Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. IST Semester–Remedial Examination – July- 2011

Subject code: 712105N

Subject Name: Cryogenic Heat Exchangers

Date:12/07/2011 **Time: 10:30 am – 01:00 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)**	State and explain Lockart and Martinelli correlation of Two-phase flow pressure drop for cryogenic fluids.	**07**
	(b)	State the factors affecting the effectiveness of heat exchanger	**07**
Q.2	**(a)**	Derive the 3-dimentional equation in Cartesian co-ordinates for a homogeneous material with heat generation in steady state condition.	**07**
	(b)	Briefly explain with neat sketch Film wise and Drop wise condensation.	**07**
		OR	
	(b)	What are TEMA standards? Discuss any three useful TEMA configurations for heat exchangers.	**07**
Q.3	**(a)**	Prove that for cryogenics application the minimum allowable effective of regenerator is 0.905.	**07**
	(b)	A regenerator matrix is made up of stacked wire screens having an equivalent diameter of 0.40 mm. The free-flow area through the screen is 3.0 x 10^{-3} m^2, and the porosity of matrix is 0.675. The mean temperature of the air flowing through the regenerator is 200 K, at which temperature the gas properties are: μ = 13.3 μPa-s, C_p = 1.006 kJ/kg-K and N_{Pr} = 0.739. The mass flow rate of the air through the regenerator is 50 g/s. Determine the convective heat transfer co-efficient between air and matrix material.	**07**
		OR	
Q.3	**(a)**	List out the two methods for regenerator design. Explain any one.	**07**
	(b)	What are the advantages of regenerator? Explain the regenerator used in Gifford-McMahon cryocooler.	**07**
Q.4	**(a)**	Derive the relation between Ntu and ϵ for parallel flow heat exchanger.	**07**
	(b)	Hot exhaust gases which enter finned tube, cross flow heat exchanger at 300 ºC and leave at 100 ºC, are used to pressurize water at a flow rate of 1 kg/s from 35 ºC to 125 ºC. The exhaust gas specific heat is 1000 J/kg-K and overall heat transfer co-efficient based on gas side is 100 W/m^2. Determine required gas side surface area using Ntu method.	**07**
		OR	
Q.4	**(a)**	Write a short note on Compact Heat Exchangers	**07**

(b) A counter flow heat exchanger on a helium liquefaction system operates under the following condition. **07**

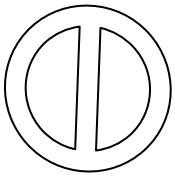
Warm fluid: helium gas at 2.027 MPa, temperature 22K, mass flow 10 g/s, Cp= 6.274 KJ/Kg-k.

Cold fluid: helium gas lat 101.3 kPa, temperature 21.1 K, mass flow 9 g/s, Cp= 5.4900 KJ/Kg-k.

The overall heat transfer co-efficient is 170 W/m^2-K.

Q.5 **(a)** Explain with neat sketch Collins heat exchanger. **07**

(b) Determine the fin effectiveness and surface effectiveness for configuration shown in the fig. below. The nitrogen gas at 95 K and 140 kPa is flowing inside the tube wall has temperature of 105 K. and the mass flow rate of nitrogen gas is 40 g/s. The tube has an inside diameter of 20 mm, the fin thickness is 1.5 mm and the fin material conductivity is 225 W/m-K. **07**



Properties of nitrogen: μ = 6.98 μPa-s, C_p = 1.o67 kJ/kg-K and N_{Pr} = 0.797

OR

Q.5 **(a)** Explain fin effectiveness, surface effectiveness and overall heat transfer coefficient for the heat exchanger. **07**

(b) Explain importance of heat exchanger effectiveness on cryogenics liquefaction system **07**

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