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Question Paper Code : 50886

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Sixth/Eighth Semester

Mechanical Engineering

ME 8693 — HEAT AND MASS TRANSFER

(Common to Mechanical Engineering (Sandwich))

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Fourier's law of heat conduction

2. How critical radius of insulation is important?

3. Mention two examples of free convection.

4. Why boundary layer is formed?

5. List out the different regimes involved in pool boiling.

6. What are the limitations of LMTD method? Mention the advantage of NTU over the LMTD method.

7. State Planck's distribution law.

8. Give two applications of radiation shield.

9. Write any two examples of mass transfer.

10. State Fick's law of diffusion.

PART B — (5 × 13 = 65 marks)

11. (a) Derive the heat conduction equation in cylindrical coordinates and write its 3D equation.

Or

(b) Derive the energy equation for one-dimensional heat dissipation from extended surfaces.

12. (a) Air at 25°C at the atmospheric pressure is flowing over a flat plate at 3 m/s. If the plate is 1 m wide and the temperature T_w = 75°C, calculate the following at a location of 1 m from leading edge (i) Hydrodynamic boundary layer thickness, (ii) Local friction coefficient, (iii) Thermal Heat transfer coefficient, (iv) Local heat transfer coefficient.

Or

(b) A thin 100 cm long and 10 cm wide horizontal plate is maintained at a uniform temperature of 150°C in a large tank full of water at 75°C. Estimate the rate of heat to be supplied to the plate to maintain constant plate temperature. Heat dissipation takes place from either side of plate.

13. (a) Discuss in detail the pool boiling regimes of water at atmospheric pressure with a neat sketch.

Or

(b) With neat sketches explain the different types of heat exchangers.

14. (a) The sun emits maximum radiation at $\lambda = 0.52\ \mu$. Assuming the sun to be a black body, calculate the surface temperature of the sun. Also calculate the monochromatic emissive power of the sun's surface.

Or

(b) A black body at 3000 K emits radiation. Calculate the following :

(i) Monochromatic emissive power at 1 μm wave length (3)

(ii) Wave length at which emission is maximum (3)

(iii) Maximum emissive power (3)

(iv) Total emissive power (2)

(v) Total emissivity of the surface if it is assumed as a real surface having emissivity equal to 0.85 (2)

15. (a) Derive the general mass transfer equation in Cartesian coordinates.

Or

(b) Discuss in detail the analogy between heat and mass transfer.

PART C — (1 × 15 = 15 marks)

16. (a) A heat exchanger is to be designed to condense an organic vapour at a rate of 500 kg/min, which is available at its saturation temperature of 355 K. Cooling water at 286 K is available at a flow rate of 60 kg/s. The overall heat transfer coefficient is 475 W/m²°C and the Latent heat of condensation of the organic vapour is 600 kJ/kg. Calculate

(i) The number of tubes required, if tubes of 25 mm outer diameter, 2 mm thick and 4.87 m long are available, and (8)

(ii) The number of tube passes, if cooling water velocity (tube side) should not exceed 2 m/s. (7)

Or

(b) Explain the Fick's First law and Second law of Diffusion with their applications.