Reg. No. :

Question Paper Code : 51628

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fourth Semester

Mechanical Engineering

ME 2251/ME 41/ME 1251/10122 ME 502/080120015 — HEAT AND MASS TRANSFER

(Common to Mechanical and Automation Engineering)

(Regulation 2008/2010)

(Common to PTME 2251 – Heat and Mass Transfer for Sixth Semester B.E. (Part-Time) Mechanical Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Use of Heat and Mass Transfer Tables permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write any two examples of heat conduction with heat generation.

2. Define critical thickness of insulation with its significance.

3. Differentiate viscous sublayer and buffer layer.

4. Define grashoff number and prandtl number.

5. What are the different regimes involved in pool boiling?

6. Write down the relation for overall heat transfer coefficient in heat exchanger with fouling factor.

7. Define irradiation and emissive power.

8. Write down any two shape factor algebra.

9. State Fick's law of diffusion.

10. Write down the analogous terms in heat and mass transfer.

PART B — (5 × 16 = 80 marks)

11. (a) Derive the general heat conduction equation in cylindrical coordinate and solve the following. (8)

Hot air at a temperature of 65°C is flowing through steel pipe of 120 mm diameter. The pipe is covered with two layers of different insulating materials of thickness 60 mm and 40 mm, and their corresponding thermal conductivities are 0.24 and 0.4 W/mK. The inside and outside heat transfer coefficients are 60 W/m^2K and 12W/m^2K respectively. The atmosphere is at 20°C. Find the Rate of heat loss from 60 m length of pipe. (8)

Or

(b) Derive the heat dissipation equation through pin fin with insulated end and solve the following. (8)

A temperature rise of 50°C in a circular shaft of 50 mm diameter is caused by the amount of heat generated due to friction in the bearing mounted on the crankshaft. The thermal conductivity of shaft material is 55 W/mK and heat transfer coefficient is 7 W/m^2K. Determine the amount of heat transferred through shaft assume that the shaft is a rod of infinite length. (8)

12. (a) Using dimensional analysis find dimensionless groups involved in free convection and solve the following. (8)

A horizontal heated plate measuring 1.5 m × 1.1 m and at 215°C, facing upwards is placed in still air at 25°C. Calculate the heat loss by natural convection. Use the relation

$h = 3.05\ (T_f)^{1/4}$, T_f = Mean film temperature (8)

Or

(b) Explain development of hydrodynamic and thermal boundary layers with suitable figure and solve the following.

In a straight tube of 50 mm diameter, water is flowing at 15m/s. The tube surface temperature is maintained at 60°C and the flowing water is heated from the inlet temperature 15°C to an outlet temperature of 45°C. Calculate the heat transfer coefficient from the tube surface to the water and length of the tube.

13. (a) Explain nucleate boiling and solve the following.

A wire of 1 mm diameter and 150 mm length is submerged horizontally in water at 7 bar. The wire carries a current of 131.5 ampere with an applied voltage of 2.15 Volt. If the surface of the wire is maintained at 180°C, calculate the heat flux and the boiling heat transfer coefficient.

Or

(b) Classify the heat exchangers, draw temperature distribution in a condenser and evaporator and derive the expression for effectiveness of parallel flow heat exchanger by NTU method.

14. (a) State laws of radiation and solve the following.

Assuming the sun to be black body emitting radiation with maximum intensity at $\lambda = 0.5 \ \mu m$, Calculate the surface temperature of the sun and the heat flux at its surface.

Or

(b) Derive the relation for heat exchange between infinite parallel planes and solve.

Consider double wall as two infinite parallel planes. The emissivity of the walls is 0.3 and 0.8 respectively. The space between the walls is evacuated. Find the heat transfer/unit area when inner and outer surface temperatures are 300 K and 260 K. To Reduce the heat flow, a shield of polished aluminum with $\varepsilon = 0.05$ is inserted between the walls. Find the reduction in heat transfer.

15. (a) Explain different modes of mass transfer and derive the general mass diffusion equation in stationary media.

Or

(b) Explain Reynold's number, Sherwood number, Schmidt number and solve the following.

A vessel contains a binary mixture of oxygen and nitrogen with partial pressures in the ratio 0.21 and 0.79 at 15°C. The total pressure of the mixture is 1.1 bar. Calculate the following

(i) Molar concentrations (4)

(ii) Mass densities (4)

(iii) Mass Fractions (4)

(iv) Molar fractions of each species. (4)