R17

Code No: 5421AB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Semester Examinations, June/July - 2019

ADVANCED HEAT TRANSFER

(Thermal Engineering)

Time: 3hrs Max.Marks:75

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) Define conduction shape factor and its applications. [5]

b) What is the physical significance of a lumped heat capacity system? When can such an approximation be made? Explain. [5]

c) Define hydrodynamic and thermal entry lengths, as referred to internal flows in circular tubes, with the help of neat sketches. [5]

d) Explain the concept of free convection and perimeter significance. [5]

e) Distinguish between film-wise condensation and drop-wise condensation. [5]

PART - B

5 × 10 Marks = 50

2.a) Derive the basic Fourier equation in 3-D system for polar co-ordinate system (any method can adopt).

b) Derive the equation for solid cylinder with internal heat generation and mention the boundary conditions. [5+5]

OR

3.a) Derive the equation for temperature distribution and heat transfer rate for infinitely long fin.

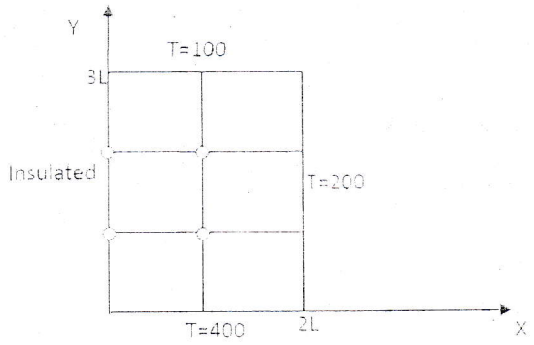
b) What is meant by thermometer well and explain the significance of conduction shape factor and how it is different from other shape factors. [5+5]

4.a) Show that in Newtonian cooling the temperature variation of a body is a function of Biot number and Fourier number.

b) An aluminum plate (thermal conductivity = 160 W/m K, density = 2790 Kg/m^3, specific heat= 0.88 KJ/Kg K) of thickness 30 mm and at a uniform temperature of 225^0 C is suddenly immersed at time t=0 in a well stirred fluid at a constant temperature of 25^0 C. The heat transfer coefficient between the plate and the fluid is 320 W/m^2 K. Determine the time required for the centre of the plate to reach 50^0 C. [5+5]

OR

5. Consider two dimensional, steady state heat conduction in a rectangular region of cross section 2L by 3L subjected to the boundary conditions as shown in the figure below. By using coarse mesh $\Delta x = \Delta y = L$, write the finite difference formulation of this heat conduction problem and calculate the node temperatures T_1, T_2, T_3 and T_4. [10]



6.a) Define Nusselt number, Reynolds number, Prandtl number, Grashoff number and Stanton number.

b) Engine oil at 40^0 C flows with a velocity of 1 m/sec over a 2 m long flat plate whose surface is maintained at a uniform temperature of 80^0 C. Determine the average heat transfer coefficient. [5+5]

OR

7. Air at atmospheric pressure and 100^0 C enters a 3 m long tube of 4 cm inner diameter with a velocity of 9 m/sec and leaves at 192^0 C. An electric heater is wound on the outer surface of the tube such that heat absorption rate by air per unit area is uniform throughout the length of the tube. If the mean velocity of the air is also 9 m/sec, find

a) Mass flow rate of air

b) The rate of heat absorption by the tube from the heater in KW

c) The wall temperature of the tube at outlet.

Assume average properties of air at 146^0C as specific heat = 1.005 KJ/kg K, thermal conductivity = 0.035 W/m K, kinematic viscosity = 28.8×10^{-6} m^2/sec and Pr = 0.683. [10]

8.a) Derive the equation for heat transfer coefficient and heat transfer for constant wall temperature internal flow condition.

b) Draw the shear stress profiles and velocity profiles for the above conditions. [5+5]

OR

9.a) Derive the heat transfer coefficient for flat vertical plate in free convection and hence find the rate of heat transfer equation.

b) How do you calculate the heat transfer coefficients for the combined free and forced convection conditions. [5+5]

10.a) What is critical heat flux? What is its importance?

b) Saturated water at 100^0 C is boiled inside a copper pan having a heating surface area of 6×10^{-2} m^2 which is maintained at a uniform temperature of 110^0 C. Calculate the i) surface heat flux ii) rate of evaporation. [5+5]

OR

11.a) What would be the shape factor of a concave, convex and flat surface with respect to itself? State the important properties of view factor.

b) Two circular discs of 50 cm diameter maintained at 500^0C and 300^0C are placed opposite to one another and parallel at a distance of 1 m apart. Determine the radiant flux between them i) when they are black ii) when they are gray with emissivities 0.5 and 0.3 respectively. [5+5]

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