BITS, Pilani –Dubai

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

IV Year I Semester 2009-2010

COMPREHENSIVE EXAMINATION [CLOSED BOOK]

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

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

Date: 28-12-2009 **Duration:** 3HRS

Notes:

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

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1a) Explain the necessity of cooling the Aeroplane:- **[4M]**

b) Analyze the actual ***Bell-Coleman Air refrigeration*** cycle **[4M]**

c) A dense air refrigeration machine operates on reversed Brayton cycle and is required for 10 tonnes of refrigeration capacity. The cooler pressure is 4.2 bar and refrigerator pressure is 1.4 bar. The air is cooled in the cooler to a temperature of 50^0C and the temperature of air at inlet to the compressor is -20^0C. For an ideal cycle, determine the following:

(i) COP of the system

(ii) Mass of air circulated per minute

(iii) Theoretical piston displacement of the compressor

(iv) Net power per ton of refrigeration, Show the cycle on P-v and T-s diagrams. **[8M]**

2a) Enumerate the ***Merits & Demerits*** of Vapour Compression refrigeration system over Air refrigeration system **[5M]**

b) A simple refrigerant R134a heat pump for heating operates between temperature limits of 15^0C and 50^0C. The heat required to be pumped is 100 MJ/h. Determine:

(i) Dryness fraction of refrigerant entering the evaporator.

(ii) The discharge temperature assuming the specific heat of vapor as 0.996 kJ/kg.K

(iii) COP **[8M]**

3a) Explain the principle of Vapour Absorption refrigeration system:- **[5M]**

b) What is the importance of Hydrogen in Electrolux Refrigerator ? **[3M]**

c) Explain Alternative Refrigerants:- **[4M]**

4a) Explain with diagram the ***Winter Air conditioning*** **[5M]**

b) Explain ***Vasodilation*** & ***Vasoconstriction*** **[4M]**

5. An Air-Conditioning system is to be designed for a **small Restaurant** when the following data is available:-

Transmission gain through Doors, Glass, Roof & Floor = 15000 kJ/hr

Solar transmission through Walls, Roof & Floor = 16000 kJ/hr

Solar Heat gain through glass = 7000 kJ/hr.

Equipment sensible heat gain = 10500 kJ/hr

Equipment Latent heat gain = 2500 kJ/hr

Infiltrated air flow = 400 m^3/hr

The Hall seating capacity = 50

Servants serving meals = 5

Sensible heat gain per diner : 250 kJ/ h

Latent heat gain per diner : 260 kJ/ h

Outside Design conditions : 35^0C DBT and 26^0C WBT

Inside design conditions : 25^0C and 55% RH

By pass factor of the coil is 0.15

Find the **Room Sensible & Latent heat load** and **total load** in tons in the Restaurant **[18M]**

6. Find the Duct sizes by ***Equal friction Method*** for the duct layout shown below.

Assume velocity in main duct A is 300 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]**

