UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, November/ December 2021

Course: Space Dynamics & Orbital Mechanics **Semester: VII**
Program: B. Tech ASE/ASE+AVE **Time 03 hrs.**
Course Code: ASEG 4012 **Max. Marks: 100**

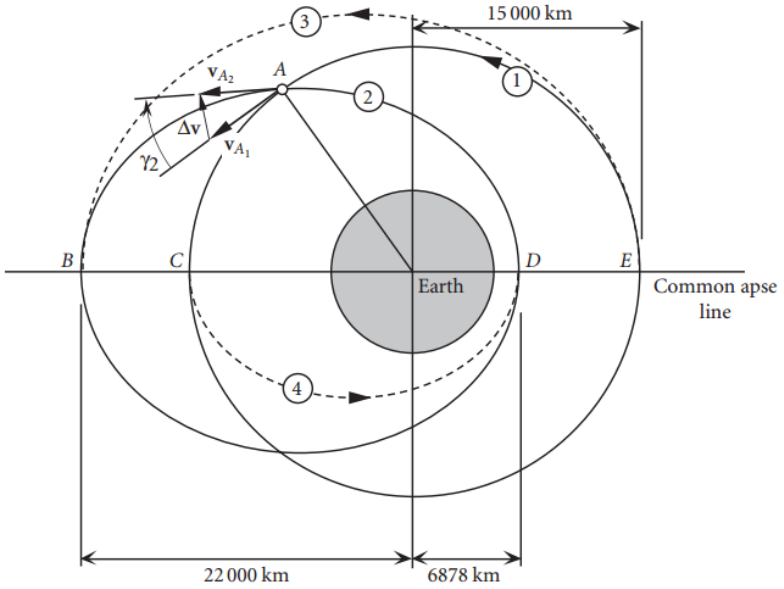
Instructions: a) All questions are compulsory.
b) Assume any suitable value for the missing data
c) For man-made earth satellites use μ = 398 600 km2/s2. *RE* = 6378 km

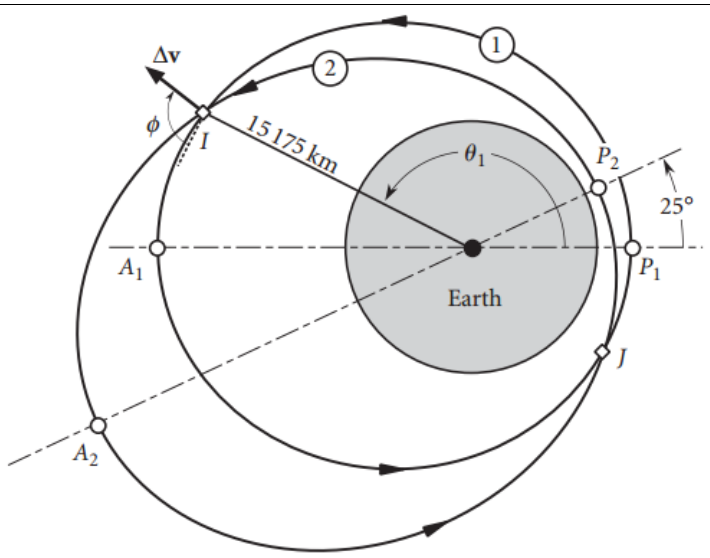
SECTION A

S. No.		Marks	CO
Q 1	What is sun-synchronous orbit? How it is different from geosynchronous orbit?	**4**	**CO1**
Q2.	Define Prograde and Retrograde Orbit.	**4**	**CO1**
Q3	How re-entry is more important in (a) Ballistics Missiles (b) Planetary entry probes & (c) manned spacecraft.	**4**	**CO3**
Q4	What are the objectives of Chandrayaan-2 mission by ISRO? Explain the key learnings from the mission.	**4**	**CO3**
Q5	What is attitude maneuvering?	**4**	**CO2**

SECTION B

Q 1	Calculate the altitude Z_{GEO} and speed V_{GEO} of a geostationary earth satellite.	**10**	**CO2**
Q 2	An unmanned satellite orbits the earth with a perigee radius of 7000 km and an apogee radius of 70 000 km. Calculate (a) the eccentricity of the orbit; (b) the semimajor axis of the orbit (km); (c) the period of the orbit (hours); (d) the specific energy of the orbit (km2/s2); (e) the true anomaly at which the altitude is 1000 km (degrees); (f) *vr* and $v\perp$ at the points found in part (e) (km/s); (g) the speed at perigee and apogee (km/s).	**10**	**CO2**
Q 3	For the sun–earth system, find the distance of the $L1$, $L2$ and $L3$ Lagrange points from the center of mass of the sun–earth system **OR** At two points on a geocentric orbit the altitude and true anomaly are z_1 = 1545 km, θ_1 = 126◦ and z_2 = 852 km, θ_2 = 58◦, respectively.	**10**	**CO1**

	Find (a) the eccentricity; (b) the altitude of perigee; (c) the semi major axis; and (d) the period.		
Q 4	 (a) With a single delta-v maneuver, the earth orbit of a satellite is to be changed from a circle of radius 15 000 km to a coplanar ellipse with perigee altitude of 500 km and apogee radius of 22 000 km. Calculate the magnitude of the required delta-v and the change in the flight path angle $\Delta\gamma$. (b) What is the minimum total delta-v if the orbit change is accomplished instead by a Hohmann transfer?	**10**	**CO1**
	SECTION-C		
Q 1	A spacecraft is in a 300 km circular parking orbit. It is desired to increase the altitude to 600 km and change the inclination by 20◦. Find the total delta-v required if (a) the plane change is made after insertion into the 600 km orbit (so that there are a total of three delta-v burns); (b) the plane change and insertion into the 600 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**	**CO3**
Q 2	Mars Orbiter Mission (MOM) 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** An earth satellite is in an 8000 km by 16 000 km radius orbit (orbit 1 of Figure). Calculate the delta-v and the true anomaly θ_1 required to obtain a 7000 km by 21 000 km radius orbit (orbit 2) whose apse line is rotated 25◦ counterclockwise. Indicate the orientation φ of $\Delta\mathbf{v}$ to the local horizon.	**20**	**CO3**


Δv
2
1
ϕ
I
15 175 km
θ1
P2
25°
A1
P1
Earth
J
A2