17560

16172

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.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

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

(i) State Fourier's Law for conduction and given the mathematical expression.

(ii) Describe convection as a mode of heat transfer with examples.

(iii) Define Absorptivity, Reflectivity and Transmissivity.

(iv) Draw a neat labelled diagram of fixed tube sheet heat exchanger.

b) **Attempt any ONE of the following:** **6**

(i) Derive the expression for heat transfer through a slab of uniform thickness having thermal conductivity K.

(ii) Describe with neat sketch construction and working of horizontal tube evaporator.

Marks

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

a) State and define three modes of heat transfer.

b) Describe the concept of optimum thickness of insulation with neat diagram.

c) Explain the concept of black body.

d) Explain with neat sketch the construction and working scrapped surface heat exchanger.

e) Describe with diagram the construction of Graphite Block Heat Exchanger.

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

a) Methyl alcohol flowing in the inner pipe of a double pipe Heat exchanger is cooled with water flowing in the outer pipe. The inside and outside diameter of the inner pipe are 26 mm and 35 mm respectively. The thermal conductivity of steel is 50 W / (M.K.) The individual film coefficient and fouling factors are:

Alcohol coefficient (ho) = 250 W/(m^2.K)

Water coefficient (ha) = 500 W/(m^2.K)

Outside fouling factor (Rdo) = 1.7×10^{-3} W/(m^2.K)/W

Inside fouling factor (Rdi) = 0.86×10^{-3} W/(m^2.K)/W

Calculate the overall coefficient based on outside area of inner pipe including dirt factors and excluding dirt factors.

b) Derive the equation for overall heat transfer coefficient from hot fluid to cold fluid through a metal wall.

c) Draw a neat labelled diagram of U-tube Heat Exchanger. Give its construction and working.

Marks

4. a) **Attempt any <u>THREE</u> of the following:** **12**

(i) The wall of a house, 7m wide and 6m high is made from 0.3 m thick brick with thermal conductivity as 0.6 W/(m.K). The surface temperature on the inside of the wall is 289 K and that one the outside is 279 K and that one the outside is 279 K. Find the heat flux through the wall.

(ii) Discuss the economy of an evaporator. How can economy of an evaporator can be increased?

(iii) Calculate the loss of heat by radiation from a steel tube of diameter 70 mm and 3 m long at a temperature of 500 K, if the tube is located in a square brick conduit 0.3 m side at 300 K. Assume 'e' for steel as 0.79 and for brick conduit as 0.93.

(iv) Explain the significance of baffles in heat exchanging equipments.

b) **Attempt any <u>ONE</u> of the following:** **6**

(i) Explain vapour recompression for increasing the economy of evaporator.

(ii) Derive an expression for the heat flow rate Q, for a plane wall of thickness *x*, which has its one surface at a temperature T_1 and the outer surface at a temperature T_2 and if thermal conductivity of wall varies with temperature as;
$K = K_0(1 + \alpha T)$

5. **Attempt any <u>TWO</u> of the following:** **16**

a) Derive an equation for log mean temperature difference (LMTD)

b) An evaporator operating at atmospheric pressure is fed at the rate of 10,500 kg/h of weak liquor containing 4% caustic soda. Thick liquor leaving the evaporator contains 24% caustic soda. Find:

(i) Capacity of evaporator

(ii) Economy of evaporator if 9500 kg/h of steam is fed.

Marks

c) Determine the heat transfer coefficient for water flowing in a tube of 16 mm diameter at a velocity of 3m/s. The temperature of the tube is 297 K and the water enters at 353 K and leaves at 309 K. Use:

(i) The dittus - Boelter equation and

(ii) Sieder - Tate equation.

Data: Properties of water 331 K i.e. at arithmetic mean bulk temperature are

$\rho = 984.1 \text{ kg/m}^3$

$\mu = 485 \times 10^{-6}$ Pa.s

Cp = 4187 J/(kg. k)

K = 0.657 W/(m.k)

Viscosity of water at 297 K. $\mu_W = 920 \times 10^{-6}$ Pa.s

6. Attempt any <u>TWO</u> of the following: **16**

a) Distinguish dropwise and filmwise condensation on basis of following points.

(i) Mechanism

(ii) heat transfer coefficient

(iii) Surface types

(iv) Stability

(v) Equations for predicting film coefficients.

b) State the empirical equations for calculating heat transfer coefficient in laminar and turbulent regions and explain each term.

c) Compare forward and backward feed arrangements in case of multiple effect evaporators. Draw neat sketches for both arrangements.