Registration No: | | | | | | | | | | |

Total Number of Pages: 03 **M.TECH**
P2TFCC09

2nd Semester Regular Examination 2016-17
Heat Exchanger Analysis & Design.
BRANCH: THERMAL & FLUID ENGG
Time: 3 Hours
Max Marks: 100
Q.CODE: Z820

Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.

Q1 Answer the following questions: ***Short answer type*** **(2 x 10)**

a) Classify different types of heat exchangers. Also mention their field of application.

b) Differentiate between regenerative and recuperative heat exchanger.

c) Draw the schematic diagram of a two shell and four tube pass heat exchanger.

d) What do you mean by hydraulic diameter and its impact on heat exchanger?

e) How can the flow induced vibration be minimized?

f) What is a 'header'? Why are these used in shell and tube type heat exchanger?

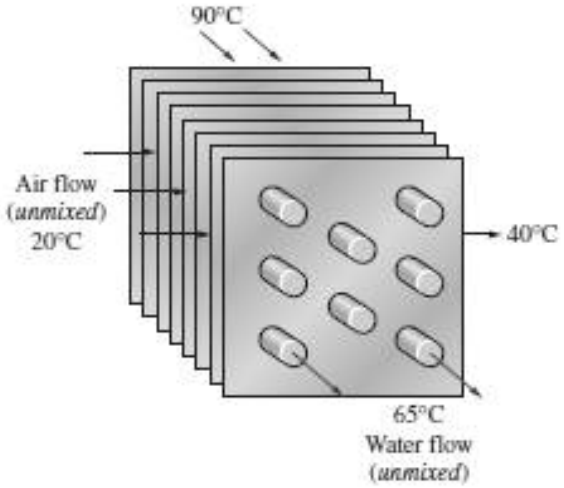
g) Explain when one fluid is undergoing phase change, the direction of flow is immaterial for finding LMTD.

h) What are baffles? Why are these used in heat exchangers?

i) What is meant by Duty of a heat exchanger?

j) What is correction factor? What is its significance?

Q2 **a)** A test is conducted to determine the overall heat transfer coefficient in an automotive radiator that is a compact cross-flow water-to-air heat exchanger with both fluids (air and water) unmixed (as shown in the figure). The radiator has 40 tubes of internal diameter 0.5 cm and length 65 cm in a closely spaced plate-finned matrix. Hot water enters the tubes at 90°C at a rate of 0.6 kg/s and leaves at 65°C. Air flows across the radiator through the inter fin spaces and is heated from 20°C to 40°C. Determine the overall heat transfer coefficient U_i of this radiator based on the inner surface area of the tubes. **(10)**



b) Derive the effectiveness of counter flow heat exchanger. What would be the effectiveness of counter flow heat exchanger if C_{min}/C_{max} =0 and C_{min}/C_{max}=1 **(10)**

Q3 **a)** Hot oil is to be cooled by water in a 1-shell-pass and 8-tube-passes heat exchanger. The tubes are thin-walled and are made of copper with an internal diameter of 1.4 cm. The length of each tube pass in the heat exchanger is 5m, and the overall heat transfer coefficient is 310 W/m^2.°C. Water flows through the tubes at a rate of 0.2 kg/s, and the oil through the shell at a rate of 0.3 kg/s. The water and the oil enter at temperatures of 20°C and 150°C, respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperatures of the water and the oil. **(10)**

b) Explain how the makeup water requirement is estimated from energy and mass balance of a cooling tower. **(10)**

Q4 **a)** What do you mean by differential thermal expansion? Write the necessary steps are being taken to avoid this. **(10)**
Show with neat sketch of temperature distribution for unmixed cross flow heat exchanger and explain it.

b) What are the various sources of a noise in a heat exchanger? How it can be minimized? **(10)**
What are the causes of development of stress in a heat exchanger and how thermal stress can be minimized?

Q5 **a)** The condenser of a steam power plant operates at a pressure of 7.38kPa. Steam at this pressure condenses on the outer surfaces of horizontal pipes through which cooling water circulates. The outer diameter of the pipes is 3 cm, and the outer surfaces of the pipes are maintained at 30°C. Determine **a)** the rate of heat transfer to the cooling water circulating in the pipes and **b)** the rate of condensation of steam per unit length of a horizontal pipe. **(10)**

b) A 56 mm outer diameter vertical tube condenser operates at a pressure of 1.52×10^4 N/m^2 and condenses steam free from non-condensable gas at a rate of 25 kg/h per tube. **(10)**
Determine the heat transfer coefficient and the length of tube required if the temperature drop across the condensate film is 5^oC.

Q6 **a)** The coolant passages in a reactor core are 0.127 m long and have a rectangular cross section of 19 mm × 25.4 mm. The walls of the passages are to be maintained at a constant temperature of 371^0C. **(10)**

a) If the coolant is nitrogen gas at 8 atm pressure and a temperature of 260^0C, what velocity in the passages will result in a nitrogen discharge temperature of 316^0C?
b) If the passage walls are assumed to have a roughness equivalent to that of commercial steel pipes (e = 0.046 mm), what velocity is required for nitrogen discharge temperature of 316^0C?

b) Write short notes on Turbulence and friection factor in pipe flow. **(10)**

Q7 **a)** A water–water gasketed plate heat exchanger has an overall heat transfer coefficient under fouled conditions of 4200 W/m^2.K. Hot- and cold-fluid-side heat transfer coefficients are 15,000 and 14,000W/m^2.K, respectively. The plate thickness (stainless steel 316) is 0.6 mm, and the thermal conductivity is 17W/m.K. **(10)**
Calculate the total fouling resistance for this heat exchanger.

b) Briefly explain about Flow pattern of baffles. **(10)**