Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (AEROSPACE ENGINEERING)

END SEMESTER DEGREE EXAMINATIONS, JUNE- 2018

SUBJECT: SPACECRAFT DYNAMICS AND CONTROL (ICE 5201)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Derive solution of homogenous equations of motion of a rigid spinning spacecraft from Euler's moment equation when external disturbance torques are zero. **5**

1B. Relative to $\hat{i}$, $\hat{j}$, $\hat{k}$, frame of reference the components of angular momentum H are given by:

$$\{H\} = \begin{bmatrix} 1000 & 0 & -300 \\ 0 & 1000 & 500 \\ -300 & 500 & 1000 \end{bmatrix} \begin{bmatrix} \omega_x \\ \omega_y \\ \omega_z \end{bmatrix} \text{ (kg m}^2\text{/s)}$$

where, ω_x, ω_y and ω_z are the components of the angular velocity ω. Find the components of ω such that $\{H\} = 1000\,\{\omega\}$, where the magnitude of ω is 20 rad/s. **3**

1C. What is Gravity Gradient Stabilization? List different passive GG stabilization methods. **2**

2A. Describe and derive spinning body dynamics with the help of polhode formation of moment of inertia, angular momentum and angular velocity. **6**

2B. Determine the image of the point (+1, -1, +2) under the rotation by an angle of 60 ° about an axis in YZ plane that is inclined at an angle 60 ° to the positive Y axis. (Start with unit vector u in the direction of axis of rotation about X axis). **4**

3A. Explain passive wheel nutation damping in single spin stabilization. Derive condition for nutational stability with the help of root locus plot. **5**

3B. With necessary equations describe control command law using Euler angle errors. **3**

3C. A dual spin satellite platform is despun with 4 thrusters acted upon by a force of 5N with specific impulse of propellant being 200s and torque arm equal to 1.5m. Assume the satellite with I_Z =200 kgm^2, $\omega_z(0)$=5 rad/s. Find the mass of fuel consumed during de spinning phase. **2**

4A. Derive the equation of motion of three axes stabilized satellite with three reaction wheels. **5**

		3
4B.	Mention one advantage and one disadvantage of momentum wheel, Reaction wheel and Control moment gyro.	
4C.	Briefly describe any one type of attitude control sensors used in a spacecraft.	**2**
5A.	With necessary equations, explain tetrahedral configuration of reaction thruster control of a satellite.	**5**
5B.	With block diagram illustrate solar sailing.	**3**
5C.	Discuss advantages and disadvantages of reaction thruster control techniques.	**2**

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