Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Regular Examination January / February 2011

Subject code: 712105N
Subject Name: Cryogenic Heat Exchangers

Date: 03 /02 /2011 **Time: 02.30 pm – 05.00 pm**
Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Why the heat exchanger design is different for cryogenic temperature applications as compared to the general high temperature applications? **07**

(b) A spacer used in small Dewar flasks is in the form of a frustrum of a cone. The small end of the spacer has a diameter of 12 mm and is maintained at a temperature of 90 K. the larger end of the spacer has a diameter of 36 mm and is maintained at 300 K. The height of the spacer is 48 mm. The material of the spacer is Teflon. Determine the heat transfer rate through the spacer. **07**

Q.2 **(a)** Explain various insulations recommended for cryogenic temperature applications. Compare the typical characteristics of them. **07**

(b) State and explain Lockhart Martinelli correlation of two phase pressure drop for cryogenic fluids. **07**

OR

(b) Explain essentials of cool down characteristics of materials used at very low temperature applications. **07**

Q.3 **(a)** Gaseous nitrogen flows in a tube having a diameter of 22.5 mm and a length of 1.372 m. The tube roughness is 0.0076 mm. The mass flow rate through the tube is 10.08 gm/sec. The average temperature of the gaseous nitrogen is 150 K, and the tube-wall temperature is 200 K. The average pressure is 507 kPa. Determine the pressure drop and heat transfer rate.
Assume the tube as 'rough' with friction factor 0.0219. **07**

(b) Explain in detail 'Giauque-Hampson Exchanger'. **07**

OR

Q.3 **(a)** State types of cryogenic heat exchangers. Explain with neat sketch **07**

(b) Explain regenerative heat exchangers. Discuss in detail construction and working of stationary type in applications at cryogenic temperatures. **07**

Q.4 **(a)** The fin on an ambient temperature vaporizer may be treated as a vertical plate, 1.5 m high and 200 mm wide. Heat is transferred to both sides of the plate. The average surface temperature of the plate is 200 K and the air temperature around the plate is 300 K. Determine the natural convection heat transfer rate to the plate. **07**

(b) Explain in detail essentials of Kapitza conductance. **07**

OR

Q.4 **(a)** Discuss the design of cryogenic heat exchangers considering (1) Cool down characteristics and (2) Freezing at cryogenic temperatures. **07**

	(b)	Explain importance of compact heat exchangers over traditional design. Discuss basic aspects of compactness for a heat exchanger.	**07**
Q.5	**(a)**	Explain 'Forced convection boiling phenomena'.	**07**
	(b)	Explain with appropriate example in cryogenic temperature applications 'The network method for enclosures' for radiation cases.	**07**

OR

Q.5	**(a)**	Explain construction, working and design aspects of a Plate-fin type heat exchanger.	**07**
	(b)	A tube-bank cross-flow heat exchanger is used to warm helium gas (C_p=5.2 kJ/kg-K) from an inlet temperature of 20 K to an outlet temperature of 206 K. The heating fluid is nitrogen gas (C_p=1.05 kJ/kg-K), which enters at 305 K at a mass flow rate of 1.85 kg/sec. The helium gas flows within the tubes at a mass flow rate of 0.30 kg/sec, and the nitrogen gas flows over the tubes. The overall heat transfer coefficient for the heat exchanger is 160 W/m^2-K. Determine the required heat transfer surface area for the exchanger.	**07**

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