1.

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

2.

[[1,0,0,0],[0,0,-1,0],[0,1,0,-2],[0,0,0,1]]

3.

[[0,-1,0,-1],[-1,0,0,0],[0,0,-1,-2],[0,0,0,1]]

4.

Yes

5.

[1, 5, -2]

6.

Yes

7.

[-2,-1,3,3,1,-1]

8.

[[0, -1.2092, -1.2092], [1.2092, 0, -1.2092], [1.2092, 1.2092, 0]] is the matrix, need to extract the rotation amount to get it correct.

2.0944

9. Wrong Answers:

[[0,-0.8944,0.4472,1.3416],[0.8944,0,0,0],[-0.4472,0,0,0],[0,0,0,0]]

[[0,-0.8944,0.4472,1.3416],[0.8944,0,0,0],[-0.4472,0,0,0],[0,0,0,1]]

[[0, -2, 1, 0], [2, 0, 0, 0], [-1, 0, 0, 3], [0, 0, 0, 0]]

[[0, -2, 1, 0], [2, 0, 0, 0], [-1, 0, 0, 3], [0, 0, 0, 1]]

[[0, -2, 1, 1.3416], [2, 0, 0, 0], [-1, 0, 0, 0], [0, 0, 0, 0]]

[[0.5403, -0.7526, 0.3763, 1.129], [0.7526, 0.6322, 0.1839, 0.5516], [-0.3763, 0.1839, 0.9081, -0.2758], [0, 0, 0, 1]]

Approach:

First convert from exponential coordinates - TwistNine=AxisAng6(expc6Nine)

Then go from 6 vector twist to the se3 matrix with the se3Nine=VecTose3(TwistNine) function.

Then go to matrix exponential with the MatrixExponentialNine=MatrixExp6(se3Nine)

New Approach:

Extract omega and v from exponential coordinates – somehow???? Need to convert to a twist from exponential coordinates. Then the velocity is the bottom three numbers of the twist. The function I tried is AxisAng6(Expc6Nine) which is described as taking exponential coordinates and returning the normalized screw axis.

Calculate so3 from omega / omg.

Combine into matrix as described in this post:

<https://www.coursera.org/learn/modernrobotics-course1/discussions/all/threads/FSkhKFNlEemiBRIUlZREOg/replies/ZYjluFQuEemc1BKbV-hOtg>

Other Relevant Posts:

<https://www.coursera.org/learn/modernrobotics-course1/discussions/all/threads/i7NSS3UnEemVShI7i-4e7g/replies/ZNaFMnVzEemnNg74XiyYlg>

<https://www.coursera.org/learn/modernrobotics-course1/discussions/all/threads/l4tbdzlQEembEArV_AZQOA/replies/CJCpxDyWEemq9A5TXPAMWg>

10. For some reason this is wrong:

[1, 0, 0, 2, 0, -3], So is 1,0,0,2,-2,0

Kevin Lynch answer on Forum:

<https://www.coursera.org/learn/modernrobotics-course1/discussions/all/threads/RWJ7K40dEei5mgqx2ua69g/replies/mM6CbI2pEeihEQ7V0BfvOA>

Mecharithm Description of Wrenches

<https://mecharithm.com/learning/lesson/fundamentals-of-robotics-wrenches-8>  
  
The issue was that I needed to use the transpose not the inverse!!!

Correct answer is:

[-1,0,-4,2,0,-1]

11. Literally putting a matrix into a function to compute the inverse of the homogeneous transformation matrix. Doesn’t read the correct answer however.

[[0,1,0,0],[-1,0,0,3],[0,0,1,-1],[0,0,0,1]]

12.

[[0, 0, 0, 0], [0, 0, -1, 2], [0, 1, 0, 3], [0, 0, 0, 0]]

13.

[1, 0, 0, 1, 2, 0]

14.

[[0, -1, 0, 3], [1, 0, 0, 0], [0, 0, 1, 1], [0, 0, 0, 1]]

15.

