Code: 9A03505

R09

B.Tech IV Year II Semester (R09) Advanced Supplementary Examinations, July 2013

HEAT TRANSFER

(Aeronautical Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Derive general differential equation of heat conduction in Cartesian coordinates.

(b) An immersion water heater of surface area 1.0 m^2 and rating 1 KW is designed to operate fully submerged in water. Estimate the surface temperature of the heater when the water is at 40^0C and the heat transfer coefficient is 300 W/m^2K. If this heater is by mistake used in air at 40^0C with h = 9 W/m^2K, what will be the surface temperature.

2 (a) What is critical thickness of insulation on a small diameter wire or pipe? Explain its physical significance and derive an expression for the same.

(b) A plane wall 10 cm thick generates heat at the rate of 4×10^4 W/m^3 when an electric current is passed through it. The convective heat transfer coefficient between each face of the wall and ambient air is 50 W/m^2K.
Determine:
(i) the surface temperature.
(ii) the maximum temperature in wall. Assume the ambient air temperature to be 20^0C and the thermal conductivity of the wall material to be 15 W/mK.

3 (a) What are Biot and Fourier numbers? Explain their physical significance.

(b) A stainless steel rod of outer diameter 1 cm originally at a temperature of 320^0C is suddenly immersed in a liquid at 120^0C for which convective heat transfer coefficient is 100 W/m^2K. Determine the time required for rod to reach a temperature of 200^0C.

4 State the Buckingham's π theorem. Establish a relation between Nusselt, Reynolds and Prandtl numbers for forced convection.

5 (a) Air at 20^0C flows over a flat plate with a velocity of 2 m/sec. The size of the plate is 60 cm × 30 cm. The plate is maintained at a 100^0C. Calculate the heat transfer rate from the plate (i) the air is flowing parallel to 60 cm side. (ii) the flow is parallel to 30 cm side.

(b) Sketch the temperature and velocity profiles in free convection on a vertical wall.

Contd. in Page 2

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6 (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient?

(b) A wire of 1.2 mm diameter and 200 mm length is submerged horizontally in water at 7 bar. The wire carries a current of 135 A within applied voltage of 2.18 V. If the surface of the wire is maintained at 200^0C.
Calculate: (i) The heat flux. (ii) The boiling heat transfer coefficient.

7 (a) Derive the expression for LMTD when the flow is parallel i.e for parallel flow heat exchanger.

(b) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on hot and cold sides are 75^0C and 20^0C respectively. The exit temperature of hot water is 45^0C. If the individual heat transfer coefficients on both sides are 650 W/m^2 ℃, calculate the area of heat exchanger.

8 (a) State and explain Planck's law.

(b) What is "intensity of radiation" and define Lambert's law of radiation?

(c) What are radiation shape factors and why are they used?

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