17560

21819

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answer with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use no Non- programmable Electronic Pocket Calculator is permissible.

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

Marks

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

(i) Define thermal insulators? State its use. Give two examples.

(ii) Define fouling factors? Describe the effect of fouling factor on heat transfer process?

(iii) Define Radiation. State Stefan- Boltzman law.

(iv) Draw a neat labeled diagram of 1-2 shell and tube heat exchanger.

Marks

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

(i) 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.

(ii) Draw a labeled diagram of forced circulation evaporator and give any one application of forced circulation evaporation.

2. Attempt any <u>FOUR</u> of the following: **16**

a) Define thermal conductivity? Explain it in detail and give its units.

b) A flat furnace wall is constructed of 4s mm layer of sil-o-cel brick with a thermal conductivity of 0.138 w/m.k backed by a 90 mm layer of common brick of conductivity 1.38 w/mk. Calculate the total thermal resistance considering the area of the wall in one square meter.

c) Show that at thermal equilibrium the ratio of the total emissive power to its absorptiving is same for all the bodies.

d) Draw a neat diagram of 1-2 floated head shell and tube heat exchanger.

e) With neat sketch explain construction and working of plate and frame heat exchanger

Marks

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

a) Derive the equation Q = U.A. ΔTm

Where Q : Rate of heat transfer

U : Overall heat transfer coefficient

A : Heat transfer area

ΔTm : log mean temperature difference.

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

c) Find the overall heat transfer coefficient if:

(i) Inside and outside film heat transfer coefficient are 12 mm and 11600 w/m^2k

(ii) Inside and outside diameter are 25 mm and 29 mm respectively.

(iii) Thermal conductivity of the metal = 34.9 w/m.k.

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

(i) State optimum thickness of insulation. Explain determination process.

(ii) State and prove Kirchoff's law of radiation.

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

(iv) 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.

Marks

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

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

(ii) 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) Thermic fluid flowing at a rate of 5000 kg/hr is to be cooled from 423 k to 363 k by circulating water at a rate of 15000 kg/hr. If the water is available at 303 k, find the outlet temperature of water

Data: Specific heat of thermic fluid =2.72 kJ/kg.k

Specific heat of water =4.187 KJ/kg.k

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

c) A single effect evaporator is to concentrate 2000 kg/hr 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 the heat load and steam economy.

Data: Feed temperature = 298 k

Specific heat of feed = 4 kJ/kg. K

Latent heat of condensation of steam at 399 k = 2185 kJ/kg

Latent heat of vaporisation of water at 373 k = 2257 kJ/kg

Marks

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

a) Differentiate between filmwise and dropwise condensation.

b) Determine the heat transfer coefficient for water flowing at a velocity of 3 m/sec. The temperature of the tube is at 297°k and water enters at 353 k leaves at 300 k using Dittus bolter equation.

Properties of water at 331°k

Data : Density of water (ϱ) = 984.1 kg/m^3

Specific heat of water (Cp) = 4187 J/kg.k

Viscosity of water (μ) = 485 × 10^{-6} pa.s

Thermal conductivity (k) = 0.657 w/mk

Viscosity of water at 297°k (μw) = 920 × 10^{-6} pa.s

Diameter of the tube = 20 mm

c) With neat sketch write construction and working of "Long tube vertical evaporator".