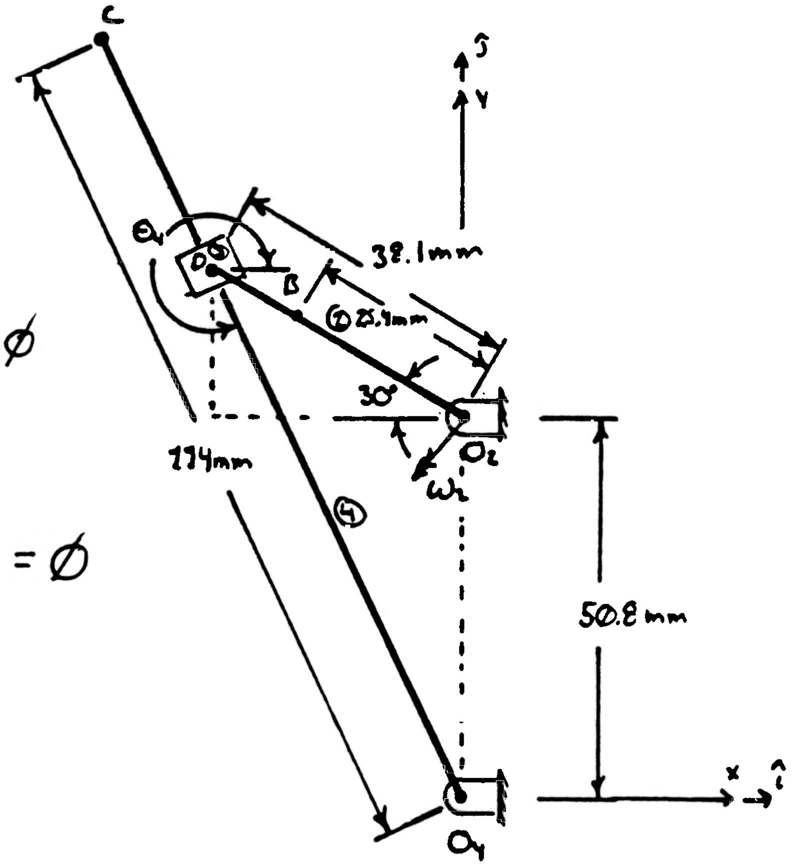
MER042: Design III
Exam #1

Union College
April 22, 1996

NAME: Solution

PROBLEM 1: The figure to the right shows a slider crank mechanism. The drive link is 0_2-D. Link D is restricted by geometry to slide along 0_4-C.



1.a) Write the loop closure equation for this mechanism.

$$\vec{R}_{O_2D} + \vec{R}_{DO_4} + \vec{R}_{O_4O_2} = \vec{\emptyset}$$

$$R_{O_2D}e^{j\theta_2} + R_{DO_4}e^{j\theta_4} + R_{O_4O_2}e^{j90} = \emptyset$$

$$R_{O_2D}\hat{e}_{O_2D} + R_{DO_4}\hat{e}_{DO_4} + R_{O_4O_2}\hat{e}_{O_4O_2} = \emptyset$$

1b) Determine the geometry of the linkage using an analytical technique.

$\Theta_2 = 15\emptyset°$

$$R_{DO_4} = \sqrt{(38.1mm)^2 + (5\emptyset.8mm)^2 - 2(38.1mm)\cdot(5\emptyset.8mm)\cos 12\emptyset°}$$

