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NPTEL (https://swayam.gov.in/explorer?ncCode=NPTEL) » Robotics and Control: Theory and Practice (course)

Announcements (announcements) **About the Course (https://swayam.gov.in/nd1_noc20_me03/preview)**

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Unit 3 - Week 2

Assignment 2

The due date for submitting this assignment has passed. **Due on 2020-02-12, 23:59 IST.**

Assignment submitted on 2020-02-08, 15:16 IST

1) If a point $p(x, y, z)$ in a coordinate frame rotates about the $z - axis$ with angular velocity 0.01 rad. per second, then ***1 point***

- $\dot{x} = 0.01y, \dot{y} = -0.01x$
- $\dot{x} = -0.01y, \dot{y} = 0.01x$
- $\dot{x} = -0.01x, \dot{y} = 0.01y$
- $\dot{x} = 0.01x, \dot{y} = -0.01y$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\dot{x} = -0.01y, \dot{y} = 0.01x$

2) If the z_{k-1} and z_k axes of a robot joint coordinate frames are non intersecting then: ***1 point***

- x_k is the common normal to z_{k-1} and z_k.
- x_{k-1} is the common normal to z_{k-1} and z_k.
- y_k is parallel to z_{k-1}.
- y_{k-1} is parallel to z_{k-1}.

(unit?unit=55&lesson=91)

Week 3

Week 4

Week 5

Week 6

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Yes, the answer is correct.
Score: 1

Accepted Answers:
x_k is the common normal to z_{k-1} and z_k.

3) If ${}^{i-1}T_i : i = 1, 2, \ldots n$ denotes i^{th} coordinate frame with respect to $i-1^{th}$ coordinate frame of a n dof manipulator, then the k^{th} column of the Jacobian matrix is obtained using: ***1 point***

- ${}^{0}T_k$
- ${}^{k}T_n$
- ${}^{k-1}T_k$
- ${}^{k-1}T_n$

Yes, the answer is correct.
Score: 1

Accepted Answers:
${}^{k-1}T_n$

4) The homogeneous transformation matrix representing the k^{th} joint frame with respect to $k-1^{th}$ joint frame of a robot manipulator is given by ${}^{k-1}T_k =$: ***1 point***

- $$\begin{bmatrix} cos\theta_k & -cos\alpha_k sin\theta_k & sin\alpha_k sin\theta_k & a_k cos\theta_k \\ sin\theta_k & cos\alpha_k cos\theta_k & -sin\alpha_k cos\theta_k & a_k sin\theta_k \\ 0 & sin\alpha_k & cos\alpha_k & d_k \\ 0 & 0 & 0 & 1 \end{bmatrix}$$
- $$\begin{bmatrix} cos\theta_k & cos\alpha_k sin\theta_k & sin\alpha_k sin\theta_k & a_k cos\theta_k \\ sin\theta_k & -cos\alpha_k cos\theta_k & -sin\alpha_k cos\theta_k & a_k sin\theta_k \\ 0 & sin\alpha_k & cos\alpha_k & d_k \\ 0 & 0 & 0 & 1 \end{bmatrix}$$
- $$\begin{bmatrix} cos\theta_k & -cos\alpha_k sin\theta_k & -sin\alpha_k sin\theta_k & a_k cos\theta_k \\ sin\theta_k & cos\alpha_k cos\theta_k & sin\alpha_k cos\theta_k & a_k sin\theta_k \\ 0 & sin\alpha_k & cos\alpha_k & d_k \\ 0 & 0 & 0 & 1 \end{bmatrix}$$
- $$\begin{bmatrix} cos\theta_k & -cos\alpha_k sin\theta_k & sin\alpha_k sin\theta_k & a_k cos\theta_k \\ sin\theta_k & cos\alpha_k cos\theta_k & -sin\alpha_k cos\theta_k & a_k sin\theta_k \\ 0 & cos\alpha_k & sin\alpha_k & d_k \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Yes, the answer is correct.
Score: 1

Accepted Answers:
$$\begin{bmatrix} cos\theta_k & -cos\alpha_k sin\theta_k & sin\alpha_k sin\theta_k & a_k cos\theta_k \\ sin\theta_k & cos\alpha_k cos\theta_k & -sin\alpha_k cos\theta_k & a_k sin\theta_k \\ 0 & sin\alpha_k & cos\alpha_k & d_k \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

