Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH (TSES) END SEMESTER EXAMINATIONS,

APRIL 2018

SUBJECT: REFRIGERATION AND CRYOGENIC SYSTEMS [MME 5273]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Use of Thermodynamics Data book is permitted

1A. Using schematic and P-h diagram, obtain expressions for the mass flow rates to low and high stage compressor and COP of the system for a multi evaporator refrigeration system with multi compression, intercooling and flash gas removal. What are the limitations of these systems? **(05)**

1B. A reduced ambient air refrigeration system used for an aircraft consists of two cooling turbines with heat exchanger in between. The output of both the turbines is used to run the exhaust fan. The ambient air pressure and temperature are 0.25 bar and -40^0 C. The compressed air is cooled to 50^0 C in the heat exchanger. The pressure ratio of the main compressor is 4. There is a pressure loss of 0.05 bar at the supply air nozzle to the cabin. The cabin condition is maintained at 1 bar and 25^0 C. The aircraft is moving at 1500 km/hr. Ram efficiency is 90%. Determine:

i) Mass flow rate of air supplied to the cabin if the cooling load is 25 TR.

ii) Air flow rate of ram air passed over heat exchanger if its maximum rises in temperature is limited to 12^0C. **(05)**

2A. Explain the need for capacity control of reciprocating compressors used in vapor compression refrigeration system. Briefly explain the methods used for capacity control. **(05)**

2B. A two-stage cascade refrigeration system operates between the pressure limits of 0.9 and 0.1 MPa. Each stage operates on the ideal vapor-compression refrigeration cycle with refrigerant R22 as the working fluid. Heat rejection from the lower cycle to the upper cycle takes place in an adiabatic counter-flow heat exchanger where both streams enter at about 0.4 MPa. If the mass flow rate of the refrigerant through the upper cycle is 0.28 kg/s, determine:

(a) The mass flow rate of the refrigerant through the lower cycle

(b) The rate of heat removal from the refrigerated space and the power input to the compressor,

(c) The coefficient of performance of this cascade refrigerator **(05)**

3A. Explain with the help of schematic and p-h diagram, how the use of following components improves the COP of a vapour compression refrigeration system.
i) Sub-cooler ii) Liquid-suction Heat exchanger **(05)**

3B. A refrigeration system using R-21 as refrigerant has 3 evaporators, 10 TR at 10^0C, 20 TR at 5^0C and 30 TR at -10^0C. The system is provided with one compressor and 3 multiple expansion valves and back pressure valves. The condenser pressure is 1.8 bar and liquid refrigerant coming out of condenser is sub-cooled by 10^0C. The vapours leave the evaporators in dry saturated condition and assuming compressions are isentropic, find
i) Mass flow rate in each evaporator
ii) Power to run the system
iii) COP **(05)**

4A. Stating the assumptions made for Steady flow analysis of water-lithium bromide vapor absorption refrigeration system, find expressions for the
i) Mass flow rate of strong and weak solution
ii) Heat transfer rate in the solution heat exchanger
iii) Heat transfer in Generator and Absorber **(05)**

4B. A simple linde liquefaction system operates between 290 K and 72 K and uses nitrogen as the working fluid. The gas is isothermally and reversibly compressed to 10 MPa. The low pressure corresponds to the saturation pressure of liquid nitrogen at 72 K which is 0.05 MPa. Assuming ideal heat exchangers and no heat leak to the system, find the liquid yield and FOM for the system. If this system is utilized as a refrigerator, determine the refrigeration effect, COP and FOM.
The following properties of nitrogen may be taken for calculation
At 0.05 MPa and 290 K, enthalpy is 452 kJ/kg and entropy is 4.59 kJ/kg K
At 10 MPa and 290 K, enthalpy is 432 kJ/kg and entropy is 2.95 kJ/kg K
Enthalpy of liquid Nitrogen at 0.05 MPa and 72 K is 18 kJ/kg and its entropy is 0.27 kJ/kg K **(05)**

5A. Explain with sketch, the working of a G.M. cryocooler. What are its advantages and limitations? **(05)**

5B. Explain the working of Linde Dual pressure Liquefaction system and Obtain an expression for liquid yield, work required per unit mass liquefied and FOM. **(05)**

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