16117

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) State and explain Fourier's law of heat radiation.

(b) Write the formula for following :

(i) Nusselt Number

(ii) Grashof Number

In calculating film coefficient also state the meaning of each term used.

(c) State and explain Kirchhoff's law of radiation.

(d) Write advantages and disadvantages of multi-pass heat exchanger.

(B) Attempt any ONE of the following : **06**

(a) Derive an expression to findout rate of heat transfer through a composite wall of three materials of different thickness having different thermal conductivities.

(b) What is thermal recompression ? State the properties that influences evaporation.

2. Attempt any FOUR of the following : 16

(a) Draw the diagram and describe the concept of optimum thickness of insulation with a neat diagram.

(b) Write two modes of heat transfer with examples.

(c) State and explain Stefan – Boltzmann law of radiation.

(d) Distinguish between co-current and counter current heat exchanger with neat diagram.

(e) Explain the construction and working of plate type heat exchanger with a neat diagram.

3. Attempt any TWO of the following : 16

(a) What are film coefficient ? How they play an important role when heat transfer takes place by combined convection and conduction mechanism ?

(b) Cold fluid is flowing through the heat exchanger at a rate of 15 m^3/h. It enters the heat exchanger at 303 K and leaves at 328 K. A hot thermic fluid enters the heat exchanger at a rate of 21 m^3/h at a temperature of 388 K. Find the area of heat transfer required assuming the flow to be counter current and overall heat transfer coefficient be 3490 W/(m^2. K)

Data : Density of cold fluid = 1000 kg/m^3

Density of thermic fluid = 950 kg/m^3

Specific heat of cold fluid = 4.187 kJ/(kg. K)

Specific heat of thermic fluid = 2.93 kJ/(kg. K)

(c) Explain the construction and working of Kettle type reboiler with floating head arrangement with neat labelled diagram.

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

(a) A wall is made of brick of thermal conductivity 1.0 W/ (m.K), 230 mm thick. It is lined on the inner face with plaster of thermal conductivity 0.4 W/(m. K) and of thickness 10 mm. If a temperature difference of 30 K is maintained between the two faces, what is the heat flow per unit area of wall ?

(b) Name the type of evaporator for concentrating

(i) Viscous solution

(ii) Foaming solution

and give reason for the same.

(c) Define absorptivity, reflectivity and transmissivity of a body and prove that when any body is in thermal equilibrium with its surrounding, its emissivity and absorptivity are equal.

(d) Why baffels are used on the shell side of a shell and tube heat exchanger ?

(B) Attempt any ONE of the following : **06**

(a) Derive rate equation for heat transfer through a thick walled cylinder.

(b) A single effect evaporator is to concentrate 20000 kg/h of a solution having a concentration of 5% salt to a concentration of 20% salt by weight. Steam is fed to the evaporator at a pressure corresponding to the saturation temperature of 399 K. The evaporator is operating at atmospheric pressure and the boiling point rise is 7 K. Calculate heat load and steam economy.

Data : Feed temperature = 298 K

Specific heat of feed = 4.0 kJ/(kg. K)

Latent heat of condensation of steam at 399 K = 218 5 kJ/kg

Latent heat of vaporization of water at 373 K = 2257 kJ/kg

P.T.O.

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

(a) Explain mechanism of heat transfer in boiling liquids.

(b) How economy of an evaporator can be increased ? Explain in detail any one method.

(c) A hot fluid enters a double pipe heat exchanger at a temperature of 423 K and is to be cooled to 367 K by a cold fluid entering at 311 K and heated to 339 K. Shall they be directed in parallel or counter-current flow ?

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

(a) What is Wilson plot ? Explain how to calculate the individual heat transfer coefficient with the help of Wilson plot.

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

(i) Dittus – Bolter equation and

(ii) Sider – Tate equation.

Data :

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

$\rho = 984.1$ kg/m^3, $C_p = 4187$ J/(kg. K),

$\mu = 485 \times 10^{-6}$ pa.s, K = 0.657 W/(m. K)

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

(c) Explain in detail construction and working of standard vertical tube evaporator with neat flow diagram.

———————