# ME604: Introduction to Robotics

Spring 2025

# Quiz 1

- **Duration: 45 minutes**
- **Write legibly and show all your work.**
- **You may refer to up to 1 A4 sized sheet of handwritten material during the exam.**

1. Consider the rotation matrix ${}^0_1R = \begin{bmatrix} -0.5633 & 0.7560 & 0.3334 \\ -0.6822 & -0.1978 & -0.7039 \\ -0.4662 & -0.6239 & 0.6272 \end{bmatrix}$. Assume reference frames $\{1\}$ and $\{0\}$ to have a common origin initially.

   First col of R  First row of R  (R is the given matrix here)

   a. [1 mark] What the unit vectors ${}^0x_1$ and ${}^1x_0$?
   b. [1 mark] What are co-ordinates of a point P in frame $\{0\}$ if ${}^1P = [1\ 1\ 1]^T$? Rp
   c. [2 marks] Obtain the axis-angle representation corresponding to ${}^0_1R$. Use formula
   d. [2 marks] If frame $\{1\}$ is rotated about $x_1$ by 45 degrees, and subsequently translated along $y_0$ by 1 unit, write the transformation matrix ${}^0_1T$ corresponding to the final position of frame $\{1\}$.

The map between final and current position is Rx(45). Hence, map from final to 0 frame is RRx(45). Final position of origin: [0 1 0]^T. Use the two to construct transformation matrix.

2. [4 marks] Consider the two-link RP manipulator in Fig 1a. Write, without using DH parameters, the transformation matrix ${}^0_2T$. Justify your answer. (You may obtain the answer using DH framework for reduced credit).

   Joint 2 is prismatic, so the rotation matrix is just Rz(q1).
   position vector for origin of 2=[L1c1 L1s1 d2]. Use these to construct the needed matrix

3. [10 marks] Consider the 6 DOF manipulator shown in Fig 1b. Assign DH frames and make the table of DH parameters for this manipulator.

   Note that rectangles denote revolutes of axes lying in the plane of the figure, while circles with dots indicate revolutes with axes normal to the plane of the figure. The dashpot indicates a prismatic joint.

   Note that this manipulator is same as stanford manipulator that was discussed in class, but without any offset. See the Stanford Manipulator Example folder for DH frames and table.

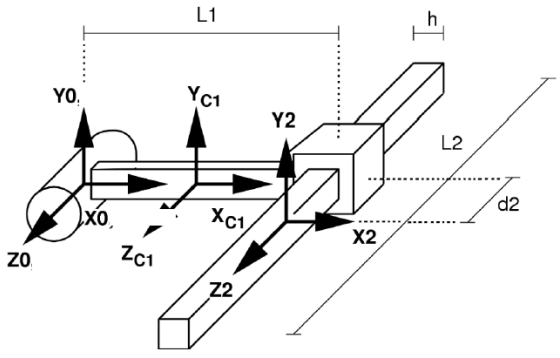


Figure 1(a)

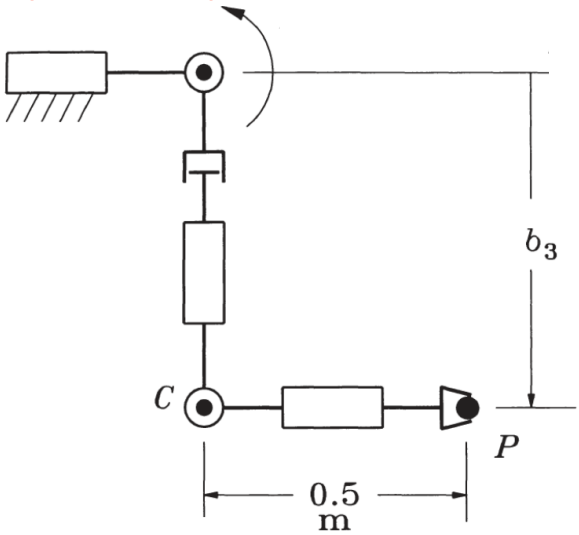


Figure1(b)