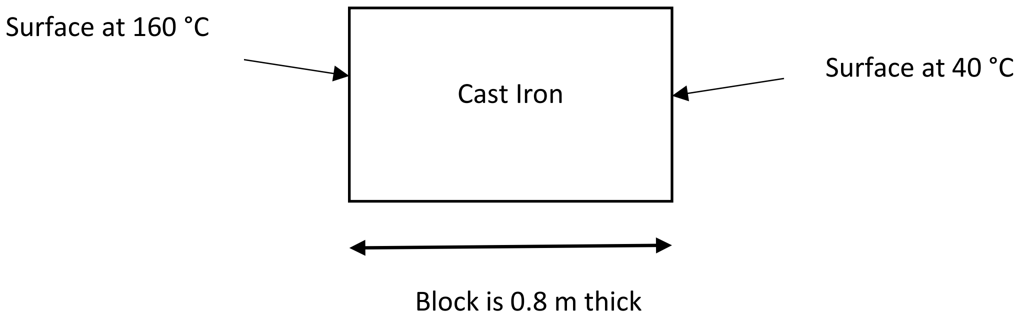
New Problems Chapter 13

13.1-5. ***Heat Removal from a Block of Cast Iron.*** A block cast iron (0.8 m thick) is at 160 °C on one side and the other side is at 40°C.



The thermal conductivity of the cast iron as a function of temperature is given below:

Temperature (°C)	Thermal Conductivity $\left(\frac{W}{m \cdot K}\right)$
0	55
100	52
200	48

a) Fit the data above to a 2nd order polynomial. (I used Excel)
b) What is the equation obtained in part a) and what units are associated with each term?
c) Calculate the heat removal in W/m^2, using the equation obtained in part a.

13.2-1 ***Conduction, Convection and Outside U for a spherical vessel.*** A spherical reactor for producing pharmaceuticals has a 20-mm thick stainless steel wall $k = 20\frac{W}{m \cdot K}$ and an inner diameter of 1.1 m. The exterior surface of the vessel is exposed to ambient air (T =25°C), for which a convection coefficient $h = 5\frac{W}{m^2 \cdot K}$ may be assumed.

(a) During steady state operation an inner surface temperature of 200°C is maintained by an exothermic reaction. What is the heat loss in (W) from this vessel?

(b) Based on the outside Area what is the U_0?

(c) What is the surface temperature of the spherical vessel?

13.3-4 ***Uniform Radioactive Heat Generation.*** Radioactive waste generates thermal energy at a rate of 3 x 10^4 W/m^3 in a 304 - stainless steel cylinder, 1.0 m in diameter. The cylinder is exposed to air making its surface 30°C. What is the temperature at the center of the cylinder and at a radius of 0.5m?

13.3-5 ***Uniform Radioactive Heat Generation in series.*** Radioactive waste $\left(k = 20\frac{W}{m \cdot K}\right)$ generates thermal energy at a rate of 5 x 10^4 W/m^3 in a lead cylinder, with an inner diameter of 0.8m and an outer diameter of 1.0 m. The cylinder is exposed to air at 25°C with an $\left(h = 33\frac{W}{m^2 \cdot K}\right)$. What is the temperature at the center of the radioactive waste and at the surface of the lead cylinder? Hint in the waste material $q = \dot{q} V = \dot{q}\left(\pi \cdot r^2 \cdot L\right)$.

13.5-6 ***Heat Conduction in a two-dimensional Solid using a computer.*** The entire part/shape is made of Beryllium copper $\left(k = 118\frac{W}{m \cdot K}\right)$. Use a grid size of $\Delta x = \Delta y = 0.5$m and calculate the steady-state temperatures of the various nodes (16 nodes total).