Please place this page on the front of your work, with the integrity statement signed.

R.G. Melton
Spring 2020

NAME: ______________________________

AERSP 458/550
Problem Set #8
Due Friday April 3 at 11:59pm

Submit your work via Canvas upload.
Please submit a high-contrast pdf (scan or tablet output) – no photos please.

AERSP 458, 550: do all of the problems

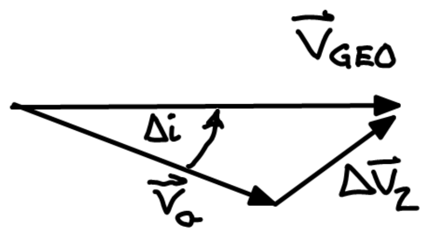
1. Orbit #1 (Earth orbit) has $a_1 = 20000$ km and $e_1 = 0.5$. When the s/c reaches $\theta_1 = 30$ deg, it performs a single-impulse maneuver that places it on orbit #2 (same plane as orbit #1) with $a_2 = a_1$, but at a new true anomaly $\theta_2 = 60$ deg. $\mu_\oplus = 3.986 \times 10^5$ km^3/s^2.
   (a) Calculate the new eccentricity e_2.
   (b) Calculate the Δv required for the maneuver.
   (c) Determine the alternative location (true anomaly) on orbit #1 where the maneuver could be performed to produce the same orbit #2. (It's not necessary to repeat parts a and b here).
2. Show that, for a pure inclination change, the maneuver location (node) closer to apoapsis will always require lower Δv.

(continued on reverse)

You may discuss homework problems and work on them together, but the work that you submit must be your own. In the space below, write and sign the integrity statement: *I have completed this work with integrity.*

Write and sign the integrity statement here:

3. Consider a Hohmann-like transfer from low Earth orbit (LEO) to geosynchronous equatorial orbit (GEO). The typical LEO has non-zero inclination (usually the same as the latitude of the launch site), whereas GEO has zero inclination. To reduce the total required Δv for the transfer, the s/c performs Δv_1 to depart LEO on the Hohmann ellipse in the same orbital plane as LEO. When it arrives at GEO, it performs a single Δv_2 (at the apoapsis of the ellipse) that both increases the orbital speed to v_{GEO} *and* changes the orbital plane to zero inclination, as shown in the figure.



For $r_{LEO} = 7000$ km, $i_{LEO} = 28.5$ deg, and $r_{GEO} = 42164$ km,

(a) Calculate the total $\Delta v_{TOT} = \Delta v_1 + \Delta v_2$ for the transfer as described above.

(b) Now consider what happens if the s/c performs two separate maneuvers when it arrives at GEO: 1) $\Delta v_{GEO,c}$ which simply places it on a circular orbit with radius r_{GEO} but with no change in inclination, then 2) $\Delta v_{GEO,i}$ which is a pure inclination change from i_{LEO} to $i = 0$. Calculate the $\Delta v_{TOT} = \Delta v_1 + \Delta v_{GEO,c} + \Delta v_{GEO,i}$ for the transfer and compare it with the value in part a) above.

4. A s/c on Earth orbit #1 with $a_1 = 12500$ km, $e_1 = 0.4$, $i_1 = 51.6$ deg, $\Omega_1 = 17$ deg, $\omega_1 = 45$ deg performs a single-impulse maneuver at true anomaly $\theta_1 = 22$ deg, resulting in a plane-rotation of 10 deg. (positive right-hand sense about the $\vec{r}$ vector. The new orbit #2 has the same values of a and e.

(a) Calculate the new values of i_2, Ω_2, ω_2.

(b) Calculate the required Δv for this maneuver. Note that a and e are unchanged, so this is similar to a pure inclination change.