Roll No .....

ME-6003 (CBGS)

B.E. VI Semester

Examination, May 2019

Choice Based Grading System (CBGS)

Heat and Mass Transfer

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any five questions out of eight.
ii) All questions carry equal marks.
iii) The standard HMT data book is permitted in exam.

1. a) State Fourier's law of heat conduction. How this law is similar to ohm's law. Explain.
   b) A plastic pipe (K=0.5W/mk) of ID 3cm and OD 4cm carries a fluid of average temperature 100°C and n = 300 W/m²k The rate of heat transfer per unit length is 500 W/m. Find.
      i) Outside surface temperature of pipe
      ii) The overall heat transfer coefficient based on out side area.

2. A 3 cm diameter pipe at 100°C is losing heat at the rate of 100 W per m length of pipe to the surrounding air at 20°C. This is to be reduced to a minimum value by providing insulation . The following insulation materials are available:
   Insulation A=Quantity=$3.15\times10^{-3}m^3$ per m length of pipe
   Thermal conductivity=5W/m deg.
   Insulation B Quantity=$4\times10^{-3}m^3$ per m length of pipe.Thermal conductivity=1W/m deg.
   Examine the position of better insulating layer relative to pipe. What percentage saving in heat dissipation results from the arrangement.

3. a) Define fin effectiveness.

   b) A stainless steel fin (k = 20W/mk) having a diameter of 20mm and a length of 0.1 m is attached to a wall at 300°C. The ambient temperature is 50°C and heat transfer coefficient is 10 W/m²k.The fin tip is insulated. Determine
      i) The rate of heat transfer
      ii) Temperature at the fin tip
      iii) Heat transfer rate from the same fin geometry of the stainless steel fin is replaced by a fictitious fin with infinite thermal conductivity.
      iv) Rate of heat transfer from the wall area covered by the fin if the fin was not used.

4. a) State Buckingham π theorm. What are it's merits?
   b) Air at 20°C and 1 atm flows over a flat plate at 40m/sec. The plate is 80 cm long and is maintained at 60°C. Assume unit length in Z direction, calculate the heat transfer rate from the plate. Properties of air at 40°C are Pr = 0.7, k = 0.02723 W/mk, Cp = 1.007kJ/kg K and $\mu = 1.906\times10^{-5}$ kg/ms.

5. a) What is limitation of LMTD method. How ∈-NTU method superior to it.
   b) Explain Fick's law of diffusion. What is mass diffusivity

6. A 4kg/sec of product stream from a distillation column is to be cooled by 3kg/sec water stream in a counterflow heat exchanger. The hot and cold stream inlet temperatures are 400K and 300K respectively and the area of heat exchanger is 30m². If the overall heat transfer coefficient is estimated to be 820W/m²K.Determine the outlet temperature of both fluid if the specific heat is product stream is 2500J/kg k.

7. Define the following:
   i) Emissivity of surface. ii) Black body.
   iii) Film wise condensation. iv) Planck's distribution law.

8. a) Explain different regime of boiling.
   b) The filament of a 75 W light bulb may be considered a black body radiating into black enclosure at 80°C. The filament dia is 0.10m and length is 60 mm. Considering radiation only, determine filament temperature.

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