Code No: 5421AB **R17**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Semester Examinations, January - 2018

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) State and explain the different types of boundary conditions applied to heat conduction problems. [5]

b) Derive the equation for lumped heat analysis. [5]

c) Explain the development of hydrodynamic boundary layer over a flat plate. [5]

d) Explain the significance of combined forced and natural convection. What is the role of the parameter Gr/Re^2 in this regard? [5]

e) Explain the difference between radiation from gases and that from solids. [5]

PART - B

5 × 10 Marks = 50

2.a) Derive the basic fourier heat conduction equation in Cartesian co-ordinate system in 3-D system.

b) Explain the significance of conduction shape factor and derive the values for plain wall, hollow cylinder and hollow sphere and their applications. [5+5]

OR

3.a) Derive the temperature distribution and heat transfer rate for a short fin (end insulated) and explain the applications.

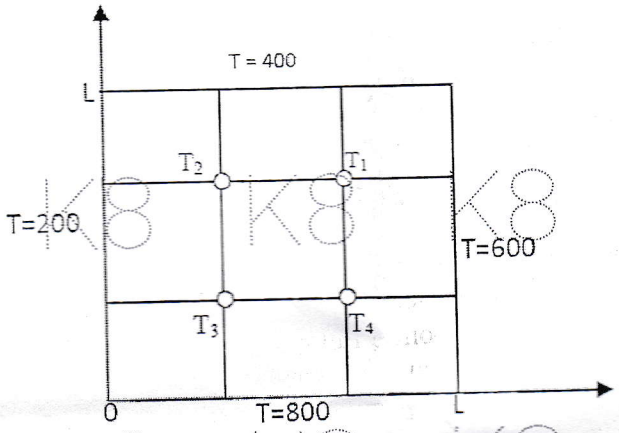
b) Explain the analytical solution for 2-D fins and explain the simple boundary conditions and temperature profiles. [5+5]

4.a) What is the physical significance of Biot number? Is the Biot number more likely to be larger for highly conducting solids or poorly conducting ones?

b) An aluminum block of 20 cm thick having thermal conductivity =200 W/mK at a temperature of 400^0C is suddenly immersed in oil at 200^0C. If the convective heat transfer coefficient between the block and oil is 1000 W/m^2K, determine the temperature at the surface and centre line after 90 seconds. Also calculate the total heat removed from the block per unit area. Assume for aluminum thermal diffusivity = 8.3×10^{-5} m^2/sec, density = 2650 kg/m^3 and specific heat = 0.9KJ/kgK. [5+5]

OR

5. Consider two dimensional steady state heat conduction in a region L by L subjected to boundary conditions as shown in the figure below. By using coarse mesh $\Delta x = \Delta y = L/3$, 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) Write the expression of the general continuity equation. What does it reduce to for a steady incompressible flow?

b) Air at 27 ^{0} C and 1 atm pressure flows over a flat plate with a velocity of 2 m/sec. i) Estimate the boundary layer thickness at distances of 20 cm and 40 cm from the leading edge of the plate ii) Mass flow that enters the boundary layer between x= 20 cm and x= 40 cm. Assume unit depth in Z- direction. If the plate is heated over its entire length to a temperature of 60 ^{0}C, calculate the heat transfer in iii) the first 20 cm of the plate iv) the first 40 cm of the plate v) compute the drag force exerted on the first 40 cm of the plate. [5+5]

OR

7.a) Define bulk temperature and film temperature. Discuss the significance of bulk temperature in the case of fully developed laminar flow in a tube.

b) Air at atmospheric pressure and 27^0 C enters a 12 m long 1.5 cm inner diameter tube with a mass flow rate of 0.1 kg/sec. The tube surface is maintained at a uniform temperature of 90 ^{0} C. Calculate the average heat transfer coefficient and the rate of heat transfer to the air. [5+5]

8.a) What is Boussinesq approximation? How does it help in solving free convection problem vis-a-vis an isothermal flat plate? Explain.

b) A circular disc of diameter 25 cm is suspended horizontally in air whose surface temperature is at 120^{0}C. Determine the heat transfer from its top and bottom faces. Assume atmospheric temperature as 20^{0}C. [5+5]

OR

9.a) Draw the temperature and velocity profiles indicating different boundary layers for internal flows.

b) Derive the equation for heat transfer coefficient and heat transfer rate for constant heat flux internal flow. [5+5]

10.a) Explain how nucleate boiling is different from film boiling. State the reason of heat flux in nucleate boiling being much higher than in film boiling.

b) Saturated steam at 100^0 C condenses on a 4 cm diameter tube with a surface temperature of 60^0 C. Estimate the value of condensing film coefficient if the tube is 100 cm long and is oriented i) horizontally ii) vertically. [5+5]

OR

11.a) Define shape factor. Explain the importance of superposition rule in finding shape factor.

b) A stainless steel plate (ε = 0.6) at 100^{0}C faces a brick wall (ε = 0.75) at 500^0 C. Estimate the heat flux and the radiant heat transfer coefficient. [5+5]

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