ECE 4560
Assignment 1

Due: August 29th, 11:59pm

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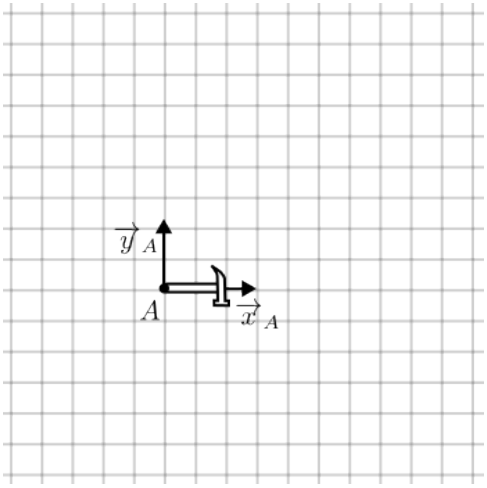
1. (0 points) Please denote the number of hours you spent on this homework (Feel free to also throw in a rating from 0-10). Please separate your time into homework vs. lab hours. I am *not* keeping track of effort per student, I just want to know if the homeworks are a reasonable length on average.

2. (3 points) Consider the diagram of a hammer below. The diagram illustrates the hammer in it's unrotated state, with the base of the hammer at the origin (you can assume the origin of frame A is located at $(0, 0)$). Please draw where the hammer would be (location and orientation) for the following three tranformations. Treat each transformation as a separate problem (i.e., all should be transformations from frame A).



   (a) Draw the new coordinate frame B given a transformation
   $g_{AB} = (\vec{d}^A_{AB}, R(\theta_{AB})) = \left(\begin{bmatrix} -1 \\ 5 \end{bmatrix}, R(\pi) \right)$.

   (b) Draw the new coordinate frame C given a transformation
   $g_{AC} = (\vec{d}^A_{AC}, R(\theta_{AC})) = \left(\begin{bmatrix} 4 \\ 0 \end{bmatrix}, R(-\pi/2) \right)$.

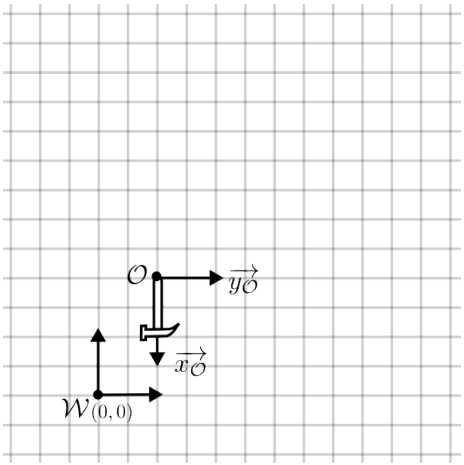
   (c) Draw the new coordinate frame C given a transformation
   $g_{AD} = (\vec{d}^A_{AD}, R(\theta_{AD})) = \left(\begin{bmatrix} 6 \\ 4 \end{bmatrix}, R(-30^\circ) \right)$.

3. (3 points) Now consider the point on the tip of the hammer (distance of $(2, 0)$ from the origin with respect to frame A, i.e., $\vec{p} = \vec{p}_A^A = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$). Solve for the location of this point for each of the three transformations in Question 1. (Hint: Note that it should match your drawing.) **Show your work!**. Please also keep track of which point you are solving for using the notation $\vec{p}_B^A$, $\vec{p}_C^A$, and $\vec{p}_D^A$. Remember our formulate to translate a point: $p_B^A = \vec{d}_{AB}^A + R(\theta_{AB})\vec{p}_A^A$.

4. (3 points) Now how would our expression for these points change if the frame A was actually at the coordinate $(2, 4)$ and orientation $-\pi/2$ with respect to a world frame? In other words, assume that the transformation between the world frame and frame A is provided by

$$g_{WA} = \left(\begin{bmatrix} 2 \\ 4 \end{bmatrix}, R(-\pi/2) \right)$$

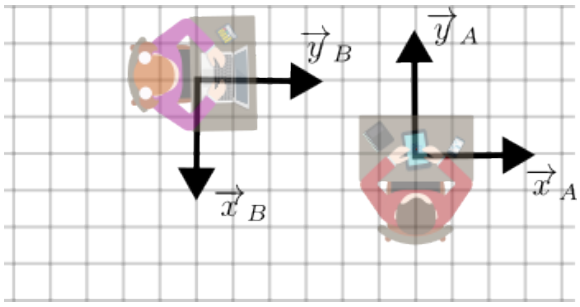
as shown below:



Given this transformation, solve for the hammer tip coordinates in reference to the world frame, i.e., solve for the points p_B^W, p_C^W, and p_D^W. **Show your work!**

(Hint: If you really wanted to get creative you could cut out your previous drawings and translate the whole drawing to match the new orientation of frame A).

5. (3 points) Assume that you and a friend are sitting at desks in a classroom, with your own local coordinate system aligned with your desk. Using the picture below, please describe the following transformations:



(a) (1 point) What is your friend's configuration relative to your own coordinate frame. Assume you are student A and your friend is student B.

(b) (1 point) What is your configuration relative to your friend's coordinate frame. Again, Assume you are student A and your friend is student B.

(c) (1 point) What is the transformation from your coordinate system to your friend's coordinate system?

6. **LAB COMPONENT:** The deliverables for the lab component this week are as follows.

   (a) (1 point) Visit lab (Van Leer E265) to check that you have access. This room will house the robot arms and turtlebots for the course. If you are interested in the biped project, these will be located in TSRB. Please note that the lab is a shared space with other classes. I recommend going during the TA office hours (there will be an announcement about this soon) so that you can meet the TA and ask him questions about the robots.

   (b) (1 point) Read through the documentation available on the course website about the various robotic platforms that currently exist through the class. Write a short paragraph about what robotic platform you are most interested in. Please describe why you are interested in this platform, and what you hope to learn from working with it.

   I will be available during office hours to discuss projects and help with brainstorming ideas. As a reminder, my office hours are Friday 10-11am and Tuesday 1-2pm in TSRB (Tech Square Research Building) office 442.

   (c) (1 point) After writing your paragraph, please sign up for a project group using the module on Canvas (I will show you how to do this in class on Tuesday). I recommend group sizes of 2-5 people. If you don't know anyone else in the class, the purpose of the Canvas module is to help with identifying other folks who are unpaired and seeing if they are open to pairing up. Additionally if you would like to work alone, please let me know and we can discuss this.