MMÜ 466 - COMPUTATIONAL MULTI-BODY DYNAMICS - HOMEWORK 4

<u>Due:</u> 16 May 2023, Tuesday

In this problem, the inverse kinematics of Puma robot will be solved whose formulation is given in the course page. The robot starts its motion at time $t = 0$ and completes its motion at $t = tf = 2$ s. The position $\bar{p} = \bar{p}^{(0)}$ and orientation $\hat{C} = \hat{C}^{(0,6)}$ of the robot hand with respect to the base frame are defined as follows.

$\bar{p} = [p_1 \quad p_2 \quad p_3]^t \quad , \quad \hat{C} = e^{\tilde{u}_3\phi}e^{\tilde{u}_2\theta}e^{\tilde{u}_1\psi}$

In the given time range, p_1 drops from 45 cm to 35 cm, p_2 increases from 0 cm to 30 cm and p_3 drops from 30 cm to -15 cm whereas $\phi = 0°$ througout the motion, θ increases from 0° to 90° and ψ increases from 0° to 45°. In order to define p_1, p_2, p_3, ϕ, θ, ψ as a function of time, fit sinusoidal functions between the initial and final values as described in the lecture notes (see ScaraRobot5.jpg). In your Matlab program, choose the time increment as 0.05 s.

The dimensions of the robot are given as,

$a_2 = 30$ cm, $d_2 = 10$ cm, $d_4 = 20$ cm, $d_6 = 12$ cm

In order to set the configuration of the robot during its motion, choose the following signs.

$\sigma_1 = +1$, $\sigma_3 = -1$, $\sigma_5 = +1$

In your program, you are advised to use the basic rotation matrices `rot1`, `rot2` and `rot3` which you have written in the first homework. Note that you will need to express the wrist point position $\bar{r}$ in your program which is given by

$\bar{r} = \bar{p} - d_6\hat{C}\bar{u}_3$

Due to the use of `atan2` function, the calculated angle values may jump from 180 deg to -180 deg and vice versa but we know that these two angles are equal. To avoid this, you should add 360 deg to the calculated angle as described in our lecture notes (see the last paragraph in the file Singularities-1.jpg).

As the ouput of the program, first plot in separate figures p_1, p_2, p_3, ϕ, θ, ψ as a function of time. Then, plot in separate figures, the calculated joint rotations θ_1, θ_2, θ_3, θ_4, θ_5, θ_6 versus time. Plot angles in degrees.