# Introduction to Flight Simulation (List 3)

Due: 26 october 2010

In this list, we will not only continue simulating planets, but also extend our scope to rockets.

1. In the previous exercise list, we tried to simulate the earth in orbit around the sun. The reason that most people did not get an orbit time of one year is the fact that I copied the average speed and distance from wikipedia. It has not certain that these averages occur at the same time. One should use a speed and distance that occur at the same time.

   It should be possible (I verified it) to obtain correct results with an initial speed of $30286.250047792 m.s^{-1}$, and a distance of $147.10e9m$.

   The resulting orbit time should be $31.5581184e6$ seconds, which is exactly one year.

   Try to obtain this result with the program of the last exercise.

2. Assume that we have a rocket with a weight of 1000000 kg.

   A rocket accelerates its fuel by burning it, which causes a force opposite to the direction of the acceleration. Let us assume that the rocket has an engine that is able to eject its fuel with a speed of $3000 m.s^{-1}$, and that it is able to burn 7000 kg of fuel per second.

   The rocket starts at an altitude of 6366.1977 km. (The earth radius.)

   It is known (the shell theorem) that the gravity of the earth can be treated as coming from a single point in the middle of the earth.

   Assume that the rocket is controlled by a control function $B(t)$ of signature $\mathcal{R} \rightarrow \mathcal{R}^3$, that determines the direction of the engine exhaust, and the power at time $t$.

   So we always have $|B(t)| < 7000$. Also, the rocket cannot burn fuel that it does not have, so when its mass becomes close to zero, we must have $B(t) = \overline{0}$.

   Try different functions $B$ in order to find the most efficient path into LEA. (Low Earth Orbit) at an altitude of 150 km. (Most efficient means: Burns as little as possible fuel, so that it can bring the biggest possible mass into orbit.)