BITS, Pilani –Dubai

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

IV Year II Semester 2008-2009

COMPREHENSIVE EXAMINATION [CLOSED BOOK]

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

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

Date: 25-05-09 **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 the difference between refrigeration and air conditioning :- **[3M]**
2. What is the standard rating of a refrigeration machine ? **[3M]**
3. Explain the **Bell-Coleman Air Refrigeration** system:- **[5M]**
4. Explain the different methods of improving the **COP** of a simple vapor compression refrigeration cycle :- **[4M]**
5. Explain **Flash chamber** in a **Multi compression** refrigeration systems with help of P-H diagram **[5M]**
6. An ammonia refrigerator produces 20 tons of ice per day from and at 0^0C. The condensation and evaporation takes at 20^0C and -20^0C respectively. The temperature of vapour at the end of isentropic compression is 50^0C and there is no under-cooling of the liquid. The actual C.O.P is 70 % of the theoretical C.O.P. Determine:
   a. The **rate** of ammonia circulation
   b. The **size** of the single acting compressor when running at 240 rpm assuming L= D and volumetric efficiency of 80%

   Take latent fusion of ice = 335kJ/kg. **[8M]**
7. In an **Absorption type** refrigerator, the heat is supplied to NH_3 generator by condensing steam at 2 bar and 90% dry. The temperature to be maintained in the refrigerator is -5^0C. The temperature of the atmosphere is 30^0C. Find the **maximum C.O.P** possible of the refrigerator.

   If the refrigeration load is 20 tons and actual C.O.P is 70% of maximum COP, find the **mass** of steam required per hour. **[8M]**
8. Explain ***comfort*** Air conditioning and ***metabolic rate*** **[4M]**
9. Find the nomenclature for the Methane base Refrigerant $C_2Cl_2F_4$ **[4M]**

10. 30 m^3 of air at 15°C DBT and 13°C WBT are mixed with 12 m^3 of air at 25°C DBT and 18°C WBT. Assuming the barometric pressure of one std atmosphere, determine the DBT and WBT of the resulting mixture. **[8M]**

11.

A space to be conditioned has the following data.

Size of space	: 30 m × 30 m × 4 m high
West glass	: 15 m^2 [3 × 5 m]
South glass	: 15 m^2
Solar gain through west glass	: 508 W/m^2 at 4 p.m
Solar gain through south glass	: 38 W/m^2 at 4 p.m.
Overall heat-transfer coefficient of roof	: 2.5 W/m^2K
Overall heat-transfer coefficient of wall	: 3.5 W/m^2K
Overall heat-transfer coefficient of glass	: 6 W/m^2K
Door in E-wall	: 3 m × 2.5 m
Overall heat-transfer coefficient of door	: 1.5 W/m^2K
Equivalent temperature differentials at 4 p.m.	
E-wall	: 15°C
W-wall	: 10.5°C
N-wall	: 6.1°C
S-wall	: 10.5°C
Roof	: 17.8°C
Infiltration through window cracks	: 5.3 m^2/h/m
Infiltration through door openings	: 3 cmm/m^2
Occupancy	: 100
Sensible heat gain per occupant	: 75 W
Latent heat gain per occupant	: 55 W
Lighting	: 33.5 W/m^2 fluorescent
Outside design conditions	: 43°C DB, 27°C WB
Inside design conditions	: 25°C DB, 50% RH
Ventilation air	: 0.24 cmm/person.

Assume a suitable fan heat and bypass factor of the air-conditioning apparatus. Calculate:

(i) Room sensible heat gain.

(ii) Room latent heat gain.

