

Total No. of printed pages = 6

ME 1818 PE 21

9/6/23

Roll No. of candidate

| | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|

2023

Bina Chowdhury Central Library
Girijananda Chowdhury University
Hatkhowapara, Azara, Ghy-17

B.Tech. 8th Semester End-Term Examination

Mechanical Engineering

AIR CONDITIONING

New Regulation (w.e.f. 2017-2018) & New syllabus (w.e.f. 2018-2019)

Full Marks – 70

Time – Three hours

Answer all questions

Use of Psychrometric charts are permitted.

The figures in the margin indicate full marks for the questions.

Answer question No.1 and any four from the rest.

1. Answer the following: (MCQ/Fill in the blanks) (10 × 1 = 10)
- (i) For air at a given temperature, as the relative humidity is increased isothermally,
- (a) the wet bulb temperature and specific enthalpy increase
 - (b) the wet bulb temperature and specific enthalpy decrease
 - (c) the wet bulb temperature increases and specific enthalpy decreases
 - (d) the wet bulb temperature decreases and specific enthalpy increases
- (ii) Which of the following are normally desired comfort conditions in an air-conditioning system?
- (a) 25°C DBT and 50% RH
 - (b) 22°C DBT and 90% RH
 - (c) 15°C DBT and 75% RH
 - (d) 15°C DBT and 40% RH

[Turn over

- (iii) The effective temperature is a measure of the combined effects of
- (a) Dry bulb temperature and relative humidity
 - (b) Dry bulb temperature and air motion
 - (c) Wet bulb temperature and air motion
 - (d) Dry bulb temperature, relative humidity and air motion
- (iv) During chemical dehumidification process of air
- (a) dry bulb temperature and specific humidity decrease
 - (b) dry bulb temperature increases and specific humidity decreases
 - (c) dry bulb temperature decreases and specific humidity increases
 - (d) dry bulb temperature and specific humidity increase
- (v) If the volume of moist air with 50% relative humidity is isothermally reduced to half its original volume, then relative humidity of moist air becomes
- (a) 25%
 - (b) 60%
 - (c) 75%
 - (d) 100%
- (vi) Evaporative air-cooler is used effectively when
- (a) dry bulb temperature is very close to the wet bulb temperature
 - (b) dry bulb temperature is high and relative humidity is high
 - (c) dry-bulb temperature is low and relative humidity is high
 - (d) dry bulb temperature is high and the relative humidity is low.
- (vii) The latent heat load in an auditorium is 25% of the sensible heat load. The value of sensible heat factor (S H F) is equal to
- (a) 0.25
 - (b) 0.5
 - (c) 0.8
 - (d) 1.0
- (viii) In the case of sensible cooling of air, the coil efficiency is given by (BPF = Bypass factor)
- (a) BPF-1
 - (b) 1 -BPF
 - (c) BPF
 - (d) 1 + BPF

Bina Chowdhury Central Library
Girijananda Chowdhury University
Hatkhowapara, Azara, Ghy-17

(ix) In the case of a cooling coil with non-zero bypass factor, the apparatus, dew point temperature lies at the intersection point of

- (a) room DB line with the saturation curve
- (b) RSHF and GSHF lines
- (c) RSHF and ESHF lines
- (d) GSHF line with the saturation curve

(x) For an air-conditioned space, RTH = 100 kW, RSHF = 0.75, volume flow rate = 100 m³/min, and indoor design specific humidity is 0.01 kg/kg of dry air. What is the specific humidity of the supply air?

- (a) 0.010
- (b) 0.0075
- (c) 0.005
- (d) 0.0025

2. (a) Define the following

- (i) Absolute humidity
- (ii) Dew point temperature.

Bina Chowdhury Central Library
Girijananda Chowdhury University
Hatkhowapara, Azara, Ghy-17

(4)

(b) Show the following processes on the skeleton psychrometric chart:

- (i) Dehumidification of moist air by cooling ; and
- (ii) Adiabatic mixing of two air streams.

(4)

(c) The humidity ratio of atmospheric air at 28°C dry bulb temperature and 760 mm mercury is 0.016kg 1 kg of dry air. (Use only steam table)

(7)

Determine:

- (i) partial pressure of water vapour
- (ii) relative humidity
- (iii) dew point temperature
- (iv) specific enthalpy; and
- (v) vapour density.

