Time to Repeat a Ground Track

This ***Numerit*** program (`repeat1`) estimates the time required for a satellite to repeat its ground track. The satellite is propagated using Kozai's algorithm and the user can select a closure tolerance that controls how well the repeat time is predicted. In the discussion which follows all orbital elements are assumed to be Kozai "mean" orbital elements.

The algorithm begins by initializing the Earth-relative longitude of the ascending node and the total number of days to repeat according to

$$\begin{aligned} l_{an} &= 0 \\ \text{ndays} &= 0 \end{aligned} \tag{1}$$

The nodal period of the satellite is computed using the expression

$$t_n = \frac{2p}{(\tilde{n} + \dot{w})} \tag{2}$$

where $\tilde{n}$ is the "perturbed" mean motion and $\dot{w}$ is the perturbation of the argument of perigee due to Earth oblateness or J_2. The nodal period is the time required for a satellite to travel from one ascending (or descending) node crossing to the next ascending (or descending) node crossing.

The delta-longitude at the ascending node per nodal period, sometimes called the *fundamental interval*, is given by

$$\Delta l = t_n(w_e - \dot{\Omega}) \tag{3}$$

where w_e is the inertial rotation rate of the Earth and $\dot{\Omega}$ is the perturbation of the right ascension of the ascending node due to Earth oblateness.

The current Earth relative longitude and number of orbits are incremented according to

$$\begin{aligned} l_{i+1} &= l_i + \Delta l \\ \text{norbits} &= \text{norbits} + 1 \end{aligned} \tag{4}$$

After each increment, convergence is checked. If $|l - 2p| \le e$ or $|l| \le e$ the method has satisfied the user-defined closure tolerance e. The total number of days to repeat the ground track is determined from ndays = norbits $t_n/86400$.

The software will prompt you for the semimajor axis, eccentricity, inclination and argument of perigee of a satellite's orbit. It will also ask you to input a closure tolerance in degrees. A number between 0.1 and 0.01 degrees is suggested.

The following is a typical draft output created with this program.

```
program repeat1

 < time to repeat ground track - Kozai orbit propagation >

mean semimajor axis                 8000  kilometers
mean eccentricity                   0
mean inclination                    28.5  degrees
mean argument of perigee            0  degrees
mean raan                           100  degrees

number of orbits to repeat          2075
number of solar days to repeat      170.653126271

Keplerian period                    118.684684295  minutes
nodal period                        118.429157509  minutes
length of nodal day                 1420.46616856  minutes
fundamental interval                30.0144400807  minutes

closure tolerance                   0.1  degrees
actual closure                      0.0368324847497  degrees
```