Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-II Examination July 2010

Subject code: 721001 **Subject Name: Cryogenic System**

Date: 05 /07 /2010 **Time: 11.00am – 1.30pm**

Instructions: **Total Marks: 60**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of properties Charts and tables permissible**
5. **Draw neat sketches, wherever necessary.**

Q.1 **(a)** Explain thermodynamically ideal system for liquefaction of air and derive an expression for finding liquid yield and work requirement. **06**

(b) Determine ideal work requirement for liquefaction of oxygen gas at 101.3 kPa & 300 K. Also determine the heat rejected per unit mass of gas in ideal isothermal compressor. **06**

Q.2 **(a)** How Kapitza system and Heylandt system for liquefaction differ from Claude system of liquefaction? Show with diagrams. What are the advantages of these changes? **06**

(b) In an ideal Claude liquefaction system for nitrogen, the gas enters the compressor at 101.3 kPa (1 atm). Determine the expander flow-rate ratio required for liquid yield of 0.20, if the gas enters the reversible expander at 4.05 MPa and 240 K. **06**

OR

(b) In a reversible Linde-Hampson system for liquefaction of nitrogen, the gas enters the isothermal compressor at 300 K and 101.3 kPa and is compressed to a high pressure. Determine the value of high pressure so that a liquid yield of 0.070 can be obtained. Could the liquid yield be increased to 0.122? In not, why? Determine the high pressure required for the later condition also. **06**

Q.3 Write short notes with neat sketches on following.

(a) Simon helium liquefier and its limitations. **06**

(b) Cascade Liquefaction system. **06**

OR

Q.3 **(a)** Define and explain adsorption process. Write the classification of adsorbents and their properties. **06**

(b) Explain the BET equation with all terms involved in it **06**

Q.4 **(a)** What are the pay-off functions to indicate performance of cryogenic systems? Explain their importance. **06**

(b) Explain the He^3-He^4 dilution refrigeration system. **06**

OR

Q.4 **(a)** A G-M refrigerator operates between 101.3 kPa and 1.013 mPa using helium as working fluid. The temperature of space being cooled is 70 K. The maximum temperature of gas leaving compressor is 310 K. Assuming that regenerator is 100% effective and compressor overall efficiency is 60%, calculate COP of system. Assume expansion efficiency 90%. **06**

(b) Explain the importance of inversion curves in cryogenic liquefaction systems. **06**

Q.5 **(a)** Explain magnetic cooling and its importance. **06**

(b) Determine ideal COP for an isobaric source refrigerator operating reversibly between sink temperature of 300 K and minimum source temperature of 70 K and maximum source temperature of 90 K. The working fluid is nitrogen working as perfect gas having source pressure of 1.013 mPa. What will be % change in COP when the medium is assumed as real gas? **06**

OR

Q.5 **(a)** Explain Linde dual pressure system. What is the importance of intermediate pressure flow rate ratio in above system? **06**

(b) What are the advantages and disadvantages of single volume and double volume Gifford-Mc Mohan cryocooler? Explain working of any one of them with a neat sketch. **06**

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