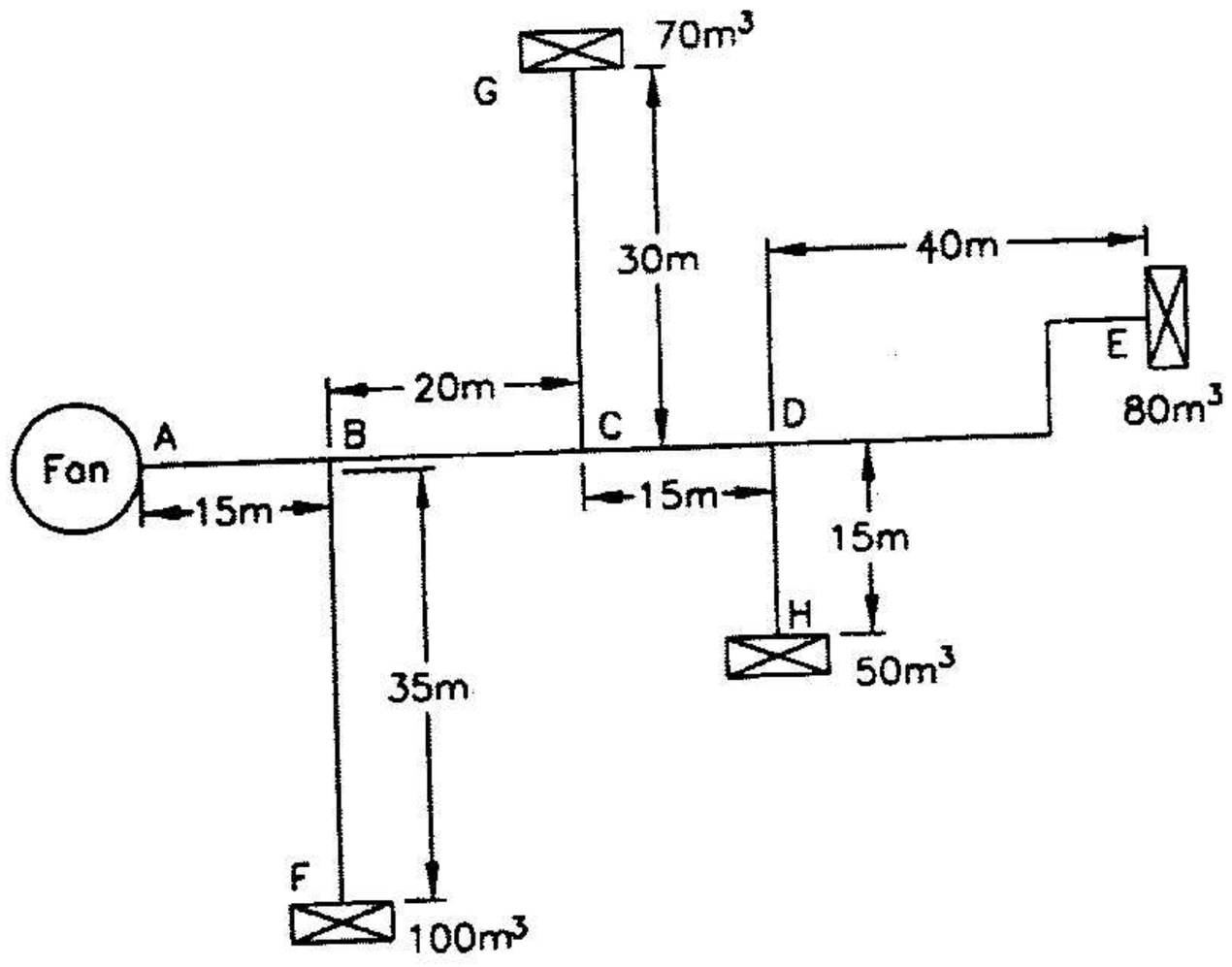

TABLE 16.2 VENTILATION AIR REQUIREMENT

Application	Smoking Status	Recommended cmm/Person	Minimum	
			cmm/ person	cmm/m floor area
Apartments	Some	0.56	0.28	—
Offices and factories	Occasional-Som	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	—	—

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

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

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COMPREHENSIVE EXAMINATION **[CLOSED BOOK]**

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

Date: 28-12-2009 **Duration:** 3HRS

1a. Write the necessary details of external and internal heat sources :- 4 marks

1b. Draw the T-s or h-s diagram and explain 4 marks

1c. Representation of the process in T- S/ P-v diagram 1 mark

COP = 2.68 1.5 marks

Mass of air circulated/min = 114 kg/min 1.5 marks

Theoretical piston displacement = 59.3 m^3/min 2 marks

Net power /ton = 1.3 kW 2 marks

2a. .Merits 2 marks

Demerits 2 marks

2b. Dryness fraction = 0.2675 2 marks

Discharge temperature = 327.15 K(54^{0}C) 2 marks

COP= 8.1 2 marks

3a. Explain with figure 2 marks

3b. Hydrogen is the third fluid in the system remains mainly in the evaporator thus reducing the partial pressure of the refrigerant to enable it to evaporate at low pressure and hence at low temperature. 2 marks

3c. write the necessity of alternative refrigerant like R290 2 marks

4a. explain with diagram 2 marks

4b)

In summer, the body temperature has a tendency to rise since the stored energy S is positive. The blood flow rate through the extremities increases, and the body starts perspiring. This is called the condition of *vasodilation*. In winter, the temperature tends to fall, the stored energy may be negative and the blood flow rate through the extremities becomes low. This leads to the condition of *vasoconstriction* resulting in shivering.

