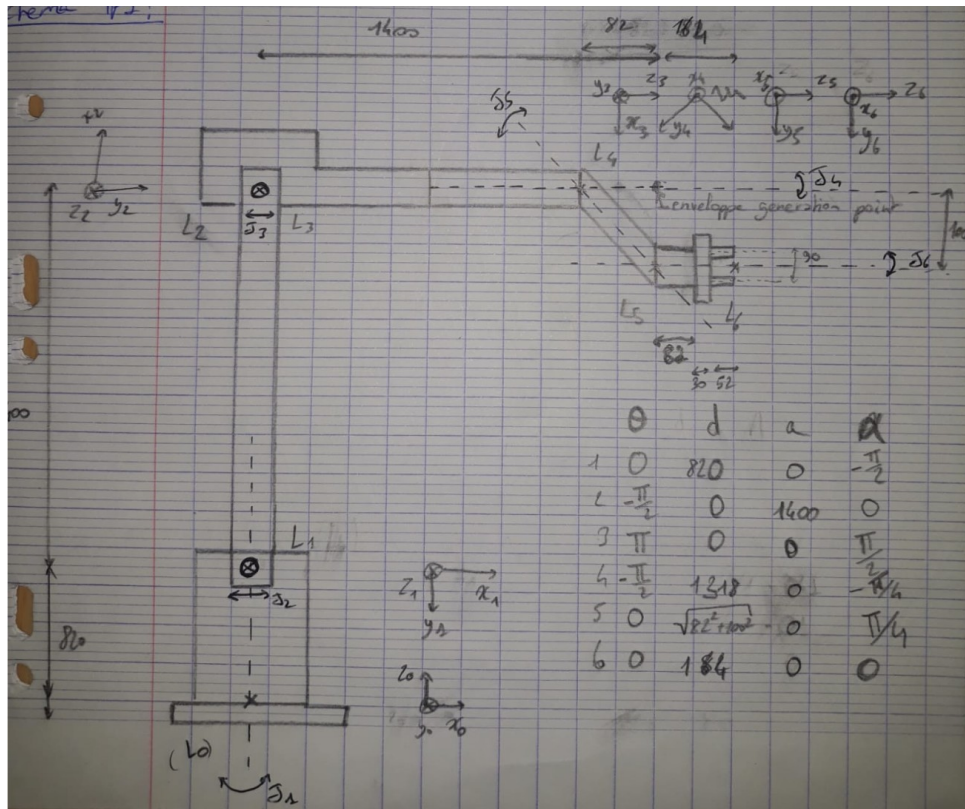# Laboratory Work 1
Forward Kinematics
Soulaïman

I- My Manipulator :

For my manipulator, I started to create the **P-250iA/15 paint robot**.
However, I needed for the lab a gripper as a tool for my robot. That's why I did some modification.

Here is my sketch:

Here is the DH paramters table :

	θ	d	a	alpha
1	0	820	0	-π/2
2	-π/2	0	1400	0
3	π	0	0	π/2
4	-π/2	1318	0	-π/4
5	0	sqrt(82²+100²)	0	π/4
6	0	164	0	0

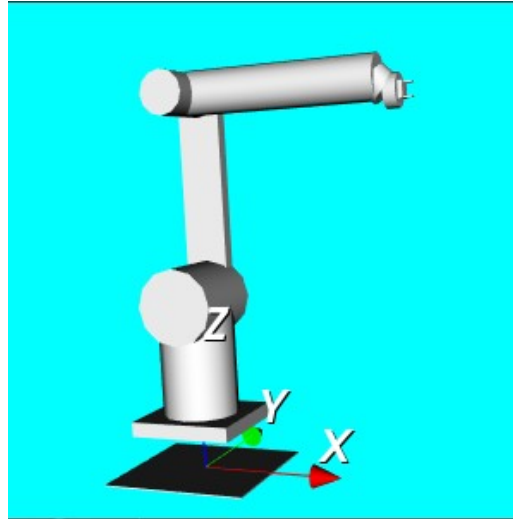## II- The manipulator with different values of the joint variables :

We display the manipulator with different values of the joint variables and we give the homogeneous transformation matrix describing the pose of the tool (which is given by 'print(T6S)').

