**UNIVERSITY OF CALIFORNIA**
**College of Engineering**
**Department of Electrical Engineering**
**and Computer Sciences**
**Coputer Science Division**

# Computer Science 184 - Computer Graphics

# Fall 1992 - Midterm Exam

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Question 1: **Transformations** [20 points]

Figure 1 shows a triangle ABC transformed by a transformation matrix **T** to a new position PQR.

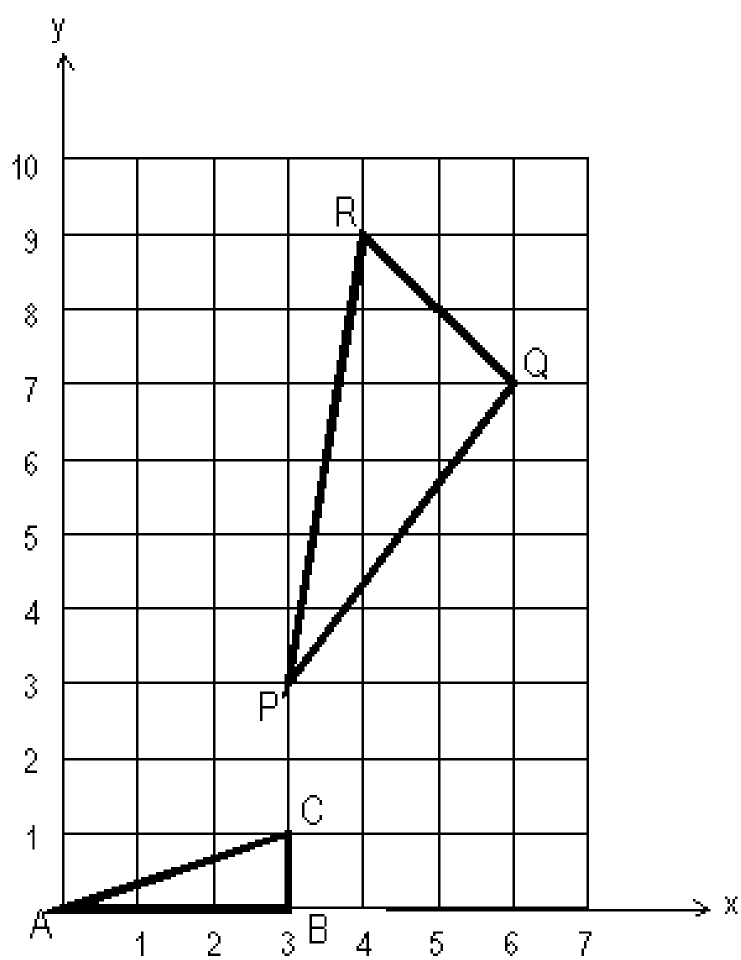


Figure 1

A) Write down the transformation matrix **T**. Show all work. [17 points]

B) If the problem was to compute the inverse matrix $\mathbf{T}^{-1}$, i.e. if the original triangle was PQR which gets transformed by $\mathbf{T}^{-1}$ to ABC, is there enough information to compute all the elements of $\mathbf{T}^{-1}$? [3 points]

Answer 1: **Transformations**

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Question 2: **Scan Conversion** [20 points]

A) For each of the 18 regions labeled a-r in figure 2, fill in the chart below with the words "IN" or "OUT" which represent what the particular scan conversion rule (odd/even vs. non-zero winding) would conclude about that region. [13 points]

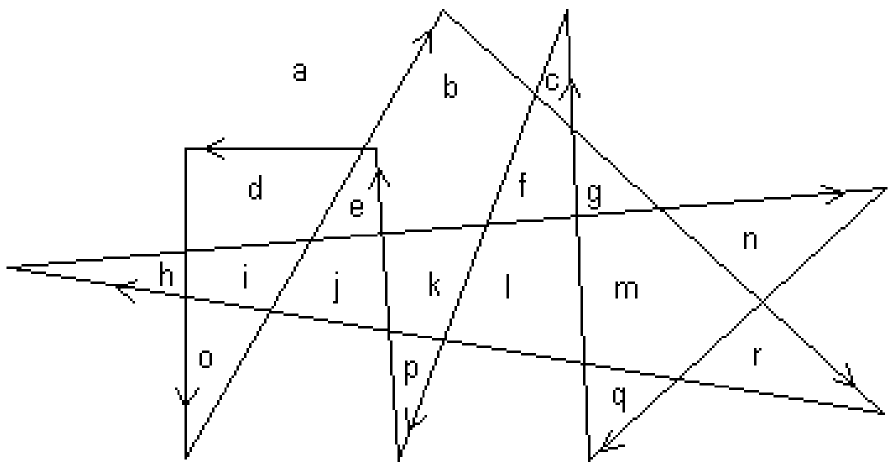


Figure 2

B) What is the minimum number of edges a polygon would need so that the non-zero winding rule and odd/even rule have differenet answers for a particular region of a polygon? Draw it, highlight the region wich is labeled differently and tell which rule labeled it in and which one out. [7 points]

