(3 hours) **Maximum Marks: 80**

N.B

1. **Question No. 1** is compulsory.

2. Attempt any **three** out of remaining **four** questions.

3. Make Suitable Assumptions if necessary and state them clearly.

4. Figures to the right indicate marks.

5. Illustrate answers with sketches wherever required.

Q1 **a)** Derive formula to calculate Critical thickness of insulation for a cylinder. **05**

b) Write note on ''Boiling point elevation in Evaporation''. **05**

c) An ice box of inner dimensions 1m x 0.7 m x 0.6 m has a 6.5 cm thick layer of thermocol on it as insulation. It contains 12 kg of ice. If the outer surface temperature of the box is 20 ^{0}C, calculate the time required for the ice to melt. Latent heat of ice to water is 3350 KJ/kg ice. The thermal conductivity of the insulation layer is 0.0355 W/m ^{0}C. Assume that this layer virtually offers all the heat transfer resistance. State any other assumption you make. **05**

d) A person is found dead at 5 pm in a room whose temperature is 20 ^{0}C. The temperature of the body is measured to be 25 ^{0}C when found, and the heat transfer coefficient is estimated to be 8 W/m^2 K. Modelling the body as a 30 cm diameter, 1.7 m long cylinder, estimate the time of death of that person. k = 0.617 W/m ^{0}C, ρ = 996kg/m^3, Cp = 4178J/kg ^{0}C. Solve using lumped parameter system. **05**

Q2 **a)** A 100mm thick brick wall is coated with 40mm gypsum plaster. To reduce heat transfer by 80% rock-wool insulation is provided. .Find the thickness of Rockwool. Data: k_{Brick}=0.7W/m K, k_{gyp}=0.48 W/m K and $k_{r.wool}$ = 0.065 W/m K. **08**

b) A solid steel ball having 50mm diameter at 723K is quenched to 363K.Find the time taken by the centre of the ball to reach 423K.data: h=11.5W/m^{2}K. ρ=8000kg/m^3, Cp=420 J/kg K. **08**

c) Derive an expression to calculate the efficiency of adiabatic tip type and infinitely long type of fins. You need not derive formulae for Q and can directly use it as well. **04**

Q3 **a)** Air at a temperature of 523K flows over a flat plate 0.3mwide, 1m long, at a velocity 8m/s. If the plate temperature is 351K, find the rate of heat transfer to the plate. Data at mean temp.: k=0.0364W/m K. Npr=0.69. Kinematic viscosity=0.0004m^2/s. **10**

b) A 20 mm φ horizontal heater is maintained at a surface temperature of 313 K and submerged in water at 298 K. Estimate the heat loss/ unit length of heater by natural convection. **10**

Data:- Properties of water at mean temperature of 32.5 ^{0}C are
K = 0.63 w/m K, $\beta = 3.04*10^{-4}$ K^{-1}, $\rho = 1000$ kg/m^3, $\mu = 8*10^{-4}$ kg/m-s,
$c_p = 4.187$ kJ/kg ^{0}C.
Use Nu = 0.53 (Gr. Pr)$^{1/4}$

Q4 **a)** Liquid oxygen at -183ºC is stored in a spherical vessel of 300mm diameter. It is insulated using another concentric sphere of 500mm dia., with vacuum in between. The emissivities of both the surfaces are 0.3. Find the heat transfer by radiation. **10**

b) Describe the various methods of feeding in Multiple effect Evaporator. **05**

c) Describe the mechanism of pool boiling. **05**

Q5 **a)** Saturated steam at 90^{0}C [P=70.14 kPa] condenses on the out surface of 1.5 m long 2.5 m OD vertical tube maintained at a uniform temperature of 70^{0}C. Assuming film condensation, Calculate the local heat transfer coefficient at the bottom of the tube. Data: $\rho = 974$kg/m^3, $\lambda = 2309$ KJ/Kg, $k_w = 0.666$ W/m K, μ = 335x10-6 Kg/m S. **10**

b) Derive the relation between Effectiveness and NTU for a co-current heat exchanger. **10**

Q6 **a)** Explain Kern's method of designing STHE. Give stepwise procedure with proper equations. **10**

b) Write short note on Heat Transfer in Agitated Vessels. **04**

c) An aluminum rod 30 mm in diameter and 150 mm long protrudes from a wall which is maintained at 275ºC into the environment maintained at 20ºC. Estimate heat loss by rod end assuming that rod end is insulated. Also find fin efficiency and temperature at the end of fin. **06**
Data : $k_{aluminum} = 210$ W/m K, h (between rod surface and environment) = 17 W/m^2 K.

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