ASTR450 Homework # 10 – Planetary Oblateness
Due Tuesday, April 29

Both of these problems make use of the Planetary Satellite Integrator (PSI). Be sure to include several plots of PSI's output with each of these problems, label them Fig. 1, Fig. 2, etc., and describe what features they show in your writeup.

1. a) Choose a moderately eccentric orbit ($e \approx 0.2$) at about 6 Earth Radii and use the Planetary Satellite Integrator to test the orbit-averaged equations for planetary oblateness. Toggle Earth's equatorial bulge on and solar gravity off. Follow a set of orbits with a given a and e, but different i's, for 0.1 years saving values every 0.1 days. Plot the $\delta\Omega$ and $\delta\omega$ experienced by your orbit over 0.1 years vs. inclination and compare to the expressions that we derived in class (Use the Orbital Elements vs. Time plot). Are the equations accurate? What features of the solution (if any) do the orbit averaged equations miss?
b) What happens to the orbits as $e \to 0$ or $i \to 0$?
c) This satellite has $a = 3.84R_p$, $e = 0.22$ and evolves under the influence of planetary oblateness only. What is the inclination of the satellite's orbit, and which planet does it circle?

2. a) Take a moderately eccentric orbit with $i = 30°$ and investigate orbits of different sizes from about 6 to about 30 Earth Radii. Consider orbits where oblateness alone is important and produce a plot which tests the $1/a^2$ dependence of the orbit averaged equations.
b) Now toggle the equatorial bulge off and solar gravity on and repeat the experiments. At what distance are the two effects comparable in magnitude? How does solar gravity appear to depend on a? What features does solar gravity add to the orbital evolution?
c) Try to predict what you will see when both solar gravity and planetary oblateness are active and test your guess with a few simulations.