Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME – SEMESTER III (NEW) – EXAMINATION – WINTER-2016**

**Subject Code: 2731105** **Date:25/10/2016**

**Subject Name: DESIGN OF HEAT EXCHANGER**

**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.**

**Q.1** **(a)** 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/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 are 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/m K). Raw water will flow inside straight tubes whose outer diameter is 19 mm and inner diameter is16 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/m2K and tube side it is 4000 W/m2K. Perform Preliminary analysis. **07**

**(b)** Name the recent correlation used for design methods of condenser and evaporator for Air conditioners and refrigerators and explain any one of them in detail. **07**

**Q.2** **(a)** Determine the overall heat transfer coefficient for liquid to liquid heat transfer through a 0.003 m thick steel plate (k = 50 W/m K) for the following heat transfer coefficients and fouling factor on one side: (a) $h_i$ = 2500 W/$m^2$ K, $h_o$ = 1800 W/$m^2$ K, $R_{fi}$ = 0.0002 $m^2$ K/W (b) Replace one of the flowing liquids in (a) with a flowing gas ($h_o$ = 50 W/$m^2$ K), (c) Replace the remaining flowing liquid in (a) with another flowing gas ($h_i$ = 20 W/$m^2$ K). Comment on the results obtained for the resistances in each case. **07**

**(b)** Explain various types of baffles used in shell and tube type of heat exchangers. **07**

**OR**

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

**Q.3** **(a)** Explain strategy for Fouling consideration in various heat exchangers. **07**

**(b)** What are recuperators and regenerators? Classify the heat exchanger according to recuperation/regeneration. **07**

**OR**

**Q.3** **(a)** What is fouling? Explain types and mechanisms of fouling. **07**

**(b)** Answers the following: **07**

1. Why are the counter flow heat exchangers the most efficient?
2. Under what conditions can a double pipe heat exchanger replace a shell and tube heat exchanger?
3. Draw a parallel and series arrangements of hairpin heat exchanger.

**Q.4** **(a)** Explain the basic steps of thermal and hydraulic design of inner tube and annulus of double pipe heat exchanger. **07**

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| | **(b)** | Explain the method of calculating pressure drop for finned-tube and plate fin exchangers. | **07** |

**OR**

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| **Q.4** | **(a)** | Explain the procedure of calculating total pressure drop in double pipe heat exchanger. | **07** |
| | **(b)** | What is compact heat exchanger? State its advantages and disadvantages. | **07** |
| **Q.5** | **(a)** | How do you enhance the heat transfer rate in Compact heat exchanger? Explain its various techniques. | **07** |
| | **(b)** | Explain the requirements suggested by Muller and Taborek while selection and design of condensers. | **07** |

**OR**

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| **Q.5** | **(a)** | Explain pinch analysis for heat exchanger. | **07** |
| | **(b)** | Explain in details about chillers and air coolers. | **07** |

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