed in vapour absorption system by

(a) generator (b) absorber (c) generator, absorber and liquid pump

(d) absorber and liquid pump [ ]

11. In vapour absorption refrigeration system heating in generator is done at 100°C, refrigeration in evaporator at 10°C and cooling by cooling water in condenser at 30°C. The (COP)max is

(a) 0.5 (b) 0.35 (c) 2 (d) in sufficient data [ ]

12. Munters Platen system of refrigeration is

(a) Vapour absorption system with ammonia and water

(b) Vapour compression system with ammonia as working substance

(c) Electrolux system with Hydrogen, ammonia and water as working substances

(d) none of the above [ ]

13. Electrolux refrigerators is

(a) Vapour compression refrigerator with one compressor

(b) vapour absorption refrigerator with no pump

(c) vapour absorption refrigerator with one aqua pump

(d) None of the above [ ]

14. Which of the following system can be called as mechanical system of refrigeration

(a) Vapour absorption system (b) Vapour compression system

(c) Steam jet refrigeration system (d) None of the above [ ]

15. The vapour absorption refrigeration system using Ammonia – water has cycle operating pressures

(a) higher than that using Lithium Bromide – water

(b) lower than that using Lithium Bromide – water

(c) may be higher or lower depending upon application

(d) higher for sub-zero application and lower for above zero application [ ]

16. Co-efficient of performance of vapour absorption refrigeration system as compared to that for vapour compression refrigeration system is

(a) more (b) less (c) may be more or less (d) un - predictable [ ]

FILL UP THE BLANKS WITH SUITABLE ANSWERS.

17. T_G = Generator temperature T_O = environment temperature T_E = Refrigerated space temperature. Then maximum COP for the absorption cycle is given by

_____ .

18. R-718 is used as a Refrigerant in Steam Jet Refrigeration. State True/ False

_____ .

19. Lithium Bromide – Water absorption refrigeration system _____ is the refrigerant.

20. _____ (Generator/ Rectifier) is the device which allows only dehydrated ammonia gas to pass to the condenser in Vapour absorption refrigeration system.

21. Solubility of Ammonia increases with increase in water temperature in Aqua – Ammonia vapour absorption refrigeration system. State True/False _____ .

22. The c.o.p of the vapour absorption cycle as compared to vapour compression is_____

23.Absorption type year round air conditioner uses _____solution in water which acts as absorbent and water vapour acts as refrigerant.

24.In a_____system the refrigerant is absorbed on leaving the evaporator, the absorbing medium being a solid or a liquid.

25.In an Electrolux refrigerator the partial pressure of ammonia is kept low in the requisite parts of the circuit by concentrating _____in those parts.

Key

1. b 2. c 3. b 4. c 5. d 6. b 7. a 8. c 9. a 10. c 11. b 12. c 13.b 14. b 15. a 16. b

17. $T_E (T_G – T_O) / T_G (T_O – T_E)$

18. True

19. Lithium Bromide

20. Rectifier

21. True

22.lesser

23.Lithium Bromide

24.Vapour absorption

25.Hydrogen

STEAM JET REFRIGERATION SYSTEM

Learning Objectives:

At the end of Unit – 5 Students will know

- The Steam Jet Refrigeration System – Working Principle and Basic Components
- The working Principle and operation of Thermoelectric refrigerator
- The working Principle and operation of Vortex tube or Hilsch tube

DESCRIPTIVE QUESTIONS(UNIT-V)

1) Describe the Steam Jet Refrigeration System – Working Principle and Basic Components
2) Explain the working Principle and operation of Thermoelectric refrigerator.
3) Explain the working Principle and operation of Vortex tube or Hilsch tube
4) Derive the expression for finding out quality of steam required per ton of refrigeration.

Problems

1) A steam jet refrigeration installation is to deliver chilled water at the rate of 2300 kg per minute at $8^{O}C$ from supply water at $18^{O}C$. Condenser saturation temperature is $38^{O}C$, nozzle efficiency is 90%, entrainment efficiency is 68% and disuffer efficiency is 78%.Quality of flashed vapour is 0.97.the steam consumption for the motive jet is 6500 kg/hr.Estimate the pressure of the dry and saturated motive steam.

