AE-641A (Space Dynamics-I)

Quiz No. 4

Quiz Procedure

(i) Clearly write out your solution to the quiz problems within the specified time on blank sheets of paper. (Marks will be given only for complete calculation/derivation steps.)

(ii) Take *low-resolution* pictures of your solution, convert them into a single PDF file (about 1MB), and send it to me by email (ashtew@iitk.ac.in) from your *registered* email account.

(iii) Submit your solution only *once*. In case of multiple submissions, only the *earliest* one will be accepted.

(iv) The time limit will be *strictly enforced*, and late submissions will *not* be accepted. The deadline includes extra ten minutes to submit your solution.

Quiz No. 4 (Time: 60 min; Total Marks: 60)

(Marks for each problem are indicated in parentheses.)

1. Calculate the velocity impulse magnitude required to change the orbital speed from 7.5 km/s to 8.5 km/s, while also changing the orbital plane by 20° at a given point in an orbit.

(10)

2. Calculate the total velocity change, waiting time, and total propellant mass required for a Hohmann transfer around the Earth from a circular orbit of radius 8000 km, for rendezvous with a target in a coplanar circular orbit of radius 9000 km, assuming that the target is currently leading the maneuvering spacecraft by 30°, the specific impulse of the rocket engine is 300 s, and the initial spacecraft mass is 1500 kg.

(20)

3. A spacecraft is in a circular orbit of period 90 min. around the Earth. An astronaut performing spacewalk has out-of-plane distance of 100 m from the spacecraft when his out-of-plane velocity is zero. His radial and in-track displacement and velocity components are also zero at this point. Determine the position and the velocity of the astronaut relative to the spacecraft after 30 min.

(10)

4. Spacecraft A is in a circular orbit of frequency, n, and radius, c, around a spherical body. Another spacecraft B has an initial separation and relative velocity with respect to A at $t = 0$ given by

$$\begin{aligned} x(0) &= -0.001c\,; \quad \dot{x}(0) = 0.005nc \\ y(0) &= 0.002c\,; \quad \dot{y}(0) = -0.001nc \end{aligned}$$

and $z(0) = \dot{z}(0) = 0$. Estimate the two velocity impulses applied on B such that it makes a rendezvous with A at $t_f = \frac{\pi}{2n}$.

(20)

Please send your solution to me (ashtew@iitk.ac.in) before 01:10 p.m. today.