1. (3) Consider an example of a single two-link manipulator in the figure. The forward kinematics equations of the leg are:

\[
\begin{align*}
    x &= l_1 \cos \theta_1 + l_2 \cos(\theta_1 + \theta_2) \\
    y &= l_1 \sin \theta_1 + l_2 \sin(\theta_1 + \theta_2)
\end{align*}
\]

Compute the determinant of the Jacobian and determine if it is singular.

**Determinant of the Jacobian is** \( \det J = l_1 l_2 \sin \theta_2 \). The Jacobian is singular when the determinant of the Jacobian = 0, i.e. when \( \theta_2 = 0, \pi, -\pi \).

2. (3) Write a Matlab/Python program to simulate the motion a differential drive robot.

- The function should take as an input vector specifying the initial pose \([x_0, y_0, \theta_0]\) and velocities \(v, \omega\) and time \(t\) denotes number of time steps and \(\delta t\) the length of the time step. You should return the resulting path as three vectors each \(1 \times n\) long where \(n\) is the number of time steps.

\[ [x, y, \theta] = \text{diffDrive}([x0, y0, theta0], v, omega, t, delta) \]

- For the following example assume that at time \(t = 0\) the configuration (pose) of the robot is \(\xi = [x, y, \theta] = [100, 50, 45^\circ]\). Robot starts moving with some angular and linear velocity \(\omega = 2^\circ/s\) and \(v = 1m/s\). How is the path affected by the choice of \(\delta t\) ? Hand in the plot of the code and the plot of the path.

3. (1) How many DOF’s are there in a human hand? **The DOF’s is the number of independent parameters which specify the pose (the configuration) of the hand.** Hand has (approximately) 22 DOF’s: 5 fingers have 4 DOF’s each and 2 DOF for wrist.