

MAE 3314: Heat Transfer
Practice Problems for Exam 1

1. **[easy]** A laboratory furnace wall is constructed of 0.2 m thick fireclay brick having $k_a=1.0\text{W/m}\cdot\text{K}$. This is covered on the outer surface with a 0.03m thick layer of insulating material having $k_b=0.07\text{W/m}\cdot\text{K}$. The furnace inner brick surface is at 1250 K and the outer surface of the insulation material is at 310K. Calculate the steady state heat transfer rate through the wall in W/m^2 , and determine the interfacial temperature T_2 between the brick and the insulation.
[Answer] $q/A=1495\text{W/m}^2$, $T_2=951\text{K}$ (or) 678°C
2. **[intermediate]** A very long, 1cm diameter copper rod ($k=377\text{ W/m}\cdot\text{K}$) is exposed to an environment at 22°C . The base temperature of the rod is maintained at 150°C . The heat transfer coefficient between the rod and the surrounding air is $11\text{ W/m}^2\cdot\text{K}$. Determine the heat transfer rate from the rod to the surrounding air.
[Answer] $q=12.95\text{W}$
3. **[difficult]** A 2.5 cm o.d. tube is fitted with 5.0 cm o.d. annular fins spaced on 0.50 cm centers. The fins are aluminum alloy ($k=161\text{W/m}\cdot\text{K}$) are of constant thickness 0.0229 cm. The external free convective heat transfer coefficient to the ambient air is $8.5\text{ W/m}^2\cdot\text{K}$. For a tube wall temperature of 165°C and an ambient temperature of 27°C , determine the heat loss per meter of length of finned tube.
[Answer] $q/L=744.9\text{W/m}$
4. **[intermediate]** Determine the time required for a 1.25cm diameter carbon steel (1%C) ($k=40\text{W/m}\cdot\text{K}$, density: 7800 kg/m^3 , heat capacitance: $473\text{W}\cdot\text{s/kg}\cdot\text{K}$) sphere to cool from $T_1=500^\circ\text{C}$ to 100°C if exposed to a cooling air flow at $T_\infty=25^\circ\text{C}$ resulting in $h=110\text{ W/m}^2\cdot\text{K}$
[Answer] $t=129\text{s}$ (or) 2.16min