1. In terms of the $\hat{x}_s$, $\hat{y}_s$, $\hat{z}_s$ coordinates of a fixed space frame {s}, the frame {a} has its $\hat{x}_a$-axis pointing in the direction $(0, 0, 1)$ and its $\hat{y}_a$-axis pointing in the direction $(-1, 0, 0)$, and frame {b} has its $\hat{x}_b$-axis pointing in the direction $(1, 0, 0)$ and its $\hat{y}_b$-axis pointing in the direction $(0, 0, -1)$. The origin of {a} is at $(0, 0, 1)$ in {s} and the origin of {b} is at $(0, 2, 0)$. Draw the {s}, {a}, and {b} frames, similar to examples in the book and videos, for easy reference in this question and later questions.

1 / 1 point

Write the transformation matrix T_{sa}. All elements of this matrix should be integers.

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1,2,3,4],[5,6,7,8],[9,10,11,12],[0,0,0,1]] for $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 0 & 0 & 0 & 1 \end{bmatrix}$.

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

Run

Reset

Correct

Good job!

2. Referring back to Question 1, write T_{sb}^{-1}. All elements of this matrix should be integers.

1 / 1 point

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1,2,3,4],[5,6,7,8],[9,10,11,12],[0,0,0,1]] for $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 0 & 0 & 0 & 1 \end{bmatrix}$.

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

Run

Reset

Correct

Good job!

3. Referring back to Question 1, write T_{ab}. All elements of this matrix should be integers.

1 / 1 point

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1,2,3,4],[5,6,7,8],[9,10,11,12],[0,0,0,1]] for $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 0 & 0 & 0 & 1 \end{bmatrix}$.

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

Run

Reset

✓ **Correct**

Good job!

4. Referring back to Question 1, let $T = T_{sb}$ be considered as a transformation operator consisting of a rotation about $\hat{x}$ by -90° and a translation along $\hat{y}$ by 2 units. Calculate $T_1 = TT_{sa}$, and think of T_{sa} as the representation of the initial configuration of {a} relative to {s}, T as a transformation operation, and T_1 as the new configuration of {a} after performing the transformation. Are the rotation axis $\hat{x}$ and translation axis $\hat{y}$ of the transformation T properly considered to be expressed in the frame {s} or the frame {a}?

1 / 1 point

- (●) The frame {s}.
- ( ) The frame {a}.

✓ **Correct**

6. Referring back to Question 1, choose a point p represented by $p_s = (1, 2, 3)^\intercal$ in {s} coordinates. Calculate $q = T_{sb} p_s$. Is q a representation of p in {b} coordinates? 1 / 1 point

- ◯ Yes
- ◉ No

✓ **Correct**

7. Referring back to Question 1, a twist $\mathcal{V}$ is represented in {s} as $\mathcal{V}_s = (3, 2, 1, -1, -2, -3)^\intercal$. What is its representation $\mathcal{V}_a$? All elements of this vector should be integers. 1 / 1 point

Enter your vector in the answer box (just modify the vector already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[1,2,3,4,5,6] for $\begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$.

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

Run

Reset

✓ **Correct**

Good job!

8. Referring back to Question 1, calculate the matrix logarithm $[\mathcal{S}]\theta$ of T_{sa}. Write the rotation amount θ in radians with at least 2 decimal places. 1 / 1 point

```
1 2.0944
```

Run

Reset

✓ **Correct**

Good job!

11. Use the function **TransInv** in the given software to calculate the inverse of the homogeneous transformation matrix

1 / 1 point

$$T = \begin{bmatrix} 0 & -1 & 0 & 3 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

All elements of this matrix should be integers.

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1,2,3],[4,5,6],[7,8,9]] for $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$.

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

Run

Reset

Correct

Good job!

12. Write the $se(3)$ matrix corresponding to the twist $\mathcal{V} = (1, 0, 0, 0, 2, 3)^{\mathsf{T}}$. All elements of this matrix should be integers. Confirm your answer using the function **VecTose3** in the given software.

1 / 1 point

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1,2,3],[4,5,6],[7,8,9]] for $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$.

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

Run

Reset

Correct

Good job!

13. Use the function **`ScrewToAxis`** in the given software to calculate the normalized screw axis representation $\mathcal{S}$ of the screw described by a unit vector $\hat{s} = (1, 0, 0)$ in the direction of the screw axis, located at the point $p = (0, 0, 2)$, with pitch $h = 1$. All elements of this vector should be integers.

1 / 1 point

Enter your vector in the answer box (just modify the vector already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[1,2,3] for $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$.

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

Run

Reset

✓ **Correct**

Good job!

14. Use the function **`MatrixExp6`** in the given software to calculate the homogeneous transformation matrix $T \in SE(3)$ corresponding to the matrix exponential of

1 / 1 point

$$[\mathcal{S}]\theta = \begin{bmatrix} 0 & -1.5708 & 0 & 2.3562 \\ 1.5708 & 0 & 0 & -2.3562 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}.$$

All elements of this matrix should be integers.

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1,2,3],[4,5,6],[7,8,9]] for $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$.

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

Run

Reset

✓ **Correct**

Good job!

15. Use the function **MatrixLog6** in the given software to calculate the matrix logarithm $[\mathcal{S}]\theta \in se(3)$ of the homogeneous transformation matrix

1 / 1 point

$$T = \begin{bmatrix} 0 & -1 & 0 & 3 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

The maximum allowable error for any matrix element is 0.01, so give enough decimal places where necessary.

Enter your matrix in the answer box (just modify the matrix already shown there) and click "Run." Your answer will not be evaluated until you submit the quiz.

[[1.11,2.22,3.33],[4.44,5.55,6.66],[7.77,8.88,9.99]] for $\begin{bmatrix} 1.11 & 2.22 & 3.33 \\ 4.44 & 5.55 & 6.66 \\ 7.77 & 8.88 & 9.99 \end{bmatrix}$.

```
1 [[0,-1.5708,0,2.3562],[1.5708,0,0,-2.3562],[0,0,0,1.0000],[0,0,0,0]]
```

Run

Reset

Correct

Good job!