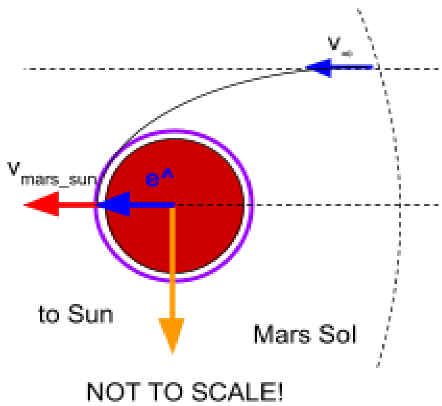
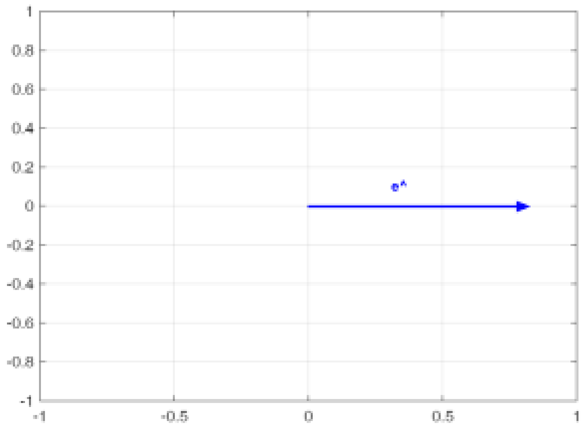
Homework 6

DUE: **Mon** 2025-11-24 @ 23:59 on *Canvas*

(PDF submissions only; can be pictures/scans as needed)

1. In HW5 P2 the arrival to Mars was presented (below) with arrival from “right to left”, which put the periapsis on the *left* side of the planet - meaning that the “origin” of the perifocal frame points left. Matlab/Python default to the “origin” pointing *right*.

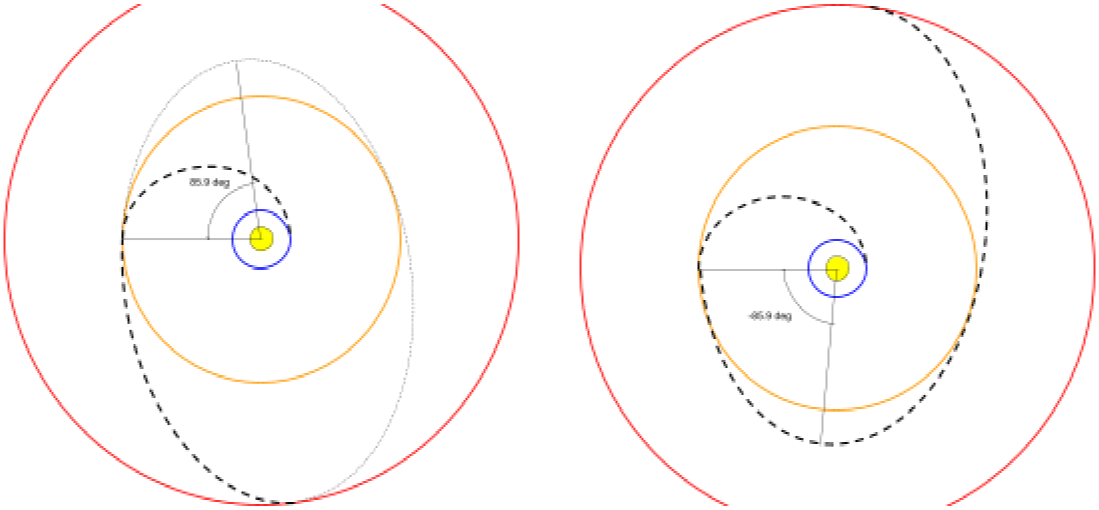




   a. Create a 2D rotation matrix that would allow you to plot the standard output of your Matlab/Python functions but align it with the “arrival” picture, rather than in the default *right* direction.

   b. Make that same matrix into a 3D matrix, which correctly handles the 3rd dimension during the rotation.

At the end of HW5 P4, the transfer orbits to Saturn after the fly-by had a true anomaly of ±85.9°, which means it was not aligned with the original transfer orbit:



c. What are the 2 2D rotation matrices to rotate from the original transfer orbit axis? (provide numerical answers)

2. The elliptical orbit of an Earth satellite has the following orbital elements:

$\Omega = 90°$	*right ascension of the ascending node*
$i = 90°$	*inclination*
$\omega = -45°$	*argument of perigee*
$r_p = 12000$ km	*radius of perigee*
$e = 0.5000$	*eccentricity*
$\theta = 45°$	*true anomaly*

a. *Carefully* sketch the orbit (in 3D) in the geocentric reference frame XYZ. Clearly identify in your sketch the orbital parameters Ω, i, ω, θ and the position vector **r**.

b. What is the position vector **r** in the geocentric reference frame? [*Partial answer:* |**r**| = 13,298km]

3. If we know **r** and **v** in the geocentric equatorial frame we can know everything about an orbit. Given:

r = 1000**I^** + 2000**J^** + 20000**K^** (km)

v = 3**I^** + 3**J^** - 0.3**K^** (km/s)

calculate all the orbital parameters [Ω, i, ω, e, h, θ] by coding Curtis Algorithm 4.2 into Matlab/Python and showing all your code and intermediate answers.
[*Partial answer: i=92.010°; e = 0.093685*]

4. A measurement taken from the UW Jacobson Observatory (Latitude: 47.660503°, Longitude: -122.309424°, Altitude: 220.00 feet) when its local sidereal time is 36.00° makes the following observations of a space object *(Based on Curtis Problems 5.12 + 5.13)*:

   Azimuth: 8.0000°
   Azimuth rate: 0.050000°/s.
   Elevation: 24.000°
   Elevation rate: 0.02000°/s
   Range: 8250.0 km
   Range rate: -0.25000 km/s

   a. What are the **r** & **v** vectors (the state vector) in geocentric coordinates?
      (Answer ***r*** *= [230.51   1464.0   12199] km*
      v *= [-1.0662   7.1295   0.31939] km/s)*

   b. Calculate the orbital parameters [Ω, i, ω, e, h, *Θ*] of the satellite. (For your thoughts: what type of object could this be?)
      (*Partial Answer e = 0.61784, i=87.902)*

   Tip: use Curtis algorithms 5.4 and 4.2.