EENG 533 Video Response Questions

Week 2: GPS Satellite Orbits

After Video M2-1: Classical Orbital Elements

1. A common way to express a satellite orbit, for the purpose of describe the basic orbits of satellites for display or prediction purposes, is something called a "two line element" set, or TLE. Look at the Wikipedia page for TLE's (https://en.wikipedia.org/wiki/Two-line_element_set), and attempt to figure out where the six classical orbital elements described in class (a, e, τ, Ω, ω, and i) are reflected in the TLE. Note that the orbital period is directly related to the semi-major axis a through the relationship

$$\text{Mean motion} = \sqrt{\frac{\mu}{a^3}}, \text{ where } \mu \text{ is the earth's gravitational constant (known)}$$

Also, recognize that "right ascension" is essential longitude in reference to a stellar coordinate system, rather than relative to the earth. Do the best you can to fill in where the information for the classical orbital element listed is found in the TLE description:

Orbital Element	How described/where found in TLE
a	Semi-major axis, half the length of the longest axis of the orbital ellipse
e	Eccentricity, a value of 0 is perfectly circular
τ	The when the satellite is at perigee
Ω	Longitude of the ascending node, the longitude of the satellite when it crosses over the plane of the equator
ω	Argument of periapsis, the angle from the ascending node to the periapsis position
i	Inclination, the angle between the plane of the orbit and the plane of the equator

After Video M2-2: GPS Ephemeris and Timing Scheme

2. Write down today's date, day of the week, and time (UTC, not local time—can obtain UTC time from time.gov): _____Sunday, January 19, 2020 17:20:00_____. Now figure out what GPS week number and GPS Week seconds correspond with the date/time that you wrote down. Hint: search for "GPS calendar" online to get a calendar which will help you to figure out the week number.

It is GPS week 2089, 62400 seconds

After Video M2-3: Calculating Satellite Position

3. Download IS-GPS-200. What is the starting page number of the table that gives the equations for calculating satellite position? Save this file for this week's project.

    Table 20-IV starts on page 99 of IS-GPS-200

After Video M2-4: Reference Systems

4. How do you think the position solution would be affected if you were to neglect the correction for signal propagation time described in this video?

    The position solution will be off due to the rotation of the earth. The ECEF frame will have rotated between the time the signal sent and the time the signal was received, accounting for a 20 meter error in the measurement.