ASTR450 Homework # 8 – Escape Orbits, ZVCs
Due Thursday, April 25 or Tuesday April 30

1. 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 an initially circular orbit and the other initial conditions right by viewing the Orbital Elements vs. Time plot or the Cartesian Coordinates vs. Time Plot.

Emily: Initially Circular Orbits with $i = 0°$
Claire: Initially Circular Orbits with $i = 10°$
Josh: Initially Circular Orbits with $i = 20°$
Hannah: Initially Circular Orbits with $i = 30°$
Doug: Initially Circular Orbits with $i = 40°$
Josh: Initially Circular Orbits with $i = 50°$
Claire: Initially Circular Orbits with $i = 60°$
Hannah Initially Circular Orbits with $i = 70°$
Emily: Initially Circular Orbits with $i = 80°$
Doug: Initially Circular Orbits with $i = 90°$
Emily: Initially Circular Orbits with $i = 100°$
Hannah: Initially Circular Orbits with $i = 110°$
Claire: Initially Circular Orbits with $i = 120°$
Josh: Initially Circular Orbits with $i = 130°$
Doug: Initially Circular Orbits with $i = 140°$
Hannah: Initially Circular Orbits with $i = 150°$
Claire: Initially Circular Orbits with $i = 160°$
Josh: Initially Circular Orbits with $i = 170°$
Emily: Initially Circular Orbits with $i = 180°$

You each have four 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 from Earth 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)!