Reg. No. _____

Karunya University

(Declared as Deemed to be University under Sec.3 of the UGC Act, 1956)

MODEL QUESTION

Subject Title: HEAT AND MASS TRANSFER
Time: 3 hours
Subject Code: 09ME204 **Maximum Marks: 100**

(Use of approved data book is permitted)
Answer ALL questions
PART – A (10 x 1 = 10 MARKS)

1. Give the equation for Fourier law of conduction.
2. Define overall heat transfer co-efficient.
3. What is meant by Semi-infinite solids?
4. Define Biot number.
5. Define term effectiveness for a fin?
6. What is free convection?
7. List the classification of heat exchangers based on flow direction.
8. Define Stephen's Law.
9. Mention a few industrial applications where boiling and condensation are important.
10. Define shape factor.

PART – B (5 x 3 = 15 MARKS)

11. A brick wall (k = 0.7 W/m^{o}C) is 0.3 m thick. Inner surface is maintained at 45^{o}C and outside surface, at 25^{o}C. Calculate the heat transfer rate per m^2 of area. Also find the temperature at the mid-plane.

12. A hot plate 35 cm high and 1.1 m wide at 160^{o}C is exposed to ambient air at 20^{o}C. Calculate the boundary layer thickness at 10 cm from the leading edge of the plate.

13. What is overall heat transfer coefficient? What is its importance?

14. The flow rates of hot and cold water streams running through parallel flow heat exchangers are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75^{o}C and 20^{o}C respectively. The exit temperature of hot water is 45^{o}C. Find outlet temperature of cold streams and Logarithmic mean temperature difference.

15. Emissivities of two large parallel planes maintained at 800 ^{o}C and 300 ^{o}C are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square metre for these plates?

PART – C (5 x 15 = 75 MARKS)

16. Derive the heat conduction equation in cylindrical coordinates.

(OR)

17. A steel pipe line (k=50W/mK) of ID 100mm and OD 110mm is to be covered with two layers of insulation each having a thickness of 50mm. The thermal conductivity of the first insulation material is 0.06 W/mK and that of the second is 0.12 W/mK. Calculate the loss of heat per meter length of pipe and the interface temperatures between the two layers of insulation when the temperature of the inside tube surface is 250 º C and that of the outside surface of the insulation is 50 º C.

18. An iron sphere of diameter 5 cm is initially at a uniform temperature of 225^{o}C. It is suddenly exposed to an ambient at 25^{o}C with convection coefficient of 500 W/m^{2} ^{o}K.
    a. Calculate the centre temperature 2 minute after the start of exposure.
    b. Calculate the temperature at the depth of 1 cm from the surface after 2 minute of exposure.
    c. Calculate the energy removed from the sphere during this period.
    Take properties of iron plate K = 60 W/m^{o}K, ρ = 7850 kg/m^{3}, C = 460 J/kg, α = 1.6 x 10^{-5} m^{2}/s.

(OR)

19. An Aluminium sphere weighting 6 kg and initially at temperature of 350^{o}C is suddenly immersed in a fluid at 30^{o}C with convection coefficient of 60 W/m^{2} ^{o}C. Estimate the time required to cool the sphere to 100^{o}C. Take thermo physical properties as C = 900 J/Kg^{o}K, ρ = 2700 kg/m^{3} and k = 205 W/m^{o}K.

20. A 30cm long glass plate is hung vertically in the air at 27 º C while its temperature is maintained at 77 º C. Calculate the boundary layer thickness at the trailing edge of the plate. If a similar plate is placed in a wind tunnel and air is blown over it at a velocity of 4 m/s, estimate the boundary layer thickness at its trailing edge.

(OR)

21. A hot square plate 50 cm x 50 cm at 100^{0}C is exposed to atmospheric air at 20^{0}C.Find the Heat loss from both surfaces of the plate if (i) The plate is kept in vertical plane and (ii)A plate is kept in horizontal plane. Determine the percentage heat loss if the plate is kept horizontal instead of vertical

22. In a counter flow double pipe heat exchanger, oil is cooled from 85^0C to 55^0 C by water entering at 25^0 C. the mass flow rate of oil is 9,800kg/h and specific heat of water is 4180 J/kg K. Determine the heat exchanger area and heat transfer rate for an overall heat transfer co-efficient of 280 W/m^2K.

(OR)

23. Co_2 and air experience equimolar counter diffusion in circular tube whose length and diameter are 1m and 50mm respectively. The system is at a total pressure of 1 atmosphere and a temperature of 25^0C.The ends of the tube are connected to large chambers in which the species concentration are maintain a fixed values. The partial pressure of Co_2at one end is 190 mm of Hg while other end is 95mm of Hg. Estimate the mass transfer rate of Co_2 and the air through the tube.

24. A pipe carrying steam having an outside diameter of 20 cm runs in a large room and is exposed to air at a temperature of 30˚C. The pipe surface temperature is 400˚C. Calculate the loss of heat to surroundings per meter length of pipe due to thermal radiation. The emissivity of pipe surface is 0.8. What would be the loss of heat due to radiation if the pipe is enclosed in a 40cm diameter brick conduit of emissivity 0.91?

(OR)

25. Discuss briefly the various regimes in pool boiling heat transfer with a neat sketch.