Code No: RR422108 **Set No. 1**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
SPACE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Discuss different kinds of reference frames used in describing an object in space.
   (b) An artificial earth satellite is in an elliptical orbit, which brings it to an altitude of 250 km at perigee and out to an altitude of 500 km at apogee. Calculate the velocity of the satellite at both perigee and apogee. [8+8]

2. (a) List out various elements and bring out the significance of parabolic and hyperbolic orbits.
   (b) Discuss about the following:
      i. The many body problem
      ii. Circular restricted 3-body problem [8+8]

3. (a) Discuss the various assumptions considered in two body mechanics and what are liberation points.
   (b) Discuss various orbital elements required to describe a satellite with respect to the earth. [8+8]

4. How the ground conditions can be tracked in case of LEO? [16]

5. Sketch a diagram showing the position of a satellite on the celestial sphesre that has the following orbital elements: e = 0.1; I = 96^0; argument of perigee = 65^0; and longitude of ascending none = 65^0. Mark on the diagram the eccentricity vector e, and an arrow showing the direction of the space craft is moving around the orbit. What are the six elements that define the space craft position and velocity over time?. [16]

6. Compare and discuss two-dimensional and three dimensional interplanetary trajectory analysis. [16]

7. How can the trajectory geometry be designed for a given ballistic missile trajectory. [16]

8. (a) Discuss about solar electron and solar proton events.
   (b) Write about meteoroids and micrometeoroids. [8+8]

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Code No: RR422108 **Set No. 2**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
SPACE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Write short notes on the following:
   (a) Solar time
   (b) Co-ordinate system
   (c) Standard Time
   (d) Celestial sphere [16]
2. Write short notes on the following:
   (a) Circular orbit
   (b) Medium earth orbit
   (c) Conic orbit
   (d) Hyperbolic trajectory. [16]
3. Write short notes on the following:
   (a) Helio-centric theory
   (b) Kepler's third law
   (c) Polar orbit
   (d) Lagrange identity. [16]
4. Write short notes on the following:
   (a) On-station operation
   (b) Tri-axiality perturbation
   (c) Highly elliptical orbit
   (d) Solar radiation pressure distribution. [16]
5. A satellite is in a circular orbit with a period of 90 minutes and an inclination of 96.58^0. Calculate the altitude of the orbit and the change in the line of nodes due to theJ_2 gravity perturbation. [16]
6. Explain in detail the two-dimensional interplanetary trajectory analysis. [16]
7. What is the fundamental problem associated with reentry in a space mission and explain how the problem has been handled in reentry dynamics. [16]
8. Write a detailed note on earth orbit environment. [16]

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Code No: RR422108 **Set No. 3**

IV B.Tech II Semester Regular Examinations, Apr/May 2006
SPACE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Write short notes on the following:
   (a) Solar time
   (b) Co-ordinate system
   (c) Standard Time
   (d) Celestial sphere [16]
2. (a) Give a detailed note on introduction to atmosphere.
   (b) List out the various characteristics of the atmosphere in the troposphere.[8+8]
3. Write short notes on the following:
   (a) Polar orbit
   (b) Lagrage Identity
   (c) Liberation point
   (d) Molniya orbit. [16]
4. Explain in detail GEO. Also, discuss how the final stage of launch vehicle will place a satellite in a nominal orbit. [16]
5. Calculate the nodal regression and apsidal rotation rate per orbit due to the gravity perturbation for a satellite in a 400 km circular orbit with I = 90^0 or 63.4^0? [16]
6. Write in detail about different perturbations, which affect spacecraft trajectory. [16]
7. Differentiate between boost and ballistic phases in case of a ballistic missile trajectory analysis. [16]
8. Explain in detail the operational spacecraft environments. [16]

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IV B.Tech II Semester Regular Examinations, Apr/May 2006
SPACE MECHANICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Discuss in detail about
   i. Solar time, and
   ii. Standard time.
   (b) Describe cylindrical and spherical coordinates in space and give suitable relationships between them. [8+8]

2. (a) Derive the Newtonian vector equation of motion that describes the relative motion of the smaller body with respect to the larger body.
   (b) Discuss about the following:
   i. Elevation angle
   ii. Hyperbolic and parabolic trajectories [8+8]

3. (a) Explain in detail the terms
   i. Gravity assist maneuvers and
   ii. Time of flight
   (b) The elements of the Magellan mapping orbit about Venus are as follows: a = 10,400 km and e = 0.4. The mapping pass is started at a true anomaly of 280^0. Find out the altitude, flight path velocity, velocity and time since periapsis at this point. [8+8]

4. Explain in detail GEO. Also, discuss how the final stage of launch vehicle will place a satellite in a nominal orbit. [16]

5. Sketch a diagram showing the position of a satellite on the celestial sphesre that has the following orbital elements: e = 0.1; I = 96^0; argument of perigee = 65^0; and longitude of ascending none = 65^0. Mark on the diagram the eccentricity vector e, and an arrow showing the direction of the space craft is moving around the orbit. What are the six elements that define the space craft position and velocity over time?. [16]

6. Transfer of a spacecraft from an orbit around the Earth to an orbit around Jupiter is considered, using a Hohmann minimum-energy transfer. The orbits of the Earth and Jupiter round the Sun are considered to be circular and co-planar. Spacecraft is moving round the Earth in a circular orbit at an altitude of 300km. At a particular point on this orbit, an attempt has been made to inject the vehicle into a hyperbolic escape trajectory and proceed to Jupiter. The spacecraft enters the Jupiter planets sphere of influence at a particular point from where it changes its trajectory from

hyperbolic into circular. Let the radius of the circular orbit at which this takes place is 6 times the radius of the Jupiter planet, by means of an impulsive burn resulting in a velocity increment. Find:

(a) Speed of the spacecraft before the manoeuvre; and

(b) The required velocity increment, at the point of interest on the circular orbit from where trajectory changes into circular orbit.
Use the following data for calulations-
Gravitational parameter (μ) values: Sun : $1.327 \times 10^{11} km^3 s^{-2}$
Earth : $3.986 \times 10^5 km^3 s^{-2}$
Jupiter : $1.267 \times 10^8 km^3 s^{-2}$
Orbit Radius round the Sun values: Earth : 1.496×10^8 km
Jupiter : 7.783×10^8 km
Orbit Radius round the Sun values :Earth : 6.378×10^3 km
Jupiter : 7.160×10^4 km [16]

7. Write a detailed notes on

(a) Optimal flight considerations and

(b) Boost phase and Re-entry phase [16]

8. Explain in detail the operational spacecraft environments. [16]

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