

Sign the exam with your student number - not your name \_\_\_\_\_

Answer the following questions to the best of your ability.

1. (20 pts) It is common to clip against a standard volume, say the unit cube:

$$0 \leq x \leq 1, \quad 0 \leq y \leq 1, \quad 0 \leq z \leq 1.$$

Construct a matrix that will map an arbitrary cube

$$a \leq x \leq b, \quad c \leq y \leq d, \quad e \leq z \leq f$$

onto the unit cube.

2. (20 pts) In clipping to the unit cube it is common to use “out-codes” to quickly determine trivially visible and invisible line segments. Explain how to this is done.

3. (10 pts) Given two points:  $p_0 = (x_0, y_0, z_0)$  and  $p_1 = (x_1, y_1, z_1)$ , give the *parametric equation of the line segment* between them.

4. (50 pts) Pretend the line segment from  $p_0$  to  $p_1$  can not be trivially accepted as visible or trivially rejected as invisible. Also, pretend you want to clip it against the plane containing the left face of the cube:  $x = 0$ ,  $0 \leq y \leq 1$ ,  $0 \leq z \leq 1$ .

(a) (10 pts) What is the unit length normal vector to the left face?

(b) (10 pts) How would you determine if the line segment from  $p_0$  to  $p_1$  is potentially entering or potentially leaving with respect to the plane of the left face?

- (c) (10 pts) How would you determine the parameter value where the line segment from  $p_0$  to  $p_1$  intersects the plane of the left face?
- (d) (10 pts) What conditions on the parameter value determine that the line segment does or does not intersect the plane of the left face?
- (e) (10 pts) As you apply the procedure you have just describe to the remaining five (5) faces of the unit cube, how do you determine the ultimate parameter values where the line segment will be clipped (if the line segment is partially visible), or that the entire line segment will be discarded (if the line segment is not visible within the unit cube)?