[[0, -1.5708, 0, 2.3562], [1.5708, 0, 0, -2.3562], [0, 0, 0, 1], [0, 0, 0, 0]]

# Question for Number 7

Question 1

In terms of the x^sx^s​, y^sy^​s​, z^sz^s​ coordinates of a fixed space frame {s}, the frame {a} has its x^ax^a​-axis pointing in the direction (0,0,1)(0,0,1) and its y^ay^​a​-axis pointing in the direction (−1,0,0)(−1,0,0), and frame {b} has its x^bx^b​-axis pointing in the direction (1,0,0)(1,0,0) and its y^by^​b​-axis pointing in the direction (0,0,−1)(0,0,−1). The origin of {a} is at (0,0,1)(0,0,1) in {s} and the origin of {b} is at (0,2,0)(0,2,0). Write the transformation matrices Tsa​. All elements of this matrix should be integers.

Question 2

Referring back to Question 1, a twist V is represented in {s} as Vs=(3,2,1,−1,−2,−3)⊺Vs​=(3,2,1,−1,−2,−3)⊺. What is its representation Va? All elements of this vector should be integers.

Question 3

Referring back to Question 1, calculate the matrix exponential corresponding to the exponential coordinates of rigid-body motion Sθ=(0,1,2,3,0,0)⊺Sθ=(0,1,2,3,0,0)⊺. Give at least 2 decimal places for each element in the matrix.

# Question for Number 10

Question 1

In terms of the x^sx^s​, y^sy^​s​, z^sz^s​ coordinates of a fixed space frame {s}, the frame {a} has its x^ax^a​-axis pointing in the direction (0,0,1)(0,0,1) and its y^ay^​a​-axis pointing in the direction (−1,0,0)(−1,0,0), and frame {b} has its x^bx^b​-axis pointing in the direction (1,0,0)(1,0,0) and its y^by^​b​-axis pointing in the direction (0,0,−1)(0,0,−1). The origin of {a} is at (0,0,1)(0,0,1) in {s} and the origin of {b} is at (0,2,0)(0,2,0). Write the transformation matrices Tsa​. All elements of this matrix should be integers.

Question 2

Referring back to Question 1, use TsbTsb​ to change the representation of the wrench Fb​=(1,0,0,2,1,0)⊺ (in {b} coordinates) to {s} coordinates. All elements of this vector should be integers.

# Online Thread About Test

Question 7:

[1, -3, -2, -3, -1, 5]

Question 9:

[[-0.62, -0.70, 0.35, 2.36],[ 0.70, -0.29, 0.65, 4.34],-0.35, 0.65, 0.68, -2.17],[ 0.00,0.00,0.00,1.00]]

Question 11:

[[ 0, 1, 0, 0],

[-1, 0, 0, 3],

[ 0, 0, 1, -1],

[ 0, 0, 0, 1]]

Question 11 Rabbit Hole:

I had this very question and went through a rabbit hole of trying to figure it out... reported it and requested an explanation if for some reason I was wrong. See below for the breakdown of how I calculated it:

so RTSB = the 3x3 top left matrix of the Homogeneous Transformation Matrix. It tells you the orientation of the axes of one frame relative to another, so it's the Rotation matrix.

The -RTSB = The 3x3 rotation matrix from above (but negative values)

*p* = the 3x1 position vector (this is the vector of displacement from the first frame origin to the second... so from S to B)

Bottom row is 0 0 0 1 to make it a square (symmetrical) matrix. Placeholder.

Transpose RSB to get RTSB = [[0, 1, 0], [-1, 0, 0], [0, 0, 1]]

Multiply -RTSB **x** *p* so: [[0, -1, 0], [1, 0, 0], [0, 0, -1]] **x** [[3, 0, 1]]T = [0, 3, -1]T

Put them together you get [[0, 1, 0, 0], [-1, 0, 0, 3], [0, 0, 1, -1]]

Add bottom placeholder to make symmetrical: [[0, 1, 0, 0], [-1, 0, 0, 3], [0, 0, 1, -1], [0, 0, 0, 1]]

I don't think we're doing anything wrong but if anyone can point out the mistake I would very much appreciate it.