BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

IV Year I Semester 2008-2009

Test No.1 (Closed Book)

Course No. CHE C471 /ME C461 **Course Title:** REFRIGERATION &A/C

Max.Marks: 25 **Weightage:** 25%

Date: 19-10-2008 **Duration:** 50 min.

Notes:

- Answer all the questions
- Draw neat sketches wherever necessary
- Make suitable assumptions if required and clearly state them
- ***Refrigeration charts and Tables*** are permitted

Q 1 A. Enumerate the difference between ***Refrigeration*** and ***Air conditioning***: **[4M]**

B. Explain ***DART***. **[2M]**

Q 2.A. Describe ***Boot strap*** Air Refrigeration systems **[5M]**

B. An air-cooling system for a jet plane cockpit operates on simple cycle. The cockpit is to be maintained at 25^0C. The ambient air pressure and temperature are 0.35 bar and -15^0Crespectively. The pressure ratio of the jet compressor is 0.1bar. The plane speed is 1000kilometers per hour. The pressure drop through the cooler coil is 0.1bar. The pressure of air leaving the cooling turbine is 1.06bar and that in the cockpit is 1.01325bar. The cockpit cooling load is 58.05kW. Calculate:

(1) Stagnation temperature and pressure of the air entering the compressor.

(2) COP of the system **[6M]**

Q.3.A. what is meant by ***one tonn*** of Refrigeration **[2M]**

B. An R-134- a refrigeration system works between pressure limits 1.67 bar and 10.16 bar, respectively. The heat transfer from the condenser is found to be 72 kJ/min. The refrigerant vapour leaves the evaporator in the saturated state. The condensate leaves the condenser in just saturated state. The refrigerant flow rate through the system is found to be 0.4 kg/min. Obtain (a) COP, (b) capacity of the plant. **[6M]**

BEST OF LUCK

BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

IV Year I Semester 2008-2009

Test No.2 (Open Book)

Course No. CHE C471 /ME C461 **Course Title:** REFRIGERATION &A/C

Max.Marks: 20 **Weightage:** 20%

Date: 27-11-2008 **Duration:** 50 min.

Notes:

- Answer all the questions
- Draw neat sketches wherever necessary
- Make suitable assumptions if required and clearly state them
- ***Refrigeration charts and Tables*** are permitted

Q 1. Have a ***absorption refrigerators*** ever been made using ***sulphurdioxide*** ? What is the absorber used here? **[3M]**

Q. 2. Is it proper to compare COP's of the vapour-***absorption*** and vapour–***compression*** systems obtained on the basis of different forms of energy? **[3M]**

Q.3. The state of return air from an air conditioned building is T_{db} = 300K and T_{wb} = 292K. the heat transfer to the conditioned building is 31600kJ/h. The rate of moisture gain is found to be 4.54 kg/h from the occupancy. The moisture is assumed to be saturated vapour at 303K. The moist air is supplied to the conditioned space at T_{db} = 288K. Compute the relative humidity and wet bulb temperature of the conditioned air and corresponding volume flow rate:- **[5M]**

Q.4. Why is the ***psychrometric chart*** most commonly employed in solving problems on air conditioning ? **[3M]**

Q.5. Enumerate the role and function of all the four components in a ***vapour compression refrigeration*** system. **[6M]**

BEST OF LUCK

BITS, PILANI-DUBAI

INTERNATIONAL ACADEMIC CITY, DUBAI

FIRST SEMESTER 2008-2009

CHE C471/ ME C461 REFRIGERATION & AIRCONDITIONING

[FINAL YEAR ELECTIVE]

QUIZ -1

DURATION: 15 MINUTES MAXIMUM MARKS: 10 **DATE :** 22/09/08.