2) In a steam jet refrigeration plant, steam enters the thermo compressor at 0.01 bar and with dryness fraction of 0.09, make up water enters the flash chamber at 18OC. Determine i)Quality of steam leaving the flash chamber. ii) COP of the plant based on heat input from motive steam .Assume isentropic efficiency n of turbine =90%: Nozzle efficiency=90%: Entrainment efficiency =65%: Thermocompressure efficiency= 65%

Objective Questions

1.Which of the following refrigerant used in the steam jet refrigeration?
[ ]

a) Ammonia b) R12 c) Water d) Air

2.. Which of the following is used as a Refrigerant in Steam Jet Refrigeration.
3.By which of the following systems chilled water with the application of principle of flash cooling is obtained? [ ]

a)Vortex system b)Steamjet Refrigeration system
c)Vapour compression system d)Absorption refrigeration system.

Fill in the Blanks

4. The refrigerant used for steam jet refrigeration is_____

5._____refrigeration system is particularly useful to air conditioning installation.

6._____ is the simplest device for producing cooled gas.

Key
1.c 2.b 3.b 4.Water 5.Steam Jet 6.Vortex tube

UNIT – 4

INTRODUCTION TO AIR CONDITIONING

PSYCHROMETRY

Learning Objectives:

At the end of Unit – 6 Students will know

- Acquainted with Psychometric Properties & Processes
- Able to identify Sensible and latent heat loads
- the need for Ventilation, Consideration of Infiltration
- The Load concepts of RSHF, GSHF- Problems, Concept of ESHF and ADP.

DESCRIPTIVE QUESTIONS(UNIT-VI)

1) Explain the process of heating and humidification.
2) What is meant by ADP of a coil and how is it different from dew point of air?
3) Why ventilation is required? Explain why different ventilation standards for different purposes are recommended.
4) What are the important considerations in the design of air conditioning system?
5) Write a short note on by-pass factor for cooling coils.

Problems

1) The pressure, temperature and relative humidity of air at a pace are 1.013 bar, 32°C and 65% respectively. Find
   i. The dew point.
   ii. Specific volume of the constituent and
   iii. The humidity ratio. The universal gas constant. R =8.3143 kJ/kg mole K.

2) The atmospheric conditions of air are 30°C dry bulb temperature and specific humidity of 0.02 kg/kg of dry air. Find
   i. Partial pressure of vapour in air
   ii. Relative humidity
   iii. dew point temperature.

3) Air at $28^{O}C$, 78% RH is cooled by spraying in water at $10^{O}C$. This Causes saturation, followed by condensate, the mixing being assumed to take place adiabatically an the condensate being drained off at $17.5^{O}C$. the resulting saturated mixture is then heated to produce the required conditions of 55%RH at $23^{O}C$. The total pressure is constant at 101 kPa. Determine the mass of water supplied to the sprays to provide 12 m^3/h of conditioned air. What is the heater power required?

4) The sensible heat load factor (SHF) of an air – conditioned room is 0.67. The condition of the air leaving the air- conditioned room is $27^{O}C$ DBT and 52% RH the maximum permissible temperature difference between the inlet air and out-let air is $11^{O}C$. If the quantity of air flow at the inlet of the room is $180m^3$/mm. Then find the sensible heat load and latent heat load of the air conditioned room.

5) A stream of air has the dry bulb temperature =$28^{O}C$ and moisture =0.016kg/kg of the dry Determine i) relative humidity: ii) dew point and iii) specific enthalpy of the moist air stream, if the barometer reads 760 mmHg.

6) The air conditioning system of a room is required to deliver air at 290K and having 60% relative humidity , determine i) Specific humidity ii) dew point temperature at moist air, given the barometer pressure = 1.01326 bar.

