Reg. No. | | | | | | | | | | |

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIRST SEMESTER M.TECH. (AEROSPACE ENGG.)

END SEMESTER DEGREE EXAMINATIONS, FEBRUARY - 2021

SUBJECT: ORBITAL MECHANICS [ICE 5174]

TIME: 3 HOURS 01-03-2021 MAX. MARKS: 50

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

1A. State the laws governing two body orbital motion and derive an expression for two body equation of motion.

1B. At two points on a geocentric orbit, the altitude and true anomaly are 1545 km, 126^0 and 852 km, 58^0 respectively. Find (a) the eccentricity (b) the altitude of perigee (c) the semi major axis (d) the period.

1C. Obtain the direction cosine matrix for rotation of a vector about the z-axis.

(4+4+2)

2A. The geocentric position vectors of a space object at three successive times are:

$$\overrightarrow{r_1} = -294.32\hat{I} + 4265.1\hat{J} + 5986.7\hat{K}(km)$$
$$\overrightarrow{r_2} = -1365.5\hat{I} + 3637.6\hat{J} + 6346.8\hat{K}(km)$$
$$\overrightarrow{r_3} = -2940.3\hat{I} + 2473.7\hat{J} + 6555.8\hat{K}(km)$$

Determine p, e, v_2 and the P, Q, W vectors.

2B. With respect to the geocentric equatorial frame $\vec{r} = -6000\hat{I} - 1000\hat{J} - 5000\hat{K}(km)$, $\vec{v} = 6\hat{I} - 7\hat{J} - 2\hat{K}(\frac{km}{s})$ and the eccentricity vector $\vec{e} = -0.4\hat{I} - 0.5\hat{J} - 0.6\hat{K}$. Calculate true anomaly of the earth-orbiting satellite.

2C. Illustrate the p-iteration method with steps for solving the Gauss problem.

(5+3+2)

3A. On December 1, 2005, a spacecraft left a 180 km altitude circular orbit around the earth on a mission to Venus. It arrived at Venus 121 days later on April 1, 2006, entering a 300 km by 9000 km capture ellipse around the planet. Calculate the total delta-v requirement for this mission. [μ_{sun}=132,712,439,935.5 km^3/s^2, μ_{Venus}=324,858.8 km^3/s^2, R_{Venus}=6051.8 km]

3B. Calculate the Δv required to transfer a satellite from a circular orbit of radius=2 DU to a circular orbit of radius=5 DU.

3C. Obtain the expression for radius of sphere of influence.

(5+3+2)

4A. Explain stability and dynamics at Lagrangian points.

4B. Briefly explain why the analysis of three-body motion is different from two-body motion.

4C. What is the significance of Jacobi's integral in three-body motion?

(4+3+3)

5A. Describe Cowell's method in orbit perturbation with equations.
5B. With necessary equations, explain Encke's method in orbit perturbation.

(5+5)

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