Homework Assignment 5: Prediction Problem and More Maneuvers

ENAE 404: Space Flight Dynamics

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). For problems requiring coding, attach your code.

1. (27 points) Use the patched conic method to calculate the total ΔV required to transfer from a 400km altitude orbit about Mercury to a 10,000km altitude orbit about Jupiter. Assume both planets move in perfectly circular orbits, and that the heliocentric transfer is a Hohmann transfer. **In addition to the ΔV**:
   - calculate the radius of the sphere of influence for each planet
   - calculate the hyperbolic excess speed (V_∞) at both planets
   - sketch the sphere of influence, planet velocity and transfer hyperbola at each planet
   - calculate the time of flight of the heliocentric transfer orbit
2. Consider a spacecraft on a Mars flyby. The flyby hyperbola has an eccentricity of 1.2 and a radius of periapsis of 5380 km. For each of these cases:
   (a) (21pts) Assume that the radius of periapsis for the flyby is along the velocity vector of the planet (leading edge flyby)
   (b) (11pts) Assume that the radius of periapsis for the flyby is 30°from the direction of the velocity vector of the planet (leading edge flyby)
   (c) (11pts) Assume that the radius of periapsis for the flyby is along the *negative* of the velocity vector of the planet

   do the following:
   - Sketch the hyperbolic flyby with respect to Mars, indicating the Mars velocity direction, v_∞^-, v_∞^+, the radius of periapsis, and the hyperbola's turn angle.
   - Sketch the inertial velocity of Mars, v_∞ and the inertial initial and final spacecraft velocities (2 sketches total).
   - Calculate the ΔV, and state whether the spacecraft's velocity magnitude increases or decreases in the inertial frame.

3. (15 points code, 15 points solution) Using the computer language of your choice, write a code to solve Kepler's Prediction Problem. For each of the spacecraft describe below (orbiting Earth), calculate the position and velocity vectors after 1 hour.

Spacecraft ID	a (km)	e	i (deg)	Ω (deg)	ω (deg)	ν (deg)
Spacecraft 1	15,000	0.4	60	45	0	145
Spacecraft 2	21,000	0.6	90	0	0	35