Reg. No. : | | | | | | | | | | | | |

Question Paper Code: 1106420

B.E. / B.Tech. DEGREE EXAMINATIONS, NOV / DEC 2024
Sixth Semester
Aerospace Engineering
U20AS601 – SPACECRAFT DYNAMICS
(Regulation 2020)

Time: Three Hours | Maximum: 100 Marks

Answer ALL questions

PART – A (10 x 2 = 20 Marks)

1. List out the orbital Elements.
2. Classify the Spacecraft.
3. Define Oblateness.
4. List out the Orbital Perturbations gravitational and non-gravitational forces.
5. Examine the direction angles of the vector A = i -4j +8k.
6. Distinguish between particles and rigid body?
7. Recall the expression for gyroscopic couple.
8. Define gyroscopic precession.
9. Distinguish between Prolate and oblate.
10. Demonstrate the ADCS Block Diagram.

PART – B (5 x 16 = 80 Marks Marks)

11. (a) Explain and List out the present day satellites in all over the world and important events in space industry. (16)

(OR)

(b) Describe the orbital elements used in spacecraft. (16)

12. (a) AZA of 322 km and is to be transferred to a geostationary orbit (GEO) at 35,860 km using a Hohmann transfer determine the characteristics of the transfer ellipse, the total Δv required and Δv_T. (16)

(OR)

(b) Analyze the Elevation and Azimuth look angles for the following case r_s=42164 km and Earth station latitude 52^0N, Earth station longitude 0^0, Satellite Latitude 0^0 and Satellite Longitude 68^0. (16)

13. (a) Develop an expression of displacement and momentum of momentum equation. (16)

(OR)

(b) At a given instant, the absolute position, velocity, and acceleration of the origin O of a moving frame are

$$\mathbf{r}_O = 100\hat{\mathbf{I}} + 200\hat{\mathbf{J}} + 300\hat{\mathbf{K}} \text{ (m)}$$
$$\mathbf{v}_O = -50\hat{\mathbf{I}} + 30\hat{\mathbf{J}} - 10\hat{\mathbf{K}} \text{ (m/s)}$$
$$\mathbf{a}_O = -15\hat{\mathbf{I}} + 40\hat{\mathbf{J}} + 25\hat{\mathbf{K}} \text{ (m/s}^2\text{)}$$

The angular velocity and acceleration of the moving frame are

$$\boldsymbol{\Omega} = 1.0\hat{\mathbf{I}} - 0.4\hat{\mathbf{J}} + 0.6\hat{\mathbf{K}} \text{ (rad/s)}$$
$$\dot{\boldsymbol{\Omega}} = -1.0\hat{\mathbf{I}} \times 0.3\hat{\mathbf{J}} - 0.4\hat{\mathbf{K}} \text{ (rad/s}^2\text{)}$$

The unit vectors of the moving frame are

$$\hat{\mathbf{i}} = 0.5571\hat{\mathbf{I}} + 0.7428\hat{\mathbf{J}} + 0.3714\hat{\mathbf{K}}$$
$$\hat{\mathbf{j}} = -0.06331\hat{\mathbf{I}} + 0.4839\hat{\mathbf{J}} - 0.8728\hat{\mathbf{K}}$$
$$\hat{\mathbf{k}} = -0.8280\hat{\mathbf{I}} + 0.4627\hat{\mathbf{J}} + 0.3166\hat{\mathbf{K}}$$

The absolute position, velocity, and acceleration of P are

$$\mathbf{r} = 300\hat{\mathbf{I}} - 100\hat{\mathbf{J}} + 150\hat{\mathbf{K}} \text{ (m)}$$
$$\mathbf{v} = 70\hat{\mathbf{I}} + 25\hat{\mathbf{J}} - 20\hat{\mathbf{K}} \text{ (m/s)}$$
$$\mathbf{a} = 7.5\hat{\mathbf{I}} - 8.5\hat{\mathbf{J}} + 6.0\hat{\mathbf{K}} \text{ (m/s}^2\text{)}$$

Evaluate (a) the velocity v_{rel} and (b) the acceleration a_{rel} of P relative to the moving frame. (16)

14. (a) Analyse in detail about general motion of a symmetric gyro. (16)

(OR)

(b) Determine an Euler equation for Principal axis. (16)

15. (a) Determine an expression of attitude control of spinning satellites for response in axes fixed in the structure and response in non-spinning axes. (16)

(OR)

(b) Analyse in detail about actuation mechanisms for attitude control. (16)

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