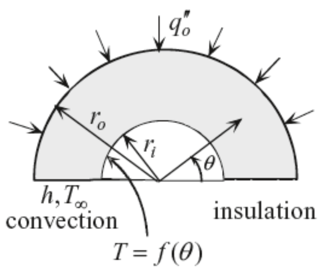
Advanced Heat Transfer HW#1

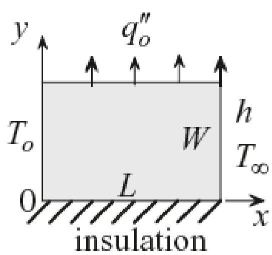
1- A long electric wire of radius r_o generates heat at a rate q" The surface is maintained at uniform temperature T_o. Write the heat equation and boundary conditions for steady state one-dimensional conduction.

2- You are interested in analyzing the rate at which a spherical ice ball melts. What heat quation should you use for the ice? List all assumptions.

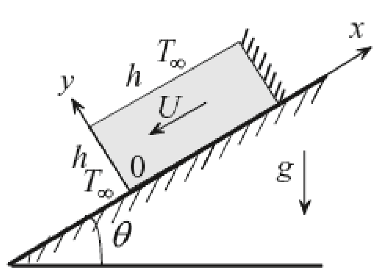
3- Consider two-dimensional conduction in the semi-circular cylinder shown. The cylinder is heated with uniform flux along its outer surface and is maintained at a variable temperature along its inner surface. One of the plane surfaces is insulated while the other exchanges heat by convection with an ambient fluid at T_∞ . The heat transfer coefficient is h. Write the heat equation and boundary conditions for steady state conduction.



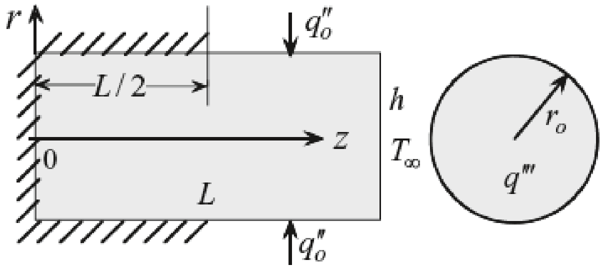
4- Write the heat equation and boundary conditions for steady state two-dimensional conduction in the rectangular plate shown.



5- A rectangular plate of length L and height H slides down an inclined surface with a velocity U. Sliding friction results in surface heat flux q". The front and top sides of the plate exchange heat by convection. The heat transfer coefficient is h and the ambient temperature is T_∞. Neglect heat loss from the back side and assume that no frictional heat is conducted through the inclined surface. Write the two-dimensional steady state heat equation and boundary conditions.



6- Heat is generated at a volumetric rate q''' in a rod of radius r_o and length L. Half the cylindrical surface is insulated while the other half is heated at a flux q_0 .One end is insulated and the other exchanges heat by convection. Write the heat equation and boundary conditions for steady state two-dimensional conduction.



7 -A rod of length L and diameter D with conductivity of k is ended to two heating sources having temperature of T_1 and T_2 . The rod loses heat to a environment at temperature T_∞ with heat transfer coefficient of h_∞ :

For two various cases of :

(a) constant conductivity coefficient

(b) varying conductivity coefficient as $k := k_0\ (1+ ßT)$

find :

I . temperature and heat flux distribution

II. heat transfer rate.

8 -Drive an expression for the temperature distribution in a slab in which its heat source varies linearly as below relation :

$$\dot{q} := \dot{q}_\omega[1+\beta(T-T_\omega)]$$

where :

$\dot{q}_\omega$ :: rate of heat generation per unit volume at wall temperature (constant)

T_ω ::wall temperature

The slab has thickness of $2L$ and both sides of the slab are maintained at a constant temperature of T_ω .

9 -The temperature distribution in a slab with thickness of L which each side of its wall are in temperature of T_1 and T_2 is :

$$\frac{T - T_1}{T_2 - T_1} := C_0 + C_1 x^2 + C_2 x^3$$

For a constant conductivity coefficient derive an expression for the rate of heat generation per unit volume as function of x, the distance from the wall where is kept in $T = T_1$. assume the rate of heat generation at $x = 0$ be $\dot{q}_0$.