R15

Code No: 126VF

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, November/December - 2020
HEAT TRANSFER
(Common to ME, AME)

Time: 2 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks
- - -

1. A heat flux meter attached to the inner surface of a 3-cm-thick refrigerator door indicates a heat flux of 25 W/m ^{2} through the door. Also, the temperatures of the inner and the outer surfaces of the door are measured to be 7^{0}C and 15^{0}C, respectively. Determine the average thermal conductivity of the refrigerator door. [15]

2. Consider a 3m × 3m × 3m cubical furnace whose top and side surfaces closely approximate black surfaces at a temperature of 1200 K. The base surface has an emissivity of ε= 0.7, and is maintained at 800 K. Determine the net rate of radiation heat transfer to the base surface from the top and side surfaces. [15]

3. Write down the one-dimensional transient heat conduction equation for a plane wall with constant thermal conductivity and heat generation in its simplest form, and indicate what each variable represents. [15]

4. A 3-m internal diameter spherical tank made of 2-cm-thick stainless steel (k= 15 W/m·^{0}C) is used to store iced water at $T_{\alpha 1}$ = 0^{0}C. The tank is located in a room whose temperature is $T_{\alpha 2}$ = 22 ^{0}C. The walls of the room are also at 22 ^{0}C. The outer surface of the tank is black and heat transfer between the outer surface of the tank and the surroundings is by natural convection and radiation. The convection heat transfer coefficients at the inner and the outer surfaces of the tank are h_1 = 80 W/m^2·^{0}C and h_2 =10 W/m^2·^{0}C, respectively. Determine (*a*) the rate of heat transfer to the iced water in the tank and (*b*) the amount of ice at 0^{0}C that melts during a 24-h period. [7+8]

5. Oil flow in a journal bearing can be treated as parallel flow between two large isothermal plates with one plate moving at a constant velocity of 12 m/s and the other stationary. Consider such a flow with a uniform spacing of 0.7 mm between the plates. The temperatures of the upper and lower plates are 40 and 15^{0}C, respectively. By simplifying and solving the continuity, momentum, and energy equations, determine (*a*) the velocity and temperature distributions in the oil, (*b*) the maximum temperature and where it occurs, and (*c*) the heat flux from the oil to each plate. [5+5+5]

6.a) What is the difference between skin friction drag and pressure drag? Which is usually more significant for slender bodies such as airfoils?

b) Consider a 5-cm-diameter shaft rotating at 2500 rpm in a 10-cm-long bearing with a clearance of 0.5 mm. Determine the power required to rotate the shaft if the fluid in the gap is (*i*) air, (*ii*) water, and (*iii*) oil at 40^{0}C and 1 Atm. [8+7]

7.a) Saturated steam at 1 Atm condenses on a 3-m-high and 5-m-wide vertical plate that is maintained at 90^0C by circulating cooling water through the other side. Determine (*i*) the rate of heat transfer by condensation to the plate, and (*ii*) the rate at which the condensate drips off the plate at the bottom.

b) What is the difference between subcooled and saturated boiling? [10+5]

8. How is the thermal resistance due to fouling in a heat exchanger accounted for? How do the fluid velocity and temperature affect fouling? [15]

---ooOoo---