EXAM 1: Introduction to Computer Graphics CS480/580

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Your NAME:

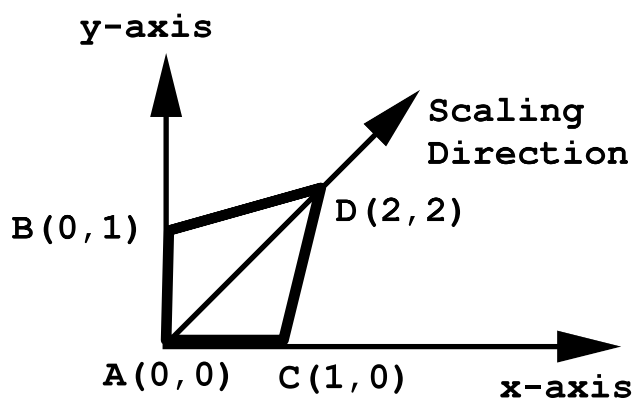
Do all FIVE questions. If you have any questions, please raise your hand and I will get to you. If you need more space to write the answer then use the back of the page. Note that 2-D/3-D transformation matrices are supplied with the exam.

Question 1 (a): (10 points) (2D rotation and scaling) Prove that 2D rotation and scaling commute only if $s_x = s_y$. Note: s_x and s_y are the scaling along x and y axis.

Question 1 (b): (5 points) (3D) Direction cosines of a vector are (a, b, c). Shear this vector to (0, 0, c). Give the Shear matrix and prove your answer.

Question 2: (15 points) (2D Clipping) Using parametric equations, find the intersection point of two lines. The first line starts at (-2, -2) and ends at (2, 2). The second line is a vertical line starting at (0,0) and ending at (0, 5).

Question 3: (20 points) (2D Scaling in arbitrary direction) Consider a polygon ABCD as shown in the figure below. Scale this polygon by a factor of 2 along the direction from point A at (0,0) to point D at (2,2). Derive the transformation matrix. Calculate the position of all the four points after the transformation. Show that they move in the desired direction. Would the position of point A at (0,0) also change? Why or why not? Explain your answer.
Note: $cos 45 = sin 45 = \frac{1}{\sqrt{2}}$.



Question 4: (20 points) (3D rotations) Direction cosines of two vectors are: (a, b, c) and (d, e, f). Use this information to find three orthogonal vectors (defining a right-handed coordinate system) so that one of them is parallel to the vector (d, e, f). Next, give a rotational matrix which will transform these three vectors so that (d,e,f) becomes parallel to the x-axis after the rotation.

Question 5 (a): (10 points) What is the main advantage of using homogeneous coordinate system for manipulating rotation, translation and scaling matrices? How would you represent a point at infinity in homogeneous coordinate system?

Question 5 (b): (20 points) (3D) A rectangular box is defined by a $\leq$ x $\leq$ d; b $\leq$ y $\leq$ e; c $\leq$ z $\leq$ f. Transform so that the box becomes: 2 $\leq$ x $\leq$ 4; 1 $\leq$ y $\leq$ 4; -1 $\leq$ z $\leq$ 2. Explain your transformation.