ANNA UNIVERSITY – 2006

B.E/B.TECH VI SEMESTER DEGREE EXAMINATION

HEAT AND MASS TRANSFER

(MECHANICAL ENGINEERING)

TIME-3HOUR
MARK-100

ANSWER ALL QUESTIONS

PART A (10 * 2 = 20)

1. Write down the equation for heat conduction through a hollow cylinder for one dimensional steady state without heat generation.

2. What is meant by critical radius of Insulation?

3. State the Wien's displacement law.

4. Define radiation shape factor.

5. Give two examples of the application of free convection.

6. What is the significance of Nusselt Number?

7. What is the difference between film-wise and drop-wise condensation?

8. List out the different types of Heat exchangers.

9. Define Fick's Law of Diffusion.

10. Give two practical examples of mass transfer.

PART B (5 * 16 = 80)

11. Water enters a cross flow Heat exchanger (both fluids unmixed) at 5oC and flows at the rate of 4600 kg/h to cool 4000 kg/h of air that is initially at 40oC. Assume the over all heat transfer coefficient value to be 150 W/m2K. For an exchanger surface area of 25m2, Calculate the exit temperature of air and water.

12. a) A steel tube k=43.26 W/mK of 5.08 cm ID and 7.62 cm OD is covered with 2.54 cm of asbestos Insulation k=0.208 W/mK. The inside surface of the tube receives heat by convection from a hot gas at a temperature of 316oC with heat transfer coefficient ha=284 W/m2K while the outer surface of Insulation is exposed to atmosphere air at 38oC with heat transfer coefficient of 17 W/m2K. Calculate heat loss to atmosphere for 3 m length of the tube and temperature drop across each layer.

(OR)

12. b) (i) A plane wall 20 cm thickness generates heat at the rate of 5 x 104 W/m3 when an electric current is passed through it. The convective heat transfer coefficient between each face of the wall and the ambient air is 60 W/m2K. Determine.

· The surface temperature
· The maximum temperature in the wall. Assume ambient air temperature to be 25oC and the thermal conductivity of the wall material to be 16 W/mK.

(ii) A steel ball 100 mm diameter was initially at 500oC and is placed in air which is at 35oC. Calculate time required to attain 400oC and 300oC.

k steel = 35 W/mK
c = 0.46 kJ/ kgK
p = 7800 kg/m3

h = 10 W/m2K

13. a) (i) Two parallel, infinite grey surface are maintained at temperature of 127oC and 227oC respectively. If the temperature of the hot surface is increased to 327oC, by what factor is the net radiation exchange per unit area increased?. Assume the emissivities of cold and hot surface to be 0.9 and 0.7 respectively.

(ii) Two equal and parallel discs of diameter 25 cm are separated by a distance of 50 cm. If the discs are maintained at 600oC and 250oC. Calculate the radiation heat exchange between them.

(OR)

b) Two large parallel planes with emissivities 0.35 and 0.85 exchange heat by radiation. The planes are respectively 1073K and 773K . A radiation shield having the emissivity of 0.04 is placed between them. Find the percentage reduction in radiation heat exchange and temperature of the shield.

14. a) State the Buckingham's p- Theorem. Explain the various parameters used in forced convection and using dimensional analysis obtain an expression for Nusselt number interms of Reynolds number and Prandtl number.

(OR)

b) A circular disc heater 0.2m in diameter is exposed to ambient air at 25oC. One surface of the disc is insulated at 130oC. Calculate the amount of heat transferred from the disc when it is.

(i) Horizontal with hot surface facing up

(ii) Horizontal with hot surface facing down

(iii) Vertical

15. a) CO2 and air experience equimolar counter diffusion in a circular tube whose length and diameter are 1m and 50mm respectively. The system is at a toal pressure of 1 atm and a temperature of 25oC. The ends of the tube are connected to large chambers in which the species concentration are maintained at fixed values. The partial pressure of CO2 at one end is 190mm of Hg while at other end is 95mm of Hg. Estimate the mass transfer rate of CO2 and air through the tube. The diffusion coefficient for CO2 – air combination is 0.16 x 10 –4 m2/s.

(OR)

b) (i) Define the non dimensional numbers in mass transfer

(ii) Dry air at 27oC and 1 atm flows over a wet flat plate 50cm long at a velocity of 50m/sec. Calculate the mass transfer co-efficient of water vapour in air at the end of the plate. Take D=0.26x10–4 m2/sec.

b = 1.1614 kg/m3

m = 184.6 10-7 Ns/m2

Pr = 0.707 (10)