Answer 2: **Scan Conversion**

| Label | Odd/Even | Non-zero Winding |
|---|---|---|
| a | | |
| b | | |
| c | | |
| d | | |

| | | |
|---|---|---|
| e | | |
| f | | |
| g | | |
| h | | |
| i | | |
| j | | |
| k | | |
| l | | |
| m | | |
| n | | |
| o | | |
| p | | |
| q | | |
| r | | |

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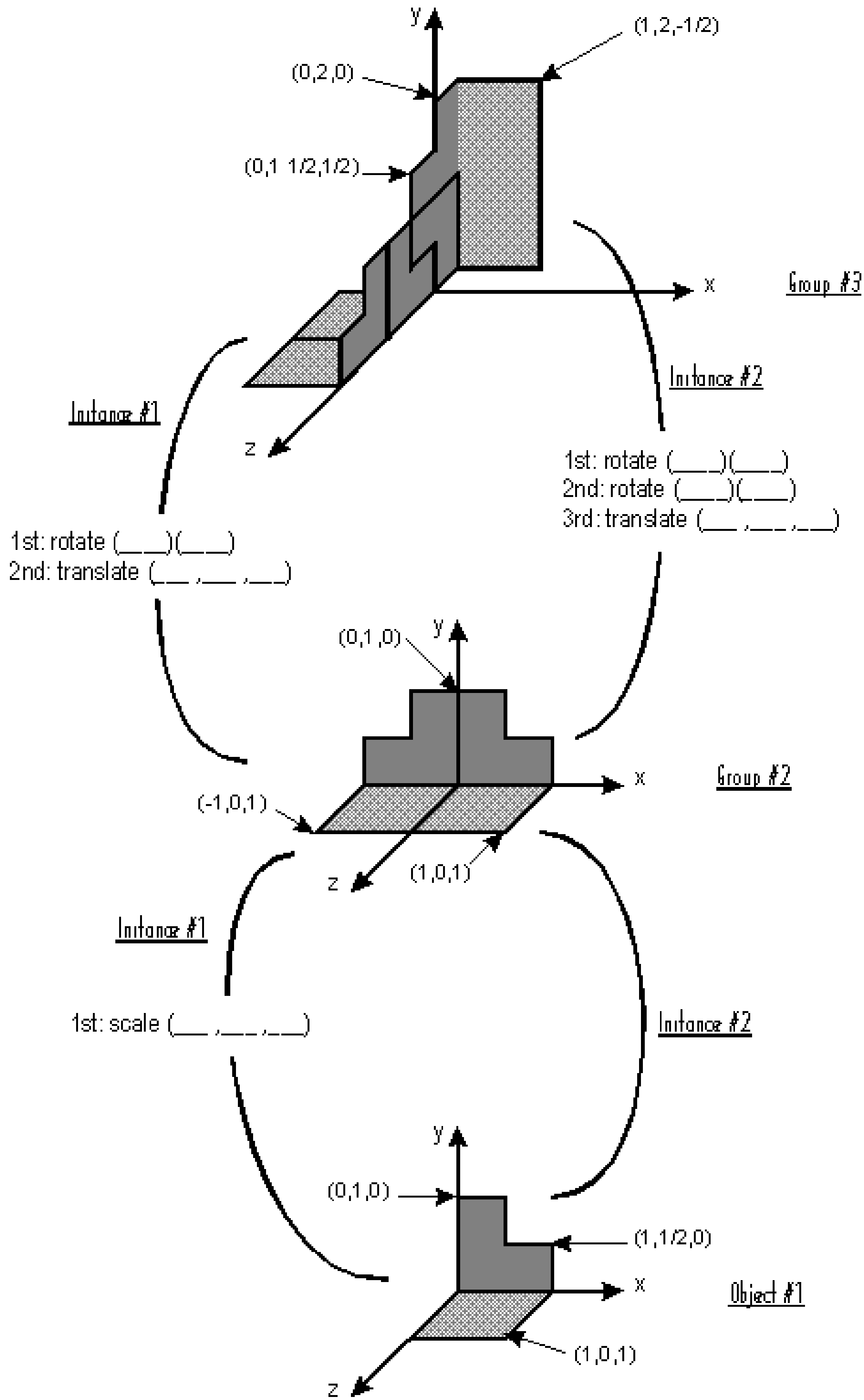
Question 3: **Hierarchial Modeling** [20 points - 10 points this page, 10 points next page]

