Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech(CHE)(O)/SEM-5/CHE-502/2012-13

2012
PROCESS HEAT TRANSFER

Time Allotted : 3 Hours   *Full Marks :* 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1.   Choose the correct alternatives for any *ten* of the following :

$$10 \times 1 = 10$$

i)   The expression for thermal diffusivity is

a) $\dfrac{\rho \cdot C_p}{K}$ b) $\dfrac{C_p \cdot \mu}{K}$

c) $\dfrac{K}{\rho \cdot C_p}$ d) $\dfrac{\mu}{h.C_p}$.

ii)   Viscosity of gases

a)   decreases with increase of temperature

b)   increases with increase in temperature

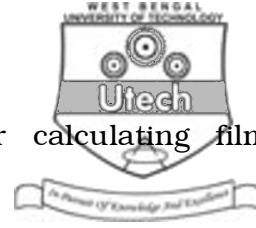c)   does not change with change in temperature

d)   none of these.

iii)   Prandtl Number for water at 20° C is around

a) $7 \cdot 5 \times 10^{-2}$ b) $7 \cdot 5 \times 10^{2}$

c)   7·5   d)   1·0·

iv) The dimensionless group used for calculating film coefficient in natural convection is

a) Peclet number

b) Stanton number

c) Grasshoff number

d) Graetz number.

v) Transient convection takes place when the Reynolds Number varies between

a) 1 and 2100   b) 2100 and 4200

c) 4200 and 100000   d) 100000 and above.

vi) Drop-wise condensation takes place for condensation of

a) Glycerine vapour   b) Petroleum fractions

c) Metal vapour   d) None of these.

vii) At what value of Prandtl number, the hydrodynamic and thermal boundary layers of fluid flowing over a heated plate will be identical ?

a) 1   b) < 1

c) > 1   d) none of these.

viii) Choose the correct equation :

a) $Nu = (Re)(Re)(Gz)$ b) $Nu = (Re)(Pr)(St)$

c) $Nu = (Re)(Pr)$ d) $Nu = (Pr)(St)$.

ix) In an extended surface heat exchanger, fluid having lower coefficient

a) flows through the tube

b) flows outside the tubes

c) can flow either inside or outside the tubes

d) should not be used as it gives very high pressure drop.

x) The purpose of floating head in a heat exchanger is to

a) avoid buckling of tubes

b) provide support for tubes

c) can flow either inside or outside the tubes

d) should not be used as it gives very high pressure drop.

xi) Economy of a multiple effect evaporator is not influenced much by

a) boiling point elevations

b) the temperature of the feed

c) rate of heat transfer

d) the ratio of the weight of the thin liquor to thick liquor.

GROUP – B
(Short Answer Type Questions)
Answer any *three* of the following.   3 × 5 = 15

2. Derive the expression for rate of heat transfer by conduction through a hollow sphere under steady state condition.

3. Derive the general equation of Fourier's law of heat conduction based on unsteady state 3-dimensional conduction of heat.

4. What is Reynolds Analogy between heat transfer and momentum transfer ? Derive the expression.

5. Discuss about the methods of feeding of Evaporators.

6. a) Define heat exchanger effectiveness. 3

   b) Write down the usefulness of baffles. 2

GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following. 3 × 15 = 45

7. a) Derive the expression for a steady rate of heat conduction through composite wall : Resistance in series. 5

   b) Inside and outside layers of a furnace wall are constructed of 11·5 cm of non-corrosive brick and 22 cm of clay brick, the thermal conductivities of the both being unknown. Inner and outer temperatures of the wall are 700° C and 160° C respectively. To save the heat loss the furnace is lagged with 5 cm of mineral wool, thermal conductivity being 0·525 kcal/hr. cm°C. The temperature at various points at this lag condition are :

   Temperature of the outer surface of non-corrosive brick is 650°C

   Temperature of the outer surface of clay brick is 515°C

   Temperature of the outer surface of mineral wool is 80°C

   Find the % of heat loss saved by lagging. 10

8. a) A heavy hydrocarbon oil with a specific heat of 2·3 kJ/kg.K is being cooled in a heat exchanger from 371·9 K to 349·7 K float inside the tube at a rate of 3630 kg/hr. A flow of 1450 kg of H_2O/hr enters at 288·6 K for cooling and flows outside the tube.

    b) Calculate the H_2O outlet temperature and heat transfer area if the overall heat transfer co-efficient is 340 watt/m^2K and the streams are counter-current.

    7 + 8

9. A continuous single effect evaporator is to be fed with 5000 kg/h of solution containing 1 wt% solute. The feed is at a temperature of 303 kg. It is to be concentrated to a solution of 2 wt% solute. The evaporation is at atmospheric pressure and the area of the evaporator is 69·7 m^2. Saturated steam is supplied at 193·3 kPa for heating.

    Calculate the amount of vapour and liquid transfer coefficient.

    Data : Enthalpy of feed = 125·79 kJ/kg

    Enthalpy of saturated steam = 2691·5 kJ/kg

    Enthalpy of liquid = 419·04 kJ/kg

    Enthalpy of vapour = 2676·1 kJ/kg

    Enthalpy of condensed steam = 461·30 kJ/kg.   15

10. a) What are the advantages of drop-wise condensation over film-type condensation ?

    b) Derive the equation of heat transfer coefficient (h), for single vertical tube for condensing vapour having film-type condensation. 5 + 10

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