# ME 380: Kinematics and Machine Dynamics
# Loop Equations and Midterm Worksheet

In this worksheet, we are going to solve for the position-level kinematics of the Stephenson linkage, depicted in Figure 1.

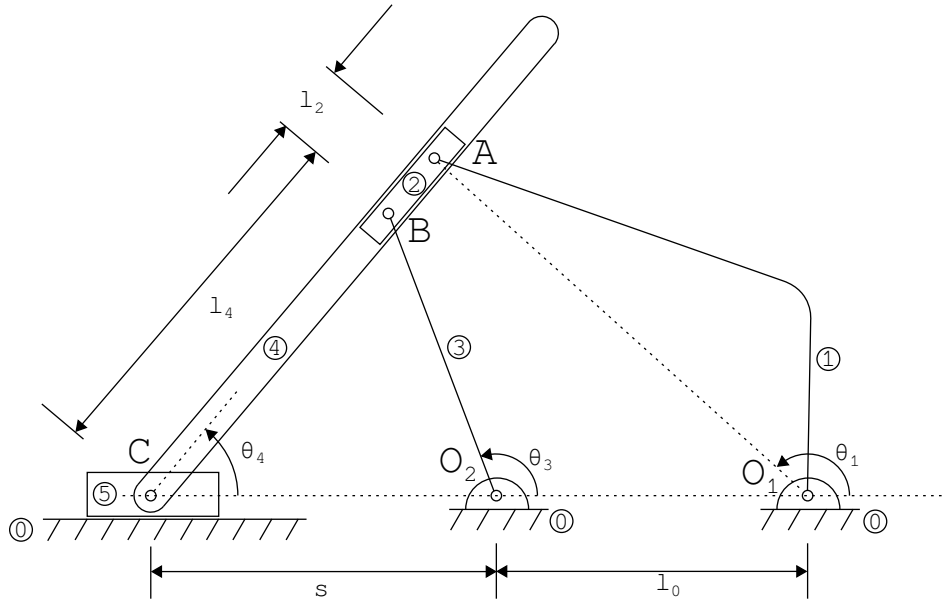


Figure 1: `Stephenson Linkage`

1. Determine the degrees of freedom of this mechanism. From this computation, decide how many variables you have to solve for in position-level kinematics.

2. Based on your answer, decide how many loop equations you need, and write down these loop equations in *vector-form* (this means, do not worry about their representation in a particular coordinate frame yet).

3. Assign coordinate frames $\Sigma_i$ to each link $i$ and derive the rotation matrices of each of these frames with respect to the world (inertial frame, $\Sigma_0$), i.e., find $\{R_i^0\}_1^5$.

4. Express the vector loop equation you wrote down in question 2 in the inertial frame, $\Sigma_0$.

5. (Home exercise) Suppose the link lengths are given as follows: $l_0 = |O_2O_1| = \frac{3}{5}$, $l_1 = |O_1A| = 1.0$, $l_2 = |AB| = \frac{1}{4}$, $l_3 = |O_2B| = \frac{7}{10}$. Use your Newton-Raphson algorithm to solve for

   (a) $\theta_3$, $\theta_4$, $s$ and $l_4$ if $\theta_1 = \frac{4\pi}{5}$.

   (b) $\theta_1$, $\theta_3$, $\theta_4$, and $l_4$ if $s = 2.856$.