Cryogenic Engg.

Con. 3352-08.

(OLD & REVISED COURSE)

CO-3094

(3 Hours)

[Total Marks : 100]

N.B. (1) Question No. **1** is **compulsory**.
    (2) Attempt any **four** questions from question Nos. **2** to **6**.
    (3) **Figures** on the **right** indicate **full** marks.
    (4) Use Illustrative diagrams where ever possible.
    (5) Use of T-S and h-s charts **permitted**.

1. (a) Linde-Hampson cycle cannot be used as it is for Neon, Hydrogen and Helium. Explain.   8
    (b) Explain the term cryogenics and explain the need to have separate science and technology   12
        subject in comparison with refrigeration.

2. Write short notes on (any **four**) :—   20
        (a) Orthoparahydrogen conversion.
        (b) Behaviour of thermal conductivity at cryogenic temperature.
        (c) Superconductivity and superfluidity.
        (d) Explain "DEEWAR" vessel and transfer lines.
        (e) Explain any one application of cryogenics.

3. (a) Stating assumptions find an expression for liquid yield and figure of merit (FOM) for a   8
        simple L-H cycle.
    (b) Find yield and FOM of an air liquefaction system working on simple L-H cycle. Initial air   12
        temp = 300 K, PH = 200 atm, PL = 1 atm, heat exchanger ε = 0·97. Heat gained into
        liquid receiver = 10 kJ/kg of air.

4. (a) Cryogenic temperature measurement is critical. Comment. Also explain different methods   12
        used for it.
    (b) Explain the importance of insulation in cryogenics with their types.   8

5. (a) A G-M refrigerator operates between pressure limits of 1 atm to 10 atm using He as working   12
        fluid. The max. Temp of the space to be cooled is 70 K and the temperature of gas leaving
        the compressor is 300 K. Assume that regenerator is 100% effective and compressor
        overall efficiency is 60%. The expansion efficiency is 90%. Determine COP for the system.
    (b) With the help of schematic and T-S diagram, explain 'Philips Refrigerator'. Also explain   8
        briefly the importance of regenerator effectiveness.

6. (a) With a net sketch, describe functioning of Basic pulse tube refrigerator, orifice and double   12
        inlet pulse tube refrigerator.
    (b) Describe Walker's classification of cryogenic cryocoolers.   8

7. Determine the numer of theoretical plates required to yield 97% as top product stream and   20
    94% of as bottom product. The feed composition is 79% N_2 and 21% O_2. The feed system is
    in saturated liquid and bottom product is also in saturated liquids. The desired flow rate is
    28 kg mol/s. The heat removal at top column is 1100 kW. The column operates at a pressure
    of 1 atm. Top product is in saturated vapor state.