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

IV B.Tech II Semester Supplementary Examinations, June 2007
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) Explain in detail regarding
   i. co-ordinate systems in space and
   ii. Classification of planets.
   (b) Explain how celestial sphere concept is used in studying motion of an object in the sky. [8+8]

2. Write short notes on the following:
   (a) Elevation angle
   (b) Many body problems
   (c) Turning angle
   (d) Hyperbolic orbit. [16]

3. Discuss various orbital elements required to describe a target with respect to earth. [16]

4. Write short notes on the following:
   (a) Luni-solar perturbation
   (b) Geo-stationary earth orbit
   (c) Solar radiation perturbation
   (d) Atmospheric drag. [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 short notes on the following:-
   (a) Departure phase
   (b) Parabolic trajectory
   (c) Hyperbolic excess velocity
   (d) Arrival phase. [16]

7. A ballistic missile has the following burn out conditions:
   V = 7168 $ms^{-}1$; h = 276 km; and $\phi = 25^0$. Find the range using algebraic development and geometric development. [16]

8. Explain the necessity for studying space environment in space applications. Write about solar radiation. [16]

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

IV B.Tech II Semester Supplementary Examinations, June 2007
SPACE MECHANICS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Halley's comet last passed perihelion in 1986. It has a semi-major axis (a) = 17.9564 AU and eccentricity (e) = 0.967298. [One astronomical unit (AU) is the distance between the earth and the sun]. Calculate the period of Halley's comet and predict the year of next return. Solve Kepler's equation and calculate E, v, and scalar radius vector r for the current data. [16]

2. (a) Discuss about the following:
   i. Turning angle
   ii. Circular and elliptical orbits
   (b) What is the velocity at perigee, apogee and period of an earth bound spacecraft in an elliptical orbit having 1000 km of perigee and 15000 km of apogee. Also compare the result when the same spacecraft in a circular orbit of 10000 km. [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. Write a note on
   (a) solar radiation perturbation,
   (b) earth triaxiality perturbation and
   (c) Luni-solar perturbation. [16]

5. (a) Describe in detail Cowells and Encke's methods as applicable to orbital perturbations?
   (b) How does the Reaction Control System (RCS) affect the perturbations caused to spacecraft in orbit? [8+8]

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

7. A ballistic missile to have a free fall range of 10,120 km. It is capable of achieving a burn out velocity of 8825 $ms^{-}1$ at an altitude of 276 km. Find
   (a) the approximate values of ϕ_{60},

(b) the characteristics of the trajectory associated with each ϕ_{60}, , E, a, H, ε , h_p, and h_a. [16]

8. (a) Discuss about solar electron and solar proton events.

(b) Write about meteoroids and micrometeoroids. [8+8]

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IV B.Tech II Semester Supplementary Examinations, June 2007
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) Explain 'motion of vernal equinox' in detail.
   (b) State Kepler's laws. An earth bound satellite is so positioned that it appears stationary to an observer on the earth and serve the purpose of a fixed relay station for intercontinental transmission and other communications. What would be the height at which the satellite should be positioned and the direction of its motion? [8+8]

2. (a) Discuss about the following:
      i. Turning angle
      ii. Circular and elliptical orbits
   (b) What is the velocity at perigee, apogee and period of an earth bound spacecraft in an elliptical orbit having 1000 km of perigee and 15000 km of apogee. Also compare the result when the same spacecraft in a circular orbit of 10000 km. [8+8]

3. Write short notes on the following:
   (a) Helio-centric theory
   (b) Kepler's third law
   (c) Polar orbit
   (d) Lagrange identity. [16]

4. (a) What factors on which solar radiation perturbation depend on and how does it affect the satellite motion in orbit?
   (b) What is the significance of gravity assist maneuvers? Also, discuss tri-axiality perturbations. [8+8]

5. (a) Write a detailed note on six classical orbital elements which are necessary to specify a particular orbit on the basis of a two-body problem.
   (b) Describe in detail Cowell's and Encke's methods as applicable to orbital perturbations? [8+8]

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. Illustrate different phases involved in reentry of a spacecraft. [16]

8. Write a detailed note on earth orbit environment. [16]

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Code No: RR422108 **Set No. 4**

IV B.Tech II Semester Supplementary Examinations, June 2007
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) Discuss about the following:
   i. Turning angle
   ii. Circular and elliptical orbits
   (b) What is the velocity at perigee, apogee and period of an earth bound spacecraft in an elliptical orbit having 1000 km of perigee and 15000 km of apogee. Also compare the result when the same spacecraft in a circular orbit of 10000 km. [8+8]

3. (a) Discuss in detail the circular restricted three body problem and state all the assumptions.
   (b) Write down different types of satellite orbits usually used by ISRO. [8+8]

4. Write short notes on the following:
   (a) Low earth orbit
   (b) Geostationary earth orbit
   (c) Highly elliptical orbit
   (d) Non- geocentric 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. What are the main points to be considered during launching of an interplanetary spacecraft and discuss. [16]

7. (a) Mention the main assumptions made in reentry dynamics.
   (b) Obtain range equation through algebraic development method. [8+8]

8. Enumerate salient points about solar system environments. [16]

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