ASEN 6008 – Interplanetary Mission Design
Homework #1
Due February 2, 2016

Problem #1: Design a patched conic mission from a 400 km circular Earth orbit to a 400 km circular orbit about Mars. Assume a Hohmann transfer and circular, coplanar orbits for Earth and Mars. Compute the following values: **Departure and arrival velocities** (the velocities at periapsis and apoapsis on the transfer), the Vs necessary to depart Earth and arrive at Mars, and the transfer Time of Flight. Use the following values for constants:

μ_{Sun}	$=$	1.327×10^{11} km^3/s^2
μ_{Earth}	$=$	3.986×10^{5} km^3/s^2
μ_{Mars}	$=$	4.305×10^{4} km^3/s^2
AU	$=$	1.4959787×10^{8} km
a_{Earth}	$=$	1 AU
a_{Mars}	$=$	1.52367934 AU
r_{Earth}	$=$	6378.1363 km
r_{Mars}	$=$	3397.2 km

Problem #2: The second problem compares a Hohmann transfer to a trajectory that has been perturbed by both the Earth and Mars. Consider the scenario in Figure 1.

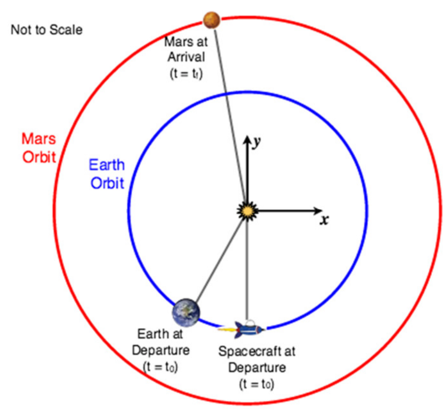

Figure 1: Problem Setup

The initial position of the spacecraft (at time $t_0 = 0$) is on the y-axis with a position magnitude equal to the semi-major axis of the Earth, and the initial velocity of the spacecraft is the velocity necessary to depart on a Hohmann transfer (the value that you computed in Problem 1). The initial position of the spacecraft is at the boundary of the sphere of influence of the Earth. The position and velocity of Earth are:

$$\overline{R}_{Earth,0} = [-578441.002878924, \ \ -149596751.684464, \ \ 0] \text{ km}$$
$$\overline{V}_{Earth,0} = [29.7830732658560, \ \ -0.115161262358529, \ \ 0] \text{ km/s}$$

At the final time (t_f = Hohmann transfer TOF), the position and velocity of Mars are:

$$\overline{R}_{Mars,f} = [-578441.618274359, \ \ 227938449.869731, \ \ 0] \text{ km}$$
$$\overline{V}_{Mars,f} = [-24.1281802482527, \ \ -0.0612303173808154, \ \ 0] \text{ km/s}$$

Integrate the state of the spacecraft from its initial condition for the time span [t_0,t_f] (the time of flight necessary to complete an idealized Hohmann transfer) in two ways:

1. Sun-Centered two-body equations of motion.
2. Sun-Centered two-body equation of motion which include perturbations from both Earth and Mars.

For both integrations, assume the Earth and Mars are on planar, circular orbits, perturbed only by the Sun.

Turn in a plot containing the Earth's orbit, Mars' orbit, an idealized Hohmann Transfer (i.e., only two-body effects), and the perturbed trajectory. Plot the differences in both the x and y position and x and y velocity between the perturbed and idealized trajectories. Provide a physical explanation of what is happening over time. What causes the perturbed trajectory to act the way that it does?