ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering

ME 123 Computer Programming

Exercises for Day 39

Note: The following exercises are intended as practice for the final exam and will not be submitted for a grade.

Exercise 1. For this problem, create a **single** program named `lastname_P1.m`

The differential equation for an object experiencing radiative cooling is

$$\frac{dT}{dt} = -10^{-9}(T^4 - T_a^4)$$

Here T is temperature in degrees Kelvin, t is time in seconds, and T_a is a constant temperature (also in degrees Kelvin) related to the environment. Assume that $T(0)$ = 400, t starts at zero, and $T_a = 293$. Use Euler's method to find out how many seconds it takes for T to reach 300.

Write your answer in the **command window** as follows using a variable (that is, **do not** just look at the result and type it into the `fprintf` statement):

```
The time for the object to cool from 400K to 300K is 22.74 s
```

Exercise 2. For this problem, create a **single** program named `lastname_P2.m`

(a) We can model predator (y) and prey (x) populations with a set of two coupled differential equations, which we can solve numerically using Euler's method. The Euler's method equations are given by:

$$x_{n+1} = x_n + \Delta t(a x_n - \alpha x_n y_n)$$
$$y_{n+1} = y_n + \Delta t(\gamma x_n y_n - c y_n)$$
$$t_{n+1} = n \cdot \Delta t$$

Here the constant parameters and initial conditions are:

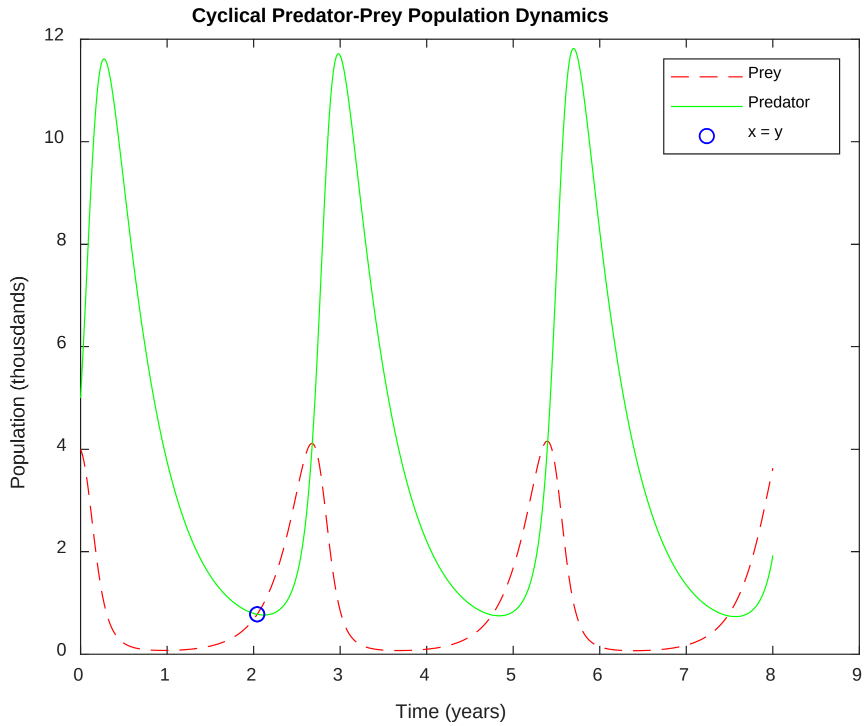
$$a = 4$$
$$\alpha = 1$$
$$\gamma = 2$$
$$c = 2$$
$$x_1 = 4$$
$$y_1 = 5$$

In the Euler equations x is the prey population in thousands, y is the predator population in thousands, and t is the time in years. Using a time step of Δt=0.001 years, plot x (dashed red line) and y (solid green line) as a function of time for 8 years. Add a title and axis labels. (See next page for how the plot will look after you also finish part (b) below.)

(b) Now find the first time when $x = y$, that is, the first time when the predator and prey populations are equal. <u>Do not use a loop to find this point.</u> Add a blue circle to your plot to mark this intersection as shown on the next page. Add a legend to the plot.

(c) Write your answer in the **command window** as follows using a variable (that is, **do not** just look at the result and type it into the fprintf statement):

```
The predator and prey populations are equal at X.XXX years
```


Cyclical Predator-Prey Population Dynamics
Population (thousdands)
Time (years)
Prey
Predator
x = y
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9