7) The temperature and relative humidity of air at a place are 33OC and 68% respectively. Find i) dew point temperature ii) humidity ratio iii) specific volume of the moist air Assume the pressure as 1.013 bar the universal gas constant as 8.3143 kJ/kgmole.k

<u>Objective Questions</u>

1.The Wet bulb depression is zero when Relative humidity equals

a) 0 b) 0.5 c) 0.75 d) 1

2. In a psychrometric chart, the vertical lines parallel to the ordinate indicate [ ]

a) Dry bulb Temperature b) Wet bulb Temperature c) Specific humidity

d) Enthalpy of saturation

3.The uniformly spaced horizontal lines running parallel to the abscissa in a

psychrometric chart indicate [ ]

a) Absolute humidity b) Specific humidity c) Dew point temperature d) volume

4. Which of the following statements are TRUE?

a) When the dry bulb temperature is equal to dew point temperature, the relative humidity of air-water mixture is

b) All specific psychrometric properties of moist air are based on unit mass of water vapour

c) All specific psychrometric properties of moist air are based on unit mass of dry air

d) All specific psychrometric properties of moist air are based on unit mass of moist air

5. Which of the following statements are TRUE?

a) Thermodynamic WBT is a property of moist air, while WBT as measured by wet bulb thermometer is not a property

b) Both the thermodynamic WBT and WBT as measured by wet bulb thermometer are properties of moist air

c) Under no circumstances, dry bulb and wet bulb temperatures are equal

d) Wet bulb temperature is always lower than dry bulb temperature, but higher than dew point temperature

6. Which of the following statements are TRUE?

a) During sensible cooling of air, both dry bulb and wet bulb temperatures decrease

b) During sensible cooling of air, dry bulb temperature decreases but wet bulb temperature remains constant

c) During sensible cooling of air, dry and wet bulb temperatures decrease but dew point temperature remains constant

d) During sensible cooling of air, dry bulb, wet bulb and dew point temperatures decrease

7. Which of the following statements are TRUE? [ ]

a) The sensible heat factor for a sensible heating process is 1.0

b) The sensible heat factor for a sensible cooling process is 0.0

c) Sensible heat factor always lies between 0.0 and 1.0

d) Sensible heat factor is low for air conditioning plants operating in humid climates

8. Which of the following statements are TRUE? [ ]

a) As the by-pass factor (BPF) of the cooling coil increases, temperature difference between air at the outlet of the coil and coil ADP decreases

b) The BPF of the coil increases as the velocity of air through the coil increases

c) The BPF of the coil increases as the fin pitch increases

d) The BPF of the coil decreases as the number of rows in the flow direction increase

9. Which of the following statements are TRUE? [ ]

a) During cooling and humidification process, the enthalpy of air decreases

b) During cooling and humidification process, the enthalpy of air increases

c) During cooling and humidification process, the enthalpy of air remains constant

d) During cooling and humidification process, the enthalpy of air may increase, decrease or remain constant depending upon the temperature of the wet surface

10.An air stream at a flow rate of 1 kg/s and a DBT of $30^{o}C$ mixes adiabatically with another air stream flowing with a mass flow rate of 2 kg/s and at a DBT of $15^{o}C$. Assuming no condensation to take place, the temperature of the mixture is approximately equal to:

a) $20^{o}C$

b) $22.5^{o}C$

c) $25^{o}C$

d) Cannot be found

11. Which of the following statements are TRUE? [ ]

a) In an air washer, water has to be externally cooled if the temperature at which it is sprayed is equal to the dry bulb temperature of air

b) In an air washer, water has to be externally heated if the temperature at which it is sprayed is equal to the dry bulb temperature of air

c) In an air washer, if water is simply recirculated, then the enthalpy of air remains nearly constant at steady state

d) In an air washer, if water is simply recirculated, then the moisture content of air remains nearly constant at steady state

12. Which of the following statements are TRUE? [ ]

a) When the enthalpy of air is equal to the enthalpy of saturated air at the wetted surface temperature, then there is no sensible heat transfer between air and the wetted surface

b) When the enthalpy of air is equal to the enthalpy of saturated air at the wetted surface temperature, then there is no latent heat transfer between air and the wetted surface

c) When the enthalpy of air is equal to the enthalpy of saturated air at the wetted surface temperature, then there is no net heat transfer between air and the wetted surface

d) When the enthalpy of air is equal to the enthalpy of saturated air at the wetted surface temperature, then the wet bulb temperature of air remains constant

13. The temperature at which the water vapour in the air starts.

condensing is known as [ ]

a)dew point b)dry bulb c)wet bulb d) saturation

14. When moisture is added to air at constant dry bulb temperature, the process is known as [ ]

a)Sensible cooling b)humidification c)dehumidification d)Chilling

15.Which of the following can be measured by a sling psychrometer? [ ]

a)Wet bulb temperature b)Dry bulb as well as wet bulb temperatures

c)Specific humidity d)Absolute humidity

Fill in the blanks

16.The simultaneous control of temperature humidity, motion and purity of atmosphere in a confined space is called _____.

