Registration No.										

Total number of printed pages - 02 **B.TECH**

PCCH4301

5th Semester Regular / Back Examination 2015-16

HEAT TRANSFER

BRANCH : Chemical Engineering

Time : 3 Hours

Max Marks : 70

Question Code : T159

Answer Question No. 1 which is compulsory and any FIVE from the rest.

The figures in the right-hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Answer all parts of a question at a place.

1. Answer the following questions : 2 x 10
   - (a) The temperature profile in a slab is linear under steady state. Explain.
   - (b) Write the differences between convection and radiation.
   - (c) In which type of boiling, radiation comes into play and why?
   - (d) When Hessler's chart is used?
   - (e) Differentiate between dropwise and filmwise condensation.
   - (f) Differentiate between Biot number and Nusselt number.
   - (g) Why impingement baffles are used in the shell and tube heat exchanger?
   - (h) Find the equivalent diameter for a triangular pitch if pitch is 1"and OD of tubes is 1.5".
   - (i) What is radiation shape factor?
   - (j) If a heat exchanger has effectiveness = 1, what does that mean?

2. (a) What do you mean by critical insulation of thickness? Write down the equation for spherical surface. 02
   (b) A 240mm steam pipe, 240meters long is covered with 50mm of high temperature insulation (K = 0.092 W/mºC) and 40mm of low temperature insulation (K= 0.062 W/mºC). The inner and outer surface temperatures as measured are 390ºC and 40ºC respectively. Neglect heat conduction through pipe material.Calculate: 08
      - (i) The total heat loss per hour,
      - (ii) The heat loss per m^2 of pipe surface,
      - (iii) The total heat loss per m^2 of outer surface, and
      - (iv) The temperature between two layers of insulation.

3. (a) A 100watt electric bulb of 3cm diameter is dumped under soil of thermal conductivity 1.2 W/m°C. What will be the temperature of the soil 3cm distance from the bulb surface? 03
   (b) Calculate the amount of energy required to solder together two very long pieces of Cu wire, 1.5 mm in diameter that melts at 190^0C. The wires are positioned vertically in air at 20^0C. Heat transfer coefficient, h = 20 W/m^2.^{0}C and thermal conductivity for Cu = 330 W/m.^{0}C. 04
   (c) Under what condition, fin efficiency will be 100%? Define fin effectiveness. 03

4. (a) A counter flow concentric tube heat exchanger is used to cool 0.12 kg/s of crude oil by using cooling water at a rate of 0.18kg/s in the inner tube (ID = 20mm, OD = 40mm). The inlet and outlet temperatures of oil are 95^0C and 65^0C respectively. The water enters at 30^0C. Neglecting tube wall resistance, fouling factor and heat loss to the surroundings, calculate the length of the tube.Data: 08

Crude oil:

C_p = 2131 J/Kg^{0}C, μ=0.0325Ns/m^2, K=0.138W/m^{0}C

Water:

C_p = 4174 J/Kg^{0}C, μ=725×10^{-6}Ns/m^2, K=0.625W/m^{0}C,

Pr=4.85

(b) Draw the flow pattern in the shell side fluid using Disc and Doughnut type of baffle in a shell and tube heat exchanger. 02

5. (a) A double pipe heat exchanger is employed with 2.4m^2 heating area to heat C_6H_6 from 20°C for which water is available at 88°Cwhich flows inside the tube. Mass flow rate of H_2O & C_6H_6 are 6250 kg/hr and 5500 kg/hr. ID & OD of Inner pipe are 37.5mm and 44.8mm. ID & OD of Outer pipe are 62.5mm & 72.7mm. Find the outlet temperatures of C_6H_6 and H_2O as well as find the rate of heat transfer. 06

	Viscosity (cP)	K (Kcal/hr.m.°C)	Cp (kcal/kg)	ρ (kg/m^3)
H_2O	0.8	0.55	1	970
C_6H_6	0.57	0.138	0.4	860

(b) All heat exchangers cannot be condensers but all condensers can be heat exchangers. Justify this statement. 02

(c) Write the enthalpy balance for the condenser operated under superheated condition with proper notations. 02

6. (a) A single effect, vertical short tube evaporator is used to concentrate a syrup from 10% to 40% solids at the rate of 2000 kg of feed per hour. The feed enters at 30ºC and a reduced pressure of 0.33 kg/cm^2 is maintained in the vapour space. At this pressure, the liquor boils at 75ºC. Saturated steam at 115ºC is supplied to the steam chest. No sub-cooling of the condensate occurs. Calculate the steam requirement and the number of tubes (0.0254m, 16 BWG) if the height of the calendria is 1.5 m. The following data are given: 08

Specific heat of liquor = 0.946 kcal/kgºC

Latent heat of steam at 0.33 Kg/cm^2 = 556.5 kcal/kg

Boiling point of water at this pressure = 345 K

The overall heat transfer coefficient = 2150 W/m^2.^{0}C

(b) Under what condition single effect evaporator is chosen over multiple effect evaporators? 02

7. (a) Derive Nusselt's equation for film wise condensation over a vertical flat plate. 08

(b) What is the effect of non-condensable gases during condensation? 02

8. Write short notes on any **TWO**: 5 x 2

(a) NTU effectiveness method

(b) Laws of black body radiation

(c) Thermal boundary layer

(d) Analogy between heat and momentum transfer