Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

Supplementary Examination, December 2023

Course: Space Dynamics & Orbital Mechanics **Semester: VII**
Program: B.Tech ASE+AVE **Time: 03 hrs.**
Course Code: ASEG4012 **Max. Marks: 100**

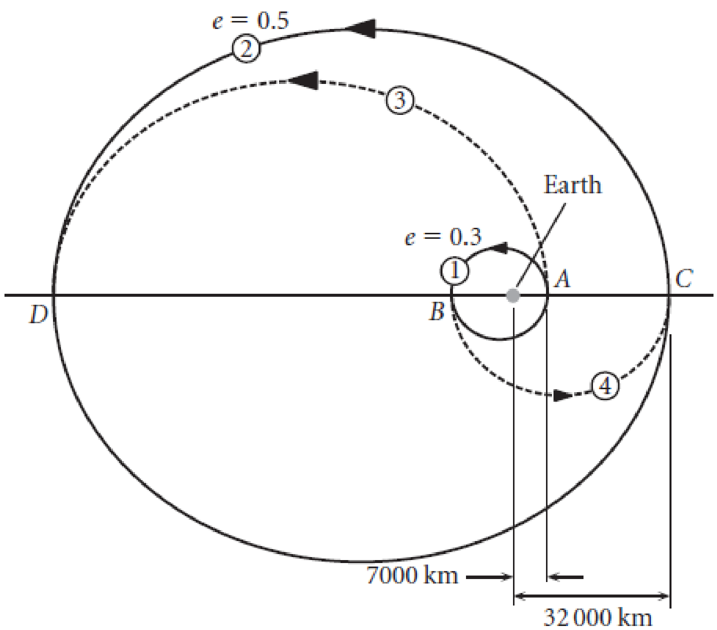
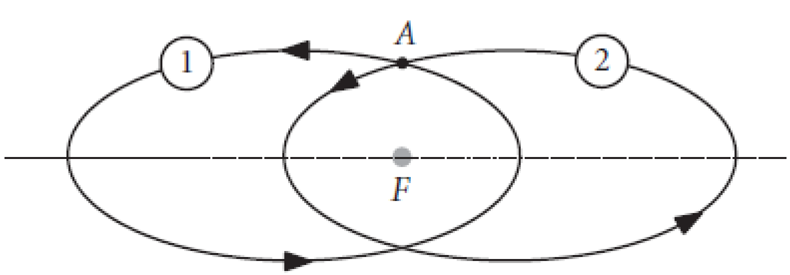
Instructions: a) All questions are compulsory.
b) Assume any suitable value for the missing data

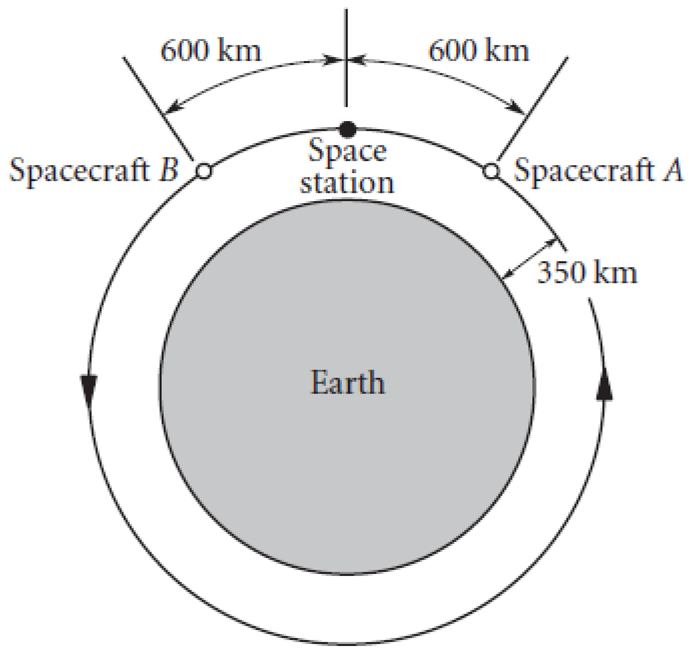
SECTION A
(5Qx4M=20Marks)

