

# 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  $45^\circ$ , then translated by  $(1, 2)$ , and then rotated again by  $-45^\circ$ . 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  $90^\circ$ , what are possible  $(\theta_1, \theta_2)$ ?
  - (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)  $[0 \ -1 \ 0; 1 \ 0 \ 1; 0 \ 0 \ 1]$

- (b)  $[0 \ -1 \ -1; 1 \ 0 \ 1; 0 \ 0 \ 1]$
- (c)  $[-1 \ 0 \ 0; 0 \ -1 \ 2; 0 \ 0 \ 1]$
- (d)  $[0 \ -1 \ -2; 1 \ 0 \ 1; 0 \ 0 \ 1]$

7. For  $l_1 = 2, l_2 = 1$ , check if  $(x, y) = (2, 1)$  with end-effector orientation  $0^\circ$  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.