ME 1020 Engineering Programming with MATLAB

Handout 09b

Homework 9b Assignment: 9.22, 9.23, 9.24, 9.25, 9.28

22. Plot the solution of the equation

$$6\dot{y} + y = f(t)$$

if $f(t) = 0$ for $t < 0$ and $f(t) = 15$ for $t \geq 0$. The initial condition is $y(0) = 7$.

Use the `ode45` Solver for this problem.

23. The equation for the voltage y across the capacitor of an RC circuit is

$$RC\frac{dy}{dt} + y = v(t)$$

where $v(t)$ is the applied voltage. Suppose that $RC = 0.2$ s and that the capacitor voltage is initially 2 V. Suppose also that the applied voltage goes from 0 to 10 V at $t = 0$. Plot the voltage $y(t)$ for $0 \leq t \leq 1$ s.

Use Euler's Method to solve this problem.

24. The following equation describes the temperature $T(t)$ of a certain object immersed in a liquid bath of constant temperature T_b.

$$10\frac{dT}{dt} + T = T_b$$

Suppose the object's temperature is initially $T(0) = 70°F$ and the bath temperature is $T_b = 170°F$.

a. How long will it take for the object's temperature T to reach the bath temperature?

b. How long will it take for the object's temperature T to reach 168°F?

c. Plot the object's temperature $T(t)$ as a function of time.

Use Euler's Method to solve this problem.

25.* The equation of motion of a rocket-propelled sled is, from Newton's law,

$$m\dot{v} = f - cv$$

where m is the sled mass, f is the rocket thrust, and c is an air resistance coefficient. Suppose that $m = 1000$ kg and $c = 500$ N · s/m. Suppose also that $v(0) = 0$ and $f = 75{,}000$ N for $t \geq 0$. Determine the speed of the sled at $t = 10$ s.

Use the `ode15s` Solver for this problem.

27. The equation for the voltage y across the capacitor of an RC circuit is

$$RC\frac{dy}{dt} + y = v(t)$$

where $v(t)$ is the applied voltage. Suppose that $RC = 0.2$ s and that the capacitor voltage is initially 2 V. Suppose also that the applied voltage is $v(t) = 10[2 - e^{-t}\sin(5\pi t)]$ V. Plot the voltage $y(t)$ for $0 \leq t \leq 5$ s.

28. The equation describing the water height h in a spherical tank with a drain at the bottom is

$$\pi(2rh - h^2)\frac{dh}{dt} = -C_d A\sqrt{2gh}$$

Suppose the tank's radius is $r = 3$ m and the circular drain hole has a radius of 2 cm. Assume that $C_d = 0.5$ and that the initial water height is $h(0) = 5$ m. Use $g = 9.81$ m/s^2.

a. Use an approximation to estimate how long it takes for the tank to empty.

b. Plot the water height as a function of time until $h(t) = 0$.

Use the Euler Method to solve this problem.

29. The following equation describes a certain dilution process, where $y(t)$ is the concentration of salt in a tank of freshwater to which salt brine is being added.

$$\frac{dy}{dt} + \frac{5}{10 + 2t}y = 4$$

Suppose that $y(0) = 0$. Plot $y(t)$ for $0 \leq t \leq 10$.