BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2015-2016

CHE F241: Heat Transfer

Comprehensive Exam Date: 09.12.2015

Duration: 9 AM - 12 PM Maximum Marks: 120

PART- A (Close book- 90 min)

Section- I **10 x 3 = 30M**

1. How is natural convection different from forced convection?
2. Define a black surface
3. Both the Nusselt number and the Biot number have the same form. What are the differences between them in terms of the variables employed and their physical significance ?
4. Define a view factor.
5. Why are higher heat transfer rates in dropwise condensation than in filmwise condensation
6. Draw the schematic diagrams of 1-2, 2-4 heat exchangers
7. Why correction factor is used for multi pass heat exchangers
8. Define capacity and economy of a evaporator
9. Define boiling point elevation and Duhring rule.
10. What is a fouling factor?

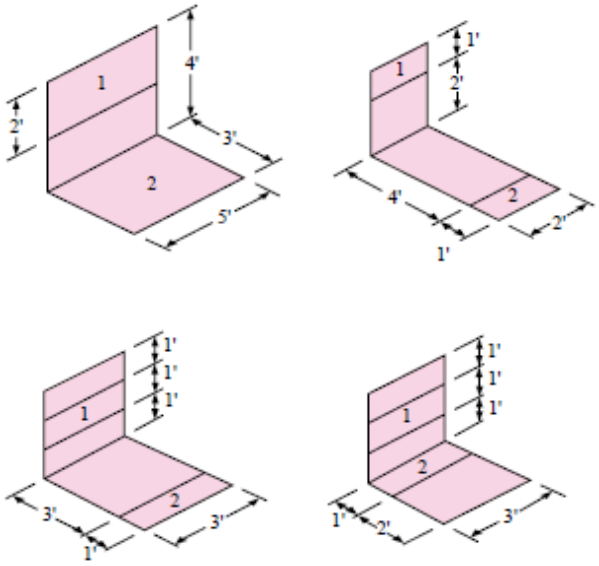
Section- II **5 x 6 = 30 M**

1. Explain the regimes in boiling heat transfer.
2. Explain the feeding methods in multiple effect evaporators
3. Why is a counter flow exchanger more effective than a parallel-flow exchanger?
4. Define heat exchanger effectiveness and NTU
5. Develop a enthalpy balance for each stage in a triple effect evaporator with backward feeding. State your assumptions clearly.

PART- B (Open book- 90 min) **5 x 12 = 60 M**

1. Condensing steam at 120 ^{o}C is to be used inside a 5 cm dia horizontal pipe to provide heating in a room where ambient air is at 5 ^{o}C. The total heating requirement is 3 kW. What length of pipe would be required to provide the necessary heat? Data at 62.5 ^{o}C: K= 0.028931 w/m K, ν= 19.2897 x 10^{-6} m^2/s, Pr = 0.70019.

2. One hundred tubes of 12 mm diameter are arranged in a horizontal position and are exposed to steam at atm. pressure. Calculate the mass of steam condensed per unit length of tube, if tube wall is maintained at 98 ^{o}C. Data: ρ = 960 kg/m^3, μ= 282 x 10^{-6} kg/m.s, K= 0.61 w/m. K, λ= 2255 kJ/kg.
3. Find the radiation shape factors $F1{-}2$ for the situations shown in Figure



4. A heat exchanger is to be designed to heat 1720 kg/h of water from 20 to 45 C with steam condensing on the outside surface of brass tubes of OD 25 mm and ID 22.5 mm, and 4 mt long. The water velocity is 1.02 m/s. Find the number of tubes. Data: k $_{tube}$= 96 kcal/h m2 C, weight of steam condensed= 4500 kg/h, λ= 532.6 kcal/kg, steam side film coefficient= 4000 kcal/hr m^2 K. Data at mean temp, ρ= 995 kg/m^3, Cp= 0.997 kcal/kg ^{o}K, K= 0.551 kcal/m .s .K, ν = 0.659 x 10^{-6} m2/s
5. Water is flowing through a inside tube of 2 cm diameter with an average velocity of 35 cm/s and with a flow rate of 4 kg/s is heated from 38 ^{o}C to 55 ^{o}C in a shell and tube heat exchanger. Hot water is available at 95 ^{o}C which is flowing at a rate of 2 kg/s is used as heating medium on the shell side. Assuming U_0 is 1500 w/m^2 ^{o}K. Design a heat exchanger such that length of tube should not be more than 2 m.