A) The following diagram represents a hierarchial object description which might be found in a SDL file. Fill in the missing arguements to the transformation statements so that object #1 is instanced correctly in group #2 and group #2 is instanced correctly in group #3. [10 points]

The transformation statement format is: rotate (axis) (degrees), translate (tx,ty,tz) and scale (sx,sy,sz). Note that the axes are in a right handed coordinate system, as in SDL and GL, therefore use the right hand convention for rotations.

Answer 3: **Hierarchial Modeling**


y
(1,2,-1/2)
(0,2,0)
(0,1 1/2,1/2)
x
Group #3
z
Instance #2
Instance #1
1st: rotate (____)(____)
2nd: rotate (____)(____)
3rd: translate (___ ,___ ,___)
1st: rotate (____)(____)
2nd: translate (___ ,___ ,___)
(0,1,0)
y
x
Group #2
(-1,0,1)
z
(1,0,1)
Instance #1
1st: scale (___ ,___ ,___)
Instance #2
y
(0,1,0)
(1,1/2,0)
x
Object #1
(1,0,1)
z

Question 3: **Hierarchial Modeling** (continued)

B) The composite object show in part (A) could be represented alternatively as a list of verticies and faces in group #3, without the hierarchy of transformations. List some advantages and disadvantages of both the hierarchial and non-hierarchial modeling schemes. Consider the problem of rendering, animation, storage and anything else you can think of. [10 points]

Answer 3: **Hierarchial Modeling**



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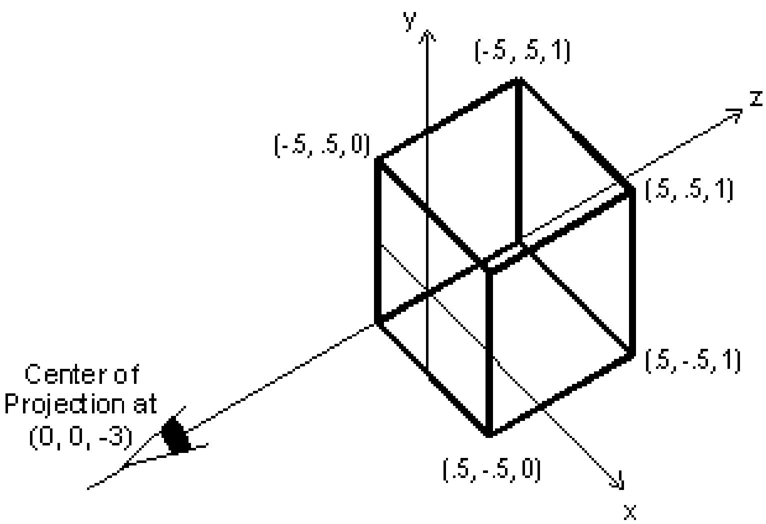
Question 4: **Projections** [20 points]

A unit wireframe cube is centered at (o,o,.5) in the left-handed picture-plane coordinate system as shown in figure 3 below. The plane of projection is the x-y plane. If the center of projection (COP) is at $(0,0,-\infty)$, the projection of the cube onto the projection plane is shown in figure 4.



