# ME 345 – HTx Fall 2023 Week 1 Homework

## Problem 1:

A solid, rectangular aluminim bar is placed in a container of hot oil such that one end of the bar is kept at a constant temperature of 240 °F. The other end of the bar is kept at constant temperature of 98 °F by a person holding on to it with their hand. The bar has a cross section of 1 inch x 2 inches, and there is a distance of 15 inches between the oil and the hand. Calculate/explain the following:

1. The average heat rate through the bar [BTU/hr]
2. The average heat flux through the bar [BTU/hr-in2]
3. What value did you use for thermal conductivity of the aluminum bar, and where did that value come from?

## Problem 2:

You’re riding your mountain bike when a surprise winter storm hits and air temperature quickly drops. You are still 1 mile from shelter and you’re trying to decide how to get there. Your options are:

1. Ride your bike as fast as you can (call it 20 mph). Due to your speed the average convection coefficient will be around 25 [W/m2-K], so it will take you about 3 minutes to get home.
2. Get off your bike and walk to shelter (call it 2 mph) Due to a much lower speed the average convection coefficient will be around 5 [W/m2-K], so it will take you about 30 minutes to get home.

Assume the outside temperature is -4 °C, and the surface temperature of outside of the rider clothing is 26 °C, and that the person has a surface area of 1.8 m2.

For each option calculate/explain:

1. The heat rate [W] leaving the person via convection heat transfer.
2. The total amount of heat [kJ] that leaves the person in getting to shelter.
3. Give your recommendation on which option would you recommend for the person.

## Problem 3:

A small 0.5 mm diameter sphere of oil starts out at 30 °C is floating in space and radiating to deep space. The temperature of deep space can be considered -270 °C. Properties of the oil are approximately:

emissivity - εoil = 0.93  
thermal conductivity - koil = 0.125 [W/m-K]  
density - ρoil = 900 [kg/m3]  
specific heat capacity - coil­ = 1670 [J/kg-K]

Calculate the following:

1. Rate of heat [W] lost from the oil via radiation heat transfer.
2. If the above heat rate occurred for 10 seconds, what would the temperature drop [°C] of the oil droplet be?