

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
Second Semester (2022-2023)
ME G513 Heating and Cooling of Buildings
Mid Semester Examination – Regular - (Closed Book)

Tuesday, March 16, 2023 (11:00 am- 12:30 pm)

Max Marks = 60

Duration 90 min

Instructions

- There are 6 questions in this paper. Question paper is printed on both sides.
- Only thermodynamic and refrigeration property tables should be used.

1. (a) Among R-12, R-22 and R-21 systems, which one requires an oil separator and why?
 (b) Among R-11, R-12, R-21 and R-22 which are best suited for centrifugal compressors and why?
 (c) Why is evaporator pressure kept above atmospheric in most refrigeration systems?
 (d) Explain the terms briefly: (i) Azeotropic mixture, (ii) Near-azeotropic refrigerant mixtures, and (iii) Non-Azeotropic refrigerant mixtures **[10 Marks]**
2. Find the theoretical C.O.P. for CO₂ refrigerator working between the temperature limit range of 25°C and -5°C. The dryness fraction of the CO₂ gas during the suction stroke is 0.6.

Temperature	Liquid		Vapour		Latent Heat h _{fg} (kJ/kg)
	h _f (kJ/kg)	s _f (kJ/kg K)	h _g (kJ/kg)	s _g (kJ/kg K)	
25°C	81.23	0.251	202.7	0.6297	121.423
-5°C	-7.54	-0.042	237.0	0.842	245.4

[8 Marks]

3. Consider a two-stage cascade refrigeration system operating between the pressure limits of 1.4 MPa and 160 kPa with refrigerant-134a as the working fluid. Heat rejection from the lower cycle to the upper cycle takes place in an adiabatic counter-flow heat exchanger where the pressure in the upper and lower cycles are 0.4 and 0.5 MPa, respectively. In both cycles, the refrigerant is a saturated liquid at the condenser exit and a saturated vapor at the compressor inlet, and the isentropic efficiency of the compressor is 80 percent. If the mass flow rate of the refrigerant through the lower cycle is 0.11 kg/s, determine (a) the mass flow rate of the refrigerant through the upper cycle, (b) the rate of heat removal from the refrigerated space, and (c) the COP of this refrigerator. **[20 Marks]**

4. 0.004 kg of water vapour per kg of atmospheric air is removed and temperature of air after removing the water vapour becomes 20°C. Determine without using psychometrics chart: (i) Relative humidity, and (ii) Dew point temperature. Assume that the condition of atmospheric air is 30°C and 55% R.H. and pressure is 1.0132 bar. **[7 Marks]**

5. Saturated air at 19°C is passed through a drier so that its final relative humidity is 25%. The drier uses silica gel adsorbent. The air is then passed through a cooler until its final temperature is 19°C DBT without change in specific humidity. Determine the following using psychometrics chart: (i) Temperature of air at the end of the drying process, (ii) heat rejected during the cooling process, (iii) relative humidity at the end of cooling process, (iv) dew point temperature at the end of the drying process, and (v) moisture removed during the drying process. **[15 Marks]**
