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UNIVERSITY OF PETROLEUM & ENERGY STUDIES

DEHRADUN

End Semester Examination – December, 2017

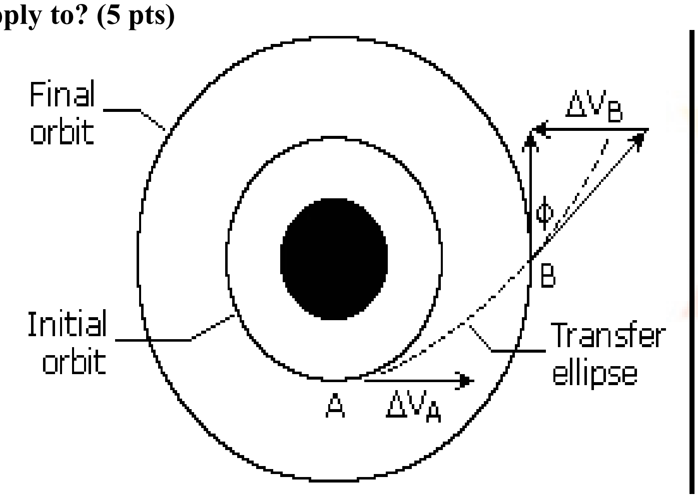
Program/course: BTech ASE, ASE+AVE **Semester – 7**
Subject: Orbital Mechanics **Max. Marks : 100**
Code : ASEG 482 **Duration : 3 Hrs**
No. of page/s: 5

SECTION A (30 pts)

1) Please fill in the blanks as per the subject lectures (10 pts)

a) The most important parameter of the 6 orbital parameters is ____________________.
b) ____________________ are linear variations of the element when it comes to orbital perturbations.
c) Roche limit depends mainly on _____________________ and not the ______________________.
d) ___________________________ orbit is when the satellite is moving in the opposite direction to the primary.
e) If you wish to do an immediate vectoral transfer of orbit, then you must perform a _______________________________________.
f) The best orbit for remote sensing satellites is ________________________________
g) At ____ the gravitational influence of the PRIMARY body will be negligible as compared to other gravity gradients.
h) ____ are important for determining the original position of the satellite in an orbit around the Earth.
i) ____ is a time vector which shows the instantaneous time position for a satellite.

2) Please explain the graph below. What does it show? Why is it significant? What type of missions does it apply to? (5 pts)



3) Select True or False for the following statements (10 pts)

a) The sphere of influence for Earth will be less then the Roche limit (T/F)
b) In an Elliptical Orbit, Hyperbolic Excess Velocity Reaches Maximum Value. (T/F)
c) Sun Perturbations on Satellites is Always a Destructive Influence ((T/F)
d) Geodesic Perturbations are Maximum for Communications Satellites (T/F)
e) Hohmann Transfers Have Minimum Energy Transfers with Minimum Time (T/F)
f) As the altitude goes down the period goes up and the velocity goes down (T/F)
g) To transfer to a higher orbit you need to increase speed in tangential direction (T/F)
h) The Mean Anomaly Distance will always be greater then the Semimajor Axis (T/F)
i) Changing the attitude of a satellite requires full orbital altitude adjustment (T/F)
J) Parabolic orbit will have a greater Mean Anomaly as Compared to an Elliptical Orbit with a Same Semimajor axis (T/F)

4) Please write the appropriate equation: (5 pts)

- True Anomaly:
- Eccentricity of an Orbit by Initial Launch Parameters:
- Apoapsis of an Elliptical Orbit:
- Location of a Satellite in Orbit (Rectangular Coordinates)
- Eccentricity by Flight Path Angle

SECTION B (Total 50 pts)

5) A satellite is in an orbit with a semi-major axis of 45,000 km and an eccentricity of 0.2 Calculate the length of its position vector, its flight-path angle, and its velocity when the satellite's true anomaly is 235 degrees. (10 pts)

6) Calculate the perturbations for the satellites with the conditions given below (10 pts)

a) in longitude of the ascending node and argument of perigee caused by the Moon and Sun for a communications satellite in MEO orbiting at an altitude of 1100 km, an inclination of 61.9 degrees, and with an orbital period of 114.2 minutes.

b) If the eccentricity of an orbit is 0.2, with inclination of 31 degrees and apogee of 1200 km and perigee of 620 km, then find the J2 perturbations?

