Karunya University
(Karunya Institute of Technology and Sciences)
(Declared as Deemed to be University under Sec.3 of the UGC Act, 1965)

End Semester Examinations - 2015-16 Even Semester - May 2016

14AE3005 Orbital Space Dynamics

Set A

Time : 3 hrs
Total Marks: 100

1. (a) What are three laws of Kepler's planetary motion? The observed average separation of Mars from Sun is 1.52 astronomical units. From Kepler's 3rd Law, calculate the orbital period for Mars.

(8)

(b) With the help of diagrams, explain the six orbital parameters of an earth satellite. If the semi-major axis (a), eccentricity (e) and eccentric anomaly (E) of an earth satellite are 10000 km, 0.2 and 30 degrees, respectively, calculate its radial distance r and velocity v of the satellite at that point. The value of the Earth's gravitational constant (μ)=398600 km^3s^{-2}. (12)

OR

2. (a) What is Kepler's equation for elliptic orbits? If mean anomaly and eccentricity are 45 degrees and 0.1 respectively, calculate the eccentric anomaly. (10)

(b) Define Sun-synchronous orbits for Earth satellites. Calculate the orbital inclination for a Sun-synchronous orbit, whose semi-major axis is 7200 km and eccentricity is 0.05. Earth's gravitational constant (μ) = 398600 km^3s^{-2}, J_2 = 0.00108263 and Earth's radius is 6378 km.
(10)

3. If the position and velocity of a satellite are (-6050, -3490, 2500) km and (-3.46, 6.62, 2.5) km/s, respectively; find the angular momentum and the orbital elements. (20)

OR

4. Name two gravitational and two non-gravitational forces. Explain Cowell's method and Encke's method. Explain advantages and disadvantages of both the methods. (20)

5. What is Lambert's problem ? Derive it analytically. (20)

OR

6. (a) Prove that the Hamiltonian of a harmonic oscillator

$$H = (p_1^2 + p_2^2)/2 + \omega^2 (x_1^2 + x_2^2)/2,$$

with the help of a generating function S, reduces in terms of the new momenta .
(12)

(b) Prove that the following transformations are canonical.

(i) $Q = (q^2 + p^2)/2, \quad P = - \tan^{-1} (q/p);$

(ii) $Q = q \tan p, \quad P = \log (\sin p);$ (8)

7. (a) What is n-body problem? Derive the 10 integrals of motion of n-body problem. (10)

(b) What are the four types of canonical transformations? (4)

(c) Explain the method briefly to generate Poincaré surface of sections for planar restricted three- body problem. (6)

OR

8. To study the motion near any Lagrangian point L_i, write the expression for the force function Ω expanded up to second-order terms. Use it to obtain equations of motion around any Lagrangian point L_i. Obtain the fourth-order equation for λ for finding the characteristic roots. Find the value of critical mass at the equilateral points. (20)

9. Define restricted three-body problem. Write the equations of motion of planar restricted three-body problem in synodic coordinate system. Derive the locations of the three collinear points L_1, L_2 and L_3. (20)

Wishing you All the Best
