---

1) Two satellites are in coplanar circular orbits around the earth. Their orbit radii are r_1, and r_2. How long is it before they are separated by 90° if their radius vectors are initially coincident?

---

2) A communications satellite launched from Cape Canaveral is placed into a 160 nautical mile high circular parking orbit inclined at 28.5° to the equator.
   a) As the vehicle crosses the equator, the upper stage is reignited to place the satellite into a highly elliptic 19,432 x 160 nautical mile transfer orbit. Determine the velocity increment needed for this maneuver.
   b) After a final checkout of the satellite, the apogee kick motor is fired on the third apogee to place the satellite into geosynchronous orbit. Determine the velocity increment needed for this maneuver.

---

3) Prussing and Conway, problem 7.11

   a) Determine the cost $(\Delta V/V_0)$ of a bi-elliptic transfer between circular orbits of equal radius in which the final orbit is inclined by $50°$ to the initial orbit and in which the radius at which the intermediate impulse is performed is twice that of the initial circular orbit.
   b) Determine the flight time in units of the period of the initial circular orbit.
   c) Determine the cost $(\Delta V/V_0)$ of the same orbit plane change accomplished by a single impulsive maneuver.

---

4) The General Mission Analysis Tool (GMAT) is a powerful software developed by NASA and private industry for simulating spacecraft orbits and trajectories. A free version of the software is available which you can download from https://sourceforge.net/projects/gmat/ and install on your home computer. The software is also available on all computers in the ST-213 and ST-226 Computer Labs.

   Start the software and on the Welcome page, as a start, view the video tutorial "Training:Part 3 Tutorial 1" to help you get familiarized with the software. A written tutorial "Simulating an Orbit" can be found at https://documentation.help/GMAT/ Subheadings: Tutorials > Simulating an Orbit.

   Use GMAT to determine the ground track of a satellite in a geosynchronous orbit inclined at 30° with respect to the equator. Run the animation for a 24 hour period and observe the ground track.