R09

Code No: D7609

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech II - Semester Examinations, March/April 2011
SPACECRAFT DYNAMICS AND CONTROL
(AEROSPACE ENGINEERING)

Time: 3hours **Max. Marks: 60**

Answer any five questions
All questions carry equal marks

\- - -

1. a) Describe the perturbing forces on a satellite orbiting the earth.
   b) Derive the Euler – Hill equation. [4+8]

2. a) Derive the equations governing the changing of semi major axis and eccentricity of an orbit that can be achieved with a single impulse thrust at any point on the orbit.
   b) The initial orbit of a satellite is $a_1 = 5\ R_e$, $e_1 = 0.2$. The final orbit is $a_2 = 12\ R_e$. Re = 6378 km. Find the minimum eccentricity of the final orbit. [6+6]

3. a) Derive the equations of angular motion of a satellite.
   b) A satellite is orbiting such that the z-axis is pointing to earth, while y-axis is normal to the orbital plane. Derive the angular velocity vector ω_{RI} of the orbit reference frame with respect to the inertial coordinate frame, if the orbit is circular. [6+6]

4. For a passively controlled satellite, the equations of motion are

$$T_{dx} = I_X\ddot{\phi} + 4\omega_0^2(I_y - I_z)\phi - \omega_0(I_x + I_z - I_y)\dot{\psi}$$

$$T_{dz} = I_z\ddot{\psi} + \omega_0^2(I_y - I_x)\psi - \omega_0(I_z + I_x - I_y)\dot{\phi}$$

$$T_{dy} = I_y\ddot{\theta} + 3\omega_0^2(I_x - I_z)\theta$$

   Using Laplace Transform, find the required solutions and discuss the stability of the angular motion of the satellite. [12]

5. a) Discuss the active nutation control and derive the governing equations for fuel consumed during active nutation control.
   b) A satellite has the following characteristics. $I_x = I_y = 75$ kg-m^2; $I_z = 130$ kg-m^2; Specific impulse of the fuel is 180 seconds; Torque arm of the thruster is 0.6 m; the angular velocity is 5 radians / second and the rate of energy dissipation is 10^{-2} W. What is the rate of fuel consumption required to keep the Active Nutation Control within two degrees? [6+6]

6. Discuss the control command laws (a) using Euler angle errors (b) using direction cosine error matrix, and (c) using the quaternion error vector. [4+4+4]

7. Derive the equation of motion for roll angle increment of a satellite and determine the momentum bias required for keeping the roll small. [12]

8. With the help of appropriate equations, describe the torque commands on a satellite and how the thruster activation time is computed. Describe PWM and PWPFM. [12]

*****