Quiz 1: 10 Marks (Set-A) **Name:** _____
23AIDS202: ITR **Roll No.:** _____
Session 2024-25 : Sem-III; Sec-F
Instructor: Dr. Yogesh Singh

Instructions:
Attempt all questions. This is a closed book quiz. Pledge to uphold the examination integrity.

Problem 1. (1.0 points) What does the rotation matrix between coordinate frames {A} and {B}, ${}^{A}_{B}R$, mean?

(a) orientation of {A} as observed by {B}.

(b) orientation of an arbitrary third frame observed by both {A} and {B}.

(c) orientation of {B} as observed by {A}.

(d) orientation of an arbitrary point observed by {A} and {B}.

Problem 2. (1.0 points) What does roll (ϕ), pitch (θ), and yaw (ψ) angles between coordinate frames {A} (ground frame; $\hat{X}_A$, $\hat{Y}_A$, $\hat{Z}_A$) and {B} (body frame; $\hat{X}_B$, $\hat{Y}_B$, $\hat{Z}_B$) mean?

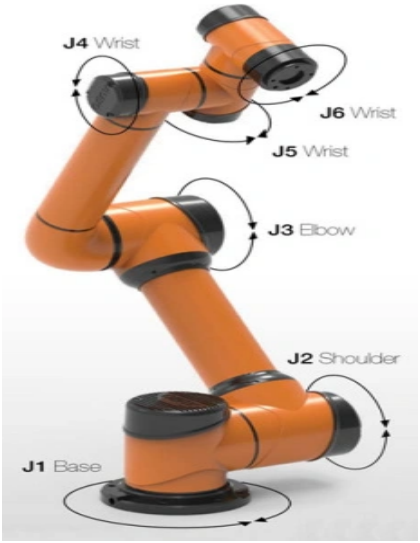
(a) Starting with both frames coincident at {A}, rotate {B} about $\hat{X}_A$ by ϕ, then about the new $\hat{Y'}_A$ axis by θ, and, finally, about the new $\hat{Z''}_A$ axis by angle ψ.

(b) Starting with both frames coincident at {A}, rotate {B} about $\hat{X}_A$ by ϕ, then about $\hat{Y}_A$ by θ, and, finally, about $\hat{Z}_A$ by angle ψ.

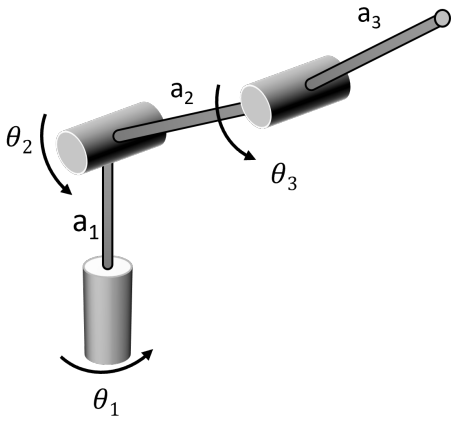
(c) Starting with both frames coincident at {A}, rotate {B} about $\hat{Z}_A$ by ψ, then about $\hat{Y}_A$ by θ, and, finally, about $\hat{X}_A$ by angle ϕ.

(d) Roll, pitch, and yaw angles are the direction cosines of the body frame's ({B}) unit vectors with ground frame's ({A} unit vectors.

Problem 3. (1.5 points) Label the coordinate frames of the robotic system shown below. All joints are revolute joints.



Problem 4. (1.5 points) Label the coordinate frames of the robotic system shown below and find the DH Parameters (write final parameters in table form).



Problem 5. (3 points) Two frames A and B are related by the following homogeneous transformation matrix. Read "**carefully**" and answer the following.

$$ {}^{A}_{B}T = \begin{bmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 & 2 \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 & 2 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

a) Where is the origin of the frame A located when observed from frame B?
b) If there exists a point P whose coordinates in frame A are given as ${}^{A}P = [1, 2, 3]^T$, find its coordinates in frame B?
c) Sketch and show the pose of frame {B} relative to {A}.

Problem 6. (2 points) From the figure below, formulate the homogeneous transformation matrices (order 4 x 4) ${}^{C}_{A}T$ and ${}^{B}_{A}T$.