MAE 4345 Exercise 1
Samuel Law & Rhys Miller

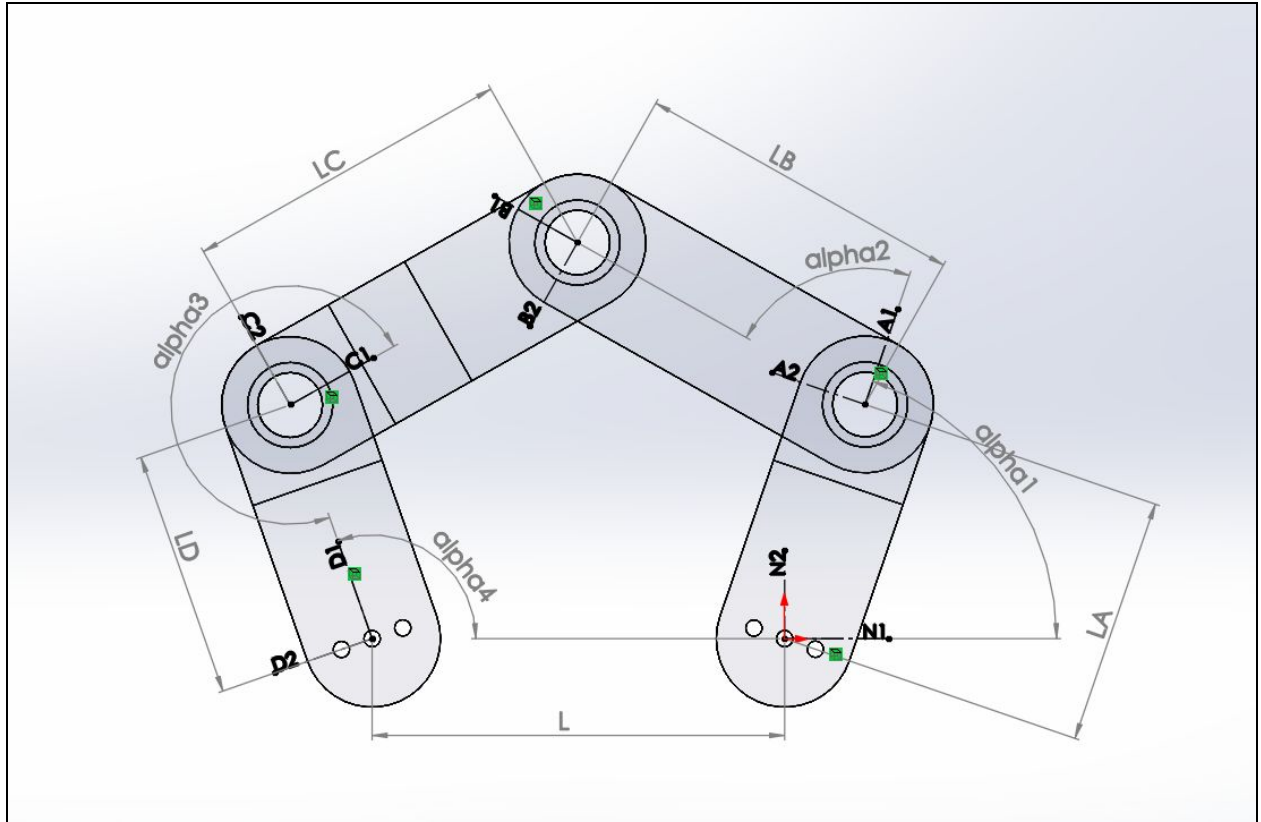Figure 1. Linkage with Frames, Lengths, and Angles

