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11. Exam (5 problems)

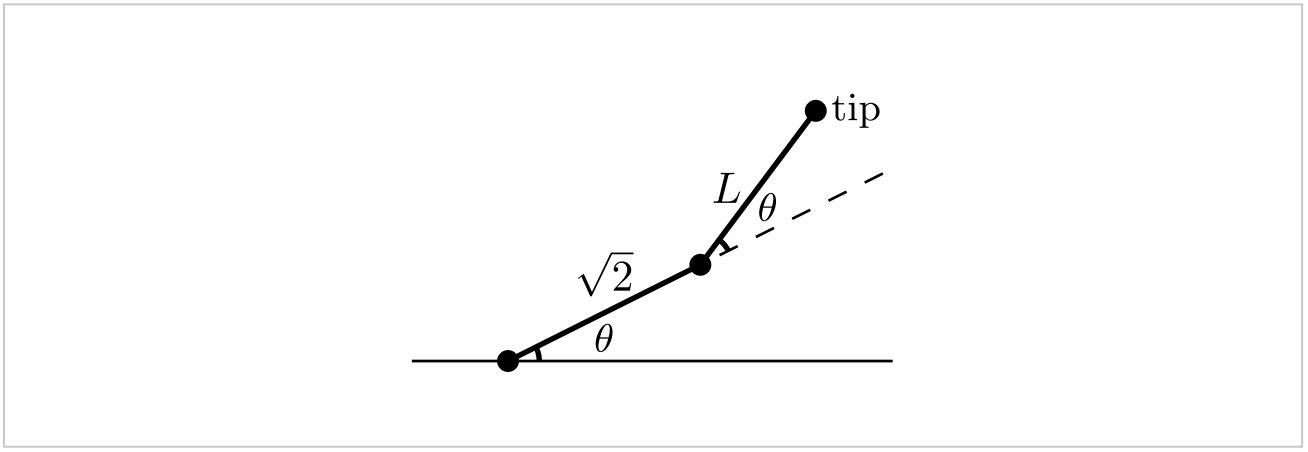
Exam due Oct 15, 2021 21:30 IST Completed

11 (a)

2 points possible (graded, results hidden)

A robot arm has two arms. The first arm has fixed length $\sqrt{2}$, and the second has length L, where L is a variable that can be controlled.

The angles of the arms are controlled by the variable θ. The first arm rotates by θ counter-clockwise from the positive x-axis, and the second arm rotates by θ counter-clockwise from the end of the first arm.



Let $x(L,\theta)$ and $y(L,\theta)$ be the horizontal and vertical distances from the start of the first arm to the tip of the second arm, for the given values of L and θ.

For example, $x(2,\pi/4) = 1$ and $y(2,\pi/4) = 3$.

Find $x(L,\theta)$ and $y(L,\theta)$.

Type `theta` for θ. Enter exact expressions or use at least three decimal places.

$x(L,\theta) =$ sqrt(2)*cos(theta)+L*cos(2*theta)

$y(L,\theta) =$ sqrt(2)*sin(theta)+L*sin(2*theta)

? INPUT HELP

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11 (b)

1 point possible (graded, results hidden)

Compute the linearization matrix of the transformation $L, \theta \implies x, y$ for the values $L = 2$ and $\theta = \pi/4$. When ordering the variables, use the ordering x, y and L, θ.

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

[[0,-5],[1,1]]

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Answer submitted.

11 (c)

1 point possible (graded, results hidden)

Let M be the matrix from part (b). Which of the following gives the value of $\begin{pmatrix} \Delta L \\ \Delta\theta \end{pmatrix}$ such that the robot arm moves purely horizontally by a distance of 0.1?

- $M^{-1}\begin{pmatrix} 0.1 \\ 0 \end{pmatrix}$

- $M^{-1}\begin{pmatrix}0\\0.1\end{pmatrix}$
- $M^{-1}\begin{pmatrix}0.1\\-0.1\end{pmatrix}$
- $M\begin{pmatrix}0.1\\0\end{pmatrix}$
- $M\begin{pmatrix}0.1\\-0.1\end{pmatrix}$
- $M\begin{pmatrix}0\\0.1\end{pmatrix}$

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Answer submitted.

11 (d)

1 point possible (graded, results hidden)

The matrix M contains exactly one zero. Which of the following is the correct interpretation of this zero?

- Holding θ at $\pi/4$, if L increases from 2, then the robot's x-coordinate stays the same.
- Holding L at 2, if θ increases from $\pi/4$, then the robot's y-coordinate stays the same.
- Holding θ at $\pi/4$, if L increases from 2, then the robot's y-coordinate stays the same.

- Holding L at 2, if θ increases from $\pi/4$, then the robot's x-coordinate stays the same.

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11 (e)

1 point possible (graded, results hidden)

Which of the following is the correct statement about the sensitivity of the y-coordinate of the tip of the robot arm (in absolute terms)?

- When $L = 2$ and $\theta = \pi/4$, the y-coordinate is equally sensitive to changes in L and θ.
- When $L = 2$ and $\theta = \pi/4$, the y-coordinate is more sensitive to changes in L and less sensitive to changes in θ.
- When $L = 2$ and $\theta = \pi/4$, the y-coordinate is more sensitive to changes in θ and less sensitive to changes in L.

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Answer submitted.

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? [Staff] Could you re-check whether question is asking for movement in Horizontally or Vertically in 11-C? 3
(as question) Thanks.

[STAFF] Final Exam 11 - typo in 1st submission 2

[Staff] (11-a) Input Field Labels Are mismatched 2