[16M]

12. In the duct layout shown in Fig. below, outlets 1 and 2 deliver 20 cmm each and outlet 3 delivers 28 cmm. Select a velocity of 8 m/s in section A. Size the duct system using the **equal friction** method. Also assume dynamic los coefficient in elbow K = 0.22 and static regain factor in fitting R = 0.75(1-- R = 0.25). Static pressure at each outlet is 3 mm of water. **[12M]**

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

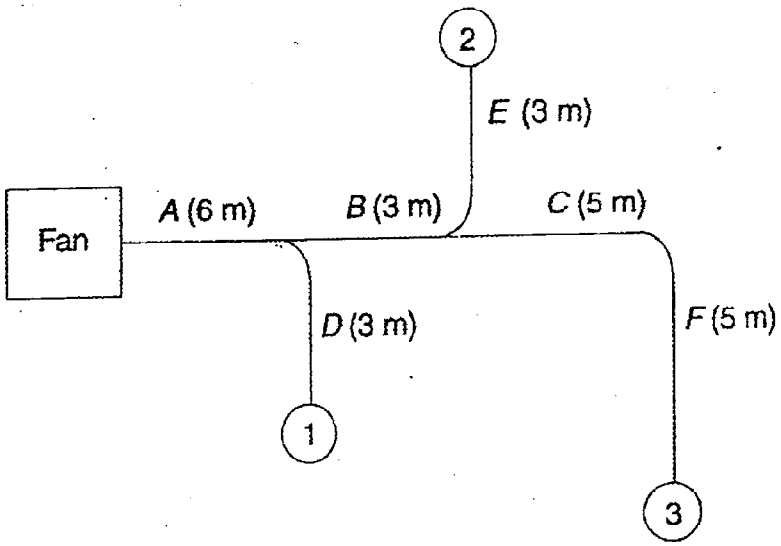

Fig: Duct

BITS, Pilani –Dubai

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

IV Year II 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: 26- 04-2009 **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*** **& Psychometric charts** are permitted

1. Saturated air at 2^0Cis required to be supplied to a room where the temperature must be held at 20^0C with RH of 50%. The air is heated and then water at 10^0C is sprayed in to give the required humidity. Determine the ***temperature*** to which the air must be heated and the ***mass*** of spray water required per m^3 of air at room conditions. Assume that the total pressure is constant at 1.013 bar and neglect the fan power **[6M]**

2. In a Lithium bromide–water Absorption ***Refrigeration*** system, heat is supplied to the generator by condensing steam at 0.3 MPa, 75% quality. The temperature to be maintained in the Refrigerator is -12^0C, and the ambient temperature is 32^0C. Estimate the ***maximum COP*** of the refrigerator.
If the actual COP is 42 % of the maximum COP and the refrigeration load is 21 tones, what will the required ***steam flow rate*** be? **[6M]**

3. How multiple pressure refrigeration system improves the coefficient of performance? **[3M]**

4. Why a throttle valve is used in vapour compression refrigeration system instead of an expansion cylinder between condenser and Evaporator? **[3M]**

5. What is the condition for DBT = WBT = DPT? **[2M]**

BITS, Pilani –Dubai

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

IV Year II 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: 15-03-2009 **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. Explain how a ***Refrigerant*** produces Cooling effect? **[2M]**

B. Write the chemical formula of ***F-113*** with steps **[3M]**

Q 2.A. Describe ***BOOT-STRAP AIR REFRIGERATION*** systems **[4M]**

B. A Bell-Coleman refrigeration cycle works between 1bar and 5 bar. The adiabatic efficiency of compression is 85% and expansion is 90%. Find out the ***COP*** of the system and its ***tonnage*** when the air flow rate is 1 kg/s. The ambient temperature is 27^0C and refrigerator temperature is 0^0C. **[6M]**

Q.3.A. What are the essential ***properties*** of a good Refrigerant? **[3M]**

B. A simple R-12 plant is to develop 5 tonnes of refrigeration. The condenser and evaporator temperatures are to be 40^0C and -10^0C respectively. Determine **(a)** the refrigerant flow rate in kg/s, **(b)** the heat rejected to the condenser in kW, **(c)** the C.O.P **(d)** the power required to drive the compressor.

