21415

17560

3 Hours/100 Marks

Seat No. | | | | | | | | |

Instructions : *(1)* ***All*** *questions are* ***compulsory****.*
(2) ***Illustrate*** *your answers with* ***neat*** *sketches* ***wherever*** *necessary.*
(3) Figures to the ***right*** *indicate* ***full*** *marks.*
(4) ***Assume*** *suitable data,* ***if necessary****.*

MARKS

1. A) Attempt **any three** of the following : **12**
   a) What are thermal insulators ? Where are thermal insulators used ? Give two examples.
   b) What is fouling factor ? How does it affect the heat transfer process ?
   c) Define Radiation. State Stefan-Boltzman law.
   d) Draw a neat labeled diagram of 1-2 shell and tube heat exchanger.

   B) Attempt **any one** of the following : **6**
   a) With the help of Fourier's law derive the equation for heat loss through a composite wall of three layers of thickness X_1, X_2 and X_3 and thermal conductivities K_1, K_2 and K_3 respectively.
   b) Draw a labeled diagram of forced circulation evaporator and give any one application of forced circulation evaporator.

2. Attempt **any four** of the following : **16**
   a) Define thermal conductivity. Give its units in SI system. State the relation between temperature and thermal conductivity.
   b) Calculate the rate of heat loss through a thin walled pipe of 25 mm O.D. which is covered with a 10 mm layer of insulation of thermal conductivity 0.04 W/mK. The outside temperature of pipe is 140°C and the temperature outside the insulation is 35°C.

MARKS

c) Define what is a black body. Give any two examples that are nearly close to behave as black body.

d) State the application of finned tube heat exchanger. Give any two examples where finned tube heat exchangers are used.

e) What is the use of baffles in a shell and tube heat exchanger ? (State atleast two uses). Compare square pitch and triangular pitch arrangement in shell and tube heat exchanger (two points).

3. Attempt **any two** of the following : **16**

a) Derive the equation :

$$Q = U. A. \Delta T_{lm}$$

Where Q : Rate of heat transfer

U : Overall heat transfer coefficient

A : Heat transfer Area ; ΔT_{lm} : log mean temperature difference.

b) Differentiate between a co-current and counter-current flow arrangement in heat transfer (minimum four points).

c) Draw a neat labeled diagram of a graphite block heat exchanger and state any two advantages of it over shell and tube heat exchanger. State any two applications of graphite block heat exchanger.

4. A) Attempt **any three** of the following : **12**

a) What is optimum thickness of insulation ? How is it determined ?

b) State and prove Kirchoff's law of radiation.

c) State any four parts of shell and tube heat exchanger with their function.

d) 10,000 kg/hr. of 10% NaOH solution is concentrated in an evaporator to obtain a product of 50% NaOH solution. Find the capacity of the evaporator.

B) Attempt **any one** of the following : **6**

a) Compare forward feed and backward feed arrangement for a multiple effect evaporation (atleast four points).

MARKS

b) A steam pipe of 120 mm O.D. is covered with two layers of insulation. The first layer is 50 mm thick and its thermal conductivity is 0.062 W/mK. The second layer is 30 mm thick and its thermal conductivity is 0.872 W/mK. Outside surface temperature of the steam pipe is 235°C and outer surface temperature of lagging is 38°C. Calculate the temperature between two layers of insulation.

5. Attempt **any two** of the following : **16**

a) Explain how will you calculate the value of individual heat transfer coefficients with help of Wilson Plot.

b) Water is being heated in a double pipe heat exchanger with help of condensing steam. The steam condenses on the outer pipe at 120°C and water enters the inner pipe at 25°C and leaves at 85°C. The inner diameter of inner pipe is 25 mm and the flow rate of water is 1 kg/s. Calculate the following :

i) Inner heat transfer coefficient

ii) Overall heat transfer coefficient based on outside area

iii) Length of heat exchanger.

Data :

- Neglect metal wall resistance
- ho = 15000 W/m^2K
- Thermal conductivity of water = $0.63 \frac{W}{mK}$
- Absolute viscosity of water = 0.0008 Pa.s
- Average density of water = 980 kg/m^3
- Specific heat of water = 4.187 kJ/kg K.

c) State any two methods for increasing the economy of evaporation. Describe any one of them with neat labeled diagram.

MARKS

6. Attempt **any two** of the following : **16**

a) Differentiate between filmwise and dropwise condensation. Draw a temperature – length curve for a condenser.

b) Water is heated from 25°C to 55°C at rate of 25 kg/s with help of hot water available at 90°C, at a rate of 30 kg/s. Calculate the following :

i) Suitable arrangement of flow : co-current or counter current.

ii) Heat transfer area required, if overall heat transfer coefficient is 1500 W/m^2K.

c) A solution containing 10% solids is to be concentrated to 50% solids by evaporation. The steam available is at 120°C and the feed rate to evaporator is 30000 kg/hr. The evaporator is a single effect evaporator and is working at a reduced pressure such that the boiling point is 50°C. The overall heat transfer coefficient is 3.0 KW/m^2K. Calculate the steam economy and heat transfer area if the feed is fed at 20°C.

Data :

Specific heat of feed = 4.0 kJ/kgk

Latent heat of condensation of steam (at 120°C) = 2202 kJ/kg

Latent heat of vaporization of water (at 50°C) = 2383 kJ/kg
