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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (AEROSPACE ENGG.)

END SEMESTER DEGREE EXAMINATION, JUNE - 2019

SUBJECT: RENDEZVOUS AND DOCKING OF SPACECRAFT [ICE 5236]

TIME: 3 HOURS MAX. MARKS: 50

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

1A List the kind of missions in which Rendezvous and Docking/Berthing (RVD/B) technology is used.

1B Illustrate various phasing strategies that can be employed during a rendezvous and docking/berthing mission with diagrams.

1C Obtain the trajectory equation of a chaser with a ΔV applied in the radial direction employing CW equations given below:

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

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

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

(3+3+4)

2A Briefly explain the causes of deviation from the planned trajectory during a mission.

2B Describe the types of failures that occur in passively safe trajectories during a radial thrust transfer along V-bar.

2C List and explain the constraints in the operating range of different types of sensors.

(3+4+3)

3A Discuss the time-flexible elements during approach.

3B Illustrate the working of a GNC system with a block diagram.

3C Explain the sequencing of nominal and contingency modes with a diagram.

(3+3+4)

4A Illustrate the functional principle of absolute GPS with a block diagram.

4B Explain briefly the measurement environment and disturbances involved in absolute and relative satellite navigation systems.

4C What are the design driving requirements for docking/berthing systems? Explain

(4+3+3)

5A Explain various principles of measuring the navigation parameters during the rendezvous process.

5B Describe the ground operator support functions with a block diagram.

5C Illustrate GNC verification with sensor simulation in the development phase with a block diagram.

(4+3+3)

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