AME40453 - Automation and Controls
C3 Pre-Lab Assignment

For the following questions, please express your answers as algebraic equations written on a separate sheet of paper, and show your work. Then, transcribe the equations into your lab notebook.

1. Consider a 100Ω heater being switched ON and OFF between 0 and 12V at a rate of 500Hz.
    a. Sketch a plot of voltage vs. time for the 500Hz, 12V square wave with a 30% duty cycle.
    b. Sketch a plot of *power* dissipated in the resistor vs. time with a 30% duty cycle.
    c. Derive and equation of the *average* power dissipated as a function of the % duty cycle.
    d. Calculate the average power if the duty cycle is 80%.
2. Similar to the C2 pre-lab assignment, write down the differential equation for the temperature T for a simple proportional feedback controller, where $\dot{q} = k_p(T_S - T)$.
3. Using the equation you just wrote, derive an equation for the equilibrium temperature in terms of the system parameters: mc_V, hA, k_p, etc. How does is compare to the set-point T_S? Will the actual temperature converge to the set-point T_S?
4. Using your equation from problem 2, derive an equation for the thermal time constant in terms of the system parameters: m, c_V, h, k_p, etc.
5. Sketch the time constant as a function of the proportional gain k_p.
6. Write down the *system* of differential equations for the temperature T and integral of temperature $I = \int (T_S - T)\,dt$ for the full PID controller.