EXAM 1: Introduction to Computer Graphics CS480/580

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October 14, 2004

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) (View Volume, Direction of Projection) Given the View Reference Point VRP = (0,0,0), View Plane Normal VPN = (0,0,1), View Up vector VUP = (0,1,0), Projection Reference Point PRP = (1,1,1), \((u_{min}, v_{min}) = (2, 4)\), and \((u_{max}, v_{max}) = (6,8)\).

Calculate the direction of projection (DOP). Then, approximately draw the parallel projection view volume. *Explain* your answer.
Question 1 (b): (10 points) (Vector and Raster Display) What is the main advantage of a raster display over a vector display?
Question 2: (20 points) (2D Cohen-Sutherland Algorithm) Explain the working of the Cohen-Sutherland algorithm by applying the algorithm to the situation below. First find the outcodes for all the six points A, B, C, D, E and F. Next, identify which line is a case of trivial accept and trivial reject. How is the situation handled when a line can not be trivially accepted or rejected? Explain your answers.
Question 3: (20 points) (2D Scaling in arbitrary direction) Consider a unit square ABCD as shown in the figure below. Scale the unit square by a factor of 2 along the direction from point A at (0,0) to point D at (1,1). Derive the transformation matrix. Calculate the position of all the four points after the transformation. Would the position of point A at (0,0) also change? Why or why not? Explain your answer.

Note: \( \cos 45 = \sin 45 = \frac{1}{\sqrt{2}} \).

![Diagram of a unit square with points A, B, C, D and a scaling direction vector from A to D.](image)

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\begin{align*}
A(0,0) & \quad B(0,1) \\
C(1,0) & \quad D(1,1)
\end{align*}
\]
Question 4: (20 points) (3D rotations) Three points $P_1$, $P_2$ and $P_3$ are given. $P_1$ is at the origin (0, 0, 0). Direction cosines of line $P_1P_2$ are (a,b,c). Direction cosines of $P_1P_3$ are (d,e,f). Note that $|P_1P_2| = 1$, and $|P_1P_3| = 1$.

Find the transformation matrix such that point $P_2$ is on the x-axis at (1,0,0), and point $P_3$ is on the positive y-half of the x-y plane. Explain your answer by discussing every step of your transformations and their effect.
Question 5: (20 points) (3D Transformations) Given a unit cube with one corner at (0, 0, 0) and the opposite corner at (1, 1, 1), derive the transformations necessary to rotate a cube by $\theta$ degrees about the edge from (1, 1, 0) to (1, 1, 1) in the counterclockwise direction when looking from point (1, 1, 1) towards the point (1, 1, 0). Explain your answer by discussing every step of your transformations and their effect.