Dynamics of the 4 DOF excavator (2 dynamical DOF).

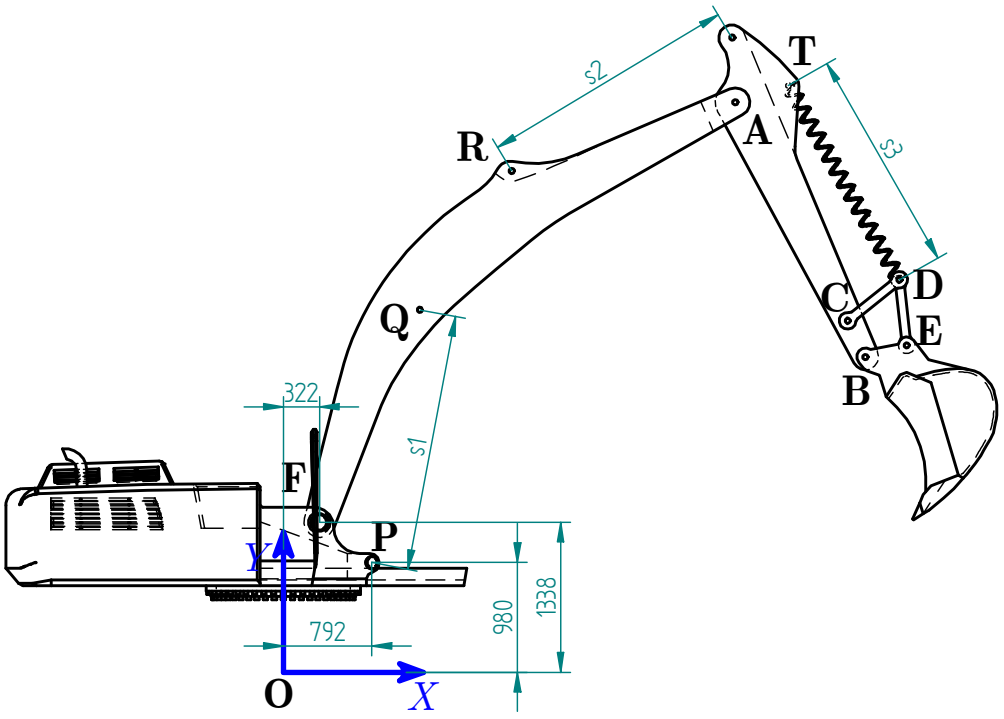

FIGURE 1: 4 DOF EXCAVATOR ARM WITH CABIN. ALL THE DIMENSIONS ARE IN "MM".

The system shown in the figure is a 4 DOF excavator arm with cabin, composed of six bodies. The system is affected by gravity forces and by the following: a torque acting on the cabin, coincident with the "Y" global axis; two translational actuators represented in the figure by s_1 and s_2 that can be modeled as driving constraints; a TSDA acting on the distance s_3.

$T_1 = 10000 Nm$ (torque)
$s_1 = 2.35 - 0.5t$
$s_2 = 2.10 + 0.45\sin(10t)$
$k = 6000\ N/m, \quad c = 500\ Ns/m, \quad l_0 = 2\ m$ (TSDA)

The masses and the inertia tensors of the bodies (given by their six components) are the following:

$m_{cabin} = 12000\,kg, \quad \mathbf{J}_{cabin} = [10000, 25000, 20000, 0, 0, 0]\,kg \cdot m^2$
$m_{boom} = 1800\,kg, \quad \mathbf{J}_{boom} = [780, 4400, 5100, 0, -1500, 0, 0]\,kg \cdot m^2$
$m_{stick} = 1200\,kg, \quad \mathbf{J}_{stick} = [40, 800, 800, 0, 0, 0]\,kg \cdot m^2$
$m_{bucket} = 770\,kg, \quad \mathbf{J}_{bucket} = [192, 220, 320, 0, 0, 0]\,kg \cdot m^2$

The masses and inertias of the bars can be neglected.

Modeling the system in 3D with the help of Euler parameters for the rotations, simulate 1 second of motion of the mechanism, obtaining positions and velocities of the CG for the boom, stick and bucket.

* Remark 1: use the international system of units (SI) for all the magnitudes.

*Remark 2: for the cabin consider the local and global axis coincident in the initial position shown in the figure and the CG coincident with the local origin.

*Remark 3: use the initial position obtained in the kinematics and the same geometry.

*Remark 4: two driving constraints should be removed from the kinematics, but the driving constraints for the distances 1 and 2 still remain, therefore the system has two actual degrees of freedom.