R17

Code No: 5421AB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Semester Examinations, June/July - 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) Explain the function of extended surfaces with classification. [5]

b) Air at 20^0C flows over a flat plate having a uniform heat flux of 800 W/m^2. The flow velocity is 4 m/s and the length of the plate is 1.2 m. Determine the value of heat transfer coefficient. [5]

c) Explain the mechanism of laminar film condensation on a vertical plate. [5]

d) Differentiate between forced and free convection heat transfer mechanism. [5]

e) Discuss the various regimes of pool boiling with neat sketch. [5]

PART - B

5 × 10 Marks = 50

2. Obtain an expression for the steady state temperature distribution of two dimensional rectangular fin having constant thermal conductivity. The fin has thickness of L in Y-direction and is semi infinite in X- direction. The base temperature of fin and ambient temperature are t_0 and t_∞ respectively. Assume the heat transfer coefficient to be large. [10]

OR

3. A long cylinder of radius 15 cm initially at 30 ^{0}C is exposed to gases at 600^{0}C with a convective heat transfer coefficient of 65 W/m^{2}K. Using the following property values determine the temperatures at the centre, mid radius and outside surface after 20 minutes. Density = 3550 kg/m^3, sp. heat = 586 j/kg K, thermal conductivity = 19.5 W/mK . Also calculate the heat flow. [10]

4. In a production facility, large brass plates of 4 cm thickness that are initially at a uniform temperature of 20^0C are heated by passing them through an oven that is maintained at 500^0C. The plates remain in the oven for a period of 7 min. Taking the combined convection and radiation heat transfer coefficient to be h = 120 W/m^2 ^{0}C, determine the surface temperature of the plates when they come out of the oven using Heisler charts. The properties of brass at room temperature are k = 110 W/m ^{0}C, ρ = 8530 kg/m^3. Cp = 380 J/kg ^{0}C, and $\alpha = 33.9 \times 10^{-6}$ m^2/s. [10]

OR

5. Develop the numerical formulation and solution of two-dimensional steady heat conduction with heat generation in rectangular coordinates using the finite difference method. Prove that finite difference formulation of an interior node is obtained by adding the temperatures of the four nearest neighbors of the node, subtracting four times the temperature of the node itself, and adding the heat generation term. [10]

6. The water flows at 20^0C enters a 2 cm diameter tube with a velocity of 1.5 m/s. The tube is maintained at 100^0C. Find the tube length required to heat the water to a temperature of 60^0C. The properties of water are:
$\rho = 992.2$ kg/m^3, $\nu = 0.659 \times 10^{-6}$ m^2/s, k= 0.634 W/mK, Cp= 4.174 kJ/KgK, Pr= 4.31. [10]

OR

7. A plate is maintained at 60^0C is kept vertical in still air at 20^0C.
a) Determine the velocity profile at $x = 0.4$ m.
b) Also determine the value of u_{max} at 0.2, 0.4 and 0.6 m heights.
c) Calculate the value of average free convection heat transfer coefficient for $x = 0.6$ m.
d) Compare this value with that of forced convection with $u_\infty = 0.912$ m/s. [10]

8. In a wind tunnel, air at 5 m/s flows over a flat plate and 15^0C, 1 m × 0.8 m in size. The surface temperature of plate is 35^0C. One of the sides of the plate is arranged parallel to the flow direction, such that the heat transfer is lesser, estimate:
a) Rate of heat transfer from the one side of plate
b) Initial rate of cooling per hour of the plate, if mass of the plate is 5 kg and specific heat is 875 J/kg.K.
c) If the flow is turned off, compute the heat flow rate from the upper surface of the plate in still air at 15^0C.
d) What is the percentage change in heat flow rate?
The thermo-physical properties of air are as follows:
$\rho = 1.1707$ kg/m^3, $\nu = 15.172 \times 10^{-6}$ m^2/s, k= 0.02614 W/mK, Cp=1007 J/KgK, Pr = 0.7075.
Use the following correlations:
For free convection: $Nu = 0.27\ (Gr.\ Pr)^{0.25}$
For forced convection: $Nu = 0.664\ (Re)^{0.5}\ (Pr)^{0.33}$ [10]

OR

9. Air at 30^0C flows at 2.2 m/s over plate at 90^0C. Length and width of the plate are 900mm and 450mm. Calculate the heat transfer rate from
a) First half of the plate
b) Next half of the plate and
c) Full plate. [10]

10. The energy received from the sun at the earths atmosphere has been measured as 1353 W/m^2. The diameter of the earth = 1.29×10^7 m. Diameter of the sun = 1.39×10^9m. Mean distance = 1.5×10^{11} m. Estimate the emissive power of the sun and the surface temperature assuming it to be black. Assuming that the source of energy for the earth is from the sun and the earth to be black, estimate the temperature of the earth. [10]

OR

11. In a power controlled pool – boiling experiment, a horizontal cylindrical heater is immersed in saturated water at atmospheric pressure. The peak heat flux is 10^6 W/m^2. The power is increased slightly above this level and the nucleate boiling regime is replaced abruptly by film boiling. Estimate the excess temperature in this new regime by assuming that radiation is the dominant mode of heat transfer across the film. Assume any missing data. [10]

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