Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII (NEW) EXAMINATION – WINTER 2017

Subject Code: 2181924 Date: 15/11/2017

Subject Name: Design of Heat Exchanger(Department Elective III)

Time:02:30 PM TO 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.**

			MARKS
Q.1	**(a)**	List and Explain the basic principles of heat transfer	**03**
	(b)	List and explain the factors to be considered while selecting heat exchangers.	**04**
	(c)	Compare the LMTD and ε-NTU approach for analysis and design of heat exchangers.	**07**
Q.2	**(a)**	What is hairpin heat exchanger? Define hydraulic (Dh) and Equivalent (De) diameters for bare inner tube and annulus of a hairpin heat exchanger.	**03**
	(b)	Draw a parallel and series arrangements of hairpin heat exchanger	**04**
	(c)	Water at a flow rate of 5,000 kg/h will be heated from 20°C to 35°C by hot water at 140°C. A 15°C hot water temperature drop is allowed. A number of 3.5 m hairpins of 3 in. (ID = 0.0779 m) by 2 in. (ID = 0.0525 m, OD = 0.0603 m) counterflow double-pipe heat exchangers with annuli and pipes, each connected in series, will be used. Hot water flows through the inner tube. Fouling factors are: Rfi = 0.000176 m2 · K/W, Rfo = 0.000352 m2 · K/W. Assume that the pipe is made of carbon steel (k = 54 W/m · K). The heat exchanger is insulated against heat losses. 1. Calculate the number of hairpins.	**07**

Properties at (Tb=132.5°C)	Properties at (Tb=27.5°C)
$\rho = 932.53\ kg/m^3$, $c_p = 4.268\ kJ/kg \cdot K$ $k = 0.687\ W/m \cdot K$, $\mu = 0.207 \times 10^{-3}\ Pa \cdot s$ $Pr = 1.28$	$\rho = 996.4\ kg/m^3$, $c_p = 4.179\ kJ/kg \cdot K$ $k = 0.609\ W/m \cdot K$, $\mu = 8.41 \times 10^{-6}\ Pa \cdot s$ $Pr = 5.77$

OR

	(c)	In a double pipe heat exchanger Ch = 0.5Cc. The inlet temperatures of hot and cold fluids are th_1 and tc_1. Deduce and expression in terms of th_1, tc_1, and th_2 for the ratio of the area of the counter-flow heat exchanger to that of parallel flow heat exchanger which will give the same hot fluid outlet temperature th_2. Find this ratio if th_1 = 150°C, tc_1 = 30°C, and th_2 = 90°C.	**07**
Q.3	**(a)**	What is the use of tie rods and spacers in shell-and-tube heat exchangers	**03**
	(b)	What is a baffle? Discuss different type and geometry of baffles used in shell and tube heat exchanger.	**04**
	(c)	Discuss various shell types suggested by TEMA standard for shell and tube heat exchangers with neat sketch.	**07**

OR

Q.3 **(a)** List the steps for design procedure of shell and tube condenser design? **03**

(b) Can the outlet temperature of the cold fluid in a heat exchanger be higher than the outlet temperature of the hot fluid in a parallel-flow heat exchanger? How about in a counter-flow heat exchanger? Explain. **04**

(c) A heat exchanger is to be designed to heat raw water by the use of condensed water at 67 °C and 0.2 bar which will flow in the shell side with a mass flow rate of 50,000 kg/h. The heat will be transferred to 30,000 kg/h of city water coming from a supply at 17 °C. Water outlet temperature should not be less than 40 °C. A fouling resistance of 0.000176 m2.K/W is suggested. Calculate the overall heat transfer coefficient for fouled as well as clean surfaces and length of tube for 2-P shell and tube heat exchanger using "Kern method". Use following specifications and Correlations: **07**

Tube side specification	Shell side specification
O.D. = 19 mm	Shell diameter = 0.39 m
I.D. = 16 mm	Pitch size = 0.024
No. of tubes = 124	Baffle spacing = 0.25 m
Tube layout- Square Pitch	$Nu = 0.36\left(\frac{D_e G_s}{\mu}\right)^{0.55}\left(\frac{\mu C_p}{k}\right)^{1/3}\left(\frac{\mu_b}{\mu_w}\right)^{0.14}$
K_{tube}= 60 W/m^{2}K	
$Nu_b = \frac{(f/2)(Re_b - 1000)Pr}{1+12.7(f/2)^{1/2}(Pr^{2/3}-1)}$ Where; $f = (1.58 \ln Re - 3.28)^{-2}$	

Properties	Units	Tube side	Shell side
ρ	Kg/m^3	996.8	983.2
C_p	J/kg K	4179	4184
μ	N.s/m^2	8.2×10^{-4}	4.67×10^{-4}
k	W/m K	0.610	0.652
Pr	-	5.65	3.00
$\mu_w = 6.04\times10^{-4}$ N.s/m^2			

Q.4 **(a)** Why compact heat exchangers are more suitable for gaseous fluid **03**

(b) When is a heat exchanger classified as being compact? Name the specific exchanger construction type that may be used in the following applications: **04**
(a) Air Preheater (b) automotive Radiator (c) Condenser of an air conditioner

(c) Discuss Bell-Delaware method taking into account the effect of various leakage and bypass steams to evaluate shell side heat transfer co-efficient **07**

OR

Q.4 **(a)** State basic advantages and limitations of compact heat exchangers. **03**

(b) Explain giving the precise reasons weather the following statements are true or false: **04**
1. The square lay out is more effective in heat transfer than the triangular layout of tubes.
2. Plate heat exchangers are widely used in milk pasteurizing

(c) Derive an expression to calculate the compactness(β) of the plate fin heat exchangers having a rectangular fin configuration as shown in Fig No.1 **07**

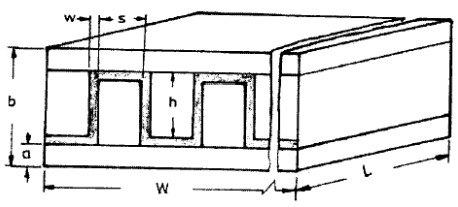

Fig No. 1

Q.5 **(a)** Classify plate fin and tube fin heat exchangers. **03**

	(b)	Classify regenerators. Explain rotary regenerators.	**04**
	(c)	According to constructional features classify heat exchange equipments.	**07**

OR

Q.5	**(a)**	Explain pinch analysis.	**03**
	(b)	Discuss the various methods for enhancement of heat transfer.	**04**
	(c)	Explain methods for performance evaluation of Heat Transfer Enhancement technique	**07**