

INDIAN INSTITUTE OF TECHNOLOGY

Mechanical Engineering Department

MEL-710

Air-conditioning

Dated: 08.05.2007

Time: 2 hour

Major Test

Max Marks: 35

-
- Note: 1. Do four questions in all, question no. 1 is compulsory.
2. Use of Refrigerant charts and tables is allowed
-

- Q.1 (a) One of the many methods used for drying air is to cool the air below the dew point so that condensation of the moisture takes place. To what temperature must atmospheric ($p=1.0132$ bar) air be cooled in order to have a humidity ratio of 0.000017 kg/kg of dry air. To what temperature must this air be cooled if its pressure is 10 bar.
- (b) On rather cold morning the breath exhaled by a man appears as a 'fog'. If the breath is at 37°C and contains on an average about 20g of moisture per kg of dry air. Estimate the maximum ambient temperature which would cause the fog formation.
- (c) How is regulatory function of a capillary in a window type air-conditioner accomplished? Explain the starving and flooding conditions in the evaporator.
- (d) State the main heat loads which you would like to consider for a large (400 student) capacity class room while estimating the cooling loads.
- (e) Explain in brief with the help of line diagram, the principle of working of control system for a central air-conditioning unit based on Face and Bypass dampers.
- (2 + 2 + 2 + 2 + 3)**

- Q.2 (a) Explain the mechanism of heat and mass transfer from unsaturated air to a finned wetted surface. Derive an expression for total heat transfer from unsaturated air to wetted surface. Explain the assumption made if any.
- (b) Describe in brief the distribution pattern of supply air in case of ceiling and high sidewall grill diffusers for cooling and heating applications. Clearly show the stagnation zones and indicate their suitability.
- (5 + 3)**

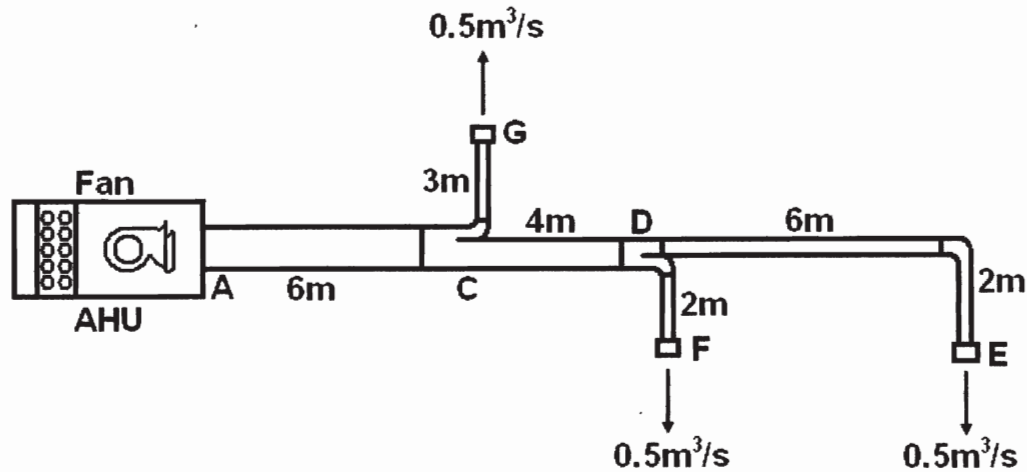
- Q.3 An air-conditioning system is to be designed for a retail store. The following information is available:

Outside design conditions	:	38°C dbt ; 25°C wbt
Inside design conditions	:	25°C dbt ; 50 % RH
Space sensible load	:	104 kW
Space latent load	:	51kW
Outside air required for ventilation	:	$1.65\text{ m}^3/\text{s}$

A direct - expansion coil with a bypass factor of 0.08 will be used. Show the process on a psychrometric chart and determine the following:

- (a) The temperature of mixed air entering the coil.
 - (b) Coil ADP.
 - (c) Moisture removal per kg of supply air.
 - (d) Refrigeration capacity in kW.
- (8)

Q.4 An air handling unit (AHU) serves three rooms in one apartment. The schematic layout of the duct system together with the volume flow-rate to each room is shown in Fig. 1.



- (a) Size the duct using Equal-Friction method. The air velocity in the first section is not to be exceed 10 m/s.
 - (b) Calculate the static pressure to be developed by the fan. The losses at outlet and other fitting are as follows:
 - Each Outlet : 20 Pa
 - For elbow : $0.20 P_{v2}$
 - For branch : $0.15 P_{v2} + \text{Elbow loss}$
 - For straight through section: $0.25 \times \text{Difference of velocity pressure}$
- (5 + 3)

Q.5 A fan supplies air to a space through a duct system. The fan characteristics are given in Table 1. The system has a total pressure loss of 450 N/m^2 when handling $3 \text{ m}^3/\text{s}$ of air.

Table 1. Fan Characteristics

Flow, m^3/s	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5
FTP, N/m^2	350	385	410	427	433	424	400	343
Power, kW				1.185	1.354	1.537	1.715	
Efficiency, %				54	64	69	70	

- (a) Calculate the quantity of air handled, total pressure developed, power consumption and efficiency of the fan.
 - (b) The filter in the above fan-duct system offers a pressure drop of 90 N/m^2 for an air flow of $3 \text{ m}^3/\text{s}$. Find the fan power consumed in the filter.
- (6 + 2)