Homework Assignment 3: Ground Tracks & Hohmann Transfers

ENAE 404: Space Flight Dynamics

Submit on Gradescope. For derivations or other pen-and-paper problems, please present your work neatly and box answers (5 points will be based on the professionalism of your submission).

1. Conceptual questions:

   (a) (3 points) Give the semi-major axis, eccentricity and inclination of an orbit whose ground track is a point.

   (b) (5 points) Explain why argument of periapsis equal to 0°or 180°produces equatorial symmetry.

   (c) (3 points) Consider the Molniya orbit. Which one orbital element would you change so that the spacecraft would spend a long time viewing the Southern hemisphere (rather than the Northern hemisphere)? Identify the orbital element and the value of this orbital element that would preserve the same structure of the ground track (just flipped to observe the Southern hemisphere).

2. (12 points) Using STK, GMAT, or equivalent software, plot ground tracks for the following orbits (submit one ground track per set of orbital elements):

Spacecraft ID	a (km)	e	i (deg)	Ω (deg)	ω (deg)
A	42164	0.3	40	0	0
B	26562	0.3	40	0	0
C	42164	0.3	60	0	70
D	42164	0.3	30	0	70
E	42164	0.3	120	0	0

   Plot all the ground tracks for 1 day. Be sure to set the orbit propagation method to two-body dynamics. For example, in the satellite properties window in STK, under Basic: Orbit, set the propagator to TwoBody. Note also that in STK (and some other programs) you will see the label 'RAAN' for the Ω values.

   Compare and contrast the ground track for Orbit E to that of Orbit A.

3. (11pts) Calculate the ΔV required to execute a Hohmann transfer from a circular orbit with radius 14,000km to a circular orbit with radius 8,000km. Assume the central body is the Earth. State whether the maneuvers increase or decrease the spacecraft's velocity.