17. The art of measuring moisture content of air is termed _____.

18._____is the temperature of air as measured by an ordinary thermometer.

19.The difference between the dry bulb and wet bulb temperature is termed as _____ depression.

20._____ is the ratio of the partial pressure of the water vapour in the mixture to the saturated partial pressure at the dry bulb temperature expressed in percentage.

21.The heat that does not affect the temperature but changes the state of a substance when added to it or subtracted to is called_____

22.The ratio of mass of water vapour associated with the unit mass of dry air to mass of water vapour associated with saturated unit mass of dry air is called_____

23.The ratio of room sensible heat to the sum of room sensible heat and room latent heat is called _____

24._____ is the ratio of total sensible heat to the grand total heat that the cooling coil or the conditioning apparatus should handle.

KEY

1.d 2.a 3.a,d 5.a 6.a,c 7.a,d 8.b,c,d 9.d 10.a 11.b,c 12.c,d 13.a 14.b 15.b

16. Air conditioning

17. Psychrometry

18.DBT

19.Wet Bulb

20.Relative Humidity

21.Latent Heat

22.degree of saturation

23.sensible heat factor

24.Grand sensible heat factor(GSHF)

UNIT – 5

REQUIREMENTS OF HUMAN COMFORT

Learning Objectives:

At the end of Unit – 7 Students will know

- Understand the requirements of human comfort
- the concept of effective temperature- Comfort chart –Comfort Air conditioning
- the requirements of Industrial air conditioning
- the Air conditioning Load Calculations

DESCRIPTIVE QUESTIONS(UNIT-VII)

1) Write about the requirements of human comfort
2) Describe the concept of effective temperature- Comfort chart –Comfort Air conditioning
3) Explain the requirements of Industrial air conditioning
4) Write about various Air conditioning Loads

Problems

1) The following data refer to summer air conditioning of a restaurant:
   Inside design conditions = 25°C DBT and 19 ^{O}C WBT , outside design conditions =36 ^{O}C DBT and 25°C WBT, sensible heat load 1,30,000kJ/h, latent heat load =50000 kJ/h , the outside air is supplied at the rate of 23 m^{3}/min directly into the

room through ventilators and by infiltration. The outside air to be conditioned is passed through a cooling coil which has an apparatus dew point of $10^{O}C$ and 58% of the total air is recirculated from the conditioned space and mixed with conditioned air after the cooling coil. Find:

a) Condition of air after the cooling coil before mixing with recirculated air
b) Condition of air entering the restaurant.
c) Mass of fresh air entering the cooling coil.
d) By-pass factor of the cooling coil.
e) Total refrigeration load of the cooling coil.

2) A class room is to be air-conditioned for the following given summer conditions. The data collected is given as follows: Size of class –room: 18 X 12 X 6m, Out-door conditions: $42^{O}C$ DBT and 52% RH., required comfort condition: $18^{O}C$ DBT and 58% RH., Seating capacity: 45, sensible heat in the room excluding infiltrated load: 40000 k J / hr, sensible heat load from other sources: 8000 kJ / hr, lighting load: 12 tubes of 80 Watts, infiltrated air: 27 m3/ min. If 35% of air is taken from outside and remaining is re-circulated then find the following:

(a) Capacity of the cooling coil in tones of refrigeration and its bypass factor

(b) Capacity of the blower in m^3 / min. Assume DPT of the coil is $6^{O}C$.

3) The following data refers for a space to be air conditioned:
Inside design conditions = $23^{O}C$ DBT,48%RH, outdoor air conditions=$45^{O}C$ DBT.$28^{O}C$WBT.room sensible heat gain =18kW,room latent heat gain =6kW,by-pass factor of the cooling coil =0.12, the returns air from the space is mixed with the outside air before entering the cooling coil in the ratio of 5:1 by mass .

Determine:

a) Apparatus dew point.

b) Condition of air entering and leaving the cooling coil.
c) Dehumidified air quantity
d) Fresh air mass flow and volume flow rate
e) Total refrigeration load on the air- conditioning plant.

