

MT 574 Industrial Automation and Robotics Technology

Fall 2026
Department of Mechatronics Engineering
Atilim University, Islamabad

Note: Except question 8, all questions are paper based. The assignment must be solved by an individual.

Q 1: Given

$$T_B^A = \begin{bmatrix} 0.25 & 0.43 & 0.86 & 5.0 \\ 0.87 & -0.50 & 0.00 & -4.0 \\ 0.43 & 0.75 & -0.50 & 3.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Without doing the inverse calculations, determine the T_A^B .

Q 2: A point P in space is defined as ${}^B P = (2, 3, 5)^T$ relative to frame B which is attached to the origin of the reference frame A and is parallel to it. Apply the following transformations to frame B and find ${}^A P$.

Rotate 90 deg about x-axis, then

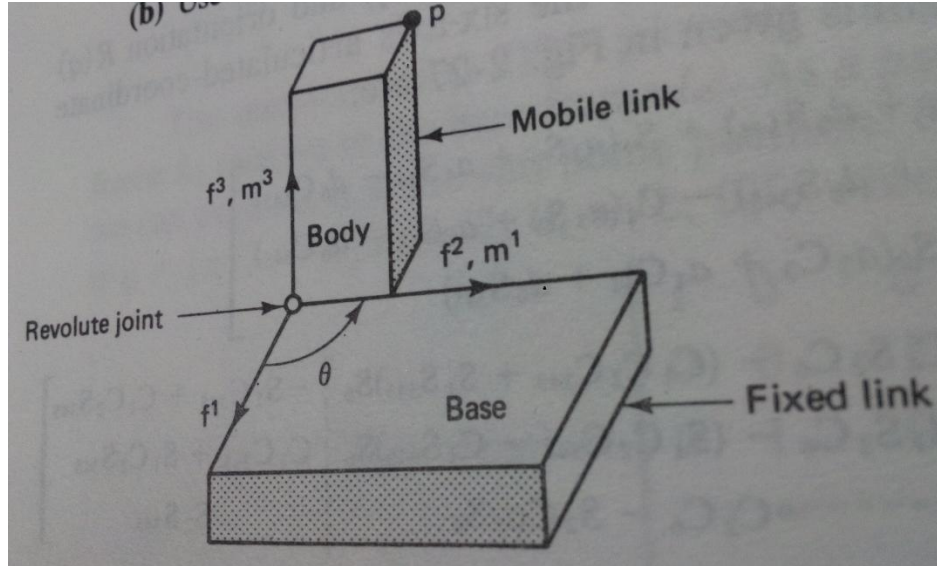
Rotate 90 deg about local a-axis, then

Translate 3 units about y, 6 units about z and 5 units about x-axis.

Q 3: Consider the single axis robot shown in the home position, which corresponds to $\theta = \pi/2$.

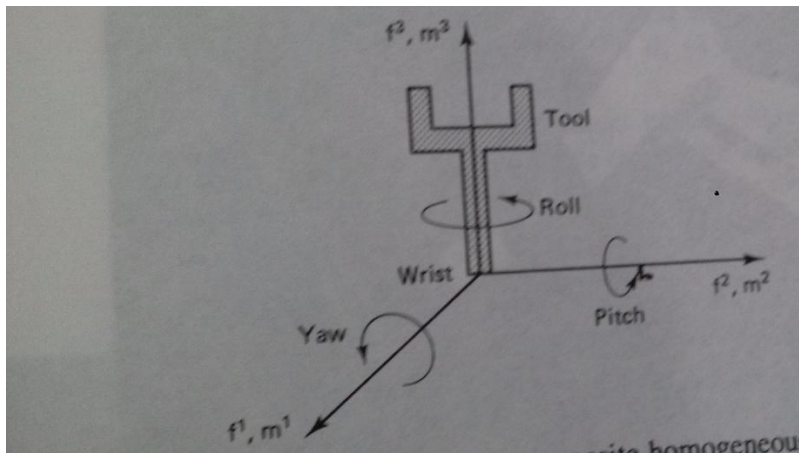
Suppose the point p on the mobile link has coordinates $[p]^m = [0.5, 0.5, 2.0]^T$.

- Find an expression for $R(\theta)$, the coordinate transformation matrix which maps mobile M coordinates into fixed F coordinates as a function of the joint variable θ .
- Use $R(\theta)$ to find $[p]^F$ when $\theta = \pi$ and when $\theta = 0$.

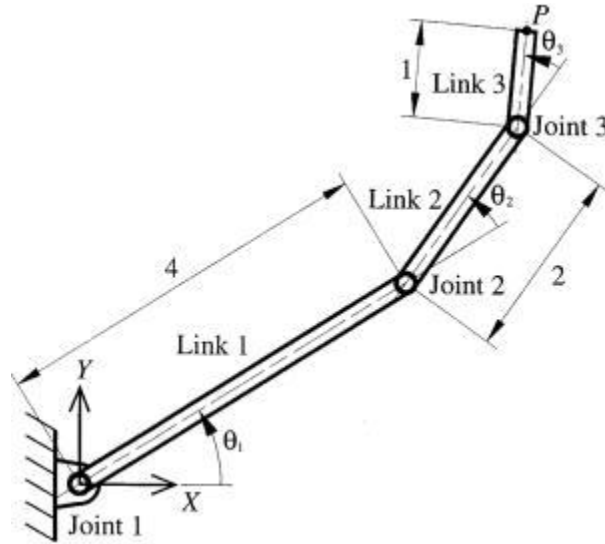


Q 4: Consider the robotic tool shown below. Suppose, we yaw the tool by π about f^1 , then pitch the tool by $-\pi/2$ about f^2 , and finally roll the tool by $\pi/2$ about f^3 .

