Sun-synchronous, Repeating Ground Track Orbit Design

This ***Numerit*** program (`ssrepeat`) can be used to design sun-synchronous, repeating ground track orbits. These types of orbits have desirable features that are useful for remote sensing, ocean altimetry and other astrodynamic applications. The nonlinear system of orbit design equations is solved to find the mean classical orbital elements of this type of *composite* orbit. The orbital element perturbation equations used in this application are based on Kozai's method and the algorithm is valid for both circular and elliptical Earth orbits.

The repeating ground track governing equation is

$$\frac{\frac{K}{N}}{w_e - \dot{l}} - \frac{1}{\dot{w} + \dot{M}} = 0 \tag{1}$$

The sun synchronous design equation is

$$\cos i + \frac{2\dot{l}\, a^{3/2}\left(1 - e^2\right)^2}{3J_2 r_{eq}^2 \sqrt{m}} = 0 \tag{2}$$

where

$K =$ number of orbits in repeat cycle
$N =$ number of days in repeat cycle
$w_e =$ inertial rotation rate of the Earth
$\dot{l} =$ orbital rate of the Earth $(\approx 0.985$ degrees/day$)$
$\dot{w} =$ argument of perigee perturbation
$\dot{M} =$ mean anomaly perturbation
$a =$ semimajor axis
$e =$ orbital eccentricity
$i =$ orbital inclination
$m =$ gravitational constant of the Earth
$r_{eq} =$ equatorial radius of the Earth

This computer program uses the `snle` function to solve the system of two nonlinear equations defined by Equations (1) and (2). The solution consists of the Kozai *mean* semimajor axis and orbital inclination of an orbit which is sun-synchronous and satisfies the user's repeating ground track criteria.

The user must provide an initial guess for these two orbital elements. Since a sun-synchronous orbit must be *retrograde*, an inclination guess larger greater than 90° should be input. The user must also specify the integer number of orbits and days in the repeat cycle.

The software will prompt you for an initial guess for the semimajor axis and inclination. It will also ask you to input the integer number of orbits and days in the repeat cycle. The program "hardwires" the value of mean argument of perigee to 90°.

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

```
program ssrepeat

< sun-synchronous, repeating ground track orbits >

mean semimajor axis                 7176.61579509  kilometers
mean eccentricity                   0.001
mean orbital inclination            98.5964449811  degrees
mean argument of perigee            90  degrees

keplerian period                    100.841487511  minutes
nodal period                        100.959413519  minutes

number of orbits in repeat cycle    271
number of days in repeat cycle      19
ground trace repetition factor      14.2631578947
```

For this example the semimajor axis initial guess was 8000 kilometers and the inclination initial guess was 100 degrees.