How does this COP compare with that of a Carnot refrigerator operating between 40^0C and -10^0C? **[7M]**

Table A—2. Saturated Dichlorodifluoromethane (CCl_2F_2), R-12

Datum at – 40°C, $h_f = 0$, $s_f = 0$

Saturation temp. in °C (*t*)	*Saturation pressure in bar* (*p*)	*Specific volume in* (m^3/kg)		*Specific enthalpy in* (kJ/kg)			*Specific entropy in* (kJ/kg K)	
		Liquid (v_f)	*Vapour* (v_g)	*Liquid* (h_f)	*Latent* (h_{fg})	*Vapour* (h_g)	*Liquid* (s_f)	*Vapour* (s_g)
– 100	0.01185	0.000600	10.1951	– 51.84	193.84	142.00	– 0.2567	0.8628
– 95	0.01864	0.000604	6.6231	– 47.56	191.78	144.22	– 0.2323	0.8442
– 90	0.02843	0.000608	4.4206	– 43.28	189.74	146.46	– 0.2086	0.8273
– 85	0.04254	0.000613	3.0531	– 39.00	187.73	148.73	– 0.1856	0.8122
– 80	0.06200	0.000617	2.1519	– 34.72	185.74	151.02	– 0.1631	0.7985
– 75	0.08826	0.000622	1.5462	– 30.42	183.74	153.32	– 0.1412	0.7861
– 70	0.12298	0.000627	1.1314	– 26.12	181.75	155.63	– 0.1198	0.7665
– 65	0.16807	0.000632	0.8421	– 21.81	179.77	157.96	– 0.0988	0.7648
– 60	0.22665	0.000637	0.6401	– 17.48	177.77	160.29	– 0.0783	0.7558
– 55	0.30052	0.000643	0.4930	– 13.14	175.76	162.62	– 0.0581	0.7475
– 50	0.39237	0.000648	0.3845	– 8.78	173.73	164.95	– 0.0384	0.7401
– 45	0.50512	0.000654	0.3035	– 4.39	171.66	167.27	– 0.0190	0.7334
– 40	0.64190	0.000660	0.2422	0.00	169.60	169.60	0.0000	0.7274
– 38	0.70460	0.000663	0.2221	1.76	168.76	170.52	0.0075	0.7251
– 36	0.77196	0.000665	0.2040	3.53	167.91	171.44	0.0149	0.7230
– 34	0.84421	0.000667	0.1877	5.31	167.05	172.36	0.0224	0.7209
– 32	0.92776	0.000670	0.1729	7.08	166.20	173.28	0.0298	0.7190
– 30	1.00441	0.000673	0.1596	8.86	165.34	174.20	0.0371	0.7171
– 28	1.09311	0.000676	0.1475	10.64	164.47	175.11	0.0444	0.7153
– 26	1.18778	0.000678	0.1364	12.43	163.59	176.02	0.0516	0.7135
– 24	1.28858	0.000681	0.1265	14.22	162.71	176.93	0.0588	0.7118
– 22	1.39581	0.000683	0.1173	16.02	161.81	177.83	0.0660	0.7102
– 20	1.50972	0.000686	0.1090	17.82	160.91	178.73	0.0731	0.7087
– 18	1.63104	0.000689	0.1014	19.62	160.01	179.63	0.0801	0.7073
– 16	1.75963	0.000692	0.0944	21.43	159.10	180.53	0.0871	0.7059
– 14	1.89575	0.000695	0.0880	23.23	159.19	181.42	0.0941	0.7045
– 12	2.04605	0.000698	0.0821	25.05	157.26	182.31	0.1010	0.7032
– 10	2.19172	0.000701	0.0767	26.87	156.32	183.19	0.1080	0.7019
– 8	2.35272	0.000704	0.0717	28.70	155.36	184.06	0.1148	0.7007
– 6	2.52244	0.000707	0.0672	30.53	154.41	184.94	0.1217	0.6996
– 4	2.70116	0.000710	0.0630	32.37	153.43	185.80	0.1285	0.6986
– 2	2.88921	0.000713	0.0591	34.20	152.47	186.67	0.1352	0.6975
0	3.08690	0.000717	0.0555	36.05	151.48	187.53	0.1420	0.6965
1	3.18974	0.000719	0.0538	36.98	150.97	187.95	0.1453	0.6961
2	3.29513	0.000720	0.0521	37.90	150.48	188.38	0.1489	0.6956
3	3.40310	0.000721	0.0505	38.83	149.98	188.81	0.1521	0.6951
4	3.51367	0.000723	0.0490	39.76	149.47	189.23	0.1553	0.6947
5	3.62690	0.000725	0.0475	40.69	148.96	189.65	0.1568	0.6943

