ME562 – Spring 2020
Purdue University
West Lafayette, IN

Homework Set No. 2

Assignment date: Friday, January 31
Due date: Thursday, February 6, 11:59pm

- Please include this cover sheet as the first page of your homework submission.
- Submit homework file on Gradescope.

Name_____

PUID _____

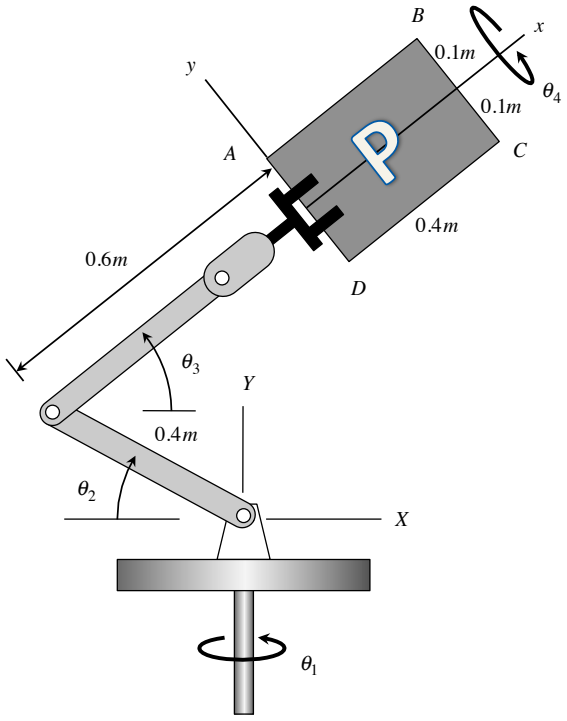
Problem 2.1 _____

Problem 2.2 _____

Problem 2.3 _____

TOTAL _____

Problem 2.1 – 30 points



Consider the robotic arm shown above holding a rectangular sign ABCD in its end effector. Let the XYZ axes be fixed in space, and the xyz axes attached to the sign. When $\theta_1 = \theta_3 = \theta_4 = 0$, the xyz and XYZ axes are aligned. With $\theta_2 = 90°$ held fixed, consider the three rotations through which the robotic arms is taken:

θ_1 : $0 \rightarrow 180°$

θ_3 : $0 \rightarrow 90°$

θ_4 : $0 \rightarrow -90°$

for two different orders of rotation:

a) θ_1 followed by θ_3 followed by θ_4

b) θ_4 followed by θ_3 followed by θ_1

For each of the two rotation orders a) and b) above, do the following:

i. Determine the final space-fixed coordinates of point B on the sign.
ii. Make a sketch of the final orientation of the sign.
iii. Determine the Euler axis of rotation and the Euler angle of rotation for the sign.

Problem 2.2 – 20 points

Reconsider the robotic arm described in Problem 2.1. Here the arm goes through the following rotations:

$\theta_3 : \ 0 \rightarrow 50°$

$\theta_4 : \ 0 \rightarrow 75°$

while $\theta_1 = 0$ and $\theta_2 = 90°$ are held fixed. As a result of these rotation:

a) Determine the distance through which point A on the sign moves.
b) Determine the distance between the initial and final positions of point A on the sign.
c) Determine the direction angles for edge AB of the sign. Verify that these three direction angles are consistent with the usual constraint on direction angles in 3-D space.

Problem 2.3 – 10 points

Reconsider the robotic arm described in Problem 2.1 where here the lower joint is locked at $\theta_2 = 90°$. When $\theta_3 = 30°$ and $\theta_4 = 60°$ it is known that $\dot{\theta}_3 = 2\ rad/sec$ and $\dot{\theta}_4 = -3\ rad/sec$. At this position, determine the angular velocity vector of the sign and the velocity vector of point B on the sign. Express your answers in terms of both the space-fixed and body-fixed coordinates.