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

R 3464

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Sixth Semester

(Regulation 2004)

Mechanical Engineering

ME 1351 — HEAT AND MASS TRANSFER

(Common to B.E. (Part-Time) Fifth Semester Regulation 2005)

Time : Three hours Maximum : 100 marks

Heat and Mass Transfer Data Books, Steam Tables are permitted.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is the main advantage of parabolic fins?

2. What is sensitivity of a thermocouple?

3. Define critical radius thickness of insulation.

4. Mention the importance of Biot Number.

5. Write an equation for Fouling Resistance.

6. Write a note on LMTD correction factor?

7. What must be the colour of an umbrella to reduce the absorption of Solar Radiation? Why?

8. State Kirchhoff's Law of Radiation.

9. Define Fick's law of Diffusion.

10. Define mass-average velocity.

PART B — (5 × 16 = 80 marks)

11. (a) Derive the general one-dimensional differential equation of heat conduction in Cartesian coordinates and deduce it to Poisson and Laplace Equations. (16)

Or

(b) (i) The average heat produced by ripening Oranges is estimated as 300 W/m^2. Taking the average radius as 0.04 m with k = 0. I 5 W/mk, Calculate the temperature at the core when the surface temperature is 10°C. (8)

(ii) Derive the log mean area of a cylinder used to transform into an equivalent slab. (8)

12. (a) (i) Assuming that a man can be represented as a cylinder of 0.30 m radius and height 1.7 m with a surface temperature of 30°C, Calculate the heat he would lose while standing in a 36 km/hour wind at 10°C. (8)

(ii) Air stream of 30°C moves with a velocity of 0.3 m/s across a 100 W electric bulb at 130°C. If the bulb is approximated by a 0.06 m diameter sphere, estimate the rate and the percentage lost due to convection alone. (8)

Or

(b) (i) Air at 8 kN/m^2 and 242°C flows over a flat plate of 0.3 m wide and 1 m long at a velocity of 8 m/s. If the plate is maintained at a temperature of 78°C, estimate the heat to be removed continuously from the plate. (8)

(ii) A 0.30 m long glass plate at 77°C is hung vertically in air at 27°C. Calculate the boundary layer thickness at the trailing edge and the average Nusselt number of the plate. (8)

13. (a) Derive the heat transfer equation of a parallel flow Heat exchanger stating the assumptions. (16)

Or

(b) (i) Saturated Steam at 120°C condenses on the outer tube surface of a single pass heat exchanger. Determine the surface area to heat 1000 kg/hour of water from 20°C to 90°C. Find the mass of the Condensate Take Heat transfer Coefficient U_0 = 1800 W/m^2 and H_{fg} = 2200 kJ/kg. (8)

(ii) Water is heated from 20°C to 50°C by condensing steam at 120°C. If the inlet temperature of water falls to 15°C with flow remaining constant, what will be the new outlet temperature? (8)

14. (a) (i) Derive the Equivalent Emissivity of a two large parallel gray planes. (8)

(ii) The intensity of radiation emitted by the Sun is maximum at a wave length of 0.5 μ. As a black body, determine it's surface temperature and the emissive power. (8)

Or

(b) (i) Deduce the generalized equation for heat transfer of a system of two parallel plates separated by "*n*" screens. (8)

(ii) Emissivities of two large parallel plates at 800°C and 300°C are 0.3 and 0.5 respectively Find the net energy transfer rate per square metre. (8)

15. (a) (i) Compare diffusion and convective mass transfer. (8)

(ii) Dry air at 27°C and 1 bar flows over a wet plate 0.5 m long at a velocity of 50 m/s. Calculate the mass transfer coefficient of water vapour in air at the end of the plate. (8)

Or

(b) (i) The mole fraction of H_2 in a mixture of H_2 and O_2 is 0.4. If H_2 moves with a velocity of 1 m/s and O_2 is stationary, find the mass and molar average velocities, mass and molar fluxes across the stationary surface. (8)

(ii) Estimate the Diffusion rate of water at 27 °C from the bottom of a test tube of 0.02 m diameter and 0.04 m long into dry air at 27°C. Take diffusion coefficient of water in air as 0.26×10^{-4} m^2/s. (8)