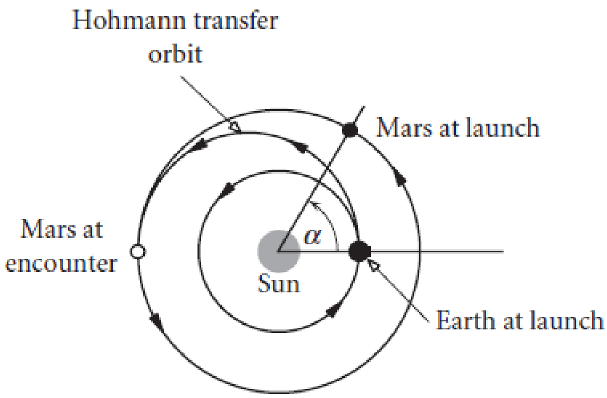
S. No.		Marks	CO
Q 1	What kind of orbits are preferred for GPS satellites? How it is different from polar orbit?	**4**	**CO1**
Q 2	Compare geostationary and polar orbits, including their applications and characteristics.	**4**	**CO1**
Q 3	Calculate the velocity of an artificial satellite orbiting the Earth in a circular orbit at an altitude of 200 km above the Earth's surface.	**4**	**CO3**
Q 4	What are J2 perturbations in Earth's orbit, and how do they affect satellite orbits over time?	**4**	**CO3**
Q 5	Discuss the concept of Lagrange points and their applications in astrodynamics.	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q 6	The shuttle orbiter has a mass of 125 000 kg. The two orbital maneuvering engines produce a combined (non-throttleable) thrust of 53.4 kN. The orbiter is in a 300 km circular orbit. A delta-v maneuver transfers the spacecraft to a coplanar 250 km by 300 km elliptical orbit. Neglecting propellant loss and using elementary physics (linear impulse equals change in linear momentum, distance equals speed times time), estimate. (a) the time required for the Δv burn, and (b) the distance traveled by the orbiter during the burn. (c) Calculate the ratio of your answer for (b) to the circumference of the initial circular orbit.	**10**	**CO2**
Q 7	A satellite is in a circular earth orbit of altitude 400 km. Determine the new perigee and apogee altitudes if the satellite on-board engine (a) increases the speed of the satellite in the flight direction by 240 m/s; (b) gives the satellite a radial (outward) component of velocity of 240 m/s.	**10**	**CO2**

Q 8	Two geocentric elliptical orbits have common apse lines, and their perigees are on the same side of the earth. The first orbit has a perigee radius of r_p =7000 km and e =0.3, whereas for the second orbit r_p =32 000 km and e=0.5 (a) Find the minimum total delta-v and the time of flight for a transfer from the perigee of the inner orbit to the apogee of the outer orbit. (b) Do part (a) for a transfer from the apogee of the inner orbit to the perigee of the outer orbit.  **OR** A spacecraft S is in a geocentric hyperbolic trajectory with a perigee radius of 7000 km and a perigee speed of $1.3v_{esc}$. At perigee, the spacecraft releases a projectile B with a speed of 7.1 km/s parallel to the spacecraft's velocity. How far d from the earth's surface is S at the instant B impacts the earth? Neglect the atmosphere.	**10**	**CO1 Or CO3**
Q 9	Calculate the delta-v required at A in orbit 1 for a single impulsive maneuver to rotate the apse line 180° counterclockwise (to become orbit 2) but keep the eccentricity e and the angular momentum **h** the same. 	**10**	**CO4**

<table>
<tr><th colspan="4">SECTION-C
(2Qx20M=40 Marks)</th></tr>
<tr><td rowspan="2">Q 10</td><td>A). The space station and spacecraft A and B are all in the same circular earth orbit of 350 km altitude. Spacecraft A is 600 km behind the space station and spacecraft B is 600 km ahead of the space station. At the same instant, both spacecraft apply a $\Delta v_{\perp}$ so as to arrive at the space station in one revolution of their phasing orbits.
(a) Calculate the times required for each spacecraft to reach the space station.
(b) Calculate the total delta-v requirement for each spacecraft.

</td><td>10</td><td>CO3</td></tr>
<tr><td>B). Assuming the orbits of earth and Mars are circular and coplanar, calculate
(a) the time required for a Hohmann transfer from earth to Mars, and
(b) the initial position ofMars (α) in its orbit relative to earth for interception to occur.
Radius of earth orbit=1.496×10^{8} km. Radius of Mars orbit=2.279×10^{8} km.
$\mu_{sun}=1.327\times10^{11}$ km^3/s^2.</td><td>10</td><td>CO4</td></tr>
</table>

			
Q 11	CHANDRAYAAN 3 is the cynosure of many of the technological breakthroughs achieved by Indian Space Research Organization (ISRO) in the Space domain. Explain the objectives of the mission, launch vehicle, scientific payloads, achievements, awards, and tracking locations. **OR** A spacecraft is in a 250 km circular parking orbit. It is desired to increase the altitude to 550 km and change the inclination by 20°. Find the total delta-v required if. (a) the plane change is made after insertion into the 550 km orbit (so that there are a total of three delta-v burns). (b) the plane change and insertion into the 550 km orbit are accomplished simultaneously (so that the total number of delta-v burns is two). (c) the plane change is made upon departing the lower orbit (so that the total number of delta-v burns is two).	**20**	**CO4**