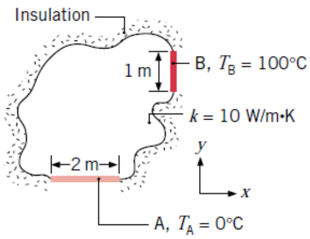
Hw # 2

1- A cylinder of radius r_o, length L, and thermal conductivity k is immersed in a fluid of convection coefficient h and unknown temperature T_∞. At a certain instant the temperature distribution in the cylinder is $T(r)=a+br^2$, where a and b are constants. Obtain expressions for the heat transfer rate at r_o and the fluid temperature.

2- In the two-dimensional body illustrated, the gradient at surface A is found to be $\delta T/\delta y$= 30 K/m. What are $\delta T/\delta y$ and $\delta T/\delta x$ at surface B?

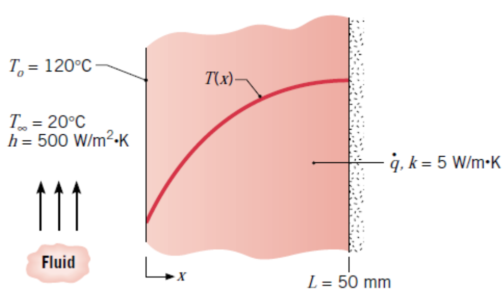


3- At a given instant of time the temperature distribution within an infinite homogeneous body is given by the function
$T(x, y, z)=x^2-2y^2+z^2-xy+2yz$
Assuming constant properties and no internal heat generation, determine the regions where the temperature changes with time.

4- Uniform internal heat generation at q= $5*10^7$ W/m^3 is occurring in a cylindrical nuclear reactor fuel rod of 50-mm diameter, and under steady-state conditions the temperature distribution is of the form $T(r)=a+br^2$, where T is in degrees Celsius and r is in meters, while a=800°C and b=4.167* 10^5°C/m². The fuel rod properties are k =30 W/m.K, ρ=1100 kg/m^3, and c_p = 800 J/kg .K.
(a) What is the rate of heat transfer per unit length of the rod at r = 0 (the centerline) and at r = 25 mm (the surface)?
(b) If the reactor power level is suddenly increased to q_2= $5*10^7$ W/m^3, what is the initial time rate of temperature change at r =0 and r= 25 mm?

5- The temperature distribution across a wall 0.3 m thick at a certain instant of time is $T(x)=a+bx+cx^2$, where T is in degrees Celsius and x is in meters, a=200°C, b=200°C/m, and c= 30°C/m2. The wall has a thermal conductivity of k=1 W/m.K. (a) On a unit surface area basis, determine the rate of heat transfer into and out of the wall and the rate of change of energy stored by the wall. (b) If the cold surface is exposed to a fluid at 100°C, what is the convection coefficient?

6- One-dimensional, steady-state conduction with uniform internal energy generation occurs in a plane wall with a thickness of 50 mm and a constant thermal conductivity of 5 W/m.K. For these conditions, the temperature distribution has the form, $T(x)=a+bx+cx^2$. The surface at x= 0 has a temperature of $T(0)=T_o$=20 C and experiences convection with a fluid for which T_∞=20 C and h=500W/m^2 K. The surface at $x=L$ is well insulated.



(a) Applying an overall energy balance to the wall, calculate the internal energy generation rate, q .
(b) Determine the coefficients a, b, and c by applying the boundary conditions to the prescribed temperature distribution. Use the results to calculate and plot the temperature distribution.
(c) Consider conditions for which the convection coefficient is halved, but the internal energy generation rate remains unchanged. Determine the new values of a, b, and c, and use the results to plot the temperature distribution. *Hint:* recognize that $T(0)$ is no longer 120°C.

7- A steam pipe is wrapped with insulation of inner and outer radii, r_i and r_o, respectively. At a particular instant the temperature distribution in the insulation is known to be of the form

$$T(r)=C_1 \ln(r/r_o)+C_2$$

Are conditions steady-state or transient? How do the heat flux and heat rate vary with radius?