Exercise 1

The current \( i \) through a capacitor is related to the voltage \( v \) across a capacitor by the following equations:

\[
v = \frac{1}{C} \int i \, dt \quad \text{and} \quad i = C \, v'.
\]

1a: The following plots show the voltage over time across a capacitor with \( C = 2 \times 10^{-6} \) F.

![Voltage plot](image)

**Units:**
- current: Amps (A)
- voltage: Volts (V)
- capacitance: Farads (F)

Farad = Amp-second/Volt

In these two plots, the slope will be in units of Volts/second.

Sketch the current over the same time periods.
1b: The following plot shows the current through a capacitor with $C=2$.

In this plot, area will be in units of Amp-seconds.

Plot the voltage across the capacitor over the same time period.

Assume that the voltage at time $= 0$ is 0 Volts.
Exercise 2

Assume that a small rocket produces constant thrust (acceleration) as long as it has fuel to burn. Once the fuel is exhausted, the only force on the rocket is gravity (-9.8 m/s²).

The fuel burns for 10 seconds, during which time the acceleration is 10 m/s². (The rocket thrust produces 29.8 m/s², which is reduced by gravity.)

Plot the velocity and the height of the rocket for 20 seconds. Assume the initial velocity of the rocket is 0 m/s and the initial height of the rocket is 0 meters. Also assume that the rocket flies (falls) straight up (down).
Exercise 3

The following plot shows the distance of a vehicle from some arbitrary point on a long straight road.

Plot the velocity and the acceleration of the vehicle over this six hour period.
Exercise 4: Create a function block diagram for the mouse population system (described on following pages).

Exercise 5: Create a function block diagram for the electric circuit in exercise 1. Let voltage be an input to the system.

Exercise 6: Create function block diagrams for the Sand Castles and Ninja Turtles systems.

\[ \text{erosion} = \frac{\text{Sand Castles}}{\text{TIME TO BE WASHED AWAY}} \]

\[ \text{UNITS: castles/hour} \]

\[ \text{buying} = \frac{\text{Kids with Ninja Turtles}}{\text{TIME TO BUY NINJA TURTLES}} \]

\[ \text{UNITS: kids/month} \]