Note :

1) Answer only in the sheet provided
2) Do not scribe or overwrite
3) Write Name, I D No. on the answer
4) Return the answer sheet

Name : ---------- **I.D No.** ----------

1. ---------- is the ratio between the heat extracted and the work done.
2. The C.O.P for a Carnot refrigerator is ---------- than that of Carnot heat pump.
3. The C.O.P of an air refrigeration system is ---------- than a vapour compression system.
4. The function of a ---------- is to meter the proper amount of refrigerant to the evaporator and to reduce the pressure of liquid entering the evaporator.
5. If the vapour is not superheated after compression, the operation is called ----------
6. Generally, ambient air temperature drops---------- ^{0}Cper 100 m of height from the sea level temperature.
7. Full form of DART is ----------.
8. ---------- --type of aircraft refrigeration system cannot be used for ground cooling.
9. ---------- type of aircraft refrigeration system is useful for supersonic aircrafts and rockets.
10. ----------statement of second law pertains to refrigerator / heat pumps.

GOOD LUCK

BITS, PILANI-DUBAI

INTERNATIONAL ACADEMIC CITY, DUBAI

FIRST SEMESTER 2008-2009

CHE C471/ ME C461 REFRIGERATION & AIRCONDITIONING

[FINAL YEAR ELECTIVE]

QUIZ -2

DURATION: 15 MINUTES MAXIMUM MARKS: 10 **DATE :** 27/10/08

Note :

1) Answer only in the sheet provided
2) Do not scribe or overwrite
3) Write Name, I D No. on the answer
4) Return the answer sheet

Name : ---------- **I.D No.** ----------

1. Consider the following statements:
   Moisture should be removed from refrigerants to avoid :
   1. Compressor seal failure 2. Freezing at the expansion valve
   3. restriction to refrigerant flow. 4. corrosion of steel part.

   On these statements

   (a) 1,2,3 and 4 are correct (b) 1and 2 are correct
   © 2,3 and 4 are correct (d) 1,3 and 4 are correct
2. The desirable combination of properties for a refrigerant include

   (a) high sp.heat and low latent heat (b) High heat transfer and low freezing point

   © High thermal conductivity and low freezing point (d) High sp.heat and high boiling point
3. The cheapest refrigerant is ----------
4. Expand GWP ----------
5. A example for a secondary refrigerant is ----------
6. An example of a multi pressure refrigeration system is ----------
7. For large ammonia refrigeration plants ---------- type of condensers are used.
8. ---------- type of expansion valve is used in the case of flooded evaporator.
9. Use of multi refrigerants in a system is called ---------- system.
10. R134a refrigerant is the trade name for ----------

BITS, PILANI-DUBAI

INTERNATIONAL ACADEMIC CITY, DUBAI

FIRST SEMESTER 2008-2009

CHE C471/ ME C461 REFRIGERATION & AIRCONDITIONING

[FINAL YEAR ELECTIVE I

QUIZ -3

Soumen Roy

DURATION: 15 MINUTES MAXIMUM MARKS: 10 **DATE :** 26/11/08

Note :

1) Answer only in the sheet provided
2) Do not scribe or overwrite
3) Write Name, I D No. on the answer
4) Return the answer sheet

Name : ---------- **I.D No.** ----------

1. The ***enthalpy lines*** on the psychrometry are approximately parallel to ---------- lines
2. ---------- property is ***non linear*** in psychrometry.
3. If a building ***gains*** or ***losses moisture***, it is supposed to have ---------- load.
4. ----------is the range of values of ***SHF*** quite common in air conditioning practice in normal climate.
5. The point on the saturation line in which the SHF line cuts is known as ---------- ----------point.
6. One method commonly employed for ***winter heating*** of air is ----------
7. The relation between ***bypass factor*** X and ***humidifying efficiency*** is ----------
8. The relation between ***contact factor*** and ***humidifying efficiency*** is ----------
9. If mean surface temperature of water(t_s) is ***equal*** to the dry bulb temperature of air in an air washer system the process is called ----------
10. For the purpose of calculations of flow rate of air, ***standard air*** is taken at ------ ^0C and ---------- ***% RH.***