5) Kinematic equations of a 3 axis manipulator are given as: ***0 points***

$x = [l_2 cos\theta_2 + l_3 cos(\theta_2 + \theta_3)] cos\theta_1$

$y = [l_2 cos\theta_2 + l_3 cos(\theta_2 + \theta_3)] sin\theta_1$
$z = l_1 + l_2 sin\theta_2 + l_3 sin(\theta_2 + \theta_3)$
Then $cos\theta_3$ is:

- $\frac{x^2+y^2+(z-l_1)^2-l_2^2-l_3^2}{-2l_2l_3}$
- $\frac{x^2+y^2+(z-l_1)^2-l_2^2-l_3^2}{2l_2l_3}$
- $\frac{x^2+y^2+(z-l_1)^2+l_2^2-l_3^2}{-2l_2l_3}$
- $\frac{x^2+y^2+(z-l_1)^2-l_2^2+l_3^2}{-2l_2l_3}$

Yes, the answer is correct.
Score: 0

Accepted Answers:
$\frac{x^2+y^2+(z-l_1)^2-l_2^2-l_3^2}{2l_2l_3}$

6) The joint co-ordinate transformations of a robot manipulator are given below: ***1 point***

$$^0T_1 = \begin{bmatrix} cos\theta_1 & 0 & -sin\theta_1 & 0 \\ sin\theta_1 & 0 & cos\theta_1 & 0 \\ 0 & -1 & 0 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}, {}^1T_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & q_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}, {}^2T_3 = \begin{bmatrix} cos\theta_3 & -sin\theta_3 & 0 & 0 \\ sin\theta_3 & cos\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix}, 0 \leq q_2 \leq$$

The arm matrix $T = {}^0T_3$ at $\theta_1 = 0, q_2 = 3$ and $\theta_3 = \pi/2$ is given by:

- $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 3 \\ 0 & -1 & 0 & -5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
- $\begin{bmatrix} 0 & 0 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & -5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
- $\begin{bmatrix} 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 3 \\ 0 & 0 & -1 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
- $\begin{bmatrix} 1 & 0 & 0 & 3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & -5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Yes, the answer is correct.
Score: 1

Accepted Answers:

$$\begin{bmatrix} 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 3 \\ 0 & 0 & -1 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

7) $\frac{\partial T}{\partial q_2}$ in (6) for mentioned values is given by: ***1 point***

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -5 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

8) Second column of manipulator jacobian in (6) for mentioned values is given by: ***1 point***

$[0 \quad -1 \quad 0 \quad 0 \quad 0 \quad 0]^T$

$[-1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0]^T$

$[0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0]^T$

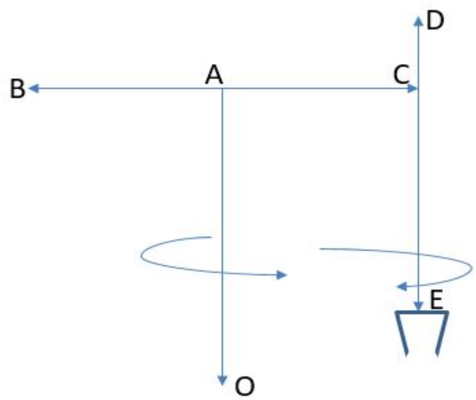
$[1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0]^T$

Yes, the answer is correct.
Score: 1

Accepted Answers:
$[-1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0]^T$

9) ***1 point***

For the manipulator shown below, OA=15, BC=10, DE=15.



Joint variables are given by θ_1, d_2, d_3 and θ_4. If the position and orientation of the end-effector E with respect to base O is given by:

$$\begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 & 4 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 & 3 \\ 0 & 0 & -1 & 9 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

What is value of $\theta_1 + \theta_4$. Here O and E are revolute joints and A and C are prismatic?

- $\theta_1 = \pi/4$
- $\theta_1 = \pi/2$
- $\theta_1 = -\pi/4$
- $\theta_1 = -\pi/2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\theta_1 = -\pi/4$

10) In previous question (9), distance variables d_2 and d_3 are: ***1 point***

- 5 & 6 respectively.
- 5 & 9 respectively.
- 4 & 6 respectively.
- 4 & 9 respectively.

Yes, the answer is correct.
Score: 1

Accepted Answers:
5 & 6 respectively.