Objective Questions

1. State which of the following statements are TRUE? [ ]

a) The purpose of psychrometric calculations is to fix the supply air conditions

b) The purpose of psychrometric calculations is to find the load on the building

c) In a 100% re-circulation system, the coil ADP is equal to room ADP

d) In a 100% re-circulation system, the coil ADP is less than room ADP

2. State which of the following statements are TRUE? [ ]

a) In a 100% re-circulation system, the load on coil is equal to the load on building

b) In a system with outdoor air for ventilation, the load on building is greater than the load on coil

c) In a system with outdoor air for ventilation, the load on building is less than the load on coil

d) In a system with outdoor air for ventilation, the Coil ADP is less than room ADP

3. Which of the following statements are TRUE? [ ]

a) Systems with reheat are used when the Room Sensible Heat Factor is low

b) Systems with reheat are used when the Room Sensible Heat Factor is high

c) When reheat coils are used, the required coil ADP can be increased

d) When reheat coils are used, the required supply airflow rate increases

4. Which of the following statements are TRUE? [ ]

a) The metabolic rate depends mainly on age of the human being

b) The metabolic rate depends mainly on the activity level of the human being

c) The metabolic rate depends mainly on the sex of the human being

d) All of the above

5. Which of the following statements are TRUE? [ ]

a) To maintain thermal comfort, the DBT of air should be increased as its moisture content increases

b) To maintain thermal comfort, the DBT of air should be decreased as air v velocity increases

c) To maintain thermal comfort, the DBT of air should be increased as the temperature of the surrounding surfaces decrease

d) All of the above

6. Which of the following statements are TRUE? [ ]

a) Surrounding air velocity affects convective heat transfer from the body only

b) Surrounding air velocity affects evaporative heat transfer from the body only

c) Surrounding air velocity affects both convective and evaporative heat transfers from the body

d) Moisture content of the air affects both convective and evaporative heat transfers from the body

7. Which of the following statements are TRUE? [ ]

a) As the amount of clothing increases, the surrounding DBT should be increased to maintain thermal comfort

b) As the amount of clothing increases, the surrounding DBT should be decreased to maintain thermal comfort

c) As the activity level increases, DBT of air should be increased to maintain thermal comfort

d) As the activity level increases, DBT of air should be decreased to maintain thermal comfort

8. Which of the following statements are TRUE? [ ]

a) Effective temperature combines the affects of dry bulb temperature and air velocity into a single index

b) Effective temperature combines the affects of dry bulb temperature and wet bulb temperature into a single index

c) Mean radiant temperature combines the affects of dry bulb temperature and surrounding surface temperature into a single index

d) Operative temperature combines the affects of dry bulb temperature and mean radiant temperature into a single index

Fill in the blanks

9. The rate at which the body produces heat is termed as the _____rate.

10. There is some kind of _____control in a human body, which tries to maintain temperature of human body at the normal of $37^{o}C$

11.A sensory index that combines into a single factor the effects of temperature , humidity and air movement on human comfort in a noise free pure3 air environment is called _____temperature

12.The empirically limited effective temperature chart , is known as _____chart.

13.In 'comfort chart' the effective temperature is represented by_____lines.

14.As compared to men, women require _____higher effective temperature.

15.The men performing heavy manual labour in factories need a _____effective temperature.

16.In summer air conditioning process comfort air conditions are_____ and _____

Key

1. a,c 2.a,c,d 3. a,c,d 4. b 5.c 6. c 7.b,d 8. b,d

9. metabolic rate

10. thermostatic

11. effective

12. comfort

13. broken

14. $0.5^{o}C$

15. lower

16. $22^{o}C$ DBT, 60% relative humidity(RH)

UNIT – 5

AIR CONDITIONING SYSTEMS

Learning Objectives:

At the end of Unit – 8 Students will know

- Understand the Air Conditioning systems
- The AC equipment classification
- Understand the cooling, heating humidification and dehumidification,
- Know the working principle of filters, grills and registers, fans and blowers, Heat Pump.
- Know various heat sources – different heat pump circuits.

