CS/B.TECH (ME)/SEM-8/ME-815/09

1. .....
Signature of Invigilator

2. ..... **Reg. No.**
Signature of the Officer-in-Charge

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CS/B.TECH (ME)/SEM-8/ME-815/09

ENGINEERING & MANAGEMENT EXAMINATIONS, APRIL – 2009

REFRIGERATION AND AIR-CONDITIONING (SEMESTER - 8)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question**.
   b) For **Groups – B** & **C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

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Marks Obtained

	Group – A										Group – B			Group – C			*Total Marks*	*Examiner's Signature*
Question Number																		
Marks Obtained																		

.....
Head-Examiner/Co-Ordinator/Scrutineer

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ENGINEERING & MANAGEMENT EXAMINATIONS, APRIL – 2009

REFRIGERATION AND AIR-CONDITIONING

SEMESTER - 8

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

i) Which of the following statements are True ?

a) The purpose of psychrometric calculation is to fix the supply air-conditions.

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

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

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

ii) The C.O.P. of a refrigerator working on Reversed Carnot Cycle with T_1 being higher temperature & T_2 being lower temperature is

a) $\frac{T_1 - T_2}{T_1}$ b) $\frac{T_1}{T_1 - T_2}$

c) $\frac{T_2}{T_1 - T_2}$ d) $\frac{T_1 - T_2}{T_2}$.

iii) Heat is rejected by the refrigerant, during vapour compression refrigeration cycle in

a) Condenser b) Evaporator

c) Throttle valve d) Compressor.

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iv) Compound compression is adopted for refrigeration system is

a) to improve volumetric efficiency

b) to reduce mechanical work input per unit mass

c) to take care of very large pressure ratios

d) to achieve all of these.

v) For high C.O.P.

a) Critical temperature in general should be low

b) Critical temperature is general should be high

c) Critical temperature is insignificant

d) Critical pressure is important.

vi) The by-pass factor of a cooling coil decreases with

a) decreases in fin spacing and increase in number of rows

b) increase in fin spacing and increase in number of rows

c) increase in fin spacing and decrease in number of rows

d) decrease in fin spacing and decrease in number of rows.

vii) The relative humidity, during heating and humidification

a) increases b) decreases

c) may increase d) remains constant.

viii) The velocity pressure in air-conditioning ducts is given by (V in m/min, p_v in mm of water column)

a) $p_v = \frac{V^2}{240 \cdot 6}$ b) $p_v = \frac{V^2}{5788 \cdot 36}$

c) $p_v = \frac{V^2}{16 \cdot 08}$ d) $p_v = \left(\frac{V}{16 \cdot 08}\right)^2$.

ix) For rectangular ducts, the aspect ratio is equal to

a) sum of longer and shorter sides

b) difference of longer and shorter sides

c) product of longer and shorter sides

d) ratio of longer and shorter sides.

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x) Cascade systems are widely used for

a) Large refrigeration capacity systems

b) Applications requiring large temperature lifts

c) Applications requiring very high efficiencies

d) All of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Explain two stage compression with intercooling and sub-cooling by external cooling source.

3. Draw a neat diagram of 'Electrolux refrigerator' and explain its working principle. What is the important role of hydrogen in this refrigeration system ?

4. Explain by flow diagram and also on *p-h* and *T-s* charts the refrigerating system with two evaporators at different temperatures with compound compression, individual expansion valves and flash intercoolers.

5. Prove that $W = 0{\cdot}622 \frac{P_v}{P_t - P_v}$,

where P_v = Partial pressure of vapour

P_t = Total pressure of moist air

W = Humidity ratio.

