Examination

Exercise 1

Consider an initial reference frame $O_0 - x_0y_0z_0$. Determine a second reference frame by rotating, counterclockwise, the previous reference frame of 30 degrees around the axis y_0 and, again, turning clockwise the frame obtained of 60 degrees around its axis x. Finally, rotate the reference frame obtained of 90 degrees in the clockwise sense around its axis z. Let $O_3 - x_3y_3z_3$ be the frame obtained at the end of the three rotations.

Compute the rotation matrix that describes the coordinate transformation of a vector expressed in the reference frame $O_3 - x_3y_3z_3$ in the coordinates of the same vector expressed in the frame $O_0 - x_0y_0z_0$.

Exercise 2

Draw a planar manipulator with three degrees of mobility: all the joints are of rotoidal type.

1. Number the joints, determine the reference frames associated with the degrees of mobility, as well as the parameters, according to the Denavit-Hartenberg Convention.
2. Define the joint variables and indicate them on the picture.
3. Determine the homogeneous transformation matrix which describes the direct kinematics of the manipulator.

Exercise 3

Describe the so-called Direct Force Control approach and draw a force control scheme with force/position parallel.