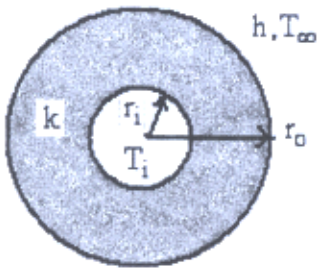
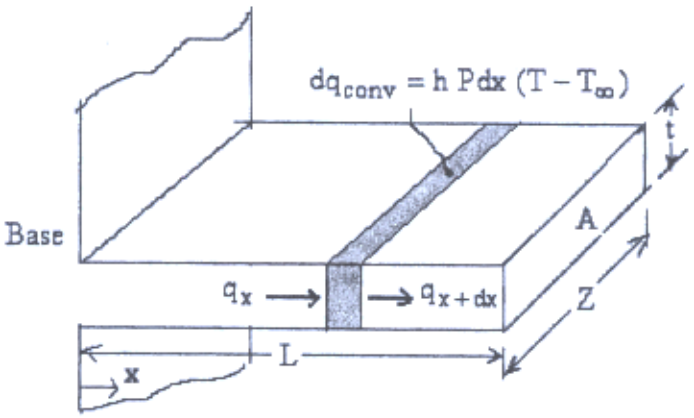
1. Derive a relation for the critical radius of insulation for a cylinder. Here k and L are the thermal conductivity and the length of cylinder. (20%)



2. A vertical square plate, 30 cm on a side, is maintained at 50℃ and exposed to room air at 20℃. The surface emissivity is 0.8 and heat transfer coefficient is 10 $W/m^2 \cdot K$. Calculate the total heat lost by both sides of the plate. (15%)
3. Derive the governing equation for the one-dimensional heat transfer of fin and its associated boundary conditions. (20%)



4. What is meant by a lumped capacity? (10%)
5. Define the Reynolds number. (10%)
6. What is meant by a thermal boundary layer? (10%)
7. Find the heat transfer per unit area through the composite wall sketched. Assume one-dimensional heat flow. (15%)

$k_A = 150\ W/m \cdot K$
$k_B = 30\ W/m \cdot K$
$k_C = 50\ W/m \cdot K$
$k_D = 70\ W/m \cdot K$
$A_B = A_D$