17560

14115

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 answers with ***neat*** *sketches* ***wherever*** *necessary.*
(4) Figures to the ***right*** *indicate* ***full*** *marks.*
(5) Assume suitable data, if ***necessary****.*
(6) ***Use*** *of 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 three** of the following : **12**

a) Define Fourier's law of heat transfer. Give its mathematical expression and explain the terms.

b) Explain the term dimensional analysis and prove that NRe is dimensionless.

c) State Stefan Boltzman law of Radiation. Give its mathematical expression and explain the terms.

d) Give classification of shell and tube heat exchanger. What are the main parts of shell and tube heat exchanger ?

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

a) A steam pipe 150/160 mm in diameter carries steam. The pipe line is lagged with a layer of heat insulating material having thermal conductivity 0.08 W/mk and thickness of (100 mm). The temperature drop from 392.8 K to 313 K across the insulating surface. Determine the rate of heat loss per metre length of the pipe.

b) What are the methods of increasing the economy of an evaporator ? Explain multiple effect evaporation. Give methods of feeding multiple effect evaporator.

MARKS

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

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

   b) A flat furnace wall is constructed of 45 mm layer of sil-o-cel brick with a thermal conductivity of 0.138 W/mk 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 is one meter square.

   c) Show that at thermal equilibrium the ratio of the total emissive power to its absorptivity 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.

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

   a) Find the inside heat transfer coefficient by using Sieder tate equation for turbulent flow.

   Data : Inner diameter of the tube – 20 mm

   Viscosity of fluid at mean Temperature – 550×10^{-6} Pa.s.

   Viscosity of fluid at average wall temperature = 900×10^{-6} Pa.s

   Reynold's number – 15745

   Prandlt number – 36

   Thermal conductivity of fluid = 0.25 W/mk.

   b) Derive relation for individual and overall heat transfer coefficient.

   c) In a double pipe counter flow heat exchanger 10,000 kg/hr of an oil having a specific heat of 2095 J/kgk is cooled from 353 K to 323 k by 8000 kg/hr of water entering at 298 K. Calculate the heat exchanger area for an overall heat transfer coefficient of 300 W/m^2k. Take C_P for water as 4180 J/kgk.

MARKS

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

a) Derive an expression to find out rate of heat transfer through a single flat furnace wall.

b) An evaporator operating at atmospheric pressure (101.325 KPa) is fed at the rate of 10,000 Kg/hr of weak liquor containing 5% caustic soda. Thick liquor leaving the evaporator contains 25% caustic soda. Find capacity of an evaporator.

c) Estimate the total heat loss by convection and radiation. From an unlagged steam pipe 50 mm outside diameter at 415 K to air at 290 K

Take emissivity = 0.90

Film coefficient-hc = $1.18\left(\frac{\Delta T}{D_0}\right)^{0.25}$ $W / m^2k.$

d) Describe the process of Maintenance of heat exchanger.

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

a) Derive an expression for rate of heat transfer through a cylindrical wall.

b) Derive the equation for material and energy balance for a single effect evaporator.

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

a) Derive an expression for $Q = UA\,\Delta Tlm$.

b) A single effect evaporator is fed with 5000 kg/hr of solution containing 1% solute by weight. Feed temperature is 303 K is to be concentrated to a solution of 2% solute by weight. The evaporation is at atmospheric pressure and area of evaporator is 69 m^2. Saturated steam is supplied at 1433 KPa as a heating medium. Calculate steam economy and overall heat transfer coefficient.

Data Given :

Enthalpy of Feed at 303 K Temp. = 125.79 kJ/kg

Enthalpy of Vapours at 101.325 KPa pressure = 2676.1 kJ/kg

Enthalpy of Saturated steam at 143.3 KPa = 2691.5 kJ/kg

MARKS

Saturation temperature of steam = 383 K

Boiling point of saturated solution = 373 K

Enthalpy of product = 419.04 $^{kJ}/_{kg}$

Enthalpy of saturated water at 383 K = 461.30 $^{kJ}/_{kg}$.

c) 27 $^{T}/_{hr}$ of pure isobutane is to be condensed at 332 K in a horizontal tubular heat. Exchanger using water as a cooling media water enters at 300 K and leaves the heat exchanger at 315 K. Calculate heat load and mass flow rate of cooling water.

Data : Latent heat of vapourisation of isobutane is = 286 $^{kJ}/_{kg}$.

Specific heat of water is = 4.187 $^{kJ}/_{kg}$ k.

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

a) Explain mechanism of heat transfer in condensation of single vapours.

b) Determine the heat transfer coefficient for a 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 – C_P = 4187 J/kgk

Viscosity of water – μ = 485×10^{-6} Pa.s.

Thermal conductivity – k = 0.657 W/mk

Viscosity of water at 297 k μ w = 920×10^{-6} Pa.s.

Diameter of the tube = 20 mm

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