2-1 Consider steady heat flow through a plane wall with constant thermal conductivity. The wall thickness is \( L \) and the material is subject to non-uniform internal heat generation according to 
\[ q''''(x) = q_0 e^{-ax} \]
The wall at \( x=0 \) is maintained at \( T_1 \) while the surface at \( x=L \) is at \( T_2 \).

a. Determine an expression for the temperature distribution in the wall.
b. Determine the maximum temperature in the wall.
c. what is the heat flux at the location found in b.?
d. what is the heat flux at \( x=L \)?

2-2 Heat is generated in a 25mm square copper “rod” at a rate of 35.3 MW/m\(^3\). The outside surface is exposed to an environment with \( T = 20^\circ\text{C} \) and \( h=4000\text{W/m}^2 \). Determine the outside surface temperature.  

(Hint: use an overall energy balance/first law of thermo).

2-3 A domestic hot water heater has a 13mm thick glass liner, a 25mm thick layer of fiberglass insulation, and a 2mm thick carbon steel outer shell. Inside the tank, water is maintained at 55°C and the natural convection in the tank give rise to a heat transfer coefficient of 5 W/m\(^2\)-K, while outside the tank the temperature is 25°C and the heat transfer coefficient is 7 W/m\(^2\)-K. The internal dimensions of the cylindrical tank are 2m high and 0.8m diameter.

a. Considering 1-D heat flow through all the surfaces of the tank, estimate the rate of heat that must be supplied to the tank to maintain steady conditions.
b. If the overall heat transfer coefficient, \( U \), is defined by \( q = UA_{\text{outside}}(T_i - T_{\text{env}}) \), determine the overall heat transfer coefficient.

2-4 A rod of length \( L \) has its base maintained at \( T_0 \) and is exposed to an environment at \( T_{\text{env}} \). The rod has uniform internal heat generation \( q'''' \).

a. Determine the steady temperature distribution in the rod.
b. Determine the heat loss from the rod.

2-5 An array of twenty-six (26) aluminum fins (\( k=180\text{ W/m-K} \)) 2mm thick, 30mm long, and 70mm wide make up a heat sink for a computer chip. The base of the heat sink is 70mm by 77mm and 7mm thick and integrally attached to the fins. Note this allows for a 3mm spacing between the fins. If the heat transfer coefficient is 20 W/m\(^2\)-K and the air temperature in the cabinet might reach 30°C, calculate the heat dissipated by the fins if the bottom of the heat sink is at 50°C.