Reg. No. : | | | | | | | | | | | |

A 1464

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2008.

Sixth Semester

Mechanical Engineering

ME 340 — HEAT AND MASS TRANSFER

Time : Three hours Maximum : 100 marks

(Use of HMT Data Book is permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What do you mean by critical Radius of Insulation?

2. Distinguish between Fin efficiency and Effectiveness.

3. Define Radiation shape factor.

4. What is re-radiation? And show its electrical analogy.

5. Define Thermal boundary layer.

6. What is the significance of Grashof number?

7. Show the various regimes of pool boiling.

8. What is fouling factor?

9. State Fick's law of diffusion.

10. What is Schmidt number?

PART B — (5 × 16 = 80 marks)

11. (a) (i) A steam pipe 10 cm external diameter is to be lagged with two layers of different lagging materials, each 25mm thick. The thermal conductivity of material A is 0.052 W/mk while that of B is 0.086 W/mk. Determine which of the two lagging materials must be on the inside to produce the best insulation arrangement. If the internal surface temperature is 320°C and the external surface temperature is 20°C. Determine the heat loss per hour for 10m run of the lagged pipe with the best lagging arrangement. (10)

(ii) A steel ball 100 mm diameter was initially at 500°C and is placed in air which is at 35°C. Calculate the time required to attain 400 °C. (6)

Or

(b) Steam in a heating systems flows through tubes whose outer diameter is $D_1 = 3cm$ and whose walls are maintained at a temperature of 120° C. Circular aluminum fins (K= 180 W/m°C) of outer diameter D_2 = 6cm and constant thickness t = 2 mm are attached to the tube. The space between the fins is 3mm and thus there are 200 fins per meter length of the tube. Heat is transferred to the surrounding air at T_∞ = 25° C, with a combined heat transfer coefficient of h= 60 W/m²°C. Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins. (16)

12. (a) Two large parallel planes with emissivity' s 0.35 and 0.85 exchange heat by radiation. The planes are respectively 1073 K and 773 K. A radiation shield having the emissivity of 0.04 is placed in between. Find the percentage reduction in radiation heat exchange and the temperature of the shield. (16)

Or

(b) (i) Define shape factor and determine the shape factor of inner and outer surfaces of concentric cylinder. (6)

(ii) A pipe carrying steam having an outside diameter of 20cm 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 metre length of pipe due to thermal radiation. The emissivity of pipe surface is 0.8. (10)

13. (a) (i) Define Nusselt Number and mention its significance. (4)

(ii) Air at 65.6°C flows over a heated flat plate at 121.1 °C with a velocity of 0.915 m/s. Determine the local heat transfer coefficient at a distance of 0.61 m from the leading edge of the plate and heat transfer for 0.61 m length taking the width of the plate as 1 m. (12)

Or

(b) Air flow through a long rectangular (30cm height × 60cm width) air conditioning duct maintains the outer duct surface temperature at 15 °C. If the duct is uninsulated and exposed to air at 25°C, calculate the heat gained by the duct per metre length, assuming it to be horizontal. (16)

14. (a) A counter flow concentric tube heat exchanger is used to cool engine oil (c = 2130 J/Kg.K) from 160 °C to 60 °C with water available at 25°C as the cooling medium. The flow rate of cooling water through the inner tube of 0.5m diameter is 2 Kg/s while the flow rate of oil through the outer annulus 0.7 m is also 2 kg/s. If the value of the overall heat transfer coefficient is 250 W/m^2K, how long must the heat exchanger be to meet its cooling requirement? (16)

Or

(b) A steam condenses at 1 atm. pressure on the external surface of a tube of a steam condenser. There are 12 tubes in number and each in 30mm in diameter 10 m long. The inlet and outlet temperature of cooling water flowing inside the tubes are 25 °C and 60 °C. If the flow rate is 1.1 kg/s, calculate the rate of condensation of steam if hfg = 2257kJ/kg, Overall heat transfer coefficient, NTU and Effectiveness. (16)

15. (a) (i) Write short notes on Equimolar counter diffusion. (6)

(ii) Estimate the diffusion rate of water from the bottom of a test tube 10mm in diameter and 15cm long into dry atmospheric air at 25°C. Take the diffusion coefficient of water through air as 0.255×10^{-4} m²/s. (10)

Or

(b) (i) Define Sherwood number and state it's Significance. (4)

(ii) Air at 25°C and atmospheric pressure, containing small quantities of iodine flows with a velocity of 5m/s inside a 3 cm inner diameter tube. Determine the mass transfer coefficient from the air stream to the wall surface. Assume D_{AB} (iodine - air) = 0.82×10^{-5}m²/s. (12)