## Congratulations! You passed!

Grade received 80% | Latest Submission Grade 80% | To pass 80% or higher

Go to next item

**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],[0,0,1,1]]
```

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 $-90^\circ$ 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

**5.** Referring back to Question 1, use $T_{sb}$ to change the representation of the point $p_b = (1,2,3)^T$ (in {b} coordinates) to {s} coordinates. All elements of this vector should be integers. **0 / 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, 1, 4]
```

Run Reset

Incorrect

Try again!

6. Referring back to Question 1, choose a point p represented by $p_s = (1, 2, 3)^T$ 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 $\mathcal{V}_s = (3, 2, 1, -1, -2, -3)^T$. 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 $\theta$ in radians with at least 2 decimal places. **1 / 1 point**

```
1  2.0944
```

Run

Reset

Correct

Good job!

9. Calculate the matrix exponential corresponding to the exponential coordinates of rigid-body motion $\mathcal{S}\theta = (0, 1, 2, 3, 0, 0)^T$. The maximum allowable error for any matrix element is 0.01, so give enough decimal places where necessary. **0 / 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.**

[[1.11,2.22,3.33],[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  [[0.54, -0.84, 0.46, 1.8],[0.84, 0.54, 0.46, 1.5],[-0.46, 0.46, 0.83, 1.2],[0, 0, 0, 1]]
```

Run

Reset

Incorrect

Try again!

10. Referring back to Question 1, use $T_{sb}$ to change the representation of the wrench $\mathcal{F}_b = (1, 0, 0, 2, 1, 0)^T$ (in {b} coordinates) to {s} coordinates. All elements of this vector should be integers. **0 / 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  [0,0,0,0,0,0]
```

Run

Reset

Incorrect

Try again!

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

Run

Reset

**Correct**

Good job!