

Robotics(ECE670/CSE633)

Quiz 1

Each Question is of 2.5 marks.

1. A point $P = (2, 1)$ in frame \mathcal{F}_0 is first rotated by 45° , then translated by $(1, 2)$, and then rotated again by -45° . What are the final coordinates of P ?
 - (a) $(3, 2)$
 - (b) $(2, 3)$
 - (c) $(2.71, 2.29)$
 - (d) $(1.29, 3.71)$
2. For $l_1 = l_2 = 1$, the target is $(x, y) = (0, \sqrt{2})$. If desired end-effector orientation is 90° , what are possible (θ_1, θ_2) ?
 - (a) $(45^\circ, 45^\circ)$ and $(135^\circ, -45^\circ)$
 - (b) $(30^\circ, 60^\circ)$ and $(60^\circ, 30^\circ)$
 - (c) $(0^\circ, 90^\circ)$ only
 - (d) No solution
3. A 2-DOF arm with $l_1 = 2, l_2 = 2$ has a circular obstacle of radius 1 centered at $(2, 0)$. Which region of workspace is no longer reachable?
 - (a) Entire annulus $0 \leq r \leq 4$
 - (b) Only the circle $x^2 + y^2 < 1$
 - (c) The region covered by the obstacle disc
 - (d) None
4. For $l_1 = 2, l_2 = 1$, at $\theta_1 = 90^\circ, ; \theta_2 = 180^\circ$, determine the rank of the Jacobian.
 - (a) 2
 - (b) 1
 - (c) 0
 - (d) Cannot be determined
5. At configuration $\theta_1 = 30^\circ, ; \theta_2 = 150^\circ, l_1 = l_2 = 1$, compute $|\det(J)|$.
 - (a) 0
 - (b) 1
 - (c) 0.5
 - (d) $\sqrt{3}/2$
6. Compute the homogeneous transformation of a 2-DOF planar arm with $l_1 = l_2 = 1, \theta_1 = 90^\circ, \theta_2 = 90^\circ$.
 - (a) $\begin{bmatrix} 0 & -1 & 0; 1 & 0 & 1; 0 & 0 & 1 \end{bmatrix}$

- (b) $\begin{bmatrix} 0 & -1 & -1; & 1 & 0 & 1; & 0 & 0 & 1 \end{bmatrix}$
- (c) $\begin{bmatrix} -1 & 0 & 0; & 0 & -1 & 2; & 0 & 0 & 1 \end{bmatrix}$
- (d) $\begin{bmatrix} 0 & -1 & -2; & 1 & 0 & 1; & 0 & 0 & 1 \end{bmatrix}$

7. For $l_1 = 2, l_2 = 1$, check if $(x, y) = (2, 1)$ with end-effector orientation 0° is feasible.

- (a) Feasible, unique solution
- (b) Feasible, two solutions
- (c) Not feasible
- (d) Feasible, infinite solutions

8. For a 1-DOF planar robot with $l = 1$, at the joint angle $\theta = 30^\circ$, can the end-effectors linear velocity be $v_0^1 = [2; 0]$? Explain.