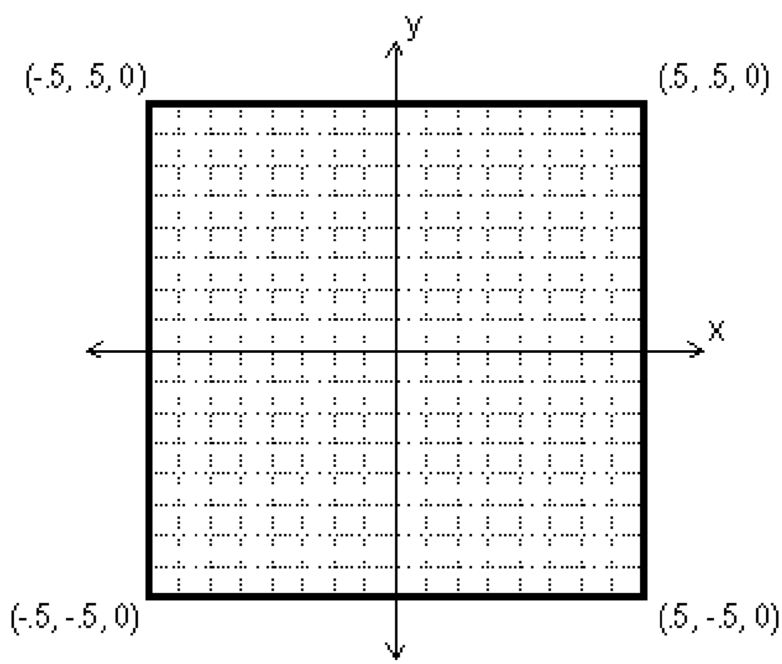
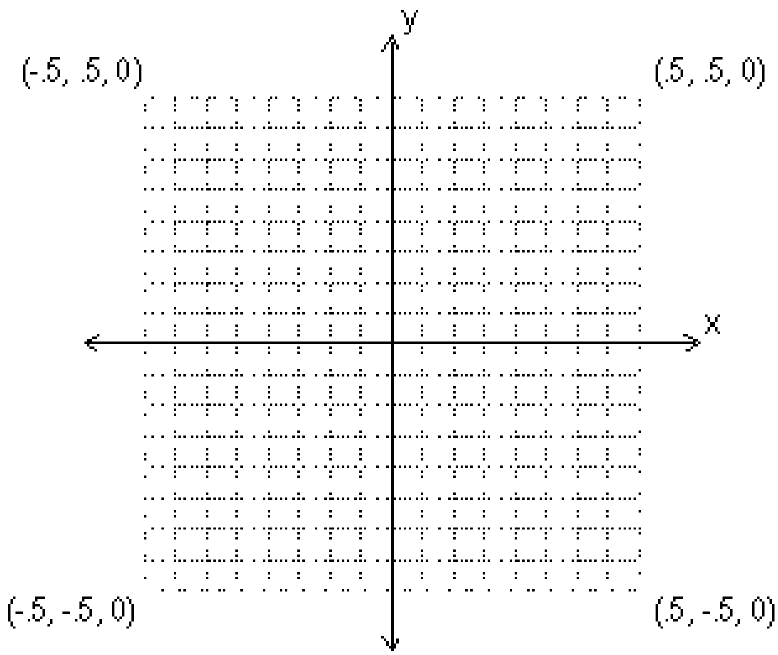




Figure 4: Projection onto x-y plane if COP at $(0, 0, -\infty)$

A) If the COP is moved to (0,0,-3) as shown in figure 3, draw the resulting projection in the grid provided below. Show all work - a sketch with no algebra will receive very little credit. [10 points]

B) The COP remains at (0,0,-3). The cube is deformed such athat its projection is exactly that of figure 4. Note that there are infinitely many deformations that generate the same projection. Assume the deformation *does not* scale the cube along the z-axis (i.e. z-coordinates are unchanged). What are the coordinates of the verticies of the cube afer deformation? [10 points]

Answer 4: **Projections**




Draw your projection for part (A) above



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Question 5: **User interface Considerations** [20 points]

In your "Polygon Entry" assignment you created polygons by clicking in the window to add verticies and then clicked a different way to signify that you were done. Here we consider user interface issues related to the *deletion* of verticies. A fellow student (who didn't attend the 2-D Interaction lecture) suggests the following interaction technique:

```
1) Type Esc-Shift-Control-7, which tells the computer the user is ready to
choose the single vertex to remove.

2) Type the pixel coordinates of the vertex in the folllowing format
exactly: "[{4-digit-X-location},{4-digit-Y-location}]". e.g. "[{0123},
{0056}]" for the vertex at point (123,56)

3) Type "REMOVE_THE_VERTEX_NOW"
```

A) Describe briefly three distinct, fundamental problems with this suggestion. [9 points]

B) You are hired by the Nanosoft™ corporation to implement the delete-vertex module in a large 2-D draw-style program. You are given an entire semester to create the most flexible and powerful module possible. Your users will be people of all ranges of computing skills - from novices to experts. Assume you have at your disposal the standard draw selection tools. Describe (at a user level, not a programming level) the mouse-oriented techniques you would use for removing verticies. Explain reasons behind the decisions you make. [11 points]

Answer 5: **User interface Considerations**

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