Satellitegeophysics, Blok 2, 2013. File: sat_geoph13/exc_day_2_1.docx

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Exercise 1. (2013-11-20)

In the following use: GM=3.986005x10^{14} m^3s^{-2}, angular velocity: ω=7.292115x10^{-5} radianes x sec^{-1}, Earth semi-major axis, a_e=6378137.0 m, inverse value of flattening of the Earth, 1/f=298.257222101, C_{20}= -J_2 =1.08263x10^{-9}. Use Matlab or Octave to carry-out the calculations.

(1) Use f=(a-b)/a, for the calculation of b, the semi-minor axis and the excentricity e=$((a^2-b^2)/a^2)^{1/2}$.

(2) A point (Frederiksværk) has the geodetic coordinates: latitude φ=56^o, longitude λ= 12^o and ellipsoide height h= 40 m. What are the (geocentric) Cartesian coordinates (X,Y,Z) in a CTS, WGS84=GRS80 ? Why is the X coordinate the smallest ? What is the distance (r) to the center of the Earth ?
Use the equations:

$$e^2 = f \times (2-f), N = a/(1-e^2 sin^2\varphi)^{1/2}$$
$$X = (N+h)cos\varphi\, cos\lambda$$
$$Y = (N+h)cos\varphi sin\lambda$$
$$Z = \big((1-e^2)N + h\big)sin\varphi$$

(3) What is the position of the polar axis Nov. 5 2013 ? See
http://www.iers.org/IERS/EN/DataProducts/EarthOrientationData/eop.html
What is the position in metres. What is the estimated error ?
What is the predicted position new-year eve 2013/14 ?

(4) Compute the revolution time (in Inertial space !) for a satellite which cross Equator in ascending direction exactly 10 times per day (24 hours) ? Which semi-major axis, a, must the orbit have ?
GRACE's orbit is repeated every 11 day. When will it overfly Denmark ?

(5) Which inclination *i*, must a satellite with circular orbit have and r=a=7000 km have in order to be sun-syncroneous (use equation from lecture notes) ?

(6) Suppose the GPS satellittes have a cirkular orbit (e=0) with center in Earths center and orbital radius 26000 km. What is the revolution time ? What would the revolution time be if e=0.01 ?

(7) A GPS satellite is right above a point with latitude and longitudee 0 degrees. Where will the satellite be after 2 revolutions ?

(8) A satellite has a=7000000 m, e=0.001, M=45^o, Ω = 60^o, ω = 60^o og i = 80^o at a time, which in ephemeris time correspond to and angle of 45^o.

First compute (iteratively) the excentric anomaly E.
Then the "latitude" v in the orbital plane (sometimes denoted f).

What is the position of the satellite (X,Y,Z) in Cartesian coordinates as well as expressed in geocentric latitude, longitude and r n an inertial-coordinatesystem. What is the longitude in a CTS ?
What is the geodetic latitude, φ for the satellitten in the GRS80 = WGS84 coordinate system ?

Hee use the GRAVSOFT program TRANS for conversion between Cartesiske (X,Y,Z) coordinates and geodetiske coordinates.

(9) What are the orbital elements for Jason 2, Ørsted and a Molniya satellit (http://en.wikipedia.org/wiki/Molniya_orbit). Use

http://celestrak.com/NORAD/elements/

(10) Use the following models for the gravity potential (without centrifugal force) :

A: V=GM/r

B: $V = \frac{GM}{r}\left(1 - J_2 \frac{a^2}{r^2}\left(\frac{3}{2} sin\bar{\varphi}^2 - \frac{1}{2}\right)\right)$

Compute the potential, the 1 and second radial derivatives on Equator and the North Pole at zero altitude and at r=7000 km.