GOOD LUCK

BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

IV Year I Semester 2008-2009

COMPREHENSIVE EXAMINATION [CLOSED BOOK]

Course No. CHE C471 / ME C461 **Course Title:** REFRIGERATION &A/C

Max.Marks: 80 **Weightage:** 40%

Date: 30-12-2008 **Duration:** 3HRS

Notes:

- Answer all the questions
- Draw neat sketches wherever necessary
- Make suitable assumptions if required and clearly state them
- ***Refrigeration charts and Tables*** are permitted

1. Enumerate different ways of producing refrigeration:- **[2M]**
2. Enumerate important refrigeration applications:- **[3M]**
3. State the merits and demerits of air refrigeration systems:- **[3M]**
4. Describe a simple vapour compression cycle giving clearly its flow diagram:- **[4M]**
5. State the functions of the following parts of a simple vapour compression systems

   (i) Compressor **(ii)** Condenser **(iii)** Expansion valve **(iv)** Evaporator **[4M]**
6. Define "***unitary system***". Where is it commonly preferred? Explain a window type air conditioner with a neat sketch:- **[5M]**
7. Explain the desirable properties of ideal refrigerants: **[3M]**
8. The evaporator and the condenser temperatures of 20 tonnes capacity freezer are -28^0C and 23^0C respectively. The refrigerant R-22 is sub cooled by 3^0C before it enters the expansion valve and is superheated to 8^0C before leaving the evaporator. The compression is isentropic. A six cylinder single acting compressor with stroke equal to bore running at 250 rpm is used.

   Determine: **[8M]**

   (i) Refrigerating effect/ kg.

   (ii) Mass of refrigerant to be circulated per minute.

   (iii) Theoretical piston displacement per minute.

   (iv) Theoretical power.

   (v) COP

   (vi) Theoretical bore & stroke of the compressor.

   Neglect valve throttling and clearance effect.

9. Explain ***Electrolux vapor absorption*** refrigerator with neat sketch:- **[4M]**

10. Express different basic processes in conditioning of air in Psychrometric chart:- **[5M]**

11. What is the difference between summer and winter air conditioning systems. ? **[3M]**

12. An air conditioning space is maintained at 27^0C DBT and 50% RH. The ambient conditions are 40^0C DBT and 27^0C WBT. The space has a sensible heat gain of 14 kW. Air is supplied to the space at 7^0C saturated. **[6M]**

Calculate:

(i) Mass of moisture air supplied to the space in kg/hr.

(ii) Latent heart gain of space in kW.

(iii) Cooling load of the air washer in kW if 30% of the air supplied to the space is fresh, the reminder being recalculated:-

13. Determine the duct sizes of the section A to G of the duct system in Fig below and the total pressure at fan outlet using ***equal friction method***. Assume velocity in main duct A is 420 mpm. Also assume dynamic loss coefficient in elbow K = 0.22 and static regain factor in fitting R = 0.75. static pressure at each out let is 4mm of water. **[12M]**

