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1) A *sun-synchronous orbit* is defined as an orbit about the earth where the angle α between the line of nodes of the orbit and the earth-sun line remains constant. For this to occur as the earth orbits the sun, the line of nodes of the satellite orbit must rotate with the same angular velocity (360° per 365.26 days) in the heliocentric frame. This progression of the line of nodes may be achieved by exploiting the earth's oblateness.

Sun-synchronous orbit
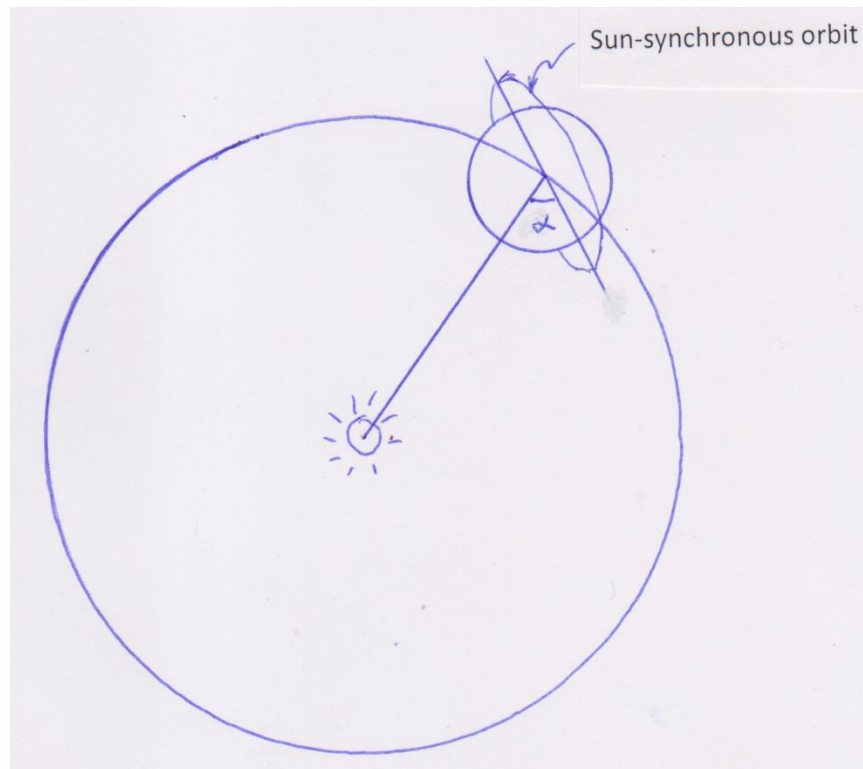
It is desired to launch a satellite into a circular sun-synchronous orbit having a period of 2 hours with $\alpha = 90°$ to maximize the exposure of its solar panels to the sun. Determine the required altitude and inclination of the orbit.

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2) For the sun-earth system, solve equation (11.36) in the notes numerically to find the distance of the L_1, L_2 and L_3 Lagrange points from the center of mass of the system.

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3) Prussing and Conway 9.8
A spacecraft is launched from earth into an orbit about the sun such that the spacecraft will make precisely three orbits in two years. It will thus make a hyperbolic flyby of the earth two years after launch.
a) Find the semimajor axis and eccentricity of the (pre-flyby) spacecraft orbit.
b) Find the the heliocentric velocity after the flyby. Assume that during the flyby the spacecraft just grazes the surface of the earth.
c) If the intention is to send the spacecraft to the outer solar system, should the spacecraft pass over the sunlit side or dark side of the earth?

d) Draw a figure illustrating the earth flyby. Show the incoming path (and its asymptote) and the outgoing path. Locate the point of close approach to the earth, and show the position precisely with respect to the earth-sun line.

e) What are the semimajor axis and eccentricity of the post-flyby heliocentric spacecraft orbit?

f) What is the true anomaly, θ, of the spacecraft on the post-flyby orbit, immediately after the flyby?

g) The Martian aphelion is located $120°$ away from earth's position at the time of the flyby, as shown. When the spacecraft crosses the Martian orbit major axis, will the spacecraft be inside or outside Mars' orbit?