Values 1 :

θ1	0
θ2	0
θ3	0
θ4	0
θ5	0
θ6	0

Homogeneous transformation T6S:
[-1, 0, 0, 1.50]
[0, 0, -1, 0   ]
[0, -1, 0, 2,47]
[0, 0, 0, 1   ]

Values 2 :

θ1	0
θ2	$\pi/4$
θ3	$-\pi/4$
θ4	π
θ5	0
θ6	0

Homogeneous transformation T6S :
[-1, 0, 0, 2,50]
[0, 0, 1, 0   ]
[0, 1, 0, 2,25]
[0, 0, 0, 1   ]
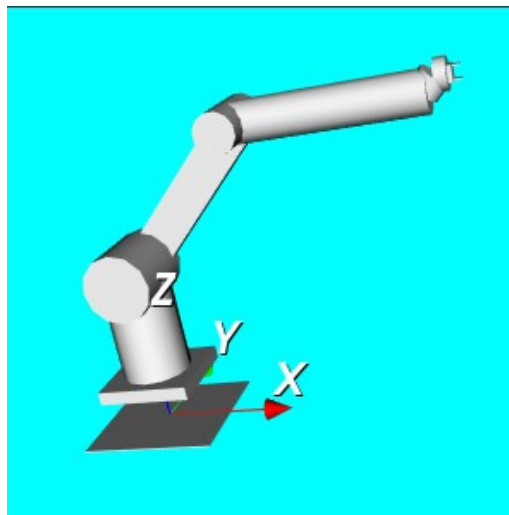
Values 3 :

θ1	0
θ2	0
θ3	0
θ4	π
θ5	π
θ6	π/2

Homogeneous transformation T6S :
[0, 0, 1, 1.40]
[0, 1, 0, 0   ]
[-1, 0, 0, 2.75]
[0, 0, 0, 1   ]
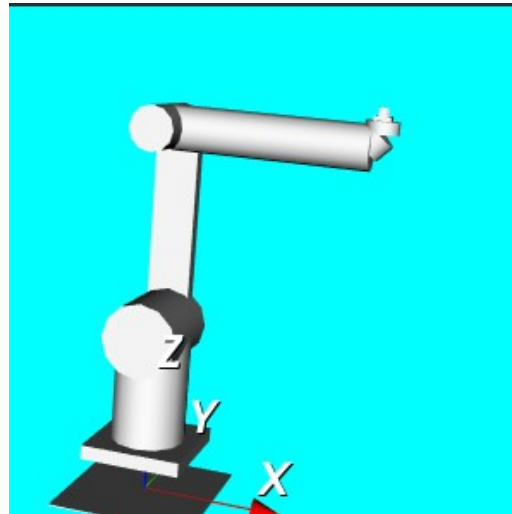
III- The cube in the tool :

To describe the pose of a cube which is inside the gripper, we just have to know the pose of the tool and also the rotation of the cube relative to the tool. Indeed, the pose of the tool gives the pose of the point L6 as we can see in the following sketch :

Let's try with the first example of the last part.
We have already the homegeneous transformation T6S.
We can imagine, for example, that the transformation from the tool to the cube is described by the following homogeneous transformation matrix :
TC6 = [-1, 0, 0, 0]
[0, 0, 1, 0]
[0, 1, 0, 0]
[0, 0, 0, 1]

Then, the homogeneous transformation matrix which describe the cube in the gripper is :
TCS = T6S * TC6

In python, we obtain :

```
#cube
TCt = np.array( [   [-1,0,0,0],
                    [0,0,1,0],
                    [0,1,0,0],
                    [0,0,0,1]])
TCS = TtS @ TCt
vis.set_pose(self.cube, TCS)
```


(Here, TtS @ Tct == T6S * TC6)