ASE387P.2 Mission Analysis and Design
Homework 4: Orbit Design

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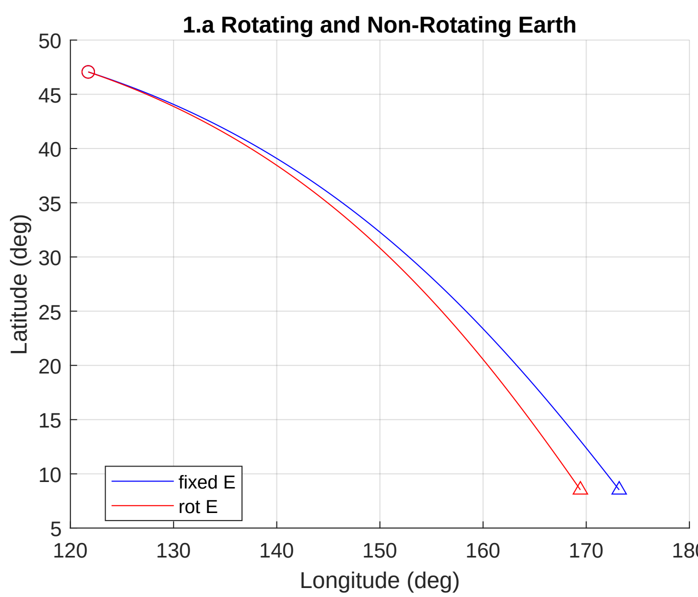
Problem 1: ISS Ground Tracks

A

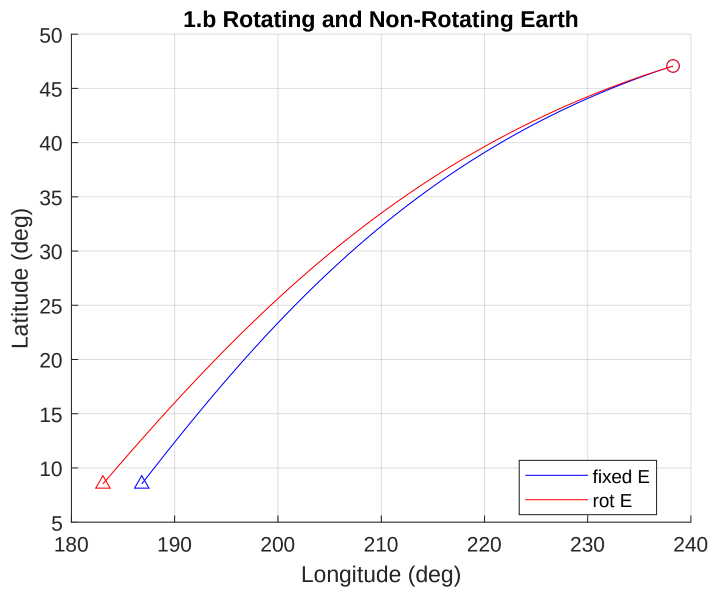
The following parameters were used to initialize the ISS orbit, which were taken from `https://in-the-sky.org/spacecraft_elements.php?id=25544` on April 19:

- a = 6794.588 km
- e = 0.00049
- i = 51.627 deg
- ω = 40.1116 deg
- Ω = 0 deg
- M = 70.88

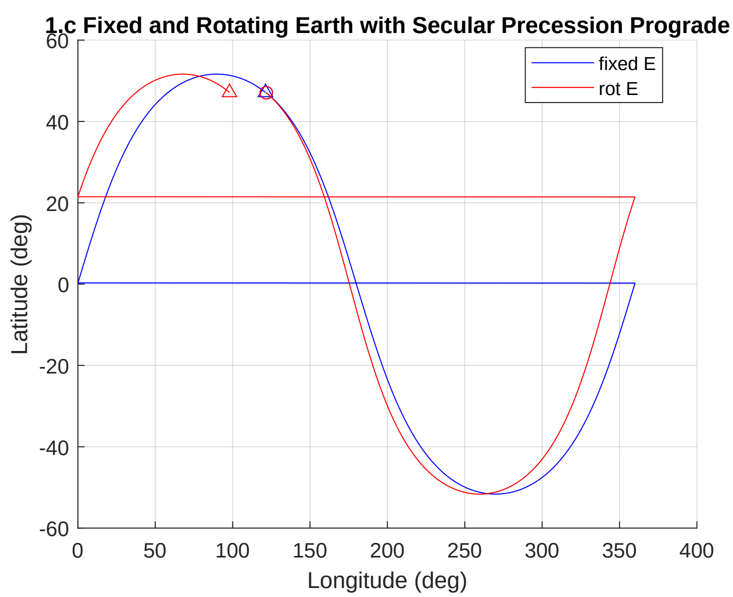
The right ascension of the ascending node, Ω, was set to 0 as stated in the problem statement.



B



C



To derive a formula for predicting the westward drift, first calculate the Draconitic period:

$$T_d = \frac{2\pi}{\dot{\omega} + \dot{M}} \tag{1}$$

Then calculate the rate of secular variation for the ascending node due to J2:

$$\dot{\Omega} = -\frac{3}{2}\bar{n}J_2(\frac{a_e}{\bar{a}})^2\frac{1}{(1-\bar{e}^2)^2}cos\bar{I} \tag{2}$$

$\bar{a}$, $\bar{e}$, and $\bar{I}$ can be taken from the initial ISS orbit parameters, and $\bar{n}$ is the mean motion of the orbit:

$$\bar{n} = \sqrt{\frac{\mu}{\bar{a}^3}} \tag{3}$$

Finally, the change in lambda was calculated as:

$$\Delta\lambda = -(w_E - \dot{\Omega})T_d \tag{4}$$

where w_E is the rotation rate of the Earth. $\Delta\lambda$ came out to **-22.870**°.

The calculated change in drift of the ascending node was taken from the difference between the initial longitude and the final longitude after one revolution, which came out to be **-22.790**°. The calculated drift was within 0.1° of the analytical prediction.

Problem 2: Orbit Design

For a sun-synchronous orbit, the Ω nodal rate needs to match the average rate of the Sun's motion projected onto the Earth's equator:

$$\frac{d\Omega}{dt} = \dot{\bar{\Omega}} = \frac{360°}{365.242\ days/year} = 0.9856\ °/day \tag{5}$$

B

Problem 3

A

B

C

Problem 4

A

B

Appendix

MATLAB code

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%% HW 4
% Junette Hsin
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