PHYS 2030 (Winter 2018) - HW 5

Due Date: Mar.7, 2018 11:30 AM

Questions

1. [2 points] For this problem, you will use `deplot.m` to extract data from a figure in a peer-reviewed journal article.

a. Use Google Scholar to identify an article of interest that has been published within the last 5 years in a peer-reviewed journal. Write a short description **in your own words** of what this paper is about (a paragraph or two) that goes beyond simply repeating the content of the abstract.

b. Now extract a figure from this paper (e.g., screen grab over a user-defined region) that has a reasonable number of data points (e.g., 20-40). Use `deplot.m` to extract those data from the figure. Make a figure that includes the original figure, a plot showing your extracted values (label the axes!), and a table of the associated values.

2. [2 point] For the harmonic oscillator, briefly describe how the eigenvalues relate to the system being under-, critically-, or over-damped? Draw a sketch that relates the time course of solutions to the eigenvalues.

3. [3 points] For this problem, you are tasked with writing a Matlab code that visualizes the electric field for several different charge configurations. The electric field at a given point in space is defined as

$$\vec{E} \equiv \frac{\vec{F}}{q_o} \tag{1}$$

where $\vec{F}$ is the electrostatic force a "test charge" (q_o) would experience if placed there. Such a field is set up by the presence of a charged particle (say, of charge q) located somewhere else in space. Note that $\vec{E}$ is a vector (i.e., it has both a magnitude and direction).

"*Electric field lines heIp us visualize the direction and magnitude of electric fields. The electric field vector at point is tangent to the field line through that point. The density of field lines in that region is proportional to the magnitude of the electric field there. Thus, closer field lines represent a stronger field*." [taken from Halliday, Resnick & Walker (10th ed.)]

For this problem, treat the charges as "point charges". From Coulomb's law, the electric field associated with a point charge q would be:

$$\vec{E} \equiv \frac{1}{4\pi\epsilon_o}\frac{q}{r^2}\hat{r} \tag{2}$$

where r is the radial distance away from the charge. When you have several charges (e.g., a dipole), superposition applies.

a. Write a code that can visualize the electric field lines for an *dipole* (i.e., two charges separated by a specified distance d)[1]. You should also include contour lines indicating the field strength[2]. You should submit your code, as well as several illustrative plots for different choices of assumed charged configurations (e.g., a simple dipole of a proton and electron pair, a +10 positive charge relative to a -1 charge, etc...).

b. Modify your code to consider a "tripole" (i.e., three charges on an equilateral triangle, separated by a specified distance d). You should submit your code, as well as several illustrative plots for different choices of assumed charged configurations.

4. [3 points] Write a code that does the following:

   1. Generates a set of "data" that comprises a noisy exponentially decaying sinusoid. At a minimum, there should be three free parameters: the sinusoid's frequency, the time constant of the decay, and the relative size of the noisiness.

   2. For three different choices of parameters, generate a curve. For each of those three curves, determine two different types of 'fits' using non-parametric regression. Make sure to clearly explain your two methods and where any additional source code might come from. Show the resulting plots and explains any differences.

[1] *Hint*: A useful built-in "blackbox" from Matlab is `streamslice.m`. However, it does not strictly follow the definition of field lines as laid out by H&R&W (but that's ok....).

[2] *Hint*(s): Field lines would be orthogonal to these contour lines. `contourf.m` might be useful. Take heed though that $1/r^2$ is a relatively rapid drop-off, so you might need to be a bit clever to get meaningful/useful contour lines...