PLANAR SLIDER-CRANK MECHANISM

Figure 1 shows a planar slider-crank mechanism. The two rods in the assembly have length L = 1 m, a uniformly distributed mass m = 1 kg, and a square cross section of width r = 0.1 m. The slider is considered to be massless. There is no friction between the slider and the ground; point P_3 is constrained to move on the x world axis. The system is in a singular configuration when the value of the angle of the first rod with respect to the x axis is $\theta = n\pi / 2$, with $n = 0, 1, 2\ldots$

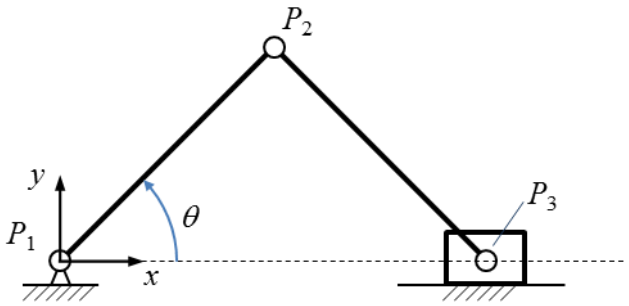

Figure 1: A planar slider-crank mechanism

The system moves under gravity effects (-9.81 m/s^2 along the global y axis) from the initial position shown in the figure, in which $\theta = \pi / 4$. The initial velocity of point P_3 is 4 m/s in the negative direction of the global x axis. The total simulation time is 10 s. Figure 2 shows the x and y coordinates of point P_2 during motion.

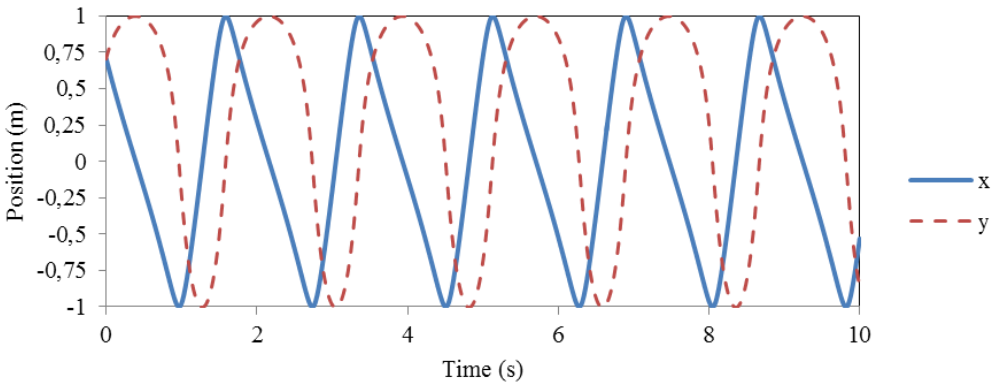

Figure 2: Time-history of the x and y coordinates of point P_2

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.

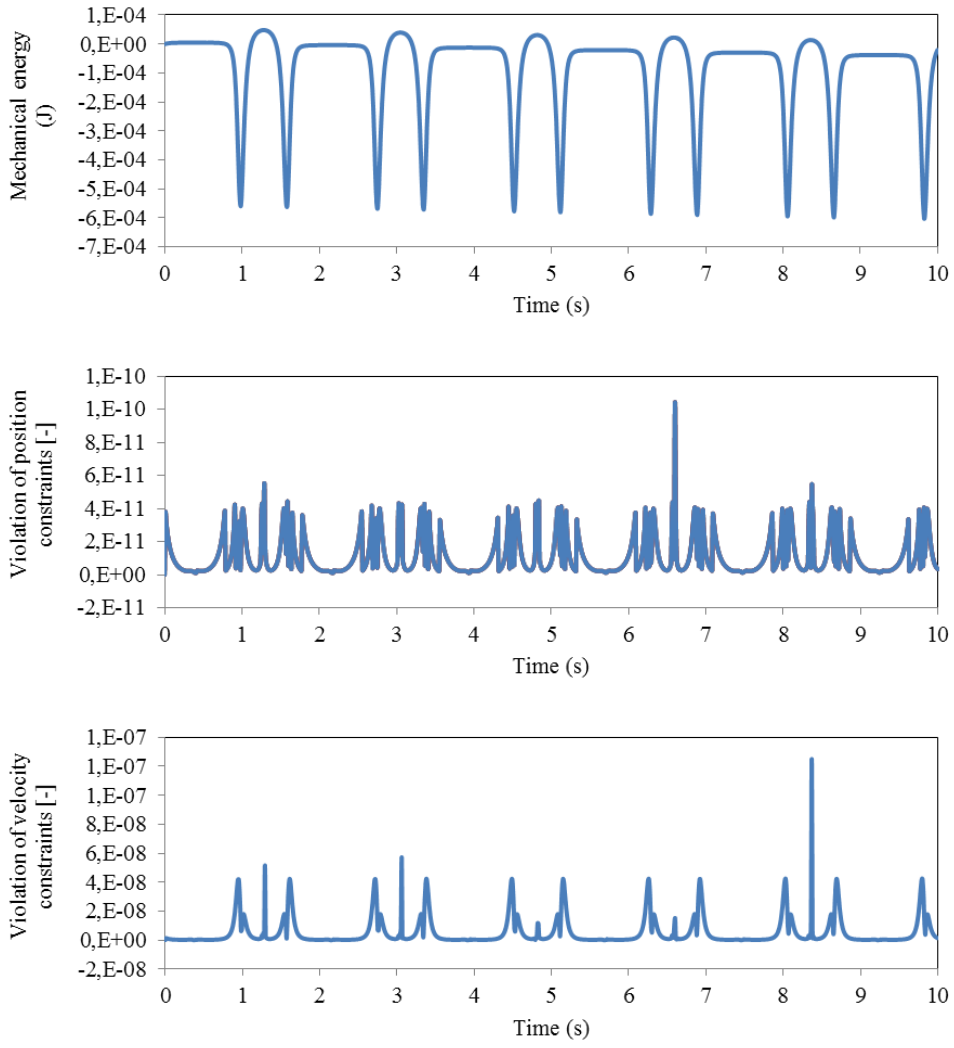

Figure 3: Time-history of the mechanical energy and the violation of constraints at the configuration and velocity levels

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 0.001 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_2 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.