6. Define aspect ratio. If Z_1 & Z_2 are constants of two resistance connected in parallel, then show that the constant of an equivalent resistance is given by

$$Z = \frac{Z_1 Z_2}{\left(\sqrt{Z_1} + \sqrt{Z_2}\right)^2} .$$

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GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following questions. 3 × 15 = 45

7. a) Prove that the equivalent dia. for circular duct to replace rectangular duct for the same velocity of flow of air is

$$d_e = 1{\cdot}265 \left(\frac{a^3 b^3}{a + b} \right)^{1/5}$$

where d_e = equivalent dia. for round duct

a = width of rectangular duct

b = breadth of rectangular duct.

b) A tunnel 1 m long is ventilated by a duct of area A and perimeter P and the frictional coefficient is f. The fresh air from the duct discharges into the tunnel through a continuous flow of air regulators which give uniform distribution of q m^3 /min per metre run of the tunnel. The total air quantity calculated is Q_0 m^3 /min and the frictional pressure drop down it is in mm of water column. Resistance of the tunnel may be neglected. Density of air in P kg/m^3 . Prove that

$$P_f = \frac{PflPQ^2}{6A^3} \quad .$$ 7 + 8

8. For a vapour compression refrigeration system using *R*-22 as refrigerant, condenser outlet temperature is 40°C and evaporator inlet temperature is – 20°C. In order to avoid flashing of refrigerant, a liquid-suction vapour heat-exchanger is provided where liquid is sub-cooled to 26°C. The refrigerant leaves the evaporator as saturated vapour. The compression process is isentropic. Find the power requirement and coefficient of performance if capacity of the system is 10 kW at – 20°C. Show cycle on pressure-enthalpy diagram. C_p of vapour is 1·03 kJ/kg K. The thermodynamic properties are given below : 15

t (°C)	p (bar)	v_f (l/kg)	v **Error!**	h_f (kJ/kg)	h **Error!**	s **Error!**	s_g (kJ/kg K)
– 20	2·448	0·741	0·0928	177·1	397·5	0·9139	1·784
26	10·723	0·840	0·0220	231·6	413·5	1·109	1·717
40	15·335	0·884	0·0151	249·7	416·6	1·167	1·699

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9. Write short notes on any *three* of the following : 3 × 5

a) Natural Refrigeration Methods

b) Thermoacoustic Method of Cooling

c) Aircraft Cooling System

d) Montreal Protocol

e) Cascade System.

10. a) Discuss the main differences between reversed Carnot Cycle operating on perfect gas and wet vapour. 5

b) An air-conditioner working on the reversed Carnot cycle has the following data :

Capacity	:	2 Tons
Temperature of heat absorption in cooling coil heat exchanger	:	5°C
Temperature of heat rejection of condenser heat exchanger	:	60°C
Temperature of air entering heat rejection heat exchanger	:	45°C
Temperature of air leaving heat rejection heat exchanger	:	55°C

Overall heat transfer coefficient of heat rejection of heat exchanger between air and working substance in the cycle : 900 kJ/hr.-m^2-K.

i) Determine the mass flow rate of entering air, area of heat exchanger, COP and work input to the air-conditioner. 5

ii) If instead of air, water is used for heat rejection and it enters the heat exchanger at 30°C and leaves at 40°C with overall heat transfer coefficient of heat rejection between water and working substance of 9000 kJ/hr.-m^2-K, determine the mass flow rate of entering water, area of heat exchanger, COP and work input. 5

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11. An air-conditioning system has volume flow rate of 7·5 m^3 /s and fan outlet velocity is 10 m/s. The duct has four branches with 90° elbows. The first branch is 10 m from fan, distance between branches is 10 m each and main duct has 90° elbow 10 m after the fourth branch. Volume flow rate in each branch is 1·5 m^3 /s. The main duct runs 10 m after the 90° bend.

i) Using equal friction method, determine the equivalent diameter of duct and dimensions of rectangular duct if one side of the duct is 0·5 m.

ii) Determine the total pressure drop. Given,

$$\frac{\Delta p_f}{L} = \frac{0{\cdot}002268\,(Q)^{1{\cdot}852}}{(D)^{4{\cdot}973}} \text{ mm } H_2O$$

$$p_v = \left(\frac{C_2}{4{\cdot}04}\right)^2 \text{ mm } H_2O$$

$$D = \frac{1{\cdot}3\,(ab)^{0{\cdot}625}}{(a+b)^{0{\cdot}25}}$$

Elbow loss = 0·25 p_v

Straight through section loss = 0·25 × difference of velocity pressures

(Fitting losses where changes in area occur)

Dynamic loss in branch = 0·2 p_v + elbow loss. 15

END

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