ME 1020 Engineering Programming with MATLAB

Problem 2.23:

23. *a.* After a dose, the concentration of medication in the blood declines due to metabolic processes. The *half-life* of a medication is the time required after an initial dosage for the concentration to be reduced by one-half. A common model for this process is

$$C(t) = C(0)e^{-kt}$$

where $C(0)$ is the initial concentration, t is time (in hours), and k is called the *elimination rate constant,* which varies among individuals. For a particular bronchodilator, k has been estimated to be in the range $0.047 \leq k \leq 0.107$ per hour. Find an expression for the half-life in terms of k, and obtain a plot of the half-life versus k for the indicated range.

b. If the concentration is initially zero and a constant delivery rate is started and maintained, the concentration as a function of time is described by

$$C(t) = \frac{a}{k}(1 - e^{-kt})$$

where a is a constant that depends on the delivery rate. Plot the concentration after 1 hr, $C(1)$, versus k for the case where $a = 1$ and k is in the range $0.047 \leq k \leq 0.107$ per hour.

The command **…** (ellipsis) can be used to wrap a line of commands to the next line. The **log** command corresponds to the natural logarithm function.

```
% Problem 2.23
clear
clc
disp('Problem 2.23: Scott Thomas')

% Part (a)
disp('Part (a): plot half-life versus k')

k=linspace(0.047,0.107,10); % elimination rate constant

t_halflife = - log(0.5)*k.^(-1);

%plot(k,t_halflife), xlabel('Elimination Rate Constant, k'),...
    ylabel('Half Life, t (hours)')

% Part (b)
disp('Part (b): plot concentration after one hour versus k')
```

```
time = 1;
a = 1;
C = a*(1-exp(-k*time))./k;

plot(k,C), xlabel('Elimination Rate Constant, k'),...
    ylabel('Concentration after One Hour')
```

```
Problem 2.23: Scott Thomas
Part (a): plot half-life versus k
Part (b): plot concentration after one hour versus k
```