AE5540 – SPACE FLIGHT DYNAMICS

Assignment No. 3 – 100 points

(Perturbations and Orbit Maneuvers)

Due: 23 March 2017

16 March 2017

1. The perturbing force acting on a satellite has the form where vectors ‘’ is for unit vector in radial direction, is for a unit vector in tangential direction, and is a unit vector in the direction of the satellite’s angular momentum vector and these vectors are mutually perpendicular to each other. Beginning with the relative equations of motion of the satellite and using relationships and where K = constant.
2. Show that the angular momentum of the satellite is not conserved and for what conditions, other than = 0, will the energy be conserved?
3. Show that the force component is related to the parameter ‘p=semi latus rectum’.
4. How will the semi-major axis change in time as a function of the perturbing force components?
5. For the satellites listed below compare the secular rate-of-change of the longitude of the ascending node and the argument of perigee in deg/day due to .

|  |  |  |  |
| --- | --- | --- | --- |
| S/C Name | ‘a’ | ‘i’ | ‘e’ |
| Shuttle | 6,600 Km | 30.0 deg | 0.02 |
| Lageos | 12,265 Km | 105.0 deg | 0.05 |
| ESPN | 42164.2 Km | 3.0 deg | 0.04 |

Use the following constants:

1. Design a sun-synchronous orbit with 3 day revisit capability (no. of orbits is variable for you to select) whose local time is 10:00 UT. Draw the Ground Trace of the designed orbit for four days and show that the revisit is happening in your design. Hint: Use the sun-synchronous orbit design s/w provided to you and also the ground trace software given in Curtis. Give the design details and the corresponding outputs in your submission and not the code.
2. The object Upper Atmosphere Research Satellite (UARS) whose mass was 5668 Kg and of size 4.6 m diameter cylinder with a length of around 9.7 m re-entered earth at the end of the life around year 2005. The residual fuel is completely drained for satellite passivation. The re-entry campaign and the predicted decay of the semi-major axis and the shape of satellite is given as below:



The ballistic coefficient for the satellite is given as 0.015 and the orbit is at an altitude of 243 and 57 deg inclination. The atmospheric density value can be taken from the plot given in class. Calculate the rate of decay of ‘a’ for this object by the procedure given in the class and compare the value to the data given above and comment on your results?

1. A 550 Kg low earth orbit satellite ‘Spacecraft Re-entry Experiment (SRE-1)’ was prepared to re-enter earth from a 485 637 Km elliptical polar orbit. The time of de-boost is planned at the true anomaly of 30⁰ prior to apogee (from perigee 150⁰) and reaches the earth at the end of the maneuver. Plan your maneuver and calculate out the required and mass of the fuel together with the orientation of SRE-1 for deboost. Assume = 275 secs. (Hint: Use the procedure given in Example 6.6 of Curtis)