Quiz #1 - CSU540 Computer Graphics - Fall 2005

Professor Futrelle - Given on Thursday, September 29th 2005

Linear Algebra and Geometric Transformations

Put your answers and all your calculations in your Blue Book. No calculator is needed or should be used. For example, a value such as $\sqrt{2}$ should be kept in that form, replaced by a parameter name you define, or approximated by a numerical value, whichever is appropriate.

Careful drawings are required in practically every question in this quiz. In drawing diagrams based on numerical values, a reasonable approximation suffices. You should write your answers using vectors in column format (needed for any matrix/vector work, for example).

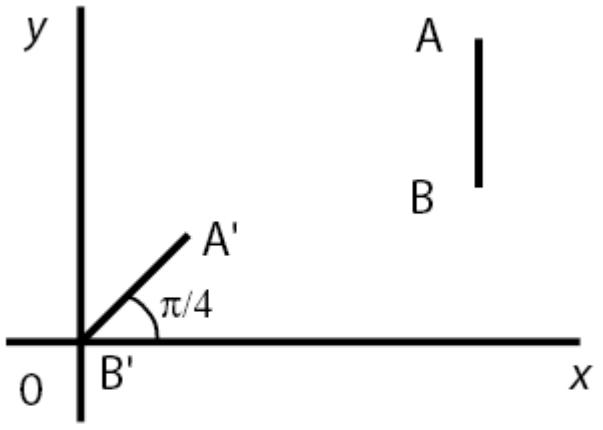
1. Draw the vectors A = [7,1] and B = [-7,1]. Draw and compute the sum C = A + B and the difference, D = A - B. Compute the normalized forms for C and D and confirm that they are normalized by computing their length.

2. Write out the rotation matrix for $\theta = -\pi/2$. Apply it to the endpoints of the line segment from [3,3] to [5,5]. Does the result agree with what you'd expect intuitively? Explain by comparing your computed result with a diagram describing the problem and solution.

3. Write out the 3x3 translation matrix for a translation by [tx,ty]. By multiplying out the components, show in general that the product of the matrix by itself (its square) produces a matrix corresponding to a translation of twice the extent, as we would expect.

4. Write out the 3D transform for $+\pi$ rotation around the z axis Apply it to the point [7,9,14]. Explain why you expected the result you obtained. Draw a diagram of the problem and solution as viewed along the z axis.

5. For the figure below, write out the transformation matrices to first, translate the line AB to the y-axis with B' at the origin, and then to rotate the line to the position shown. Apply each transformation separately to the coordinates shown to demonstrate that they accomplish the task. Then multiply the two matrices together to create a single transform and show that it accomplishes the task in one step.



A = 10,8 B = 10,5 B' = 0,0

6. The diagram below shows a sun, a planet, and its moon. Your task is to draw the changes to the scene caused by four successive transforms. You will not need to do any computations, but you will have to write down the sequences symbolically. (It goes without saying that these transformations may be of use to you in your Planets programming assignment.) Here are the transforms you are to consider:
    - Transform M_1:The planet and moon, considered as a unit, are translated so that the planet is centered at the origin.
    - Transform M_2: Applied to the moon only, rotates it around the origin about $-\pi/4$ radians.
    - Transform M_3: The planet and moon are translated as a unit so that the planet is at its original location.
    - Transform M_4: The planet and moon together are rotated about $+\pi/4$ around the origin.

    In addition, you are to do the following:

    - Write down the sequence of transforms that is applied to the planet as a product of the M_i in the correct order.
    - Write down the sequence of transforms that is applied to the moon as a product of the M_i in the correct order.