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Question Paper Code : 51849

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fourth Semester

Mechanical Engineering

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

(Common to Mechanical and Automation Engineering)

(Regulations 2008/2010)

(Common to PTME 2251/10122 ME 502 – Heat and Mass Transfer for Sixth Semester B.E. (Part-Time) Mechanical Engineering – Regulations 2009/2010)

Time : Three Hours **Maximum : 100 Marks**

(Use of Heat and Mass Transfer Tables Permitted.)

Answer ALL questions.

PART – A ($10 \times 2 = 20$ Marks)

1. List the differences between thermodynamics and heat transfer.

2. State the assumptions on which the Fourier's law of conduction is based.

3. What is the difference between friction factor and friction co-efficient.

4. Why heat transfer co-efficient of natural convection is much less than those in forced convection ?

5. What is a compact heat exchanger ? Give applications.

6. Define effectiveness and NTU of a heat exchanger.

7. Define radiation intensity.

8. Differentiate black body and grey body.

9. Enumerate important aspects of Fick's law of diffusion.

10. What is mass transfer ?

PART – B (5 × 16 = 80 Marks)

11. (a) A copper wire of 10 mm dia. is covered with 10 mm thick of plastic insulation. The plastic insulation is exposed to air at 35°C with h = 8 w/m^{2}K. The k for Cu and plastic are 400 W/m°C and 0.5 W/m°C . The resistivity is 3×10^{-3} ohms mm. The plastic insulation temperature should not exceed 180 °C. Determine (i) heat transfer rate and current carrying capacity (ii) q_{max}, maximum current carrying capacity.

OR

(b) A motor body has 500 mm O.D and 400 mm long. It is maintained at 60°C. 40 longitudinal fins with the height of 20 mm and thickness of 8 mm are attached with the body. Thermal conductivity of fin material is 55 W/m°C. Heat transfer co-efficient is 23 W/m^{2}K. Find (i) Area weighed fin efficiency (ii) % increase in heat transfer due to addition of fins.

12. (a) Air at 20°C, 1 m/sec flows over a flat plate of 2 m × 1 m maintained at 40°C. Determine (i) boundary layer thickness at 40 cm from leading edge (ii) boundary layer thickness at 2m from leading edge (iii) localised heat transfer co- efficient at 2 m (iv) average heat transfer co-efficient from leading to 2m length.

OR

(b) 1000 kg/hr of cheese at 150°C is pumped through a tube of 7.5 cm dia. After passing through an unheated length of about 50 diameters, it passes through a 1.2 m length of tube maintained at 90°C. Calculate the heat transfer co-efficient and mean temperature of cheese leaving the heated section. For cheese k = 1.55 W/mK, C_p = 2.85 kJ/kgK, ρ = 1100 kg/m^3 and μ = 56400 kg/hr-m.

13. (a) In a cross flow heat exchanger, both fluid unmixed, hot fluid with a sp. heat of 2300 J/kg K enters at 380°C and leaves at 300°C. Cold fluid enters at 25°C and leaves at 210°C. Calculate the required surface area of heat exchanger. Take over all heat transfer co-efficient as 750 W/m^2K. Mass flow rate of hot fluid is 1 kg/s.

OR

(b) A parallel flow heat exchanger is used to cool 4.2 kg/min of hot liquid of sp. heat 3.5 kJ/kg K at 130°C. A cooling water of sp. heat 4.18 kJ/kg K is used for cooling purpose at a temperature of 15°C. The mass flow rate of cooling water is 17 kg/min. Calculate the following (i) Outlet temperature of the liqd (ii) Outlet temperature of water (ii) Effectiveness of heat exchanger.

14. (a) The inner sphere of a liquid oxygen container is 400 mm dia., outer sphere is 500 mm dia., both have emissivity 0.05. Determine the rate of liquid oxygen evaporation at −183 °C, when the outer sphere temperature is 20°C. The latent heat of evaporation is 210 kJ/kg. Neglect losses due to other modes of heat transfer.

OR

(b) A large isothermal enclosure is maintained at 2500K. Determine (i) emissive power of radiation that emerge from a small aperture on the enclosed surface (ii) wavelength, below which 10% of emission is concentrated (iii) wavelength, above which 10% emission is concentrated (iv) max spectral intensity and corresponding wavelength.

15. (a) Air at 20°C flows past a tray full of water with a velocity of 2.5 m/sec. Calculate the evaporation rate of water in the temperature on the water surface is 15°C. The tray measures 25 cm along the flow direction and it's width is 40 cm. The moving air has a total pressure of 1.01 bar and the partial pressure of water associated with it is 0.0075 bar. The physical properties of air are density = 1205 kg/m^3, kinematic viscosity = 15.06×10^{-6} m^2/s and diffusivity = 0.15 m^2/hr.

OR

(b) CO_2 and air experience equimolar counter diffusion in a circular tube whose length and dia. are 1 m and 50 mm respectively. The system is at a total pressure of 1 atm and a temperature of 25°C. The ends of the tube are connected to large chambers in which the species concentrations are maintained at fixed values. The partial pressure of CO_2 at one end is 190 mm of Hg while at the other end is 95 mm of Hg. Estimate the mass transfer rate of CO_2 and air through the tube.
