B. E. MECHANICAL ENGINEERING (PART TIME) FOURTH YEAR
SECOND SEMESTER (Old) EXAM-2018

REFRIGERATION AND AIR CONDITIONING **Time -- Three hours** **Full Marks – 100**

Answer any 5(Five) questions. All questions carry equal marks.
Use of Refrigerant tables, Steam tables and psychometric chart are permitted.
Attach the Psychometric chart used for solving problems on air-conditioning with the answer sheet.

Q.1.a) A reversed Carnot cycle air-conditioner of 10 TR capacity operates with cooling coil temperature $t_0=5^0C$. The surrounding air at 43^0C is used as a cooling medium rising to 53^0C. The temperature of heat rejection is $t_k=55^0C$. The overall heat transfer coefficient of the heat exchanger between the working substance and the surrounding air is $U=250\ W/m^2K$. Determine the mass flow rate of the surrounding air entering the heat exchanger, area of the heat exchanger, COP and power consumption of the air conditioner and the heat rejected per second. 15

b) For a refrigerator and a heat pump working between the same two temperatures following the reversed Carnot cycle, prove that the COP of the heat pump will be larger that the COP of the refrigerator and find their difference. 05

Q.2.a) A Freon 12 refrigerator operating in simple saturated vapour compression cycle operates at temperatures of 40^0C and 0^0C for the condenser and evaporator respectively. Determine the COP and HP/TR of the system. Use refrigerant table for Freon 12. 10

b) Discuss the effects of subcooling of the refrigerant in the condenser on the performance of a simple saturated vapour compression refrigeration cycle. 10

Q.3.a) Dry saturated steam at 4 bar is used in the generator of vapour absorption system. The evaporator is maintained at -5^0C. The circulating cooling water rejects heat at 30^0C in the condenser. Determine $(COP)_{max}$ for the system. Also, if the steam leaves the generator as saturated liquid, determine the consumption of steam per hour for 15 TR refrigeration plant. Assume relative COP as 0.4. 10

b) Compare between vapour compression refrigeration and vapour absorption refrigeration systems. 10

Q.4.a) Derive the expression of maximum COP obtainable from a vapour absorption refrigeration system. 10

b) Moist air, at 760 mm Hg for exists at 30^0C DBT and 60% Relative Humidity. Find the following (without using the psychrometric chart):
i) Percentage Humidity
ii) Specific humidity
iii) Dew point temperature 10

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Q.5.a) Derive the expression of COP of a reversed Brayton cycle air refrigeration system. 10

b) A refrigerator unit working on Bell-Coleman cycle takes air from cold chamber at -5^0C and compresses it from 1 bar to 5 bar with index of compression being 1.4. The compressed air is cooled to a temperature of 30^0C before it is expanded in the expander where the index of expansion is 1.4.
Determine:
i) The COP of the refrigerator unit
ii) The quantity of air circulated per minute for production of 1000Kg of ice per day at 0^0C from water at 20^0C.
iii) The capacity of the plant in tons of refrigeration
Assume for air C_p=1KJ/KgK and R=0.287KJ/KgK.
Take the enthalpy of freezing of ice=335KJ/Kg and the specific heat of water=4.1868KJ/KgK. 10

Q.6.a) 39.6 cubic meter per minute of a mixture of recirculated room air and outdoor air enter a cooling coil at 31^0C DB and 18.5^0C WB temperatures. The effective surface temperature of the coil is 4.4^0C. The surface area of the coil is such as would give 12.5 kW of refrigeration with the given entering air state. Determine the dry and wet bulb temperatures of the air leaving the coil and the coil bypass factor. 10

b) With a neat sketch of the psychrometric chart explain the Cooling and Dehumidification process. Explain Bypass factor of the cooling coil. 10

Q.7. Write short notes on (any two of the following):-
a. Liquid refrigerant-suction vapour heat exchanger.
b. Sensible cooling process and Sensible heating process.
c. Thermostatic expansion valve.
d. Comparison between Dry compression and Wet compression processes. 10+10

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