ME:4140 Modern Robotics & Automation
Homework #4

Due: see ICON

Make sure to upload any supporting documents, e.g., hand work, codes, sketches, etc.

Instructions (READ THESE FIRST!)

- To complete this homework, you can use an **Adobe** pdf reader or **Google Chrome** (after completing make sure to download with changes).
- Answer all questions by typing or selecting radio buttons in this document.
- Upload your completed document and any supporting documents, code, sketches, etc., to ICON.
- Round all values to 3 decimal places.

  Example #1: what is the value of Pi? Answer: 3.142
  Example #2: what is 100/3? Answer: 33.333

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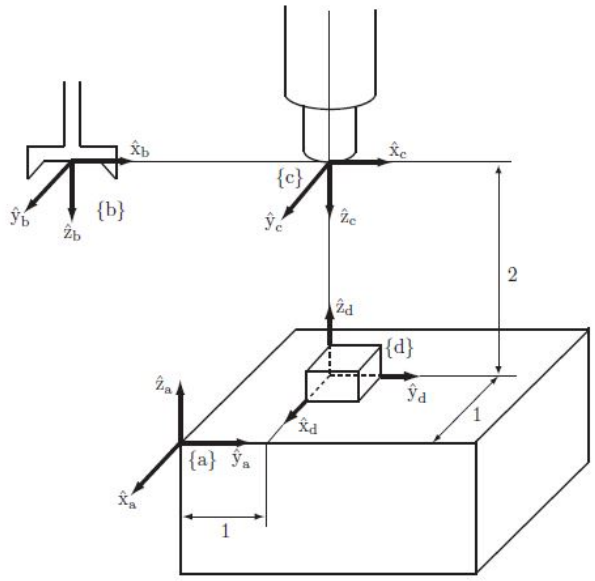
1. What is the screw axis $\mathcal{S}$ if $q = (1, 3, 6)$, $s = (3, 2, 1)$ and $h = 4$? (5)

0.802
0.535
0.267
0.802
6.682
-0.802

2. A robot has a workspace which contains four reference frames: fixed frame $\{a\}$, end-effector frame $\{b\}$, camera frame $\{c\}$ and workpiece frame $\{d\}$ as shown in the figure below. (20)



Determine the following:

(a) T_{ab} given that

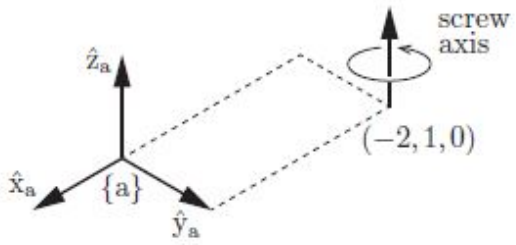
$$T_{bc} = \begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

0	1	0	-1
1	0	0	-4
0	0	-1	2
0	0	0	1

(b) If the twist in $\{b\}$ is $\mathcal{V}_b = (1, 2, 2, 0, 0, 0)$, what is the twist in $\{c\}$?

1
2
2
0
10
-10

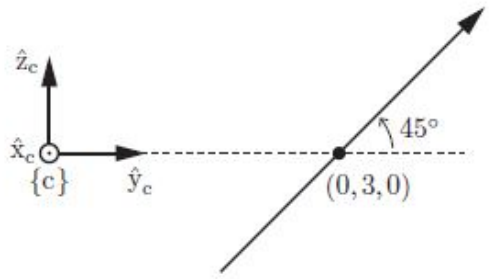
3. The zero-pitch screw axis shown in the image below, aligned with $\hat{z}_a$, passes through the point $(-2, 1, 0)$ in the $\{a\}$ frame. (15)



What is the twist $\mathcal{V}_a$ if we rotate about the screw axis at a speed of $\dot{\theta} = 7$ rad/s?

0
0
7
7
14
0

4. The figure below shows a screw axis in the $(\hat{y}_c, \hat{z}_c)$ plane, at a 45 degree angle with respect to the $\hat{y}_c$-axis. The $\hat{x}_c$-axis is aligned such that is points out of the page. The screw axis passes through the point $(0, 3, 0)$. (10)



Determine the following:

(a) If the pitch of the screw is $h = 5$ linear units per radian, what is the screw axis $\mathcal{S}_c$?

0
0.707
0.707
2.121
3.536
3.536

(b) If the speed of rotation about the screw axis is $\dot{\theta} = 2$ rad/s, what is the twist $\mathcal{V}_c$?

0
1.414
1.414
4.243
7.071
7.071