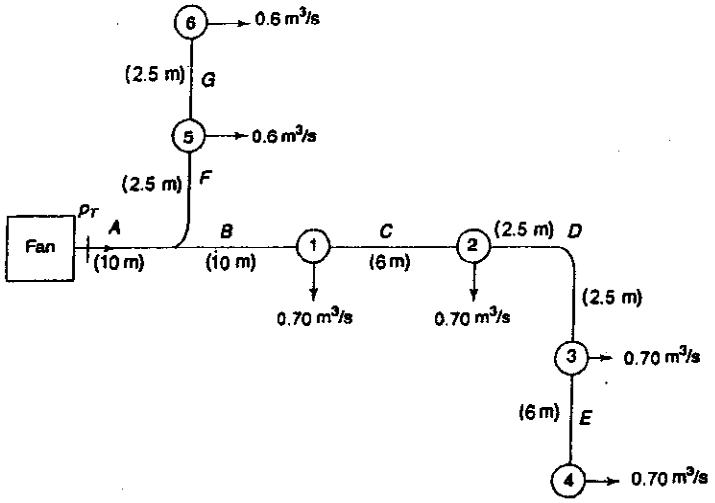


Fig. Duct System for Question No.13

14 For the air conditioning of a 4.5 m high single story office building located at 30^0N latitude, the plan of which is shown in fig. below. The following data are given:- **[18M]**

Plaster on inside wall	:	1.25 cm
Outside wall construction	:	18 cm concrete block
	:	12 cm brick veneer
Partition wall construction	:	32 cm brick
Roof construction	:	20 cm RCC slab with 4 cm asbestos cement board
Floor construction	:	22 cm concrete

Densities, brick : 2000 kg/m^3

Concrete : 1900 kg/m^3

Plaster : 1885 kg/m^3

Asbestos board : 520 kg/m^3

Fenestration (whether stripped loose fit) : 2 m x 1.25 m glass, U = 5.9 w/m^{2}K

Doors : 1.5 m x 2 m wooden panels, U = 0.63 w/m^{2}K

Outdoor design conditions : 42^{0}C DBT , 28^{0}C WBT

Indoor design conditions : 24^{0}C DBT, 52% RH

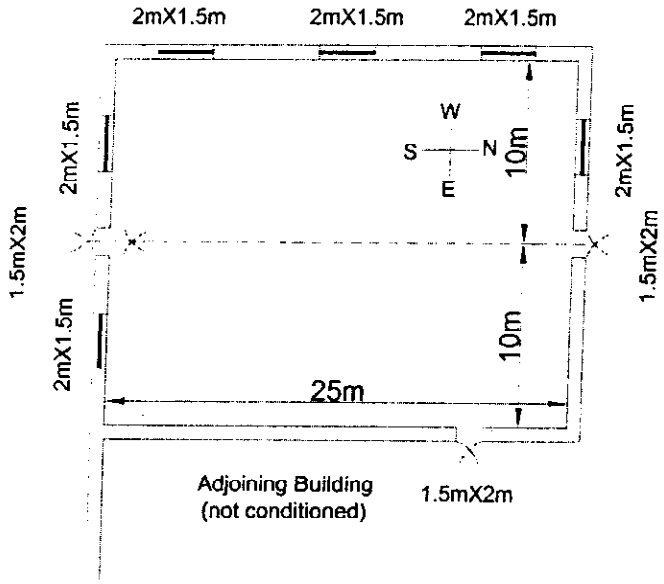
Daily range : 30^{0}C to 42^{0}C = 12^{0}C

Occupancy : 75

Lights : 12,000 W fluorescent

Assumed by pass factor of cooling coil : 0.15

Find the room sensible and latent heat loads:-



Thermal conductivities from Table 18.1

k_{glass} = 0.78 W m^{-1} K^{-1}

$k_{concrete}$ = 1.73 W m^{-1} K^{-1}

k_{brick} = 1.32 W m^{-1} K^{-1}

$k_{plaster}$ = 8.65 W m^{-1} K^{-1}

$k_{asbestos}$ = 0.154 W m^{-1} K^{-1}

Assumed film coefficients

f = 23 W m^{-2} K^{-1}

f_i = 7 W m^{-2} K^{-1}

Equivalent temperature differentials in °C, from Tables 18.9 and 18.10, and incorporating corrections:

	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.
West wall	14.4	14.8	15.2	16.5	17.5	
North wall	9.6	10.2	9.6	11.3	11.7	
South wall	13.1	14.7	16.0	17.4	17.8	
Roof (exposed)	24.0	25.8	28.0	29.7	30.5	30.2

Rates of solar gains through glass on June 21 in W/m^2 from Table 17.8(d)

