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Total number of printed pages – 2

B. Tech  
PCCH 4301

**Fifth Semester Back Examination – 2014**

**HEAT TRANSFER**

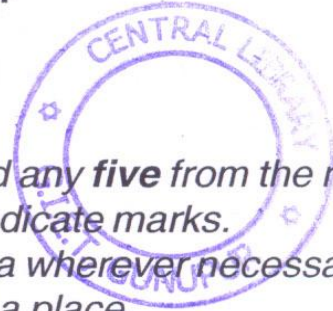
**BRANCH : CHEM**

**QUESTION CODE : L 214**

**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.  
Answer all parts of a question at a place.*



1. Answer the following questions : 2 × 10
  - (a) Define thermal conductivity. Arrange the followings in the increasing order of their thermal conductivities: Water, Ice, and Gases.
  - (b) The variation of thermal conductivity of a metal with temperature is often correlated using an expression of the form :  $k = k_0 + aT$ , where  $k$  is thermal conductivity and  $T$  is temperature in Kelvin. What is the unit of 'a' in SI system ?
  - (c) Differentiate between natural and forced convection.
  - (d) What are the assumptions taken in the derivation of Reynolds analogy equation ?
  - (e) Arrange the following in the increasing order of Prandtl number : Glycerol, Mercury, Water, and Oxygen.
  - (f) What do you mean by 25 percent baffle cut ?
  - (g) Write the advantages of square pitch over triangular pitch.
  - (h) Differentiate between sub-cooled boiling and pool boiling of saturated liquid.
  - (i) Define a grey body.
  - (j) How heat transfer coefficient is related to number of passes in a shell and tube heat exchanger ?
2. (a) Derive the steady-state heat conduction equation for a hollow spherical shell of inner radius  $R_i$  (maintained at  $T_i$ ) and outer radius  $R_o$  (maintained at  $T_o$ ). Assume  $K$  as the mean thermal conductivity of the material. 5

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- (b) A hollow sphere has an inside surface temperature of  $200^{\circ}\text{C}$  and the outside surface temperature of  $20^{\circ}\text{C}$ . Calculate the heat loss by conduction for an inside and outside diameter of 4 cm and 10 cm respectively. The thermal conductivity of the material is  $15 \text{ kcal/hr.m.}^{\circ}\text{C}$ . 5
3. (a) State the Buckingham's  $\pi$ -theorem of dimensional analysis. 3  
 (b) The resistance force  $F$  experienced by a partially submerged body depends upon the velocity- $V$ , length- $L$ , viscosity- $\mu$ , density of the fluid- $\rho$ , and gravitational acceleration- $g$ . Obtain the dimensionless expression for  $F$  by using Buckingham's  $\pi$ -theorem method of dimensional analysis. 7
4. (a) Differentiate between film type and drop wise condensation. 2  
 (b) Derive the Nusselt equation for a vertical tube of length  $L$  and film thickness  $\delta$  in film type condensation. 8
5. (a) With a neat diagram describe the different parts of a shell and tube heat exchanger. 6  
 (b) What are the advantages of multi pass over single pass heat exchanger? Draw the temperature profile for a 2-4 shell and tube heat exchanger. 4
6. (a) How evaporation is different from drying? 2  
 (b) Calculate the amount of steam required for concentrating the solution of caustic soda from 28 % wt. of solids to 40% wt. of solids in a single effect evaporator. The feed rate is 25000 kg/hr and its temperature is  $60^{\circ}$ . The absolute pressure in the evaporator is  $0.2 \text{ kg/cm}^2$  (boiling point  $60^{\circ}$ ). Saturated steam at  $1.4 \text{ kg/cm}^2$  ( $108.7^{\circ}\text{C}$ ) is to be used as heating medium. The elevation in boiling point is  $25^{\circ}\text{C}$ . If the overall heat transfer coefficient is  $670 \text{ kcal/hr.m}^2.^{\circ}\text{C}$ , calculate the heating surface required. The enthalpy data for various streams are as follows : 8  
 Vapour at  $0.2 \text{ kg/cm}^2 = 623 \text{ kcal/kg}$ ,  
 28% NaOH at  $60^{\circ}\text{C} = 50 \text{ kcal/kg}$ ,  
 40% NaOH at  $85^{\circ}\text{C} = 90 \text{ kcal/kg}$ , and  
 Latent heat of steam at  $1.4 \text{ kg/cm}^2 = 534 \text{ kcal/kg}$ .
7. Briefly explain the mechanism involved in the pool boiling of saturated liquid with a suitable graph. 10
8. Write short notes on any **two** of the following :  $5 \times 2$   
 (a) Extended surface  
 (b) Plate type heat exchanger  
 (c) Forced circulation evaporator  
 (d) Critical radius of insulation.