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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, APRIL/MAY - 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 Discuss the factors which make Rendezvous and Docking/Berthing missions complex, in comparison with other space missions.

1B Briefly explain various techniques involved in the correction of time deviations and orbital parameters during a rendezvous and docking/berthing mission.

1C Obtain a forced motion R-bar trajectory starting at $x_0 = X_0$ and $z_0 = Z_0$ with $\dot{x}_0 = 0$ employing the 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 design rules for trajectory safety for the approach phase.

2B Briefly explain the failure cases that can occur in passively safe trajectories during a Hohmann transfer.

2C Considering the Fig. Q2C briefly explain the approach strategy.

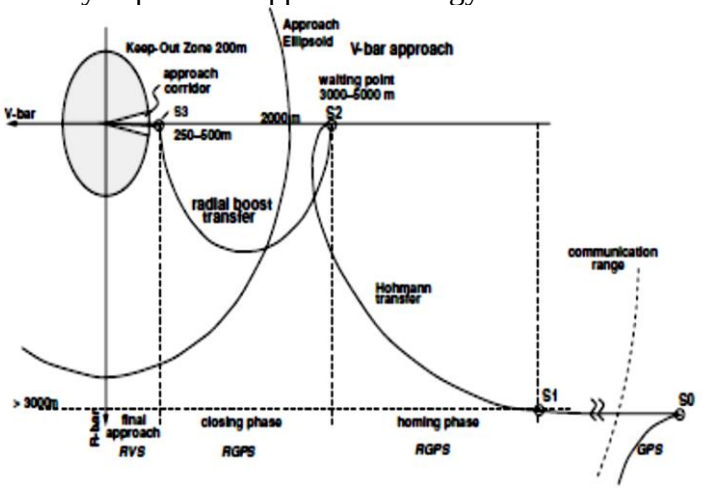

Fig. Q2C

(3+3+4)

3A Illustrate how the berthing boxes are defined with a diagram.

3B Analyse control function in a GNC system considering a MIMO control loop.

3C With the help of a block diagram, explain how remote interaction takes place with the automatic GNC system.

(3+4+3)

4A Discuss different types of sensor measurement errors with equations.

4B Compare the advantages and disadvantages of a laser range finder and a camera based rendezvous sensor.

4C Briefly discuss about different devices that are employed for shock attenuation and alignment for capture.

(3+3+4)

5A Discuss different regional navigation systems available for space missions.

5B Deliberate the overall communication scenario for a rendezvous mission.

5C Illustrate the various phases in the verification and validation in the development life-cycle of a space project.

(3+4+3)

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