

# SECOND SEMESTER M.TECH. (AEROSPACE ENGG.) END SEMESTER DEGREE EXAMINATION, APRIL/MAY - 2019

## SUBJECT: SPACE DYNAMICS AND CONTROL [ICE 5201]

### TIME: 3 HOURS

#### MAX. MARKS: 50

#### Instructions to candidates : Answer ALL questions and missing data may be suitably assumed.

- 1A List and explain any four gravity gradient passive dampers
- 1B Derive linearised attitude dynamic equations of motion of a satellite if gravity gradient moment is given by

$$G(x) = 3w_0^{-2}(I_z - I_y)\phi; \quad G(y) = 3w_0^{-2}(I_z - I_x)\theta \quad ; \quad G(z) = 0 \quad \text{with angular velocity vector}$$

$$\begin{bmatrix} w_x \\ w_y \\ w_z \end{bmatrix} = \begin{bmatrix} * \\ \theta \\ * \\ \psi \end{bmatrix} + \begin{bmatrix} -\psi w_0 \\ -w_0 \\ \phi w_0 \end{bmatrix}$$

1C Describe and derive spinning body dynamics with the help of polhode formation of moment of inertia, angular momentum and angular velocity.

(2+3+5)

- 2A What is despinning of a satellite how is it achieved. Why is it necessary?
- 2B The satellite has following physical characteristics. Is=100kg/m2, I<sub>SP</sub>=200 s. The thruster is placed 0.5 m from the centre of mass of the satellite. If the force exerted by each of thruster is 10N, with a pair of thruster having  $\omega_z(0)=10$  rad/s. Find consumed mass of fuel.
- 2C Derive an average nutation angle of a spin stabilised satellite during  $\Delta V$  stage.

(2+3+5)

- 3A With block diagram derive expression for the momentum accumulated when wheels are used for attitude control.
- 3B With the block diagram explain momentum wheel active control without yaw measurement.
- 3C Explain passive wheel nutation damping in single spin stabilization. Derive condition for nutational stability.
  - (3+3+4)

- 4A Explain attitude control using solar torques.
- 4B Briefly describe the working, advantage and disadvantage of any three attitude sensors used in a spacecraft.
- 4C With necessary equations describe control command law using quaternion error vector.

- 5A Discuss any two advantages and two disadvantages of CMG.
- 5B Explain with neat diagram, three axes stabilization of a satellite with four reaction wheels.
- 5C With neat diagram and necessary equations prove that the torque commands are transformed as thruster activation time

(2+3+5)

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