ASTR450 Homework #11 – The Last HW!
Due Thursday, May 7

1. Using the paper by Burns et al. (1979), fill in the missing steps in the derivation of Eq. 24 for da/dt. Follow the derivation of Eq. 28 for de/dt enough to understand it. Start from Energy and Angular Momentum and show your work!

2. Class Research Project. What if the Moon's orbit were different? Use the Planetary Satellite Integrator to investigate distant orbits around the Earth. Use the default settings of the form for "What if the Moon's Orbit were twice as Large?", but change the satellite's initial conditions, the integration time, and the accuracy parameter as needed. In each case, start the orbit above the positive X-axis (the reference direction) at its maximum height above the XY plane (the reference plane). See the Help File for comments on the coordinate system, and check to see that you've got the initial conditions right by viewing the Orbital Elements vs. Time plot or the Cartesian Coordinates vs. Time Plot.

Mark and Aly: Initially Circular Orbits with $i = 0°$
Harry and Maiike: Initially Circular Orbits with $i = 15°$
Nick and Kyle: Initially Circular Orbits with $i = 30°$
Victor and Ken: Initially Circular Orbits with $i = 45°$
Lenore and Harry: Initially Circular Orbits with $i = 60°$
Scott and Ryan: Initially Circular Orbits with $i = 75°$
??? and Scott: Initially Circular Orbits with $i = 90°$
Maaike and ???: Initially Circular Orbits with $i = 105°$
??? and Mark: Initially Circular Orbits with $i = 120°$
Aly and Nick: Initially Circular Orbits with $i = 135°$
Kyle and Victor: Initially Circular Orbits with $i = 150°$
Ryan and ???: Initially Circular Orbits with $i = 165°$
Ken and Lenore: Initially Circular Orbits with $i = 180°$

You each have two inclinations to investigate. Run simulations for different initial distances larger than the Moon's current distance (60 Earth Radii), and determine the fate of orbits: do they remain bound, escape the Earth, or crash into our planet? Where do transitions between the various regimes take place? Note: to determine if an orbit crashes into Earth or not, check to see if i) the integration ends early and ii) the final distance of the satellite is near 1 Earth radius. What is the escape signature in orbital elements? Interpret this. Look at orbits in inertial X,Y,Z space, in coordinates that rotate with the Earth's mean motion (Xsun, Ysun, Z), and in orbital elements to get an understanding of what is happening to each orbit. Do your orbits ever cross the Zero Velocity Curves (ZVCs)? Are the ZVCs a good indicator of the bound-escape transition? Print out examples of interesting orbits to discuss in class the day the homework is due. Please write up the results of your investigations and attach plots of interesting orbits (with the initial conditions labeled!). If you'd like to explore further, try some eccentric orbits (be sure to note all of the initial orbital elements)!