PLANAR SIMPLE PENDULUM

Figure 1 shows a planar simple pendulum. This mechanism is composed of a point mass m = 1 kg and a massless rod of length L = 1 m. The rod is connected to the ground via a revolute joint that constrains the system motion to the x-y plane.

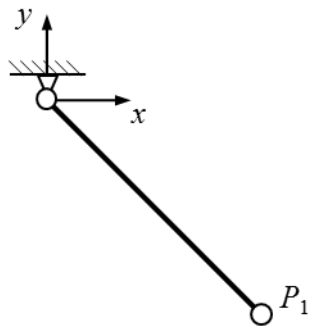

Figure 1: A planar simple pendulum

The system moves under gravity effects (-9.81 m/s^2 along the global y axis) from an initial position in which the coordinates of point P_1 are x_0 = -1 m, y_0 = 0 m. All the initial velocities are zero. The total simulation time is 10 s. Figure 2 shows the x and y coordinates of point P_1 during motion.

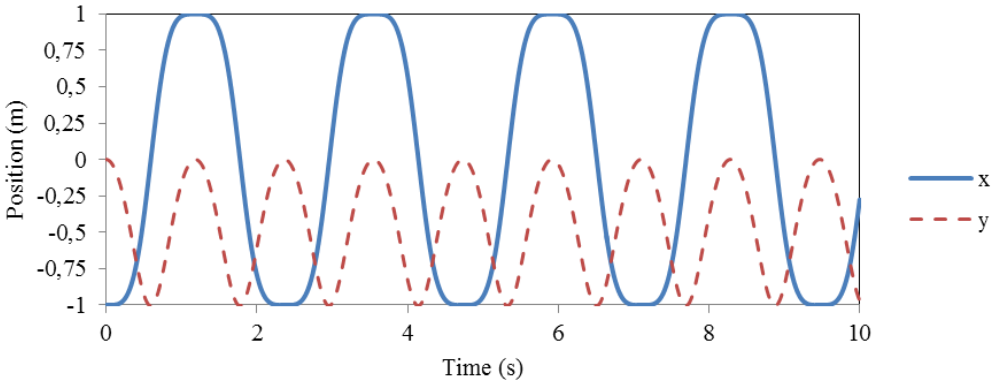

Figure 2: Time-history of the x and y coordinates of point P_1

Figure 3 shows the variation of the total energy of the system and the violations of the constraints at the position and velocity levels during the simulation. The constraints violation is the norm of the array of constraints at the corresponding level (configuration or velocities). The total energy is obtained as the sum of the kinetic and potential energy of the mechanism, taking the initial mechanical energy as reference, so that the energy value to be conserved during the simulation is zero. The error of the simulation will be considered as the maximum drift of the energy from its theoretical null value.

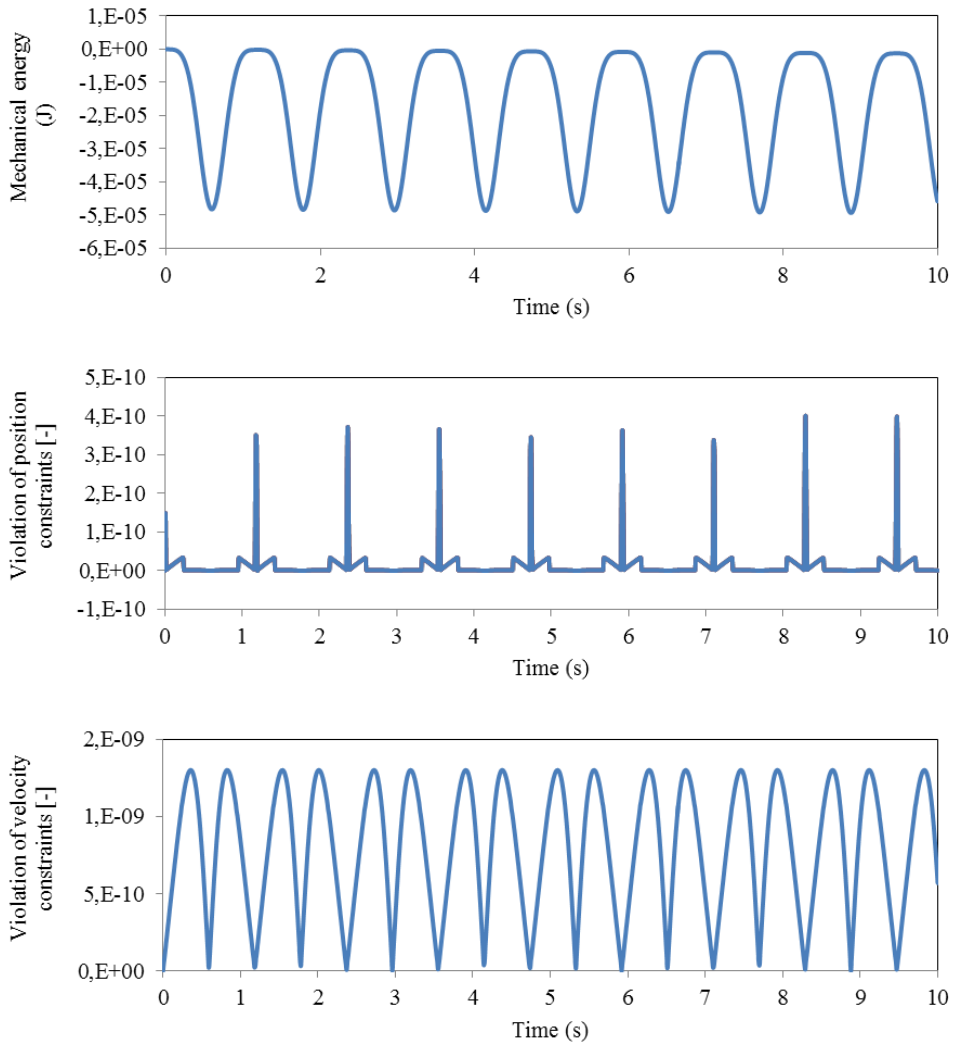

Figure 3: Time-history of the mechanical energy and the violation of constraints at the configuration and velocity levels

The objective of this benchmark problem is to carry out the simulation of the motion in the minimum CPU time, while keeping the maximum drift of the total energy away from the zero reference value below $5 \cdot 10^{-5}$ J.

A reference text file with the results is available, for comparison purposes. The file is composed of six columns. The first one represents the simulation timestamp, from 0 to 10 s. The second and third columns contain the x and y coordinates of point P_1 during motion. The fourth one is the mechanical energy of the system, and the last two ones represent the violation of constraints at the configuration and velocity levels.