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MANIPAL INSTITUTE OF TECHNOLOGY
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VII SEMESTER B.TECH (MECHANICAL ENGINEERING)

END SEMESTER (MAKE UP) EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: REFRIGERATION AND AIR CONDITIONING [MME 469]

REVISED CREDIT SYSTEM

Time: 3 Hours. MAX.MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Use of Thermodynamic data hand book is permitted
- Missing data may be suitable assumed.

1A. With schematic and T-s diagram, obtain an expression for COP of Bell-Coleman refrigeration cycle when the compression and expansion are polytropic. **5**

1B. A boot-strap air refrigeration system of 10TR capacity is used for an aero plane to take up cabin load. The ambient air pressure and temperature are 0.9 bar and 15^0C. The ram air pressure is 1.1bar. The pressure of air after isentropic compression in the main compressor is 3.5 bar and after isentropic compression in auxiliary compressor is 4.5 bar. Assuming the effectiveness of both heat exchangers as 0.6, find the power required for refrigeration system and COP, if the cabin is to be maintained at 25^0C and 1 bar. **5**

2A. Explain with sketch, working of two stage cascade refrigeration system. What are its advantages? **5**

2B. A refrigerant R22 vapor compression system includes a liquid-to-suction heat exchanger in the system. The heat exchanger warms saturated vapor coming from the evaporator from -10^0 to 5^0 C with liquid which comes from the condenser at 30^0C. The compressions are isentropic in both cases listed below. (a) Calculate the coefficient of performance of the system without the heat exchanger but with the condensing temperature at 30^0C and an evaporating temperature of -10^0C. (b) Calculate the coefficient of performance of the system with the heat exchanger? (c) If the compressor is capable of pumping 12L/s measured at the compressor suction, what is the refrigeration capacity of the system without the heat exchanger? (d) With the same compressor capacity as in (c) what is the refrigerating capacity of the system with the heat exchanger? **5**

3A. Obtain an expression for mass flow of refrigerant to the compressors and COP for a two stage vapor compression refrigeration system with flash gas

removal and water intercooling with the help of schematic and P-h diagram **5**

3B. A 2 stage compression NH_3 refrigeration system operates between overall pressure limits of 16bar and 2 bar. The temperature of the de-superheated vapour and subcooled liquid refrigerant are maintained at 30^0C. The de-superheated vapour is mixed with vapour from flash chamber before going to HPC. The flash tank separates dry vapour at 5 bar and the liquid refrigerant then expands to 2 bar. Estimate the COP of the machine and the power required to drive the compressor, if the mechanical efficiency of the drive is 80% and the load on the evaporator is 20TR. **5**

4A. Explain with neat sketch, working of vapour absorption refrigeration system using lithium bromide as absorbent. Obtain an expression for heat transfer in absorber, generator and heat exchanger **5**

4B. The refrigeration system using R12 as refrigerant consists of 3 evaporators of capacities 10 TR, 30TR and 20 TR with individual compressors and individual expansion valves. The temperatures in the 3 evaporators are to be maintained at -10^0C, 5^0C and 10^0C. The vapors leaving the evaporators are dry and saturated. The condenser temperature is 40^0C and the liquid leaving the condenser is sub-cooled to 30^0C. Assuming isentropic compression in each compressors, find;
(i) The mass of refrigerant flowing through each compressor (ii) Power required to drive the system (iii) COP **5**

5A. Explain the working of summer air conditioning system with outdoor air for ventilation and bypass factor of the coil greater than zero using schematic diagram and psychrometric chart **5**

5B. A conference room of 60 seating capacity is to be air conditioned for comfort conditions of 24^0C DBT and 55% RH. The outdoor conditions are 32^0C DBT and 22^0C WBT. The quantity of air supplied is $0.5m^3$/min/person. The comfort conditions are achieved by chemical dehumidification and by cooling coil. Determine: (i) DBT of air at exit of dehumidifier (ii) Capacity of dehumidifier (iii) Capacity and surface temperature of cooling coil if its by-pass factor is 0.3. **5**

6A. Explain with sketch the various psychrometric processes that can be performed using air washer. Show these processes on a psychrometric chart. **5**

6B. A hall is to be maintained at 25^0C DBT and 55% RH when outdoor conditions are 35^0C DBT and 25^0C WBT. Sensible heat load in room 70000 W, Latent heat load in room 18000 W, infiltrated air $25m^3$/min and DPT of the cooling coil is 6^0C. If 60% of the total air is recirculated from the hall and is mixed with the conditioned air after the conditioner (coil), find; (i) Conditions of air leaving the conditioner and just before entering the hall (ii) Mass of fresh air entering the room (iii) By-pass factor of the coil (iv) Load on the coil in tonnes **5**