Code No: 09A60305 **R09**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD
B. Tech III Year II Semester Examinations, June-2014
HEAT TRANSFER
(Common to AME, ME)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks
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1.a) Derive differential equation of heat conduction in Cylindrical coordinate system?

b) A hot plate of length 0.75 m, width 0.5m, and thickness 2 cm is place in air stream at 20°C. It is estimated that a total of 300 W is lost from the plate surface by radiation. Taking the convective heat transfer coefficient as 25 W/m^2K, and thermal conductivity of the plate as 43 W/mK, calculate the inside temperature of the plate?

2.a) Derive the expression for efficiency and effectiveness of rectangular fins?

b) Triangular fins 2.5 cm thickness at base and 10 cm long and made from stainless steel (k = 17.7 W/mK and ρ = 7850 kg/m^3) are to be fitted to an air cooled cylinder wall. If the wall temperature is 6 °C and the heat transfer coefficient between the solid surface and air (T_∞ = 40 °C) is 20 W/m^2K, derive an expression for temperature distribution along the fin. Also estimate the rate of heat flow per unit mass of the fin.

3.a) Determine thermal diffusivity. Explain its significance in terms of penetration depth for a semi infinite body.

b) A slab of aluminium 10 cm thick is originally in a temperature of 500 °C. It is suddenly immersed in a liquid at 100 °C resulting in a heat transfer coefficient of 1200 W/m^2K. Determine the temperature at the center line and the surface 1 minute after the immersion. Also calculate the total thermal energy removed per unit area of the slab during this period. The properties of aluminium for the given conditions are

$\alpha = 8.4 \times 10^{-5} m^2/s$ k = 215 W/mK
$\rho = 2700\ kg/m^3$ c = 0.9 kJ/kg/K

4.a) What is Prandtl number? Show that it is a dimensionless quantity?

b) Air at a pressure of 8 kN/m^2 and a temperature at 250 °C flows over a flat plate 0.3 m wide and 1 m long at a velocity of 8 m/s. If the plate is to be maintained a temperature of 78°C estimate the rate of heat to be removed continuously from the plate?

5.a) Using dimensional analysis establish a relation between Nuselt, Prandtl and Grashof number?

b) A 30 cm long glass plate is hung vertically in the air at 27°C while its temperature is maintained at 77°C. Calculate the boundary layer thickness at the trailing edge of the plate. If a similar plate is place in a wind tunnel and air is blown over it at a velocity of 4 m/s, estimate the boundary layer thickness at its trailing edge.

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

b) Determine the stable film boiling heat transfer coefficient for the film boiling of saturated water at atmospheric pressure on an electrically heated 1.6 mm diameter horizontal platinum wire with a temperature difference $T_s - T_{sat} = 225°C$. What would be power dissipation per unit length of the heater?

7.a) Discuss the general arrangement of parallel flow, counter flow and cross flow heat exchangers? And why a counter flow heat exchanger more effective than a parallel flow exchanger?

b) Water enters a counter flow, double pipe heat exchanges at 15°C, flowing at the rate of 1300 kg/h. It is heated by oil (C_p = 2 J/kg.K) flowing at the rate of 550 kg/h from the inlet temperature of 94°C. For an area of 1 m^2 an overall heat transfer coefficient of 1075 $W/m^2.K$, determine the total heat transfer and the outlet temperatures of water and oil?

8.a) Distinguish between:
i) A black body and gray body
ii) Specular and diffuse surfaces
iii) Absorptivity and emissivity of a surface
iv) Total emissivity and equilibrium emissivity.

b) A pipe carrying steam having an outside diameter 20 cm runs in a large room, and is exposed to air at a temperature of 30°C. The pipe surface temperature is 200°C. Find the heat loss per metre length of the pipe by convection and radiation taking the emissivity of the pipe surface as 0.8.

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