PHYS 314
HOMEWORK #6

Due : 22 March 2017

1. Use the sources I sent to you containing solutions to all problems in the text and study the solution to problem 3 - 18. Provide the intermediate steps to show that equation (3) in the solutions does represent the energy loss over one cycle. In other words, using the basic equations for damped oscillatory motion, derive eq. (3) for dE/dt.

2. Use Mathematica to plot the solutions from problem 3 - 15. First, plot x (t) and v (t) on the same set of axes, and then plot the phase diagram (v (t) vs. x (t)). Please submit your Mathematica output with this assignment.

3. Show that the Taylor series for

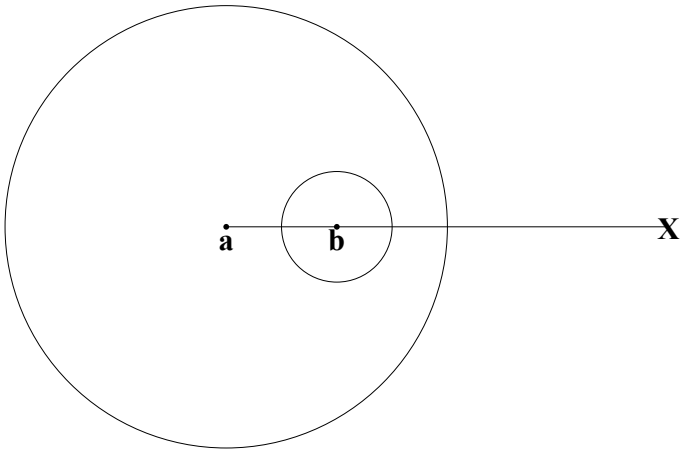
$$f(x) = \frac{1}{\sqrt{1 - k^2 x^2}} = 1 + \frac{k^2 x^2}{2} + \frac{3 k^4 x^4}{8} + \frac{5 k^6 x^6}{16} + \frac{35 k^8 x^8}{128} + \ldots$$

out to terms in x^8. You may use *Mathematica* to verify your answer, but you need to show all work by hand.

4. A standard problem in physics (both in mechanics and E & M) is to find the potential energy of a uniform sphere (of either mass or charge). Imagine a star is formed by adding successive layers of mass to a forming sphere. Assume the mass comes from infinity and forms the next spherical layer of the star, until the star has a mass M and a radius R. Show that the gravitational potential energy of a self gravitating sphere is - 3/5 G M^2 / R. (note the negative sign)

Compute the gravitational binding energy of the Earth, and compare this energy to the total explosive energy of all nuclear weapons ever built on the planet (assume this is the equivalent of 60,000 1MT devices (1 MT = 1 megaton = equivalent of energy released by one millions tons of TNT). Can nuclear weapons fragment the Earth?

5. Consider a sphere of mass M and radius a which has a hollowed out spherical region of radius b (b < a/2) such that the center of the hollow sphere lies a on the equatorial plane of the larger sphere at a distance of a/2 from the center of the larger sphere. A particle lies on the equatorial plane of the sphere at a distance X (X > a) from the center of the sphere. (see diagram below) What is the gravitational potential of the sphere as measured at X?



The sphere centered on b is hollow; the rest of the sphere is at a uniform mass density.