Reg. No. :

Question Paper Code : 11407

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2011

Fourth Semester

Mechanical Engineering

ME 2251 — HEAT AND MASS TRANSFER

(Regulation 2008)

Time : Three hours   Maximum : 100marks

(Use of approved Heat and Mass Transfer Data Book is permitted)

Answer ALL questions

PART A(2*10= marks)

1. State Fourier's law of heat conduction.

2. What is heat generation in solids? Give examples.

3. What is lumped system analysis? When is it used?

4. In which mode of heat transfer is the convection heat transfer coefficient usually higher, natural or forced convection? Why?

5. Define bulk temperature.

6. List the various promoters used for maintaining dropwise condensation.

7. Define LMTD of a heat exchanger.

8. What do you understand by thermal radiation?

9. What does the view factor represent? When the view factor from a surface to itself is zero?

10. What is the physical meaning of Schmidt number?

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PART B — (5 x 16 = 80 marks)

11. (a) (i) Define thermal conductivity. How does it vary with temperature for gases? (4)

(ii) Derive the general 3-dimensional heat conduction equation in cylindrical coordinates. Assume the material as homogeneous isotropic continues. (12)

Or

(b) A cold storage room has walls made of 23 cm of brick on the outside, 8 cm of plastic foam and finally 1.5 cm of wood on the inside. The outside and inside air temperatures are 22°C and -2°C respectively. The inside and outside heat transfer coefficients are respectively 29 and 12 $W/m^2.K$. The thermal conductivities of brick, foam and wood are 0.98, 0.02 and 0.12 W/m.K respectively. If the total wall area is 90 m^2, determine the rate of heat removal by refrigeration and the temperature of the inside t uface of the brick.

12. (a) (i) Define the velocity boundary layer and thermal boundary layer thicknesses for flow over a flat plate. % Y • (4)

(ii) Atmospheric air at 150 °C f >w? with a velocity of 1.25 m/s over a 2 m long flat plate whose temperature is 25°C. Determine the average heat transfer coefficient and the rate of heat transfer for a plate width of 0.5 m. (12)

Or

(b) A 6 - m long section of an 8 cm diameter horizontal hot water pipe passes through a large room in which the air and walls are at 20°C. The pipe surface is at 70°C and the emissivity of the pipe surface is 0.7. Find the rate of heat loss from the pipe by natural convection and radiation.

13. (a) Consider laminar film condensation of a stationary vapour on a vertical flat plate of length L and width b. Derive an expression for the average heat transfer coefficient. State the assumptions made.

Or

(b) (i) Explain briefly fouling in heat exchangers. (6)

(ii) Hot gases enter a finned tube, cross flow heat exchanger with a flow rate of 1.5 kg/s and a temperature of 250°C. The gases are used to heat water entering the exchanger at a flow rate of 1 kg/s and an inlet temperature of 35°C. On the gas side, the overall heat transfer coefficient and the area are 100 $W/m^2.K$ and 40 m^2 respectively. What is the rate of heat transfer by the exchanger and what are the gas and water exit temperatures? Assume C_P of gas as 1.0 kJ/kg.K.

(10)

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14. (a) (i) Distinguish between irradiation and radiosity. (4)

(ii) Consider a cylindrical furnace with outer radius - height - 1 m. The top (surface 1) and the base (surface 2) of the furnace have emissivities 0.8 & 0.4 and are maintained at uniform temperatures of 700 K and 500 K respectively. The side surface closely approximates a black body and is maintained at a temperature of 400 K. Find the net rate of radiation heat transfer at each surface during steady state operation. Assume the view factor from the base to the top surface as 0.38. (12)

Or

(b) (i) Considering radiation in gases, derive the exponential-decay formula. (6)

(ii) Two very large parallel planes exchange heat by radiation. The emissivities of the planes are respectively 0.8 and 0.3. To ^i, imize the radiation exchange between the planes, a polished aluminium radiation shield is placed between them. If the emissivity of the shield is 0.04 on both sides, find the percentage reduction in heat transfer rate. (10)

15. (a) (i) With neat sketches, explain the different types of fins. (4)

(ii) Air at 1.01 bar and 30°C flows past a tray full of water with a velocity of 2 m/s. The partial pressure of water vapour is 0.7 kPa and the saturation pressure is 3.17 kPa. The tray measures 40 cm along the flow direction and has a width of 20 cm. Calculate the evaporation rate of water if the temperature on the water surface is 25°C. Assume the following properties for air: density, P 1.2 kg/m^3, kinematic viscosity, V = 15 x 10^{-6} m^2/s and diffusivity, D = 0.145 m^2/h. (12)

Or

(b) Write short notes on the following: (8 + 8)

(i) Analogy between heat and mass transfer

(ii) Evaporation process in the atmosphere.

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