Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH (MECHANICAL/IP ENGG.) END SEMESTER EXAMINATIONS, APRIL/MAY 2019

SUBJECT: REFRIGERATION AND AIR CONDITIONING SYSTEMS

[MME 4012]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. With a schematic diagram explain boot strap cycle of air refrigeration system. Represent the processes on a T-s plot and also derive an expression for COP. **05**

1B. A regenerative air cooling system is used for an air plane to take 20 tonnes of refrigeration load. Ambient air at a pressure of 0.8 bar and temperature 10°C is rammed isentropically till the pressure rises to 1.2 bar. Air bled off the main compressor at 4.5 bar is cooled by the ram air in the heat exchanger whose effectiveness is 60%. Air from the heat exchanger is further cooled to 60° C in the regenerative heat exchanger with a portion of air bled after expansion in the cooling turbine. Cabin is to be maintained at a temperature of 25°C and a pressure of 1 bar. If the isentropic efficiencies of the compressor and the turbine are 90% and 80% respectively, find

a. Mass of the air bled from the cooling turbine to be used for regenerative cooling
b. Power required
c. COP of the system.

Assume the temperature of air leaving to atmosphere from the regenerative heat exchanger as 100°C. **05**

2A. With proper P-h and T-s plots explain the effect of following on the performance of vapor compression refrigeration cycle

a. Reduction in evaporator pressure
b. Super heating
c. Subcooling **05**

2B. Calculate the power needed to compress 20 kg/min of R-12 from saturated vapor at 1.5 bar to a condensing pressure of 9.6 bar by two stage

compression with inter cooling by liquid refrigerant at 4.2 bar. Assume saturated liquid to leave the condenser and dry saturated vapor to leave the evaporator. Also find the power needed when inter cooling is not employed. **05**

3A. Explain with a neat sketch and P-h diagram working of two stage cascade refrigeration system. Also list the advantages of the system over simple vapor compression system when both are operating at the same temperature limits. **05**

3B. A single compressor using R-12 as the refrigerant has three evaporators of capacity 30 TR, 20 TR and 10 TR. Temperatures in the three evaporators is to be maintained at −10°C, 5°C and10°C respectively. System is provided with multiple expansion valves and back pressure valves. Condenser temperature is 40°C. Liquid refrigerant leaving the condenser is subcooled to 30°C. Vapors leaving the evaporator are dry and saturated. Assuming isentropic compression find

(a) Mass of the refrigerant flowing through each evaporator

(b) Power required to drive the compressor **05**

4A. With the help of a neat sketch explain the working of steam jet refrigeration system. Mention its merits and demerits over other types of refrigeration systems. **04**

4B. Discuss the 4 important thermodynamic properties of a good refrigerant. **02**

4C. In a vapor absorption refrigeration system heat is supplied to the generator by condensing steam at 3 bar and 85% dry. The temperature in the evaporator is to be maintained at -10°C. If the cooling water rejects heat at 30°C in the condenser find the maximum COP of the system.

When the refrigeration load is 10 tonnes, and the actual COP is 40% of the maximum find the mass of the steam required per hour? **04**

5A. Define (i) Specific humidity (ii) Relative humidity (iii) Wet bulb temperature (iv) Dew point temperature (v) Bypass factor of a heating coil.

Derive the relationship between relative humidity, degree of saturation and saturated pressure for a sample of moist air. **05**

5B. An air conditioning system is designed for industrial process for hot and wet summer conditions.

Outdoor conditions 30°C DBT and 75%R.H

Required conditions 22°C DBT and 70% RH

Cooling coil dew point temperature 14°C

Assume 100% fresh air the condition is achieved by first cooling and dehumidifying and then by heating. If 20m^3 of air is absorbed by the plant every minute find

(a) Capacity of Cooling coil and heating coil (b) Mass of water vapor removed per hour (c) By pass factor of the heating coil if its surface temperature is 40°C **05**