Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (AEROSPACE ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL - 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 suitably assumed.

1A. A 500 kg Merry Go Round(MGR) with a radius of 10m is moving at a speed of 0.5 rad/s. A 40 kg child jumps on MGR a position of 4m away from center of rotation. **3**

a. What is the inertia of MGR?
b. What is the inertia of the child on MGR?
c. What is the final speed of MGR when child jumps on it?

1B. Determine the principal moments of inertia of a space craft whose Inertia tensor is given by, $\begin{bmatrix} 2mb^2 & 2mb^2 & 0 \\ 2mb^2 & 0 & 0 \\ 0 & 0 & 4mb^2 \end{bmatrix}$. Determine corresponding angle of rotation locating the principal axes. **5**

1C. Write the linearized attitude dynamics equations of motion incorporating gravity gradient stabilization. **2**

2A. Derive inertial angular velocity vector of a rigid body ω_{BI} . **5**
Given, ω_{RI} =[0 -jω_0 0], where ω_{RI} is orbit reference frame angular velocity vector (with respect to inertial frame) and ω_0 is angular orbital velocity of the body.

2B. With necessary equations and block diagram explain active nutation control of spin stabilized satellite. **3**

2C. Explain Dual spin stabilization with its advantages. **2**

3A. Derive an expression for average nutation angle during ΔV stage of a spin stabilized satellite. **5**

3B. With necessary equations describe control command law using direction cosine matrix. **3**

3C. With the advantages and disadvantages, discuss different attitude maneuvering techniques **2**

4A. What is momentum accumulation and momentum dumping? With the help of necessary equations explain how it is achieved? **5**

4B. Derive the dynamic equations of momentum biased satellite with two momentum wheels.(Start from Euler Moment equations with wheels placed in three axis) **5**

5A. i. Explain how torque commands are transformed into thruster activation **3+2**

time with necessary equations.

ii. Calculate minimum time of the thruster firing to achieve minimum error of 0.0092° with reference angle 1°. The sampling period is 0.25 s, moment of inertia of 2 reaction thrusters is 500 kgm^2 with band width 1 rad/s. Force produced by each thruster is 3N with torque arm 1m.

5B. With necessary equation discuss active roll yaw stabilization with magnetic torques. **3**

5C. Draw block diagram and timing diagram of Pulse width Pulse Frequency modulator used in reaction thruster attitude control. **2**

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