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[Dates](#)


[Discussion](#)


[Syllabus](#)

[Outline](#)


[laff routines](#)


[Community](#)


 [Course](#) / [Week 5: Matrix- Matrix Multiplication](#) / [5.1 Opening Remarks](#)



< Previous







Next >

# 5.1.1 Composing Rotations

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Week 5 due Nov 6, 2023 22:42 IST

## 5.1.1 Composing Rotations

Please note the following observation, posted on the discussion board:

Hello,

it appears to me that at minute 3:40 of the video , matrix component a10 is indicated as  $\cos(\rho)\sin(\theta)+x\sin(\rho)\cos(\theta)$  while in my opinion should be  $\cos(\rho)\sin(\theta)+\sin(\rho)\cos(\theta)$ .

thanks Luca

Summary

If you forget law of sines and law of cosines...

Rederive them by knowing how to compose rotations and multiply matrices!

▶ 4:20 / 4:20

▶ 2.0x 🔊 🗒 🗒 🗒

Video

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### Reading Assignment

0 points possible (ungraded)  
Read Unit 5.1.1 of the notes. [\[LINK\]](#)

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✓ Homework 5.1.1.1: Is $\tau$ a variable, or $= 2\pi$ radians?	2

Homework 5.1.1.1

3/3 points (graded)

For the following statements, find out if they are true or false.

• 
$$\begin{pmatrix} \cos(\rho + \sigma + \tau) \\ \sin(\rho + \sigma + \tau) \end{pmatrix} = \begin{pmatrix} \cos(\tau) & -\sin(\tau) \\ \sin(\tau) & \cos(\tau) \end{pmatrix} \begin{pmatrix} \cos(\rho + \sigma) \\ \sin(\rho + \sigma) \end{pmatrix}$$

True ✓ Answer: True

• 
$$\begin{pmatrix} \cos(\rho + \sigma + \tau) \\ \sin(\rho + \sigma + \tau) \end{pmatrix} = \begin{pmatrix} \cos(\tau) & -\sin(\tau) \\ \sin(\tau) & \cos(\tau) \end{pmatrix} \begin{pmatrix} \cos(\rho)\cos(\sigma) - \sin(\rho)\sin(\sigma) \\ \sin(\rho)\cos(\sigma) + \cos(\rho)\sin(\sigma) \end{pmatrix}$$

True ✓ Answer: True

• 
$$\begin{aligned} \cos(\rho + \sigma + \tau) &= \cos(\tau)(\cos(\rho)\cos(\sigma) - \sin(\rho)\sin(\sigma)) - \sin(\tau)(\sin(\rho)\cos(\sigma) + \cos(\rho)\sin(\sigma)) \\ \sin(\rho + \sigma + \tau) &= \sin(\tau)(\cos(\rho)\cos(\sigma) - \sin(\rho)\sin(\sigma)) + \cos(\tau)(\sin(\rho)\cos(\sigma) + \cos(\rho)\sin(\sigma)) \end{aligned}$$

True ✓ Answer: True

Explanation

Answer: True Extending the observations in the video, we know that

$$R_{\rho+\sigma+\tau}(e_0) = R_\tau(R_{\rho+\sigma}(e_0)).$$

But

$$R_{\rho+\sigma+\tau}(e_0) = \begin{pmatrix} \cos(\rho + \sigma + \tau) \\ \sin(\rho + \sigma + \tau) \end{pmatrix}$$

and

$$R_\tau(R_{\rho+\sigma}(e_0)) = \begin{pmatrix} \cos(\tau) & -\sin(\tau) \\ \sin(\tau) & \cos(\tau) \end{pmatrix} \begin{pmatrix} \cos(\rho + \sigma) \\ \sin(\rho + \sigma) \end{pmatrix}.$$

establishing the result.

• 
$$\begin{pmatrix} \cos(\rho + \sigma + \tau) \\ \sin(\rho + \sigma + \tau) \end{pmatrix} = \begin{pmatrix} \cos(\tau) & -\sin(\tau) \\ \sin(\tau) & \cos(\tau) \end{pmatrix} \begin{pmatrix} \cos \rho \cos \sigma - \sin \rho \sin \sigma \\ \sin \rho \cos \sigma + \cos \rho \sin \sigma \end{pmatrix}$$
 True/False

Answer: True From the video we know that

$$R_{\rho+\sigma}(e_0) = \begin{pmatrix} \cos(\sigma) & -\sin(\sigma) \\ \sin(\sigma) & \cos(\sigma) \end{pmatrix} \begin{pmatrix} \cos(\rho) & -\sin(\rho) \\ \sin(\rho) & \cos(\rho) \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} \cos \rho \cos \sigma - \sin \rho \sin \sigma \\ \sin \rho \cos \sigma + \cos \rho \sin \sigma \end{pmatrix}$$

establishing the result.

• 
$$\begin{aligned} \cos(\rho + \sigma + \tau) &= \cos(\tau)(\cos \rho \cos \sigma - \sin \rho \sin \sigma) - \sin(\tau)(\sin \rho \cos \sigma + \cos \rho \sin \sigma) \\ \sin(\rho + \sigma + \tau) &= \sin(\tau)(\cos \rho \cos \sigma - \sin \rho \sin \sigma) + \cos(\tau)(\sin \rho \cos \sigma + \cos \rho \sin \sigma) \end{aligned}$$
 True/False

Answer: True This is a matter of multiplying the last result.

Calculator

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< Previous

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