t	p	v_f	v_g	h_f	h_{fg}	h_g	s_f	s_g
6	3.74280	0.000727	0.0461	41.62	148.45	190.07	0.1620	0.6938
7	3.86141	0.000729	0.0447	42.56	147.93	190.49	0.1653	0.6933
8	3.98283	0.000730	0.0434	43.50	147.41	190.91	0.1686	0.6929
9	4.10702	0.000732	0.0422	44.43	146.89	191.32	0.1719	0.6925
10	4.23407	0.000734	0.0410	45.37	146.37	191.74	0.1752	0.6921
11	4.36442	0.000736	0.0398	46.31	145.84	192.15	0.1784	0.6917
12	4.49763	0.000738	0.0386	47.26	145.30	192.56	0.1817	0.6913
13	4.63386	0.000739	0.0375	48.20	144.77	192.97	0.1850	0.6909
14	4.77312	0.000741	0.0365	49.15	144.23	193.38	0.1883	0.6906
15	4.91545	0.000743	0.0355	50.10	143.69	193.79	0.1915	0.6902
16	5.06087	0.000745	0.0345	51.05	143.14	194.19	0.1948	0.6898
17	5.20942	0.000747	0.0335	52.00	142.59	194.59	0.1981	0.6894
18	5.36117	0.000749	0.0326	52.95	142.04	194.99	0.2013	0.6891
19	5.51614	0.000751	0.0317	53.91	141.47	195.38	0.2046	0.6888
20	5.67441	0.000753	0.0308	54.87	140.91	195.78	0.2078	0.6884
21	5.83635	0.000756	0.0300	55.83	140.34	196.17	0.2110	0.6881
22	6.00171	0.000758	0.0292	56.79	139.77	196.56	0.2143	0.6878
23	6.17050	0.000759	0.0284	57.75	139.21	196.96	0.2174	0.6875
24	6.34269	0.000761	0.0276	58.73	138.61	197.34	0.2207	0.6872
25	6.51840	0.000764	0.0269	59.70	138.03	197.73	0.2239	0.6868
26	6.69765	0.000766	0.0262	60.67	137.44	198.11	0.2271	0.6865
27	6.88048	0.000768	0.0255	61.65	136.85	198.50	0.2303	0.6862
28	7.06704	0.000770	0.0248	62.63	136.24	198.87	0.2335	0.6859
29	7.25738	0.000772	0.0241	63.61	135.64	199.25	0.2368	0.6856
30	7.45103	0.000775	0.0235	64.59	135.03	199.62	0.2400	0.6853
31	7.64903	0.000777	0.0230	65.58	134.41	199.99	0.2431	0.6850
32	7.85089	0.000779	0.0225	66.57	133.79	200.36	0.2463	0.6847
33	8.05662	0.000782	0.0218	67.56	133.17	200.73	0.2495	0.6845
34	8.26621	0.000784	0.0212	68.56	132.53	201.09	0.2527	0.6842
35	8.48000	0.000786	0.0207	69.56	131.89	201.45	0.2559	0.6839
36	8.69766	0.000789	0.0202	70.55	131.25	201.80	0.2591	0.6836
37	8.91904	0.000792	0.0196	71.55	130.61	202.16	0.2623	0.6833
38	9.14483	0.000794	0.0191	72.56	129.95	202.51	0.2654	0.6830
39	9.37497	0.000796	0.0186	73.57	129.29	202.86	0.2685	0.6828
40	9.60897	0.000799	0.0182	74.59	128.61	203.20	0.2718	0.6825
41	9.84793	0.000802	0.0177	75.61	127.93	203.54	0.2750	0.6822
42	10.09131	0.000804	0.0173	76.62	127.25	203.87	0.2782	0.6820
43	10.33862	0.000807	0.0168	77.65	126.56	204.21	0.2814	0.6817
44	10.59021	0.000810	0.0164	78.68	125.87	204.55	0.2846	0.6814
45	10.84655	0.000813	0.0160	79.71	125.16	204.87	0.2878	0.6811
46	11.10758	0.000815	0.0156	80.75	124.44	205.19	0.2909	0.6808
47	11.37304	0.000818	0.0153	81.79	123.72	205.51	0.2941	0.6805
48	11.64290	0.000821	0.0149	82.83	123.00	205.83	0.2973	0.6802
49	11.91724	0.000824	0.0146	83.88	122.26	206.14	0.3005	0.6800
50	12.19655	0.000827	0.0142	84.94	121.51	206.45	0.3037	0.6797

