

**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**  
**Second Semester (2021-2022)**  
**ME F461 Refrigeration and Air-conditioning**  
**Comprehensive Semester Examination – Regular - (Closed Book)**

**Friday, May 20, 2022 (8:00 - 11:00 A.M.)**

**Max Marks = 60**

**Maximum Duration: 2.30 Hours**

**PART B**

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**Instructions**

- Carry only thermodynamic/refrigeration property tables only.
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1. A rectangular duct 0.15 m by 0.12 m is 20 m long and carries standard air at the rate of 0.3 m<sup>3</sup>/s. Calculate the total pressure required at the inlet to the duct in order to maintain this flow and the air power. Assume that for the duct, the friction factor ( $f$ ) = 0.005. [10]

2. 800 m<sup>3</sup>/min of recirculated air at 22°C DBT and 10°C dew point temperature is to be mixed with 300 m<sup>3</sup>/min of fresh air at 30°C DBT and 50% RH. Determine the enthalpy, specific volume, humidity ratio and dew point temperature of the mixture. [10]

3. A vapour compression refrigeration plant works between pressure limits of 5.3 bar and 2.1 bar. The vapour is superheated at the end of compression, its temperature being 37°C. The vapour is superheated by 5°C before entering the compressor.

If the specific heat of superheated vapour is 0.63 KJ/kg K. Find the coefficient of performance of the plant. Use the data given below: [5]

Pressure, Bar	Saturation temperature, °C	Liquid heat, kJ/kg	Latent heat, kJ/kg
5.3	15.5	56.15	144.9
2.1	-14.0	25.12	158.7

4. (a) Discuss in details, the secondary refrigerant. [2]

(b) What if R-22 or R-290 is used as a drop-in substitute in R-12 refrigerator? [3]

5. The following data refer to a LiBr + H<sub>2</sub>O absorption system:

Generator temperature = 80°C

T<sub>condenser</sub> = T<sub>absorber</sub> = 30°C

Evaporator temperature = 10°C

Condensate temperature = 25°C

Steam enters the generator heating coil at 120°C (dry-saturated state steam) and leaves it at 100°C as condensate.

Concentration of liquid leaving generator is 0.65 and its enthalpy -75 kJ/kg, concentration of liquid leaving absorber is 0.51 and its enthalpy -170 kJ/kg. Enthalpy of vapour leaving generator is 2620 kJ/kg. Flow rate through evaporator is 0.4 kg/s. Determine the following:

- (i) Pressure in generator, condenser, evaporator and absorber in mm of mercury head;
- (ii) Tonnage
- (iii) Heat rejection to condenser and absorber;
- (iv) Rate of mass leaving absorber;
- (v) C.O.P.

[20]

6. An ice plant using NH<sub>3</sub> as refrigerant works between -15°C and 35°C and produces 10 tons of the ice per day from water supplied at 30°C. The ice temperature is -5°C. Assuming simple saturated cycle and using the following properties of NH<sub>3</sub>, determine

- (i) the capacity of the refrigeration system required.
- (ii) the mass flow rate of refrigerant.
- (iii) the diameter and stroke of the compressor cylinder if its speed is limited to 1200 r.p.m. Take L/D = 1.2 and volumetric efficiency of the compressor = 0.65.
- (iii) the power of the motor required to run the compressor if the isentropic efficiency is 85% and mechanical efficiency of 95%.
- (iv) the theoretical and actual COP.

Pressure, (bar)	Saturation temperature, (°C)	Specific Enthalpy, (kJ/kg)		Specific Entropy, (kJ/kg K)		Specific volume
		Liquid	Vapour	Liquid	Vapour	
2.36	-15	112.3	1426	0.457	5.549	0.509
13.5	35	347.5	1471	1.282	4.930	0.096

[10]

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