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: RENDEZVOUS AND DOCKING OF SPACECRAFT [ICE-5236]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL FIVE FULL** questions.
- Missing data may be suitably assumed.

1A. Illustrate the major functions involved in rendezvous and docking process with a block diagram. **3**

1B. Explain the different types of reference frames used to describe orbital motion and attitude motion of a spacecraft. **4**

1C. Obtain the trajectory equation of a chaser with continuous thrust force applied in the x-direction starting at $x_0 = X_0$ and $z_0 = Z_0$ on a lower orbit employing CW equations given below: **3**

$$x(t) = \left(\frac{4\dot{x}_0}{\omega} - 6z_0\right)\sin(\omega t) - \frac{2\dot{z}_0}{\omega}\cos(\omega t) + (6\omega z_0 - 3\dot{x}_0)t + \left(x_0 + \frac{2\dot{z}_0}{\omega}\right) + \cdots + \frac{2}{\omega^2}\gamma_z(\omega t - \sin(\omega t)) + \gamma_x\left(\frac{4}{\omega^2}(1 - \cos(\omega t)) - \frac{3}{2}t^2\right)$$

$$y(t) = y_0\cos(\omega t) + \frac{\dot{y}_0}{\omega}\sin(\omega t) + \frac{\gamma_y}{\omega^2}(1 - \cos(\omega t))$$

$$z(t) = \left(\frac{2\dot{x}_0}{\omega} - 3z_0\right)\cos(\omega t) + \frac{\dot{z}_0}{\omega}\sin(\omega t) + \left(4z_0 - \frac{2\dot{x}_0}{\omega}\right) + \cdots + \frac{2}{\omega^2}\gamma_x(\sin(\omega t) - \omega t) + \frac{\gamma_z}{\omega^2}(1 - \cos(\omega t))$$

2A. Describe the deviations observed in the trajectory due to navigation errors with equations. **4**

2B. Briefly explain how active trajectory protection helps in solving the trajectory errors and failures occurring during the mission. **3**

2C. Illustrate the final approach trajectory of a chaser to a target station with an attitude angle. **3**

3A. Explain the geometrical and equipment constraints involved in an approach strategy. **3**

3B. With equations, explain how estimation is carried out in a navigation system using a Kalman filter. **4**

3C. Discuss the execution of thruster selection function in thruster management with equations. **3**

4A. Briefly explain various principles of measuring the navigation parameters during the rendezvous process. **3**

4B.	Illustrate the working principle of a scanning laser range finder with a block diagram.	**4**
4C.	Compare the operational sequences of docking and berthing.	**3**
5A.	Discuss shock attenuation dynamics during contact in docking/berthing process.	**4**
5B.	With a block diagram, illustrate the process of supervisory control of automatic onboard system by ground operators.	**3**
5C.	Describe the process of dynamic testing in the front end of a docking system.	**3**

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