5.

a) **SENSIBL HEAT LOAD**

1. Transmission gain		= 15000 kJ/hr	= 4.16 kW
2. Solar transmission		= 16000 kJ/hr	= 4.44 kW
3. Solar Heat gain		= 7000 kJ/hr	= 1.94 kW
4. Infiltration	= [400/60] x 10x 20.4	= 6.6x10x20.4 = 1360W	= 1.36kW
5.People		= 55 x 80 = 4400W	= 4.40kW
6.Equipment		= 10500 kJ/hr	= 2.90kW

		Subtotal	= 19.21kW
Safety Factor (5%)			= 0.9605kW

Room sensible heat (Total)			= 20.17kW
Supply duct + leakage 5.5%)		= 1.10kW	= 1.10kW

Ventilate air = 0.4 x 55 = 22 cmm

Outdoor air By passed = 22 cmm x 10 x 20.4 x0.15 = 673 W = 0.673 kW

EFFECTIVE ROOM SENSIBLE HEAT = 20.17 + 1.10 + 0.673 = 21.94 kW 9 Marks

b) LATENT HEAT LOAD :

1.	Infiltration = (400/60) x 0.0052 x 50000		= 1.733 kW
2.	People = 55 x80		= 4.40kW
3.	Equipment	= 2500 kJ/hr	= 0.69kW

		Subtotal	= 6.82 kW
	Safety factor (5%)	= 0.34 kW	= 0.34 kW
	Room Latent Heat (Total)		= 7.16 kW
	Supply Duct + Leakage (0.5%) =		= 0.035kW
	Out door Air by passed	= 22 cmm x0.0052 x50000 x0.15	= 0.850kW

EFFECTIVE ROOM LATENT HEAT = 7.16 + 0.035 + 0.85 = 8.04 kW 9 Marks

6.

Section	A	B	C	D	E	F	G	H
Q (m^3/s)	5	3.33	2.16	1.33	1.33	1.66	1.16	0.83
L(m)	15	20	15	40	10	35	30	15
A(m^2)	1	0.73	0.52	0.36	0.36	0.43	0.33	0.26
D(m)	1.12	0.965	0.82	0.68	0.68	0.74	0.65	0.5775
C(m/s)	5	4.56	4.15	3.69	3.69	3.86	3.51	3.19
Pv (mm of water)	1.53	1.27	1.05	0.83	0.83	0.91	0.75	0.62

10 Marks

$\frac{\Delta P_f}{L} = \frac{0.002268Q^{1.852}}{D^{4.973}}$ **=0.025 mm of water**

∆ Pf= .025 x 90 =2.25 mm of water

Dynamic pressure drops = 0.2325 + 0.19 = 0.425

VP= 0.83 +SP (3.0) = 3.83

Total = 4.255 mm of water

Total pressure at Fan out let = 2.25 + 4.255 = 6.505 mm of water **2 Marks**

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IV Year I Semester 2009-2010

Test No.2 (Open Book)

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

Date: 13-12-2009 **Max.Marks:** 20 **Weightage:** 20% **Duration:** 50 min.

Notes:

- Answer all the questions.
- Text Book and Hand written class notes are permitted.
- Draw neat sketches wherever necessary
- Make suitable assumptions if required and clearly state them.
- Refrigeration/Psychometric charts and Tables are permitted.

Q1. What are the advantages of using a Flash chamber in parallel with evaporator? Show that the use of flash chamber has no effect on the Thermodynamics of the cycle and power required by the system in ideal condition. **[5M]**

Q 2.A. Define the term ***'bypass factor'*** used for cooling or heating coil. **[2M]**

B. An Auditorium of 1000 seating capacity is conditioned for the given data as follows:

Outdoor conditions: 35^0C and 60% R.H.

Required Indoor conditions: 15^0C and 40% R.H

The quantity of air supplied: 0.5 m^3 / min / person

The required condition is achieved first by cooling and dehumidifying and then heating.