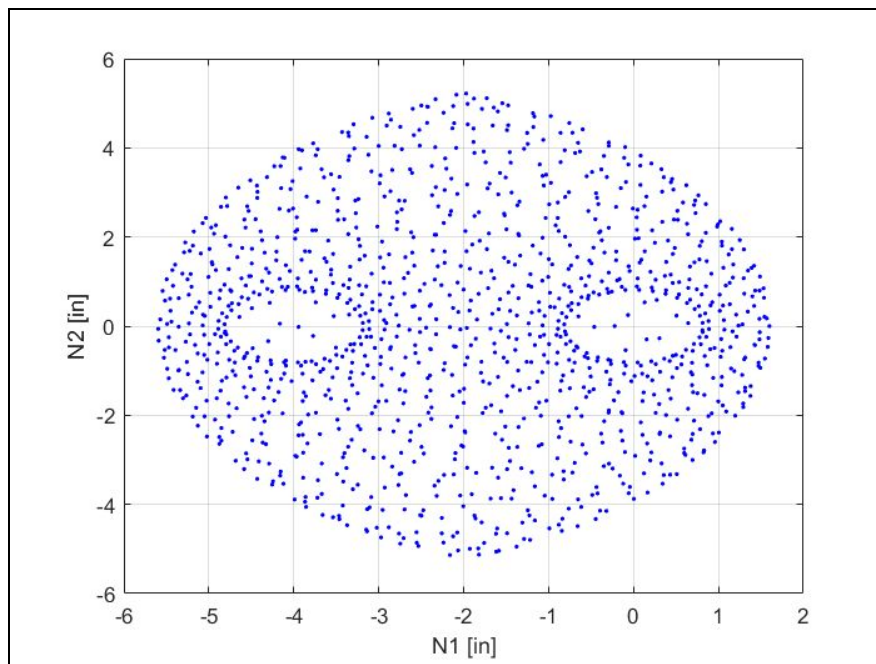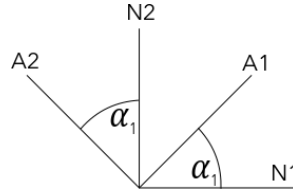Figure 2. Point Cloud

$$\mathcal{L}_A = \left\{ P_{NA}, {}_A^N R \right\}$$

$$P_{NA} = L_A \widehat{A_1}$$

$$
{}_A^N R =
\begin{bmatrix}
\cos(\alpha_1) & \sin(\alpha_1) & 0 \\
-\sin(\alpha_1) & \cos(\alpha_1) & 0 \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
\hat{N}_1 \\
\hat{N}_2 \\
\hat{N}_3
\end{bmatrix}
$$

$$\mathcal{L}_B = \left\{ P_{AB}, {}_B^A R \right\}$$
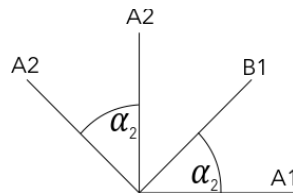
$$P_{AB} = L_B \widehat{B_1}$$

$$
{}_B^A R =
\begin{bmatrix}
\cos(\alpha_2) & \sin(\alpha_2) & 0 \\
-\sin(\alpha_2) & \cos(\alpha_2) & 0 \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
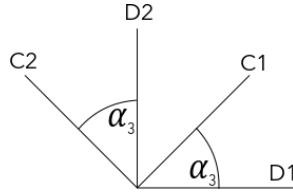\hat{A}_1 \\
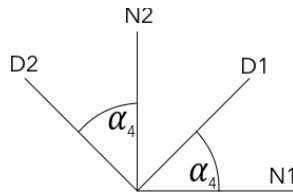\hat{A}_2 \\
\hat{A}_3
\end{bmatrix}
$$

$$\mathcal{L}_C = \{P_{DC}, {}_C^D R\}$$

$$P_{DC} = L_D \widehat{D_1}$$

$${}_B^A R = \begin{bmatrix} \cos(\alpha_3) & \sin(\alpha_3) & 0 \\ -\sin(\alpha_3) & \cos(\alpha_3) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \hat{D}_1 \\ \hat{D}_2 \\ \hat{D}_3 \end{bmatrix}$$

$$\mathcal{L}_D = \{P_{ND}, {}_D^N R\}$$

$$P_{ND} = L\left(-\widehat{N_1}\right)$$

$${}_D^N R = \begin{bmatrix} \cos(\alpha_4) & \sin(\alpha_4) & 0 \\ -\sin(\alpha_4) & \cos(\alpha_4) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \hat{N}_1 \\ \hat{N}_2 \\ \hat{N}_3 \end{bmatrix}$$

$${}_B^N R = {}_A^N R \, {}_B^A R$$

$$P_{NB} = P_{NA} + P_{AB} = P_{ND} + P_{DC} + P_{CB}$$