	2 p.m.	3 p.m.	4 p.m.	5 p.m.
West glass	309	451	508	492
North glass	44	44	51	91
South glass	47	44	38	32

Table 18.13 Infiltration through Doors on Adjacent Walls (Wind Velocity 12 kmph)[3]

Description	cmm/m² *Area*		*cmm*	
			Standing Open	
	No Use	*Average Use*	*No Vestibule*	*Vestibule*
Revolving Doors-				
Normal Operation	0.24	1.58	—	—
Panels Open	—	—	34	25
Glass Door-4.75 mm Crack	1.37	3.0	20	14
Wood Door-	0.3	1.98	20	14
Small Factory Door	0.23	1.98	—	—
Garage and Shipping Room Door	0.61	1.37	—	—
Ramp Garage Door	0.61	2.06	—	—

Table 18.12 Infiltration through Doors-Crack Method[3]

Type of door	*cmm per Linear Metre of Crack*					
	Wind Velocity, kmph					
	8	16	24	32	40	48
Glass door						
Good installation						
3.2 mm crack	0.3	0.6	0.9	1.21	1.49	1.77
Average installation						
4.76 mm crack	0.45	0.93	1.3	1.86	2.23	2.7
Poor installation						
6.4 mm crack	0.6	1.21	1.77	2.42	2.42	3.53
Ordinary wood or metal door						
Well fitted						
W-stripped	0.04	0.06	0.08	0.12	0.16	0.2
Well fitted						
Now W-stripped	0.08	0.11	0.17	0.24	0.31	0.39
Poorly fitted						
Not W-stripped	0.08	0.21	0.34	0.48	0.61	0.78
Factory door						
3.2 mm crack	0.3	0.6	0.9	1.21	1.49	1.77

Table 18.11 Infiltration through Double-Huge Windows in $m^3/h/m$ of Crack[3]

Window type	*Pressure Difference, cm* H_2O				
	0.25	0.50	0.75	1.00	1.25
Non-weather-stripped, loose fit	7.1	11.3	14	18	21
Non-weather-stripped, average fit	2.5	4	5.3	6.4	7.4
Weather-stripped, loose fit	2.5	4	5.3	6.4	7.4
Weather-stripped, average fit	1.3	2.1	2.8	3.3	3.9

Table 16.2 Ventilation Air Requirements

Application	*Smoking Status*	*Recommended cmm/person*	*Minimum*	
			cmm/person	*cmm/m floor area*
Apartments	Some	0.56	0.28	—
Offices and factories	Occasional-Some	0.28–0.6	0.21	—
Restaurants	Some	0.4	—	—
Board rooms	Very heavy	1.4	0.56	0.03
Department stores	None	0.21	0.14	0.0015
Theatres	None	0.21	0.14	—
Hotel rooms	Heavy	0.84	0.7	—
Hospital wards	None	0.84	—	—
Hospital operation theatres	None	All outdoor	—	—

$$\frac{\Delta p_f}{L} = \frac{0.002268\, \dot{Q}_v^{1.852}}{D^{4.973}} \qquad \Delta p = 0.00047\,(C)^2 \qquad p_{V_A} = \left(\frac{C}{4.04}\right)^2$$

Table 19.1 Heat Liberated due to Occupancy

Activity	*Metabolic Rate* W	*Heat Liberated, W* *Room Dry Bulb Temperature, °C*							
		20		22		24		26	
		S	*L*	*S*	*L*	*S*	*L*	*S*	*L*
Seated at rest	115	90	25	80	35	75	40	65	50
Office work	140	100	40	90	50	80	60	70	70
Standing	150	105	45	95	55	82	68	72	78
Eating in restaurant	160	110	50	100	60	85	75	75	85
Light work in factory	235	130	105	115	120	100	135	80	155
Dancing	265	140	125	125	140	105	160	90	175