MECH 105: Homework 1

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Instructions

It is not reccomended to attempt this assignment without having read Chapter 1 in your book. HINT: There is a good chance that you will have a reading quiz on Chapter 1. I highly reccomend that you use MATLAB to complete this assignment but since we haven't reviewed MATLAB yet, you can use whatever tool you would like.

Problem 1

A storage tank (see Fig. P1.9 in your book) contains a liquid at depth y where $y = 0$ when the tank is half full. Liquid is withdrawn at a constant flow rate Q to meet demands. The contents are resupplied at a sinusodial rate $3Qsin^2(t)$.

An equation representing this system can be written as:

$$(change\ in\ volume) = (inflow) - (outflow)$$

$$\frac{d(Ay)}{dt} = 3Qsin^2(t) - Q$$

Since the storage tank is cylindrical we can assyme the surface area A is constant. Therefore:

$$\frac{dy}{dt} = 3\frac{Q}{A}sin^2(t) - \frac{Q}{A}$$

Use Euler's method to solve for the depth y from $t = 0$ to $10d$ with a step size of $0.5d$. The parameter values are $A = 1250m^2$ and $Q = 450m^3/d$. Assume that the initial condition is $y = 0$.

To get full credit, include the following:

- A plot showing how the height of the tank changes over time. Be sure to label the plot appropriatley.
- A two column table with t and y data for each of the steps

- Explain the trend of the tank volume over time. Is it filling up, draining, or staying about the same?

Problem 2

You are working as a crime scene investigator and must predict the temperature of a homicide vitim over a 5 hour period. You know that the victim was found in the walk in freezer and that the room was at $0°C$ when you found the body.

As a CSU Mechanical Engineering Alumni you recall Newton's Law of Cooling

$$\frac{dT}{dt} = -k(T - T_a)$$

where:
T = the temperature of the body ($C°$), t = time (min), k = the proportionality constant (per minute), and T_a = the ambient temperature ($C°$).

You are going to use Euler's method to compute the victim's body temperature for the 5-hr period using value of $k = 0.12/hr$ and $\Delta t = 0.5$hr.

1. What should you assume that the body temperature was at the time of death?
2. Using your assumption from above, use Euler's method to compute the victims body temperature using the values above and assumiing the room was a constant $0°C$.
3. Further investigation leads you to believe that the room temperature actually rose linerally from $-5°C$ to $0°C$ over the 5 hour period. Repeat the same calculation but incorporate this new information.
4. Compare your results from 2 and 3 by plotting them on the same graph.