Find the followings:

(a) The Capacity of the cooling coil in Tons of refrigeration

(b) By-pass factor of the heating coil if the surface temperature of the coil is 22^0C.

[6M]

Q.3.A. What modification are necessary in a simple Absorption refrigeration system in order to improve the performance of the system **[3M]**

B. In an Absorption Refrigeration system, Heating, Cooling and Refrigeration take place at the temperatures of 120^0C, 30^0C and -10^0C.Find the Ideal C.O.P **[4M]**

BEST OF LUCK

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IV Year I Semester 2009-2010

Test No.1 (Closed Book)

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

Date: 25-10-2009 **Max.Marks:** 25 **Weightage:** 25% **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 **Heat engines, Refrigerator & Heat pump**: **[4M]**

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

Q 2.A. Compare different Air refrigeration system with Mach Number **[3M]**

B. An Air refrigerator working on Bell Coleman cycle takes air into the compressor at 1 bar and -5^{0}C. It is compressed in the compressor to 5 bar and cooled to 25^{0}c at the same pressure. It is further expanded in the expander to 1 bar and discharged to take the cooling load.

The isentropic efficiency of the compressor = 85 %

The isentropic efficiency of the expander = 90 %

Find the followings:

(a) Refrigeration capacity of the system if the air circulation is 40 kg/min.

(b) kW capacity of the motor required to run the compressor

(c) C.O.P of the system **[6M]**

Q.3.A. Explain **Cascading i**n refrigeration system **[4M]**

B. A vapour compression machine is used to maintain a temperature of -23^{0}C in a refrigerated space. The ambient temperature is 37^{0}C. The compressor takes in dry saturated vapour of F-12. A minimum 10^{0}C temperature difference is required at the evaporator as well as at condenser. There is no sub cooling of liquid. If the refrigerant flow rate is 1 kg/min, Find **(a)** Tonnage of refrigeration **(b)** Power requirement.

(c) C.O.P of the cycle to C.O.P of Carnot cycle **[6M]**

BEST OF LUCK

BITS, PILANI – DUBAI

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FIRST SEMESTER 2009 – 2010

QUIZ-2

Course Code: ME C461 / CHE C471 **FINAL YEAR** Date: 12-10.09

Course Title: REFRIGERATION & A/C Max Marks: 14

Duration: 20 minutes Weightage: 7%

Name: . . . . . **ID No:** . . . . . **Sec / Prog:** . . . . . .

Instructions: 1. Attempt all questions

1. Write the Chemical Name & chemical formula for **R290** & **R744** :- (2 Marks)

2. Write the **colour** of the following Refrigerants : - (2 Marks)

a) R764

b) R500

c) R22

d) R40

3. What are the Methods & Equipments fort detecting Refrigerants leakage (2 Marks)

4. Find the Chemical formula for **R11** (Write all the steps) (2 Marks)

5. Write **two** Absorbers when **water** is used as Refrigerants:- (2Marks)

6. What are the desirable properties of **Refrigerant** & **Absorber** ? (2Marks)

7. Explain **ODP** & **GWP** with examples (2Marks)

BITS, PILANI – DUBAI

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FIRST SEMESTER 2009 – 2010

QUIZ-1

Course Code: ME C461 / CHE C471 **FINAL YEAR** Date: 12-10.09

Course Title: REFRIGERATION & A/C Max Marks: 16

Duration: 20 minutes Weightage: 8%

Name: ..... **ID No:** ..... **Sec / Prog:** .....

Instructions: 1. Attempt all questions

1. Explain the difference between ***REFRIGERATION & AIR CONDITIONING*** (3 Marks)

2. Explain the effect of **liquid sub cooling** in a vapour compression refrigeration system (3 Marks)

3. What are the **merits & demerits** of Vapour compression Refrigeration system (3 Marks)

4. What is the **Standard Rating** of a Refrigeration machine ? (2 Marks)

5. Why a **throttle valve** is used in vapour compression refrigerator rather than an expansion cylinder to reduce the pressure between the condenser and evaporator (2Marks)

6. Represent vapour compression refrigeration having **superheated vapor** & **liquid sub cooling** on a P-H diagram (3Marks)