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

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B. Tech

PCCH 4301

Fifth Semester Examination – 2013

HEAT TRANSFER

BRANCH : CHEM

QUESTION CODE : C-373

Full Marks – 70

Time : 3 Hours

*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.

1. Answer the following questions : 2×10
   (a) Differentiate between steady-state and unsteady-state heat conduction.
   (b) Write the unit of thermal resistance.
   (c) Define critical insulation thickness for sphere.
   (d) Differentiate the types of flow arrangements in heat exchangers through their temperature profile diagram.
   (e) Give the physical significance of: Nusseltnumber, Grassoff number, Reynolds number, and Prandtl number.
   (f) Define the terms nucleate and film boiling.
   (g) State Duhring's rule.
   (h) State Stefan-Boltzmann law of radiation.
   (i) Differentiate between the mixed-feed and backward-feed in evaporators with a neat diagram.
   (j) Differentiate between the capacity and economy of evaporators.
2. (a) Derive and explain the expression for heat flow through a thick walled cylinder by conduction. Take r_1 and r_2 be the inner and outer radii of cylinder and k as mean thermal conductivity. Assume T_1 as inside temperature and T_2 as the outside temperature. 6
   (b) A furnace is constructed with 240 mm thick of fire brick, 120 mm of insulating brick, and 230 mm of building brick. The inside temperature is 1223K and the temperature at the outermost wall is 323 K. The thermal conductivities of fire brick, insulating brick, and building brick are: 6.05, 0.581, and 2.33 W/m.K. Find the heat lost per unit area and temperature at the interface. 4

P.T.O.

3. (a) With a neat diagram derive the relationship between the overall heat transfer coefficient and individual heat transfer coefficients. 6

(b) Methyl alcohol is flowing in the inner pipe of double pipe heat exchanger is cooled with water flowing in the outer pipe. The inside and outside diameters of the inner pipe are 30 and 40 mm respectively. The thermal conductivity of steel is 50 W/m.K. The individual coefficients and fouling factors are :

Alcohol and water coefficients are 250 and 500 $W/m^2 K$ respectively and Inside and outside fouling factors are 0.86×10^{-3} and 1.7 m^2 K/W respectively.

Calculate the overall heat transfer coefficients based on the outside area of the inner-pipe including the dirt factor. 4

4. (a) Draw the neat sketch of 1-2 shell and tube heat exchanger and label its parts. 3

(b) The inner sphere of a Diwar flask is 30 cm diameter and outer sphere is 40 cm diameter. Both the spheres are coated for which the emissivity is 0.05. Determine the rate at which liquid oxygen (latent heat = 21.44 kJ/kg) would evaporate at 90 K when outersphere temperate is 293 K. Assume that the other modes of heat transfer coefficient are absent. 7

5. With a neat diagram explain the principle, working, construction, advantages, disadvantages, and industrial applications of long tube vertical evaporator. 10

6. (a) Hot oil of 1.2 kg/s (C_p = 2083 J/kg.K) flows through double pipe heat exchanger. It enters at 630 K and leaves at 570 K. The cold fluid enters at 300 K and leaves at 400 K. If the overall heat transfer coefficient is 500 W/m^2.K, calculate the heat transfer area for : (i) parallel flow and (ii) counter-current flow. 5

(b) State the significance of dimensional analysis. What is the practical use of Nusselt equation ? 3+2

7. (a) Derive the LMTD expression for a counter-current heat exchanger. 8

(b) What are the advantages of square pitch arrangements in heat exchangers over triangular pitch. 2

8. Write short notes on any **two** : 5×2

(a) Boiling point elevation

(b) LMTD correction factor

(c) Fourier's law

(d) Black body radiation.