Question 1. Let bone1 and bone2 be two bones with length 1 as Figure 1a shows. The transformation of each bone is rigid and can be represented as: \( \mathbf{R} \mathbf{x} + \mathbf{b} \), in which \( \mathbf{R} \) is a rotation matrix, \( \mathbf{b} \) is a translation vector, and \( \mathbf{x} \) can be any point on the bone.

a. (1 point) Describe the transformation of bone1 and bone2 in Figure 1b, using the above formula.

![Figure 1: A simple arm.](image)

a. (1 point) Given a skin point \([1, 1, 0]\) in the original space (before transformation). If its bone interpolation weight is 0.5 and 0.5, what is its transformed location using the skinning method?
**Question 2.** (1 point) A specific requirement for the use of motion graph is that the start and end of the motion clips should not be too different from each other. If not, there will not a sudden jump when doing transition from one clip to another. In the lab assignment, motion clips are designed by animation artists and they can meet this requirement. But if you do motion capture and you have little control on the human motion, such a requirement is not easy to meet. Suppose that you captured a long human motion sequence. How will you use it for motion graph? (Hint: You can compare similarities between two poses.)

**Question 3.** (2 points) Co-planar test is an important step in continuous collision detection. Let \( p_0 = [0,0,0] \), \( p_1 = [0,0,1] \), \( p_2 = [0,1,0] \), \( p_3 = [1,0,0] \) be four points and \( v_0 = [0,0,0] \), \( v_1 = [0,1,0] \), \( v_2 = [1,1,0] \), \( v_3 = [0,0,1] \) be their velocities. Please derive the formula to compute the time when these four points are co-planar. (Hint: You may use Unity or calculator to compute dot and cross products. You don’t need to give the time solution.)

**Submission Guideline** Please submit your solution either in person or by email to our grader. If you finish it early, you may also give it to the professor after class.