BITS, PILANI-DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
IV YEAR SECOND SEMESTER 2008-2009

CHE C471/ ME C461 REFRIGERATION & AIRCONDITIONING

QUIZ -3

DURATION: 15 MINUTES **MAXIMUM MARKS:** 10 **DATE :** 29/04/09.

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 ***mass*** of water vapour presents per kg of dry air is known as ----------
2. The quantity of heat which can be measured by measuring the dry bulb temperature of the air is known as ----------
3. The equipment used measuring the **DBT** & **WBT** simultaneously is known as ----------
4. The **removal** of water vapour from air is known as ----------
5. **SHR** for an **Auditorium** of full capacity is ----------
6. A city in India for **Summer A/C** system for **Hot** and **Humid outdoor** condition can be used is ----------
7. **Reheating** coil is used ---------- A/C system.
8. During **Sensible heating** the dew point temperature ----------
   (Decreases/ Increases/ constant)
9. The relation ship between **Bypass** Factor and **Contact** factor is ----------
10. One method employed for winter heating of air is ----------.

BITS, PILANI-DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
IV YEAR II SEMESTER 2008-2009

CHE C471/ ME C461 REFRIGERATION & AIR CONDITIONING

QUIZ -2

DURATION: 15 MINUTES **MAXIMUM MARKS:** 10 **DATE :** 24/03/09.

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. ---------- was used as **Refrigerant** for domestic and commercial purpose until Freon's were available.
2. **HALOCARBON COMPOUNDS** Invented & developed by ---------- in 1928.
3. Chemical name for **R744** is ----------
4. ---------- Refrigerant having **maximum** COP.
5. Trade name of the Refrigerant manufactured by **MAFATAL LAL & SPINNING GROUP, INDIA** is ----------
6. The colour of the Refrigerant **R-22** is ----------
7. ---------- is a **primary lubricant** for R-134a.
8. The refrigerant having **ODP** = 1 is ----------.
9. Name of the **mutli stage system** used for Liquefaction of Petroleum vapours is ---------- ----------
10. ---------- is used for the **expansion** of refrigerant in the case of flooded evaporator.

GOOD LUCK

BITS, PILANI-DUBAI

INTERNATIONAL ACADEMIC CITY, DUBAI

SECOND SEMESTER 2008-2009

CHE C471/ ME C461 REFRIGERATION & AIRCONDITIONING

[FINAL YEAR ELECTIVE]

QUIZ -1

DURATION: 15 MINUTES **MAXIMUM MARKS:** 10 **DATE :** 23/02/09.

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. An aero plane moving with 1000 km/ hr will experience --------- ^{0}C rise in temperature of the surface.
2. An aero plane of 3000KW capacity carrying 50-75 passengers requires control equipments of 10kW capacity and it requires -------- tons of refrigeration or cooling capacity.
3. Human body continuously generates heat at a rate of ----- of heat at rest.
4. The theoretical cycle used in an air refrigeration system is ---------- cycle.
5. Full form of EPR is ----------.
6. Full form of EPA is ----------.
7. ---------- --type of aircraft refrigeration system cannot be used for ground cooling.
8. ---------- type of aircraft refrigeration system is useful for supersonic aircrafts and rockets.
9. ----------statement of second law pertains to refrigerator / heat pumps.
10. A domestic refrigerator consumes ---------- watts of power

GOOD LUCK