7) a) If a spacecraft is in an hyperbolic escape orbit if it has a burnout speed of 12,400 m/sec at the same altitude of 255 km, what is the hyperbolic excess velocity? (5 pts)

b) Calculate the Lunar Sphere of Influence on a communications satellite which is in a geosynchronous orbit? How would the Lunar Sphere of Influence change for a nanosatellite at 1000 km of altitude? (D_{sp}=384,000 km, M_e=5.9737x 10^{24} kg, M_m= 7.347 x 10^{22} kg) (5 pts)

8) A spacecraft has a velocity of 10 km/sec and flight path angle of 20 degrees when it is 12,000 km away from the Earth. Calculate the true anomaly and the eccentricity of the orbit. (10 pts)

9) Lunar spacecraft is at an altitude of 275 km and you want to take it to a special lunar injection orbit at 80,000 Km. Calculate the velocity change required for a Hohhman Transfer to the lunar injection orbit. (10 pts)

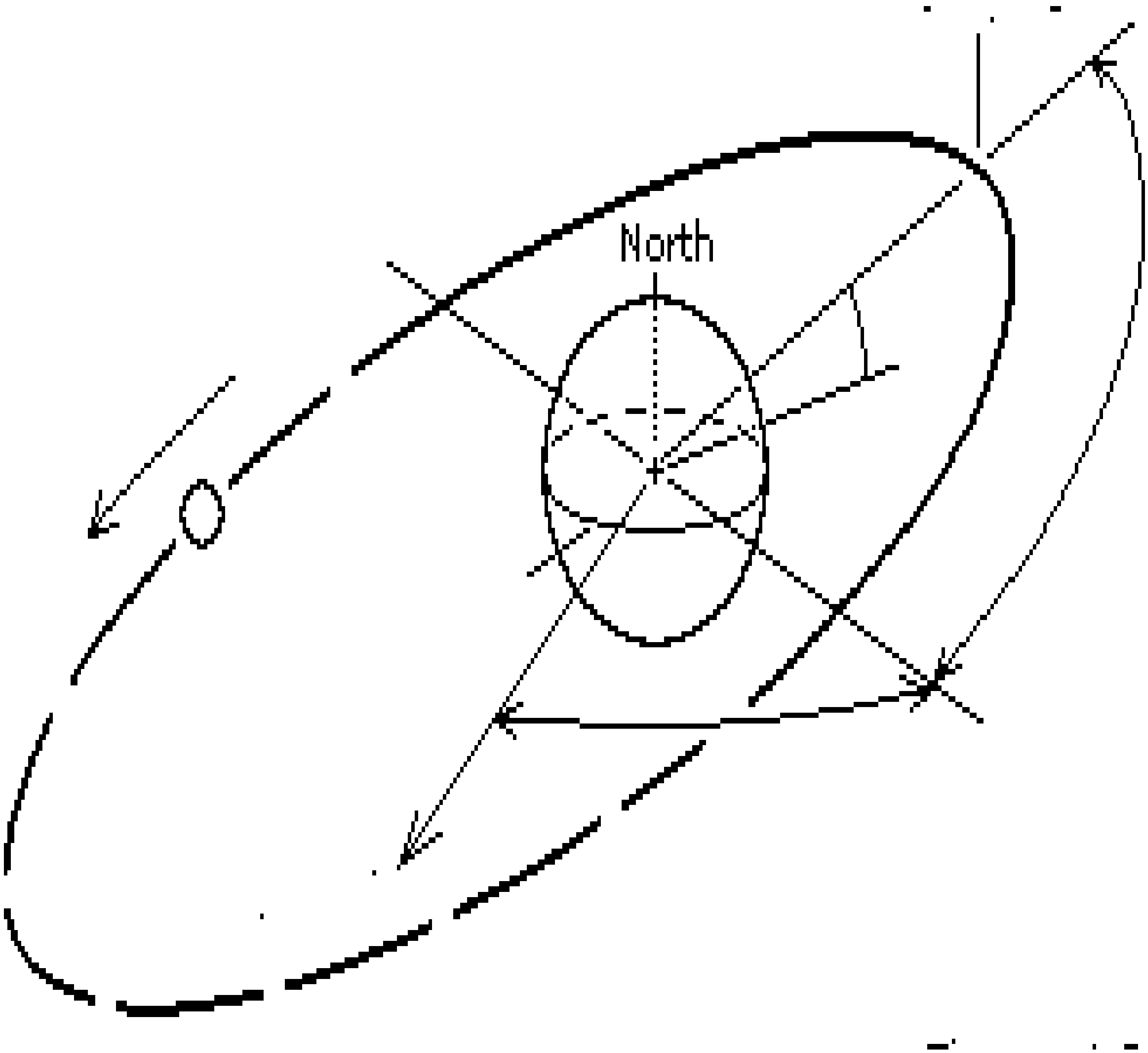
SECTION C (APPLICATION QUESTIONS) 20 Points

