Registration No.										

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

PCCH4301

5th Semester Regular / Back Examination 2016 - 17

HEAT TRANSFER

BRANCH : Chemical

Time : 3 Hours

Max Marks : 70

Question Code : Y456

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 thermal conductivity of magnesite at 600°C is 6.7×10^{-3} cal/cm.s.°C. Find its value in SI units.

(b) Differentiate between isotropic and anisotropic substances.

(c) State in which case the thermal conductivity of the material is more: the material in crystalline state or the same material in amorphous state.

(d) What is the purpose of using baffles in a shell and tube heat exchanger ?

(e) A metal wire of 0.01 m diameter and thermal conductivity 200 W/m.K is exposed to a fluid stream with a convective heat transfer coefficient 1000 $W/m^2.K$. Calculate the Biot number.

(f) State the Kirchoff's law of heat radiation.

(g) The overall heat transfer coefficient for a shell and tube heat exchanger for clean surface is U_0 = 450 $W/m^2.K$. The fouling factor after 1 year of operation is found to be h_{d0} = 1800 $W/m^2.K$. Calculate the overall heat transfer coefficient at this time.

(h) Differentiate between vent and trap in a heat exchanger.

(i) What do you mean by lumped capacity system ?

(j) Write the definition of Capacity and Economy of an evaporator.

2. (a) Define the different modes of heat transfer. **02**

(b) Derive the equation of heat transfer by conduction in a three-dimensional body, where the temperature may be changing with time and heat sources are present within the body. **08**

3. (a) What is the necessity of using critical radius of insulation? **02**

(b) Derive the expression for the critical radius of insulation in case of a cylinder of length 'L' and radius 'r'. Assume all other parameters which are required for the derivation. **05**

(c) A copper wire 5 mm in diameter is insulated with a layer of PVC of thermal conductivity K = 0.43 W/m.°C. The wire carries current and its temperature is 60°C. The film coefficient at the outer surface of the insulation is 11.35 W/m.°C. Calculate the critical insulation thickness. **03**

4. **(a)** Crude oil flows at the rate of 1000 kg/hr through the inside pipe of a double pipe heat exchanger and is heated from 30°C to 90°C. The heat supplied by kerosene initially at 200°C flowing through the annular space. If the temperature of approach (minimum temperature difference) is 10°C, determine the heat transfer area for co-current flow and the kerosene flowrate.
C_p for crude oil and kerosene are 0.5 and 0.6 kcal/kg.°C respectively and U_o = 400 kcal/hr.m^2.°C. **08**

(b) What is logarithmic temperature difference? **02**

5. **(a)** Define the term view factor. **02**

(b) State the Stefan-Boltzmann law of heat radiation. **02**

(c) A schedule 40 pipe (OD = 114 mm) carrying saturated steam at 7.33 bar absolute runs through a room having a wall temperature 27°C. The insulation on a section of the pipe has been damaged exposing the pipe wall to the ambient. Calculate the net rate of heat loss from the unit length of the bare pipe by radiation if

a) The pipe surface is considered black.
b) The pipe surface has an emissivity of 0.74 (which is the emissivity of oxidized carbon steel).

Given data: steam temperature at 7.33 bar is 440 K. **06**

6. Describe the different stages boiling phenomena with the help of boiling curve. **10**

7. **(a)** Write the different analogy equations. **02**

(b) What are the assumptions taken for the derivation of Reynold's analogy equation ? **02**

(c) Vegetable oil is heated from 30°C to 70°C by steam in a heat exchanger. Calculate the film co-efficient. Given data:

$$j_H = (St)(\mathrm{Pr})^{2/3}\left(\frac{\mu_s}{\mu}\right)^{0.14} = 0.0046$$

$$C_p = 0.456 kcal/kg.°C$$

$$\left(\frac{\mu_s}{\mu}\right)^{0.14} = 0.77$$

$$k = 0.0000335 kcal/m.\sec.°C$$

$$G = 805\, kcal/m^2.\sec$$

06

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

(a) Extended surface
(b) Multiple effect evaporator
(c) Plate type heat exchanger
(d) Thermal boundary layer
