Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –II Examination Dec. - 2011

Subject code: 1722101 **Date: 09/12/2011**
Subject Name: Design of Heat Exchange Equipments
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.**
4. **Use of steam tables is permitted**
5. **Use of Heat Exchanger Data book is permitted.**

Q.1 **A)** According to constructional features classify heat exchange equipments. 7

B) Derive an equation for effectiveness in case of counter flow heat exchanger. 7

Q.2 **A)** Compare the LMTD and ε – NTU approach for analysis and design of heat exchangers. 7

B) An oil is cooled to 375 K in concurrent heat exchanger by transferring its heat to the cooling water that leaves the cooler at 300 K. However it is required that oil must be cooled down to 350 K by lengthening the cooler while the oil and water flow rates, their inlet temperatures and other dimensions of the cooler remaining unchanged. The inlet temperatures of the cooling water and oil being 288 K and 425 K respectively. If the length of the original cooler was 1 m calculate the following : The outlet temperature of cooling water of the new cooler and the length of the new cooler. 7

OR

Q.2 **B)** In a double pipe heat exchanger $C_h = 0.5C_c$. The inlet temperature of hot and cold fluids are t_{h1} and t_{c1}. Deduce and expression in terms of t_{h1}, t_{c1}, and t_{h2} 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 t_{h2}. Find this ratio if $t_{h1} = 150^oC$, $t_{c1} = 30^oC$, and $t_{h2} = 90^0C$.

Q.3 **A)** Explain double pipe heat exchanger and derive the expression for hydraulic diameter and equivalent diameter for hairpin heat exchanger. 7

B) A heat exchanger is to be designed to heat raw water by the use of condensed water at 67^oC and 0.2 bar, which will flow in the shell side with a mass flow rate of 50,000 kg/hr. The heat will be transferred to 7

30,000 kg/hr of city water coming from a supply at 17^0C (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 5 m is required because of space limitations. The tube material of carbon steel (k=60 W/mK). 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 ^{o}C. Consider shell side heat transfer co-efficient 5000 W/m^2 K and tube side it is 4000 W/m^2 K. Perform Preliminary analysis.

OR

Q.3 **A)** Explain in details type of Baffle as per allocation of streams and its Geometry. 7

B) Explain rating procedure step by step in shell and tube heat exchanger 7

Q.4 **A)** Classify plate fin heat exchangers and tube fin heat exchangers

B) Air at 1 atm and 400 K and with a velocity of U_∞ = 10 m/s flows across a compact heat exchanger matrix has A_{min} / A_{fr} = 0.534 and D_h = 0.3633 cm calculate heat transfer co-efficient and frictional pressure drop for the air side. Take length of the matrix is 0.6 m and h $(Pr)^{2/3}/(Gc_p)$ = 0.0071. Properties of air is ρ = 0.8825 kg/m^3 μ = 2.29 X 10^{-5} kg/m.s c_p = 1013 J/kg K and Pr = 0.719.

OR

Q.4 **A)** Explain passes and flow arrangements in Gasketed plate heat exchangers. State it's application also. 7

B) Explain horizontal and vertical shell-side condensers with neat sketch. 7

Q.5 **A)** State design and operational considerations while selecting, as well as design practices of condensers. 7

B) Explain rotary and fixed matrix regenerators with their applications. 7

OR

Q.5 **A)** State design considerations for a coal based furnace. 7

B) Explain water cooling evaporators and air cooling evaporators with neat sketch. 7

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