Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2731105 **Date:03/05/2016**

Subject Name: Design of Heat Exchangers

Time:10:30 am to 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 and explain various types of heat exchangers based on constructional geometry	**07**
	(b)	Explain in brief different aspects of fouling in heat transfer devices	**07**
Q.2	**(a)**	Explain LMTD and e-NTU approach used for analysis and design of heat exchangers.	**07**
	(b)	A shell & tube heat exchanger constructed from a tube having outer diameter is 0.0254 m to cool 6.93 kg/s of 95% ethyl alcohol solution (C_p = 3810 J/kg K) from 66 °C to 42 °C, using 6.30 kg/s of water available at 10 °C (C_p = 4187 J/kg K). In the heat exchanger, 72 tubes will be used. Assume that the overall coefficient of heat transfer based on the outer-tube area is 568 W/m^2 K. Calculate the surface area and the length of the heat exchanger for parallel flow and counter flow shell and tube heat exchanger.	**07**
		OR	
	(b)	An oil cooler for lubricating system has to cool 1000 kg/hr of oil C_p = 2.09 kJ/kg K from 80°C to 40°C using cooling water. Flow of water is 1000 kJ/kg K and available at 30°C. Considering counter flow arrangement, estimate surface area of heat exchanger if overall heat transfer coefficient is 24 W/m^2 K	**07**
Q.3	**(a)**	Write a note on TEMA standards for the design of shell and tube heat exchanger. Draw the sketch of shell and tube heat exchanger and label the different parts	**07**
	(b)	Using preliminary analysis design a heat exchanger to heat raw water by the use of condensed water at 67°C and 0.2 bar (C_p = 4179 J/kg K), which will flow in the shell side with a mass flow rate of 50,000 kg/hr. The heat will be transferred to 30,000 kg/hr of city water coming from a supply at 17°C (C_p = 4184 J/kg K). A single shell and a single tube pass is preferable. A fouling resistance of 0.000176 m^2 K/W is suggested and the surface over design should not be over 40%. A maximum coolant velocity of 1.5 m/s is suggested to prevent erosion. A maximum tube length of 5m is required because of space limitations. The tube material of carbon steel (k=60 W/m K). Raw water will flow inside straight tubes whose outer diameter is 19 mm and inner diameter is 16 mm. Tubes are laid out on a square pitch with a pitch ratio of 1.25. The baffle spacing is approximated by 0.6 of shell diameter and the baffle cut is set to 25%. The water outlet temperature should not be less than 40°C. Consider shell side heat transfer co-efficient 5000 W/m^2 K and tube side it is 4000 W/m^2 K, tube length is 3 m, R_{ft} = 0.000176, F=0.9, CL=1 and CTP=0.93.	**07**
		OR	
Q.3	**(a)**	Explain various leakages and bypass taken in to account in determination of shell side heat transfer coefficient and pressure drop in Bell-Delaware method.	**07**

(b) In an oil engine, oil at a rate of 3 kg/s and 65°C temperature flows through the annulus of a double pipe heat exchanger and comes out at 55°C. Sea water is used to cool down the engine oil which flows through the inner tube at 20°C. The sea water outlet temperature is 30°C. Calculate (a) Hydraulic diameter and equivalent diameter for the annuals (b) Reynolds numbers for both the fluid. The properties of both the fluids at bulk mean temperature and also the geometrical dimension are: **07**

Fluid	**Engine oil**	**Sea water**
Density, ρ, kg/m^3	885.27	1013.4
Sp. Heat, Cp, kJ/kg-K	1.902	4.004
Viscosity, μ, kg/m-s	0.075	9.64 x 10
Thermal Conductivity, k, W/m-K	0.1442	0.639
Prandtl Number, Pr	1050	6.29

Length of the hairpin = 4.5m, Inner Tube (d_o = 0.02667 m, d_i= 0.02093 m) Outer Tube(D_i= 0.0525 m), Fin height, Hf= 0.0127 m; Fin Thickness, δ= 0.9 mm, Number of fins = 30, Material throughout = carbon steel (k = 52 W/m K)

Q.4 **(a)** Classify condensers on the basis of the cooling medium used. Explain water cooled condenser in details. **07**

(b) Explain the design of double pipe heat exchangers **07**

OR

Q.4 **(a)** Explain different techniques for heat transfer enhancement in heat exchanger **07**

(b) Derive expression for hydraulic diameter and equivalent diameter in case of double pipe heat exchanger with and without fin with neat sketch. **07**

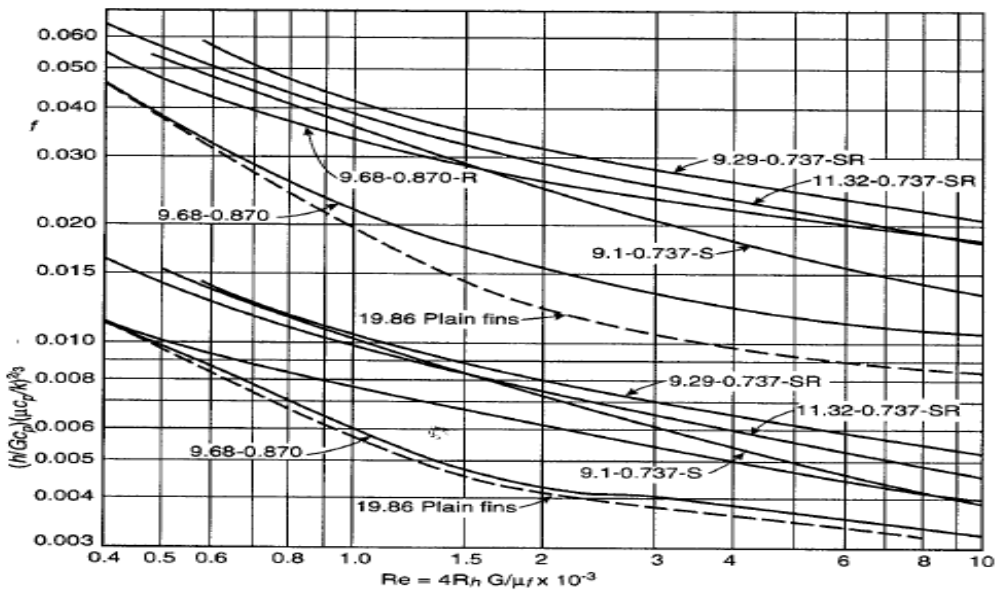
Q.5 **(a)** Discuss classification of evaporators used in refrigeration and air conditioning application in detail. Name the three recent correlation for in tube flow boiling refrigerants. **07**

(b) State and explain the advantages and limitations of compact heat exchanger. **07**

OR

Q.5 **(a)** Explain sizing procedure of compact heat exchanger **07**

(b) Air with velocity of 20 m/s flows across a compact heat exchanger matrix having the configuration surface 11.32-0737-S~R. Calculate the heat transfer coefficient and frictional pressure drop. Length of the matrix is 0.8 m. Take, D_h= 0.34 cm, σ =0.78, ρ= 1.41 kg/m^3, C_p=1030 J/Kg K, μ = 2.69 x 10^{-5} kg/m-s, Pr=0.718 **07**



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