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Name*
University of Florida Department of Physics
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1. PROBLEM 1 - PENDULUM NEWMAN 8.4A AND 8.5A-B

8.4 a)

This problem was using the Runge-Kutta method to solve for theta as a function of time, then to make a plot of it. Shufan and I managed to find the proper number of points that prevented it from noticeably decaying in within 100 seconds, which would have been from compounding rounding error due to aliasing, as there is no damping term. We used the following equation:

$$\frac{d^2g}{d\theta^2} = \frac{-g}{l} sin\theta$$

Using l =.1 meters, and g = 9.81 m/s^2 we got the following graph:

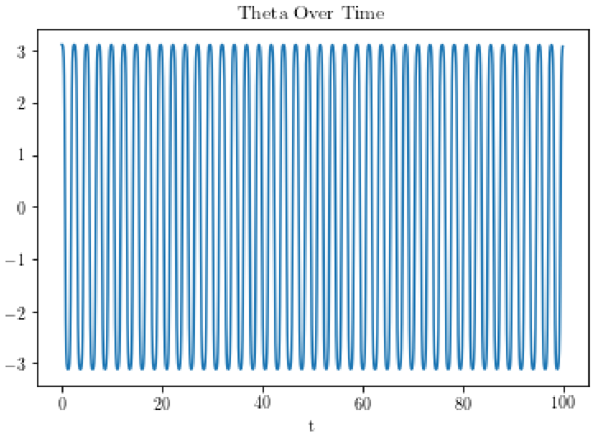

FIG. 1: Angular Displacement over Time

8.5a

This problem was made to illustrate the behavior of a pendulum over time when driven at a non-resonate frequency, using the following equation:

$$\frac{d^2g}{d\theta^2} = \frac{-g}{l} sin\theta + Ccos\theta sin\Omega t$$

Using $C = 2s^{-2}$ and $\Omega = 5s^{-1}$. We ended up needing to have the program run for $N = 10^4$ points, as otherwise aliasing became very noticeable, we checked it against $N = 10^5$ points, and noticed it was essentially the same result, just far faster to compute. Below is the graph we found, where you can clearly see the effects of beats:

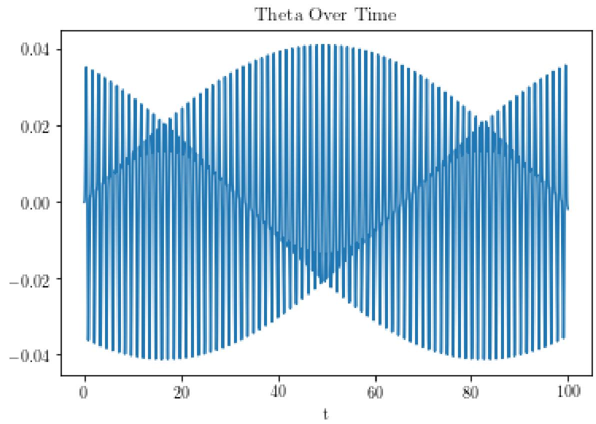

FIG. 2: Angular Displacement over Time ($\Omega = 5s^{-1}$)

8.5b

This problem is doing essentially the same thing as the previous problem, except we are substituting our own value for Ω to try and find the resonate frequency. Given my education as an astrophysicist, I can say that we should use $\Omega = \sqrt{\frac{g}{l}}$ or 9.905. Below will be the graph at the predicted resonate frequency: Here the beating pattern is far more obvious compared to the previous plot, as well as θ possessing far higher peak amplitudes.

2. PROBLEM 2 - PREDATOR - PREY RELATIONS NEWMAN 8.2

Here we used a Runge-Kutta method to solve for two variables at once, in a manner very similar to Problem 1. We used the following equations to get the slopes for the

*Electronic address: email; URL: Optionalhomepage

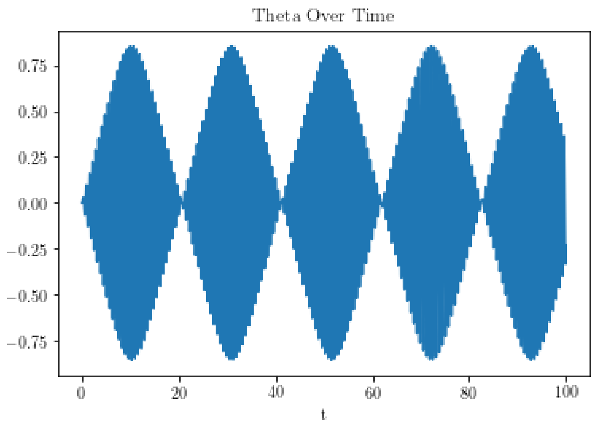

FIG. 3: Angular Displacement over Time ($\Omega = \sqrt{\frac{g}{l}}$)

Runge-Kutta:

$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = \gamma xy - \delta y$$

With $\alpha, \beta, \gamma, \delta$ as constants.

Part a)

We will plot the values provided by the book, namely $\alpha = 1$, $\beta = \gamma = 0.5$, and $\delta = 2$. Using these values, we can make the below plot.

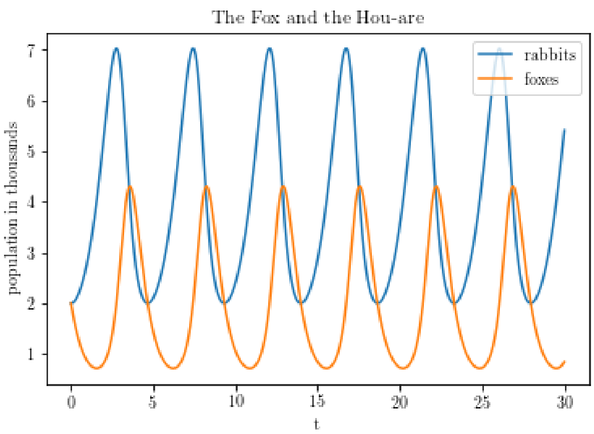

FIG. 4: The population of foxes and rabbits as a function of time

Part b)

We can see through looking at the graph that the foxes and rabbits have an interdependent relationship. As the population of the rabbits decreases, the population for the foxes likewise plummets. But whenever the population of rabbits rise, the fox population rises to meet it, causing a decrease in the rabbit population.

3. SURVEY RESPONSE

This homework was a rather painless homework assignment, with problem 2 being really simple after we figured out problem 1. Problem 1 was a little tricky with trying to figure out what we should use for the number of steps used in the equation, but we eventually managed to make it work through increasing the number of the steps. Thank you again for being understanding!