10) a) Go to Appendix A and fill out all of the necessary identifying parameters for the diagram given and explain each parameter in detail. What type of orbit is it? FILL ON THE APPENDIX DIRECTLY AND GIVE BACK WITH ANSWER SCRIPT OR IT WON'T BE GRADED. (10 points)

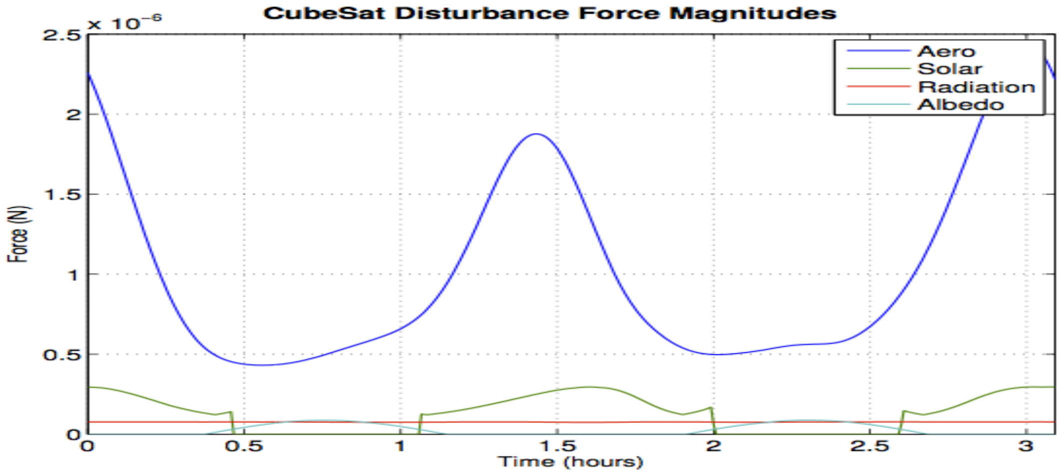
11)) Explain the type of perturbations that are effecting this particular satellite with the perturbation given in Appendix B. What can you deduce about its orbit? Which perturbations are dominant and why? Why are the changes occurring in the graph?
(For color coding Aero is the topmost wave, solar is the second wave below and the radiation is the third wave and albedo is the fourth wave in the graph)

FILL ON THE APPENDIX DIRECTLY AND GIVE BACK WITH ANSWER SCRIPT OR IT WON'T BE GRADED. (10 points)

APPENDIX A



APPENDIX B


CubeSat Disturbance Force Magnitudes
x 10^-6
2.5
2
1.5
1
0.5
0
Force (N)
0
0.5
1
1.5
2
2.5
3
Time (hours)
Aero
Solar
Radiation
Albedo