

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2013

Subject code: 711006N

Date: 17-06-2013

Subject Name: Cryogenic Heat Exchanger

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) Classify the cryogenic heat exchanger. Describe with neat sketch Plate fin heat exchanger. **07**
- (b) Define and distinguish clearly between film condensation and dropwise condensation. **07**
- Q.2** (a) With neat sketch explain two-phase flow phenomenon in a horizontal pipe. **07**
- (b) How does transient heat conduction differ from steady conduction? What is lumped system analysis? When is it applicable? **07**
- OR**
- (b) Derive two dimensional steady state equations for heat conduction in vertical plate. **07**
- Q.3** (a) What is pool boiling? Explain the different regime of pool boiling with neat sketch? **06**
- (b) Briefly discuss the TEMA standards for heat exchangers. **08**
- OR**
- Q.3** (a) Explain the forced convective boiling inside the vertical tube. **07**
- (b) A 4 kg/s product stream from a distillation column is to be cooled by a 3 kg/s water stream in a counterflow heat exchanger. The hot and cold stream inlet temperatures are 400 K and 300 K respectively and the area of the exchanger is 30 m². If the overall heat transfer coefficient is estimated to be 820 W/m² K. Determine the product stream outlet temperature if its specific heat is 2500 J/kg K and the coolant outlet temperature. **07**
- Q.4** (a) Briefly discuss the step by step design methodology for heat exchanger. **10**
- (b) A flow of 0.1 kg/s of exhaust gases at 700 K from a gas turbine is used to preheat the incoming air, which is at the ambient temperature of 300 K. It is desired to cool the exhaust to 400 K, and it is estimated that an overall heat transfer coefficient of 30 W/m² K can be achieved in an appropriate exchanger. Determine the area required for a counterflow heat exchanger. Take the specific heat of exhaust gases the same as for air, which is 1000 J/kg K. **04**
- OR**
- Q.4** (a) Discuss Effectiveness-NTU approach in heat exchanger analysis. **07**

- Q.4 (b)** A counterflow heat exchanger is employed to cool 0.55 kg/s ($C_p = 2.45 \text{ kJ/kg } ^\circ\text{C}$) of oil from $115 ^\circ\text{C}$ to $40 ^\circ\text{C}$ by the use of water. The inlet and outlet temperatures of cooling water are $15 ^\circ\text{C}$ and $75 ^\circ\text{C}$ respectively. The overall heat transfer coefficient is expected to be $1450 \text{ W/m}^2 \text{ K}$. Using the NTU method, calculate (i) the mass flow rate of water (ii) the effectiveness of the heat exchanger and (iii) the surface area required. **07**
- Q.5 (a)** Explain with neat sketch Gifford single volume cryorefrigerator. **07**
- (b)** Write note on different type of Linde heat exchangers. **07**
- OR**
- Q.5 (a)** What is regenerative type of heat exchanger? Discuss which factors you will consider in designing a regenerator with high effectiveness? **07**
- (b)** Write note on Collin's type heat exchanger. **07**
