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(3/25/25)

(Do not use Matlab, Maple, Mathematica, etc.)

ENG ME 740:

Exercises (Set 4) (Due 4/1/25)

1. Write down the inverse of the matrix

$$A = \begin{pmatrix} \cos\theta & -\sin\theta\ \cos\alpha & \sin\theta\ \sin\alpha & a\ \cos\theta \\ \sin\theta & \cos\theta\ \cos\alpha & -\cos\theta\ \sin\alpha & a\ \sin\theta \\ 0 & \sin\alpha & \cos\alpha & d \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

2. Given a prescribed position and orientation of the planar 3-bar manipulator of the second Exercise Set, there are two possible solutions to the inverse kinematics problem. If we add one more link (in such a way that the manipulator is still planar), how many solutions are there?

3. The figure shows a 2-bar planar manipulator with rotary joints. The second link is half as long as the first ($r_1 = 2r_2$). The joint limits are:

$$0 < \theta_1 < 180^\circ$$

$$-90^\circ < \theta_2 < 180^\circ.$$

Sketch the approximate workspace (= the set of points which can be reached by the tip of the second link).