DESCRIPTIVE QUESTIONS(UNIT-VIII)

1) Write about Air Conditioning systems
2) Classify the Air-conditioning equipment
3) Write about cooling, heating humidification and dehumidification
4) Explain the working principle of filters, grills and registers
5) Explain the working principle of fans and blowers
6) Explain the working principle of Heat Pump.
7) Write about various heat sources and different heat pump circuits.
8) Explain various types of temperature sensitive mechanisms used with thermostat.
9) Describe the working of sealed bellow type thermostat with the help of a neat sketch.

Objective Questions

1. Which of the following statements are TRUE? [ ]

a) Evaporative cooling systems are attractive for hot and humid climates

b) Evaporative cooling systems are attractive for hot and dry climates

c) Evaporative cooling systems are ideal for comfort applications

d) Evaporative cooling systems are ideal for several industrial applications

2. Which of the following statements are TRUE? [ ]

a) In a direct evaporative cooling system, the lowest possible temperature is the wet bulb temperature corresponding to the outdoor air

b) In a direct evaporative cooling system, the lowest possible temperature is the dew point temperature corresponding to the outdoor air

c) In a direct evaporative cooling system, cooled and humidified air is supplied to the conditioned space

d) In a direct evaporative cooling system, cooled and dehumidified air is supplied to the conditioned space

3. Which of the following statements are TRUE? [ ]

a) In an indirect evaporative cooling system, the air supplied to the conditioned space is at a lower temperature, but higher humidity ratio

b) In an indirect evaporative cooling system, the air supplied to the conditioned space is at a lower temperature and at a humidity ratio corresponding to the outdoor air

c) Compared to direct evaporative cooling systems, it is possible to achieve lower supply air temperatures in simple indirect evaporative coolers

d) In multi-stage evaporative cooling systems, it is possible to cool the air to a temperature lower than the entering air WBT

4. Which of the following statements are TRUE? [ ]

a) Evaporative cooling systems are environment friendly

b) Evaporative cooling systems offer lower initial and lower running costs

c) Evaporative cooling systems are easier to maintain and fabricate

d) Evaporative systems provide better control on indoor climate

5. Which of the following statements are TRUE? [ ]

a) Direct evaporative cooling systems are attractive in places where the summer design WBT is greater than 24 ^{o}C

b) Direct evaporative cooling systems are attractive in places where the summer design WBT is less than 24 ^{o}C

c) Indirect evaporative cooling systems can be used over an extended range of

climatic conditions

d) A combination of evaporative cooling system with conventional air conditioning system can offer better overall performance

6. Which of the following statements are TRUE? [ ]

a) In winter air conditioning systems, heated and dehumidified air is supplied to the conditioned space

b) In winter air conditioning systems, heated and humidified air is supplied to the conditioned space

c) A pre-heater is recommended in winter air conditioning systems to improve overall efficiency of the system

d) A pre-heater is recommended in winter air conditioning systems to prevent freezing of water in the humidifier and for better control

7. Which of the following statements are TRUE? [ ]

a) When humidification is done using an air washer, the temperature of air drops during humidification

b) When humidification is done using an air washer, the temperature of air rises during humidification

c) When humidification is carried out by adding dry steam, the temperature of air remains close to the WBT of entering air

d) When humidification is carried out by adding dry steam, the temperature of air remains close to the DBT of entering air

8. Which of the following statements are TRUE? [ ]

a) An all year air conditioning system can be used either as a summer air conditioning system or as a winter air conditioning system

b) When an all year air conditioning system is used during summer, the heaters are always switched-off

c) When an all year air conditioning system is used during winter, the cooling and dehumidification coils are switched-off

d) In an all year air conditioning systems, the blowers are always on

Fill in the blanks

9._____ are used for moving air.

10. _____are employed for cleaning air.

11._____ distribute the air evenly in a room.

12. In_____ system zoning and duct work is eliminated.

13. Package units may be of _____ or _____type.

14._____fans produce a flow of air in a direction parallel to the axis of rotation.

15._____ is a grille provided with a damper.

16. A desert cooler works on the principle of _____.

KEY

1.b,c 2.a,c 3.b,d 4.a,b,c 5.b,c,d 6.b,d 7.a,d 8.a,c,d

9.Fans

10.Filters

11.Supply outlets

12.unitary

13.window,console

14.axial

15. Register

16.Evaporative cooling