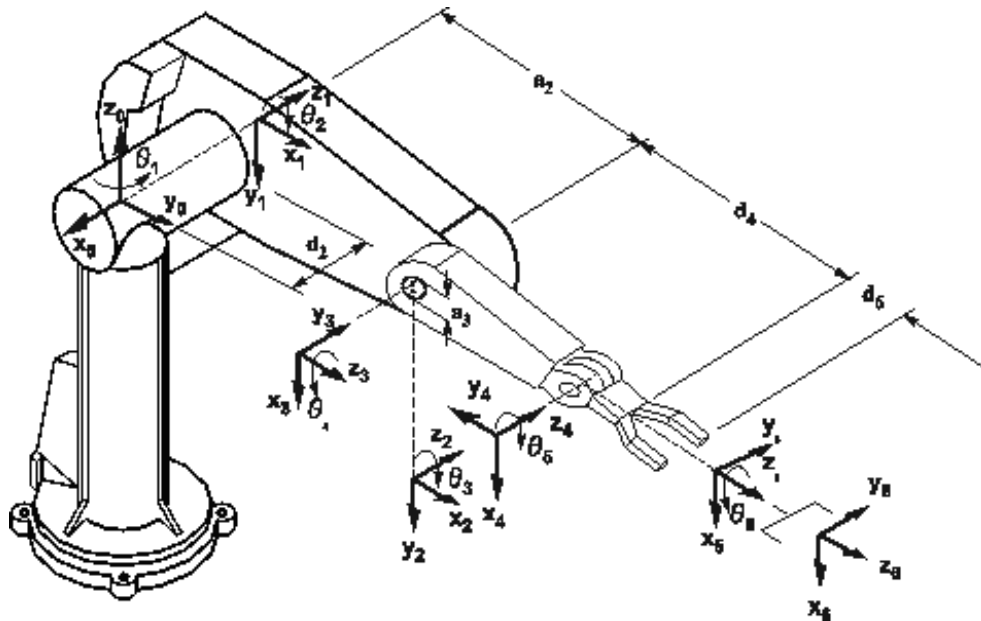
- Sketch the sequence of tool positions after each of the yaw, pitch and roll movements.
- Find the transformation matrix T which maps tool coordinates M into wrist coordinates F following the sequence of rotations.
- Find $[p]^F$, the location of the tool tip p in wrist coordinates F following the sequence of rotations, assuming that the tool tool-tip coordinates in terms of the tool frame are $[p]^M = [0, 0, 0.8]^T$.



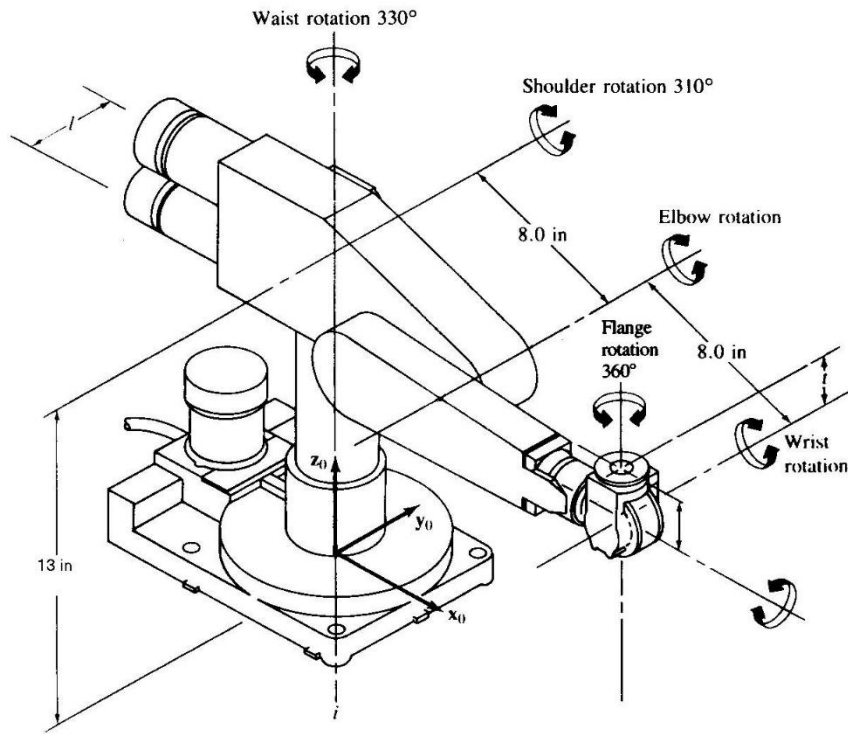
Q 5: Compute the forward and inverse kinematics of the three link planar arm shown in the figure below.



Q 6: Imagine an arm like the PUMA 560 except that the joint 3 is replaced with a prismatic joint. Make any assumptions if necessary. Derive the forward Kinematic equations.



Q 7: Derive the inverse Kinematics for the PUMA 260 shown below:



Q 8: In RoboDK, using a Universal robot or Fanuc robot, perform these tasks.

1. Add a small box as an object of interest.
2. Create 4 target points, home, pick, place, and retract.
3. Introduce any end-effector to perform pick and place operations. Use 'Attach Object' and 'Detach Object' instructions (events) to observe the move.
4. Run it as a program.

The operation is a simple pick and place operation.

Note: For Task 8, email RoboDK project to umer.khan@atilim.edu.tr

Good Luck