ASE387P.2 Mission Analysis and Design
Homework 5: TSX/TDX Orbit Design

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Problem 1:

Problem 2:

Problem 3: D'Amico vs. Lim frozen ground-track repeat orbit

Appendix

MATLAB code

In D'Amico's paper, the driving requirements for the TS-X orbit are:

- exact 11 day repeat cycle for ground track
- sun-synchronicity
- frozen-orbit at about 500 km altitude
- mean local time of 18 h ar the ascending node

The value selected for the draconic period, P, is 11/167 days (repetion cycle of 11 days, 167 orbits in the repeat).

If considering only two-body potential (J_0 and J_1), the period and semi-major axis, a_{J_1} of an elliptical orbit are related through:

$$a_{J_1} = \left(\frac{P}{2\pi} \sqrt{GM_\oplus} \right)^{\frac{2}{3}} \tag{1}$$

Expanding geo-potential to include J_2 term and neglecting eccentricity:

$$a_{J_2} = a_{J_1} + \frac{1}{J_2 GM_\oplus} \left(\frac{4\dot{\Omega} a_{J_1}^3}{3R_\oplus} \right)^2 - \frac{J_2 R_\oplus^2}{a_{J_1}} \tag{2}$$

The regression of the right ascension of the ascending node is imposed by the sun-synchronicity requirement, from which we can obtain i_{J_2}:

$$\dot{\Omega} = \frac{2\pi}{year} = -\frac{3}{2} \sqrt{GM_\oplus} J_2 \frac{R_\oplus^2}{a_{J_2}^{3.5}} \tag{3}$$

$$i_{J_2} = arccos \left(-\frac{2}{3} \frac{\dot{\Omega} a_{J_2}^{3.5}}{\sqrt{GM_\oplus J_2 R_\oplus^2}} \right) \tag{4}$$