Exercise 1.1

Derive the equations of motion for a robot arm consisting of the three first links of a UR5e robot by using Lagrange–D'Alembert's Principle (MATLAB (2021a or newer) or other software can be used). Note information about the kinematics and link masses is available here: `https://www.universal-robots.com/articles/ur/application-installation/dh-parameters-for-calculations-of-kinematics-and-dynamics/`
Solve the exercise as follows

1. Draw a diagram of the robot and include the reference frames. Beware, the diagram on the UR website is not entirely correct.

2. Use Lagrange–D'Alembert's Principle to derive a dynamical model of the robot. Use the template given in `ex01_generate_model.m`.

3. What joint torques (τ_1, τ_2, τ_3) should be applied to the joints for holding the arm at a configuration $\boldsymbol{q} = (\theta_1, \theta_2, \theta_3) = (1, \pi/3, \pi/3)$. Use the template `ex01_sim.m`.

4. Simulate the robot arm for 5 s by using `ode45` with input $\boldsymbol{Q} = (\tau_1, \tau_2, \tau_3) = -D\dot{\boldsymbol{q}}$, where $D = 5I_3$ is a diagonal matrix. Use initial condition $\boldsymbol{q} = (\theta_1, \theta_2, \theta_3) = (1, \pi/3, \pi/3)$. Use the template `ex01_sim.m`.
   Please compare your results to the simulation available in `ex01_sim_comparison.m`.

The inertia tensors of the links are

$$I_1 = \begin{bmatrix} 0.0084 & 0 & 0 \\ 0 & 0.0064 & 0 \\ 0 & 0 & 0.0084 \end{bmatrix}, I_2 = \begin{bmatrix} 0.0078 & 0 & 0 \\ 0 & 0.21 & 0 \\ 0 & 0 & 0.21 \end{bmatrix}, I_3 = \begin{bmatrix} 0.0016 & 0 & 0 \\ 0 & 0.0462 & 0 \\ 0 & 0 & 0.0462 \end{bmatrix}$$