Phys 103 – Spring 2013

Homework 3

Due on Monday 04/29 by 6 PM in box outside Daly 312

All textbook problems are from chapter 3. In problems which involve writing or revising a program you are required to provide the code by printing the m file, and any applicable output of Matlab.

1. Problem 4. Notice that the orbit equation given in the book is different by a sign change in the denominator from the equation we derived in class. This changes the initial radial distance from perihelion (in class) to aphelion (in the textbook). Use semilogy for the figures and increase the number of time steps as τ is reduced to cover a minimum of one full orbit.
2. Problem 10
3. Problem 12. Take the acceleration due to the external force to be in the x-direction. Make the necessary changes only for the fourth order R-K. In order to check your program, use $r_0 = 1AU, v_0 = 2\pi\, AU/yr$, $\tau = 0.005yr$, and 2000 steps. Provide both the orbit plot and a graph of the angular momentum as a function of time.
4. Problem 14. Calculate the mean and error of the orbit precession in terms of degrees per revolution, and compare with the theoretical prediction. Test your program with: $r_0 = 1[AU], v_0 = \pi/2[AU/yr]$ and $\alpha = 0.02$. Use 300 time steps.

   Bonus question: Prove the theoretical prediction for the orbital precession.
5. The van der Pol equation is a model of an electronic circuit that arose back in the days of vacuum tubes: $\frac{d^2y}{dt^2} - \left(1 - y^2\right)\frac{dy}{dt} + y = 0$.

   Given the initial conditions, $y(0) = dy/dt\,(0) = 1$, solve this equation from $t = 0$ to 10, by converting this equation into a system of two first-order ODEs. Use RK4, and plot y(t) for several time step choices on the same figure, determining the necessary time step for convergence of the solution.