3. (a) What is 'effective temperature'? What factors affect effective temperature? (5)
- (b) Moist air at 30°C dry-bulb temperature and 50% rh enters a cooling coil at 5 m³/s and is processed to a final saturation condition at 10°C. Find the kW of refrigeration required. (5)
- (c) A stream of 2 m³/s of outdoor air at 4°C dry-bulb temperature and 2°C thermodynamic wet-bulb temperature is adiabatically mixed with 6.25 m³/s of recirculated air at 25°C dry-bulb temperature and 50% RH. Find the dry-bulb temperature and thermodynamic wet-bulb temperature of the resulting mixture. (5)

4. (a) Define room sensible heat factor. How room sensible heat factor line is drawn on the psychometric chart? (3)
- (b) The following data refer to an air-conditioning system of a cinema hall for winter conditions:

Outdoor conditions = 10°C DBT, 60% RH

Required comfort conditions = 22°C DBT, 60% RH

Seating capacity = 2000

Amount of outdoor air supplied — 0.25 m³/min/person

The required condition is achieved by heating, humidifying and then again by heating. The air coming out of the humidifier is having 75% relative humidity.

Find: (a) the heating capacity of the first heater in kW and the surface temperature of the coil if its by-pass factor is 0.3; (b) the capacity of the humidifier in kg/h; and (c) the heating capacity of the second heater and its by-pass factor, if the surface temperature of the coil is 25°C. (12)

5. (a) What are the factors affecting comfort air conditioning. (2)
- (b) An air conditioning system is designed for a restaurant when the following data is available: (13)

Total heat flow through the walls, roof and floor = 6.2 kW

Solar heat gain through glass = 2 kW

Equipment sensible heat gain = 2.9 kW

Equipment latent heat gain 0.7 kW

Total infiltration air = 400 m³/h

Outdoor conditions = 35 °C DBT; 26 °C WBT

Inside designed conditions = 27 °C DBT, 55% RH

Minimum temperature of air supplied to room = 17 °C DBT

Total amount of fresh air supplied = 1600 m³/h

Seating chairs for dining = 50

Employees serving the meals = 5

Sensible heat gain per person = 58 W

Latent heat gain per sitting person = 44 W

Latent heat gain per employee = 76 W

Sensible heat added from meals = 0.17 kW

Latent heat added from meals = 0.3 kW

Bina Chowdhury Central Library
Girijananda Chowdhury University
Hatkhowapara, Azara, Ghy-17

Motor power connected to fan = 7.6 kW

If the fan is situated before the conditioner, then find the following:

- (i) Amount of air delivered to the room in m³per h;
- (ii) Percentage of recirculated air;
- (iii) Refrigeration load on the coil in tonnes of refrigeration; and
- (iv) Dew point temperature of the cooling coil and by-pass factor.

6. (a) What are the different methods of air conditioning duct design? Why are dampers required in some systems? (3)
- (b) The main air supply duct of an air conditioning system is 800 mm × 600 mm in-cross-section, and carries 300m³/min of standard air. It branches into two ducts of cross-section 600 mm × 500 mm and 600mm × 400 mm. If the mean velocity in the larger branch is 480 ml mm, find: (i) mean velocity in the main duct and the smaller branch, and (ii) mean velocity pressure in each duct. (5)
- (c) A rectangular duct section of 500 mm × 350 mm size carries 75 m³/min of air having density of 1.15 kg/m³ Determine the equivalent diameter of a circular duct if (i) the quantity of air carried in both the cases is same, and (ii) the velocity of air in both the cases is same. If $f = 0.01$ for sheet metal, find the pressure loss per 100 m length of duct. (7)

7. (a) What do you understand by a geometrically similar fan? Discuss the various fan similarity laws. (5)
- (b) A fan for the ventilation plant is to be exported to an area where the air density is 0.96 kg/m^3 and is scheduled to deliver $6 \text{ m}^3/\text{s}$ against a static pressure of 50 mm of water, with a static efficiency of 65 per cent. If it is driven by a constant speed motor, calculate the static pressure and shaft power in the maker's works where the air density is 1.2 kg/m^3 . (5)
- (c) Write a brief note on different types of temperature sensors used in air conditioning system. (5)

Bina Chowdhury Central Library
Girijananda Chowdhury University
Hatkhowapara, Azara, Ghy-17

Bina Chowdhury Central Library
Girijananda Chowdhury University
Hatkhowapara, Azara, Ghy-17