EAS 417/A417 Satellite Meteorology

Homework 1: Satellite Orbits

Posted: 2/10/22; due: 2/25/22

Notes:

1). Send your homework to z.johnny.luo@gmail.com by 11:59 pm of the due day
2). Put everything (figures, texts, etc) in a single file, either MS WORD or PDF format
3). Filename goes by EAS417_hw1_firstname_lastname

Problem 1 (30 points)

Download from Blackboard a file called calculate_elliptical_motion_sample.py. This is a sample Python code. Following the tutorial, run the code on Jupyter Notebook. You will see a figure. This figure shows an elliptical orbit with a circumscribed circle surrounding it. On the ellipse and circle are drawn three sets of dots in black, green and red. They correspond to the angles we discussed in class concerning elliptical orbit (true anomaly, eccentric anomaly, and mean anomaly). Study the code and answer the following questions.

1) (10 points) The symbols on the figure are represented by three quantities: variable1, variable2, and variable3. Which symbol corresponds to mean anomaly? Which one corresponds to eccentric anomaly? Which one corresponds to true anomaly?
2) (10 points) Identify these three anomalies by drawing up the angles on the figure (attach the figure in your homework).
3) (10 points) Turn on NOAA and turn off Molniya. Rerun the code and draw two figures with eccentricity = 0.7 and 0.1, respectively. What changes do you see in satellite orbit in terms of the relation between the three anomalies? Attach your new figure.

Problem 2 (30 points) Satellite Positioning

Download from the class website a file called position_satellite.py. The Python ode is intended to calculate satellite position for a highly elliptical orbit of a weather satellite called Molniya (read section 2.5.1 in the textbook for procedure). Study the code. Run it (with small modification) to answer the following questions:

1) (20 points) Use the code to calculate the positions of the satellite (in terms of x, y, and z, and radius, declination and right ascension) at following positions: t=0, 1/8th period, ¼th period, …, 7/8th period. Fill up the table below.

	t=0	1/8 period	¼ period	3/8 period	½ period	5/8 period	¾ period	7/8 period
X position								

Y position								
Z position								
Radius								
Declination								
Right ascension								

2) (10 points) Now that you have 8 positions in terms of x, y and z, you can roughly draw up the orbit in a 3D space. You may use plt.plot3d() in Python. To learn more about Molniya and to visualize the orbit in 3D space, see https://en.wikipedia.org/wiki/Molniya_orbit .

Problem 3 (40 points) Satellite groundtrack

Download from the Blackboard a python file called satellite_position_groundTrack.py. The code is similar to position_satellite.py (which was used for Problem 2). But this time, instead of calculating a single position, the program calculates a whole bunch of positions using loop. Run the code and study it.

1. (10 points) Use the code to plot two complete orbits for Molniya

2. (10 points) Use the code to plot two complete orbits for NOAA polar orbiter

3. (20 points) Use the code to plot a whole day worth of orbits for the NOAA polar orbiter. Hint: you need to figure out how many orbits this specific satellite completes within a whole day.