17560

15116

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.

(5) Use of Non-Programmable Electronic Pocket Calculator is permissible.

Marks

1. (A) Attempt any THREE of the following : **12**

(a) State and define three distinct modes of heat transfer.

(b) Define Absorptivity, Reflectivity and Transmissivity with neat figure.

(c) State and define two types of convection with suitable example.

(d) What is heat exchanger ? State and give the function of any three heat transfer equipments used in chemical industry.

(B) Attempt any ONE of the following : **6**

(a) Derive an expression to find out rate of heat transfer through a composite wall of three different materials.

(b) With neat sketch give the construction and working of short tube evaporator.

2. Attempt any FOUR of the following : **16**

(a) State Fourier's law of heat flow by conduction. Define thermal conductivity.

(b) Find the heat loss by conduction through a hollow sphere of i.d. – 40 mm and o.d. – 140 mm having inside and outside surface temperature of 570 K and 300 K respectively.

Data – Thermal conductivity of material is $17.5 \frac{W}{(m.K)}$

P.T.O.

(c) Draw a neat labelled diagram of fixed tube sheet 1-2 heat exchanger.

(d) Give the construction, working and application of Graphite Block heat exchanger.

(e) State and explain Kirchoff's law of radiation.

3. Attempt any TWO of the following : 16

(a) Derive the relationship between overall and individual film heat transfer coefficients.

(b) 7 kg/s of pure isobutane is to be condensed at 335 K in a horizontal tubular heat exchanger using water as a cooling medium. Water enters at 303 K and leaves the exchanger at 318 K. Calculate heat load and mass flow rate of cooling water.

Data : Latent heat of vaporization of isobutane is 286 kJ/kg.

Specific heat of water is 4.187 kJ/(kg.K)

(c) With neat labelled diagram, give the construction, working and industrial application of shell and tube heat exchanger.

4. (A) Attempt any THREE of the following : 12

(a) Give the two types of flow encountered in heat exchanger with neat sketches.

(b) Find the rate of heat flow from a cylindrical tube of length 4 m if inner surface is at 375 K & outer surface is at 310 K. Inside and outside diameter of the tube is 20 mm and 30 mm respectively.

Data : Thermal conductivity of tube material is 0.300 W/(m.K)

(c) Calculate the heat loss by radiation from an unlagged steam pipe of 1 m in length, 50 mm o.d at 415 K to surrounding atmosphere at 290 K.

Data : Take emissivity e = 0.900

(d) Give four points of comparison between Evaporation & Drying.

(B) Attempt any ONE of the following : 6

(a) Derive an expression for rate of heat flow Q, for a plane wall of thickness *x*, which has one surface at temp. T_1 and other surface at temp. T_2, if the thermal conductivity of the wall varies with temperature as per the following equation : $K = K_0 (1 + \alpha T)$

(b) With neat figures show the flow patterns of steam, feed, vapour and thick liquor in multiple effect evaporator for

(i) Forward feed arrangement

(ii) Backward feed arrangement

5. Attempt any TWO of the following : 16

(a) A solution containing 10% solids is to be concentrated to 50% solids. Steam is available at a pressure of 0.20 MPa. Feed rate to the evaporator is 30000 kg/h which is introduced at 293 K. The evaporator is working at reduced pressure such that boiling point is 323 K. Calculate the steam economy.

Data : Specific heat of feed = 3.98 kJ/(Kg.k)

Latent heat of condensation of steam at 0.20 MPa = 2202 kJ/kg.

Latent heat of vaporizing of water at 323 K = 2383 kJ/kg.

(b) Water is to be heated from 298 K to 313 k at a rate of 30 kg/s. Hot water is available at 353 K at a rate of 24 kg/s for heating in a counter current exchanger. Calculate the heat transfer area required, if the overall heat transfer coefficient is 1220 W/(m^2.K).

(c) Why LMTD concept is used in heat exchanger ? Show that

$$\text{LMTD} = \Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{ln\left(\frac{\Delta T_1}{\Delta T_2}\right)}$$

6. Attempt any TWO of the following : 16

(a) Find the inside heat transfer coefficient using Sider-Tate equation for turbulent flow through a tube of inside diameter 20 mm.

Data : N_{Re} = 15745, N_{Pr} = 36

Viscosity of fluid at bulk mean temperature and at average wall temperature is 550×10^{-6} Pa.s & 900×10^{-6} Pa.s respectively.

Thermal conductivity of fluid = K = 0.25 W/m.K.

P.T.O.

(b) What is condensation and boiling ? Give two distinct mechanisms of condensation and differentiate between these mechanisms. (Any four points)

(c) In case of evaporator define capacity and economy. State the methods of increasing the economy by vapour recompression method.
