

( 3 Hours )

[ Total Marks : 80

- N.B. : (1) Question No 1 is compulsory.  
 (2) Attempt any three questions out of remaining five questions.  
 (3) Assume suitable data wherever necessary.

1. Attempt any four questions :-

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- Differentiate between convection and conduction.
- Explain absorptivity, reflectivity and transmissivity.
- Discuss critical and optimum thickness of insulation.
- Give the classification of shell and tube heat exchanger.
- Explain dropwise and film wise condensation.

2. (a) Derive the expression for rate of heat flow through a composite cylinder. 10

(b) In an oxygen-nitrogen gas mixture at 101.325 kPa and 298 K, the concentration of oxygen at two phases 2 mm apart are 10 and 20% by volume respectively. 10

Calculate the flux of diffusion of oxygen for the following :-

(i) Nitrogen is non-diffusing

(ii) There is equimolar counter diffusion of two gases  $D_{AB} = 1.81 \times 10^{-5} \text{ m}^2/\text{s}$ .3. (a) Calculate the inside heat transfer coefficient for a fluid flowing at a rate of 300 cm<sup>3</sup>/s through a 20 mm inside diameter tube of a heat exchanger. 10

Data :

Viscosity of flowing fluid = 0.8 Ns/m<sup>2</sup>.

Density of flowing fluid = 1.1 g/cc.

Specific heat of fluid = 1.26 kJ/kg. K.

Thermal conductivity of fluid = 0.384 W/m. K.

Viscosity of water = 1 Ns/m<sup>2</sup>.

Length of heat exchanger = 5 m.

(b) Explain boiling point diagram of Benzene-Toluene system. 5

(c) Calculate the heat loss by radiation from an unlagged horizontal steam pipe, 50 mm OD at 377 K to air at 283 K. Take emissivity = 0.90 and  $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$ . 5

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4. (a) A furnace wall is constructed with a 299 mm thick layer of fire brick, a 115 mm thick layer of insulation brick and again a 229 mm thick layer of building brick. The inside temperature is 1223 K and the temperature at the outmost wall is 323 K. The thermal conductivities of fire brick, insulating brick and building brick are 6.05, 0.581 and 2.33 w/m.K. respectively. Find the loss per unit area and the temperature at the interface. 10
- (b) Explain the role of diffusion in bioprocessing. 10
5. (a) What are the different types of distillation ? Explain simple distillation. 10
- (b) Explain the physical significance of the following dimensionless number :- 10
- (i) Reynold's no.
  - (ii) Prandtl no.
  - (iii) Grashof no.
  - (iv) Nusselt no.
  - (v) Biot no.
6. Write a short note on any four :- 20
- (a) Flash distillation
  - (b) Nusselt theory
  - (c) Fouling factor
  - (d) Radiation shield
  - (e) Factors affecting cellular oxygen demand.

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