PHYS 160 - Exam #3

Complete as much of the Exam as you can in class. Email the completed assignment to **travis.hoppe+PHYS160@gmail.com**. You have one week to submit any missing points for 1/2 credit on this exam.

Seemingly Chaotic Mosquito Flight

You are to help your friend in bio-sciences with her model of a seemingly chaotic flight of a mosquito around a prey. She describes the trajectory followed by the mosquito by specifying the $x(t)$ and $y(t)$ coordinates along the trajectory as a function of the time t.

$$x(t) = \cos(t) + \sin(\sqrt{2}t)$$

$$y(t) = 0.5\sin(\sqrt{3}t) + \cos(\sqrt{5}t)$$

The distance of the mosquito from the prey (assumed at the origin) is obviously

$$R(t) = \sqrt{x(t)^2 + y(t)^2}$$

Using Maple

- Define $x(t)$ and $y(t)$.
- Plot simultaneously (single graph) $x(t)$ and $y(t)$ over a time domain $t = [0, 17]$. Label this plot with a title.
- Define the distance function, $R(t)$
- Plot $R(t)$ over a time domain $t = [0, 17]$. Label this plot with a title.
- Calculate *slope(t)*, the *derivative* of the $R(t)$ function.
- Plot this *slope*(t) function over a time domain $t = [0, 17]$. Label this plot with a title.
- Find at what times the mosquito is at its maximum and minimum distance from the prey within the time interval $t = [0, 17]$. What are these distances? Where is the mosquito then?

How fast is the mosquito flying?

From elementary Physics, you also know that the velocity vector components are given in terms of the *derivative* of the coordinates, namely

$$vx(t) = \frac{d}{dt}x$$

$$vy(t) = \frac{d}{dt}y$$

The *speed* is the magnitude of the velocity vector, namely

$$speed(t) = \sqrt{vx(t)^2 + vy(t)^2}$$

- Define the velocity components, $vx(t)$ and $vy(t)$.

- Define the *speed(t)* function.
- Plot $speed(t)$ over a time domain $t = [0, 17]$. Label this plot with a title.
- At what time is the mosquito flying with maximum speed within the time interval $t = [0, 17]$? What is this speed? Where is the mosquito then?

How violent is this flight?

From elementary Physics, you also know that the acceleration vector components are given in terms of the *derivative* of the velocity components, namely

$$ax(t) = \frac{d}{dt} vx$$

$$ay(t) = \frac{d}{dt} vy$$

The magnitude of the accelerator vector is

$$acc(t) = \sqrt{ax(t)^2 + ay(t)^2}$$

- Define the acceleration components, $ax(t)$ and $ay(t)$.
- Define the *acc(t)* function.
- Plot $acc(t)$ over a time domain $t = [0, 17]$. Label this plot with a title.
- At what time is the mosquito flying with maximum acceleration (magnitude) within the time interval $t = [0, 17]$? What is this acceleration? Where is the mosquito then?

Trajectory

- Plot the trajectory, i.e., the coordinate $y(t)$ versus $x(t)$ over the time domain $t = [0, 17]$. Label this plot with a title. Hint: Look up the help panel on *parametric plot*.
- Plot the trajectory. Superpose markers (symbols, lines, whatever) on this plot to mark the locations of the shortest distance, the furthest distance, the maximum speed and the maximum acceleration.
- Note the locations of the points with the greatest speed and acceleration. Are these locations obvious? Why?