Advanced Topics in Astrodynamics and Trajectory Design
Pre-Course Material

The following tutorial should be completed before the first session of the Advanced Topics in Astrodynamics and Trajectory Design (ATATD). The purpose of the exercise is to ensure that your Matlab skills are sufficiently advanced to ensure a good progress during the ATATD tutorials.

Please, complete the following exercise using Matlab.

Exercise. Solve the numerical integration of the differential equations of the two-body motion:

$$\ddot{\mathbf{r}} + \frac{\mu_E}{r^3}\mathbf{r} = 0 \tag{1}$$

For the following initial conditions:

$$\mathbf{X}(t=0) = [\text{-}18{,}676 \quad 6{,}246 \quad 12{,}474 \quad 0.551 \quad \text{-}1.946 \quad \text{-}3.886]$$

Where the three first components correspond to a position vector $\mathbf{r}$ and the three last components to a velocity vector $\dot{\mathbf{r}}$ in units of km and km/s, respectively, and μ_E is the gravitational constant of the Earth.

Plot the results in Matlab with an adequate representation, such that would allow you to recognize the orbit.

Notes and Hints. Equation (1) is a second order differential equation describing the so-called restricted two-body motion. An ordinary differential equation, often referred simply as ODE, is an equality involving a function and its derivatives. Equation (1) is referred as a second order, since its highest derivative involve a 2nd derivative of the position vector $\mathbf{r}$ with respect to time (i.e. the acceleration).

Matlab provides a series of functions and tools to solve the numerical integration of ODEs. Please, take your time revising Matlab tutorials if you are not familiar with these tools.

https://uk.mathworks.com/help/matlab/ordinary-differential-equations.html