Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY



(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING) **END SEMESTER EXAMINATIONS, NOV/DEC 2019**

SUBJECT: ORBITAL MECHANICS [AAE 4012]

REVISED CREDIT SYSTEM (25/11/2019)

	Time: 3 Hours MAX. MARKS: 50
	Instructions to Candidates:
	✤ Answer ALL the questions.
	 Missing data may be suitable assumed.
1A.	State and explain the fundamental equation of relative motion.
1B.	The position vector in meters is given as a function of time in seconds as $\mathbf{r} = (8 t^2 + 7t + 6) \mathbf{i} + (5t^3 + 4) \mathbf{j} + (0.3t^4 + 2t^2 + 1) \mathbf{k}$ (m) At t = 10 seconds, calculate (a) the magnitude of the derivative of r and (b) the derivative of the magnitude of r .
1C.	Calculate the maximum latitude and percentage of earth visible from GEO.
2A.	State and explain Kepler's equation.
2B.	A geocentric trajectory has a perigee velocity of 15 km/s and a perigee altitude of 300 km. Find the radius and the time when the true anomaly is 100 degrees.
2C.	Orbital Properties of a star orbiting a black hole is given below. Period = 15.2 years, Eccentricity = 0.876, Rp = 119.5 AU, Ra = 1812 AU, $C = 6.67 \times 10^{-11} \text{ Mm}^2 / \text{Kg}^2$ AU = 1.5 × 10^{11} m. Mass of aux = -2 × 10^{30} / \text{Kg}^2

 $G = 6.67 \times 10^{-11} \text{Nm}^2/\text{Kg}^2$, I AU = 1.5 X 10¹¹ m, Mass of sun = 2 X 10³⁰ Kg Find a) mass of black hole in terms of solar mass. b) Velocity at apogee and perigee for the star.

3A. Briefly describe impulsive maneuver.

(02)

(02)

(03)

(05)

(02)

(03)

(05)

- **3B.** Differentiate Bielliptical and Hohmann transfers with suitable diagrams and (03) equations.
- **3C.** Spacecraft at A and B are in the same orbit (1) as in figure. At the instant shown in (05) figure, the chaser vehicle at A executes a phasing maneuver so as to catch the target spacecraft back at A after just one revolution of the chaser's phasing orbit (2). What is the required total delta-v?



4A. What do you mean by sphere of influence?

(02)

- **4B.** Describe the term synodic period with necessary equations and diagrams. **(03)**
- 4C. Discuss interplanetary Hohmann transfer with all necessary diagrams and equations. (05)
- **5A.** The space shuttle is in a 280 km by 400 km orbit with an inclination of 51.43 °. Find **(02)** the rates of node regression and perigee advance.
- **5B.** What are the reasons for perturbations? Explain each. (03)
- **5C.** Discuss the effects of space debris on space missions.? Explain any one technique **(05)** to remove or reduce the space debris.