$$= \boxed{77.25mm}$$

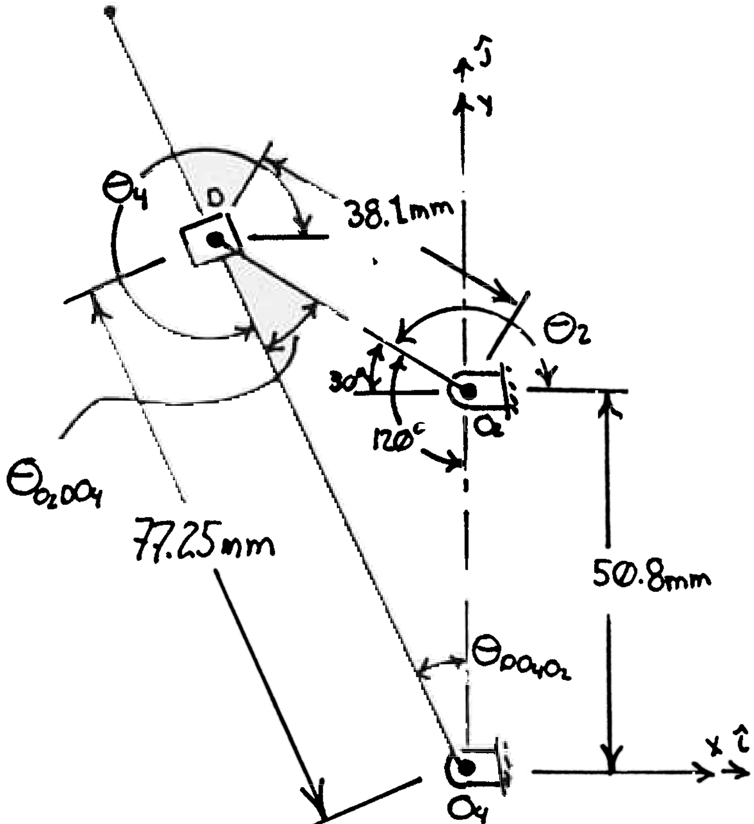
$$\frac{77.25mm}{\sin 12\emptyset°} = \frac{38.1mm}{\sin \Theta_{DO_4O_2}}$$

$$\therefore \Theta_{DO_4O_2} = 25.29°$$

$$\frac{77.25mm}{\sin 12\emptyset°} = \frac{5\emptyset.8mm}{\sin \Theta_{O_2DO_4}}$$

$$\therefore \Theta_{O_2DO_4} = 34.72°$$

$$\therefore \boxed{\Theta_4 = 295.3°}$$



Therefore the loop closure equation can be written

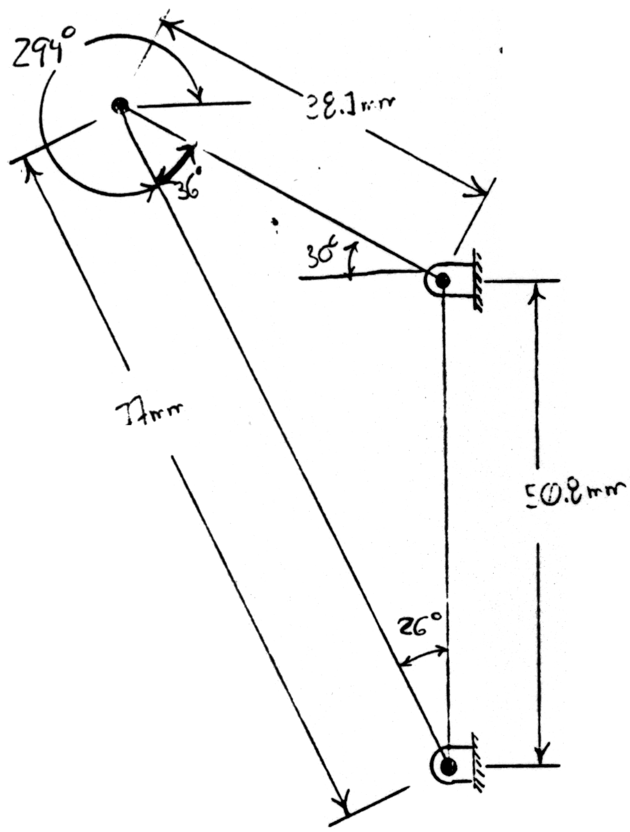
$$\vec{R}_{O_2D} + \vec{R}_{DO_4} + \vec{R}_{O_4O_2} = \emptyset$$

$$\vec{R}_{O_2D} = 38.1mm\, e^{j150} = 38.1mm(-.866\emptyset\hat{\imath} + \emptyset.5\hat{\jmath})$$

$$\vec{R}_{DO_4} = 77.25mm\, e^{j295.3} = 77.25mm(.4274\hat{\imath} - .9\emptyset91\hat{\jmath})$$

$$\vec{R}_{O_4O_2} = 5\emptyset.8mm\, e^{j90} = 5\emptyset.8mm\,\hat{\jmath}$$

1c) Verify your analytical solution using the graphical method.



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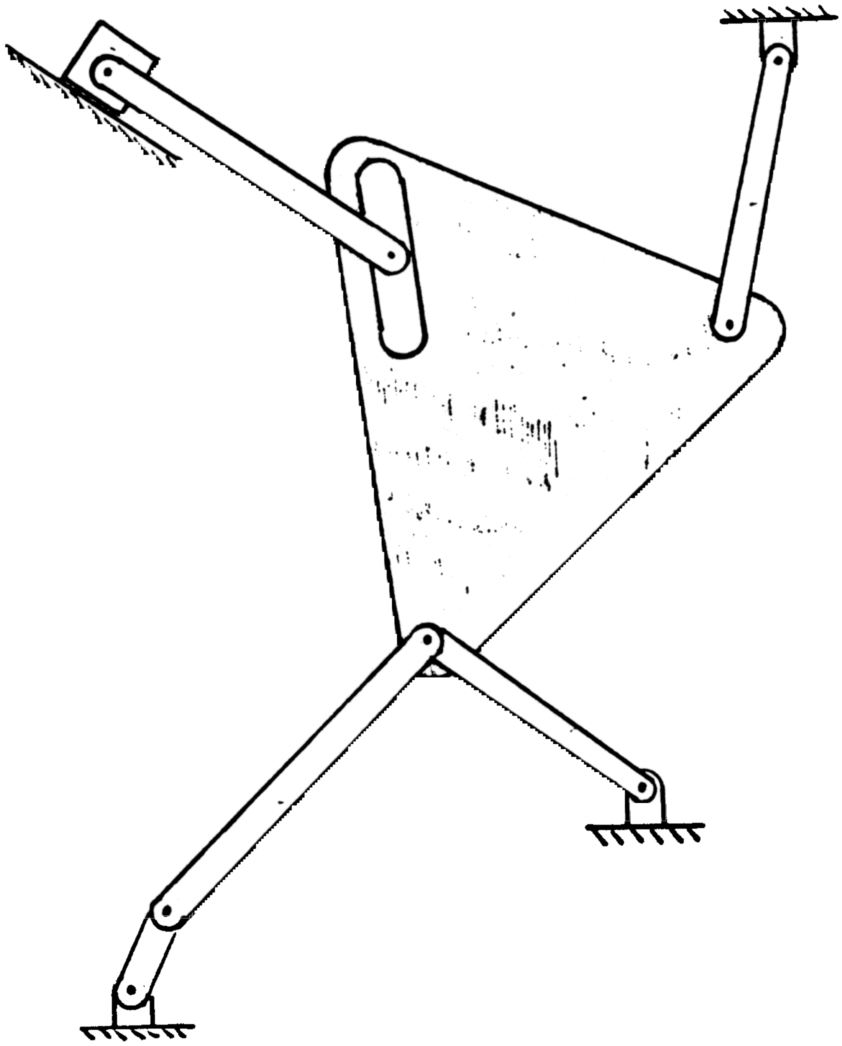
PROBLEM 2: Determine the number of degrees-of-freedom for the linkage shown.



$$N = 3(L-1) - 2j_1 - 1j_2$$
$$= 3(8-1) - 2(9) - 1(1)$$
$$= 21 - 18 - 1$$
$$= \boxed{2}$$