UNIVERSITY OF CALIFORNIA

Dept. EECS/CS Div.

CS 184 - Spring 1998 FOUNDATIONS OF COMPUTER GRAPHICS Prof. C.H.Sequin

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TAKE HOME QUIZ #2

Your Name:_______________________ Your Class Computer Account: cs184-______________

INSTRUCTIONS (Read carefully !)

YOU MAY USE YOUR LECTURE NOTES AND ANY TEXT BOOK TO DO THIS QUIZ.

On the in-class exams, you will be allowed one double-sided sheet of size 8.5 by 11 inches of your own personal notes to assist your memory. It might be worthwhile to start preparing and 'test-driving' such a sheet now. It should take you less than 2 hours to complete the Quiz. The number of points assigned to a question indicates the number of minutes you should allocate.

YOU MUST DO THIS WORK ENTIRELY BY YOURSELF.

There must be no discussion of any of the problems with anybody until after the deadline.

DO ALL WORK TO BE GRADED ON THESE SHEETS OR THEIR BACKS.

If any questions on the exam appears unclear to, write down what the difficulty is and what assumptions you made to try to solve the problem the way you understood it.

I HAVE UNDERSTOOD THESE RULES AND WILL OBEY THEM:

Your Signature: ____________________________________

DO NOT OPEN UNTIL YOU ARE ALONE AND HAVE SIGNED ABOVE.

HAND-IN THE EXAM TO PROF. SEQUIN ON OR BEFORE 9:10AM, WED, March. 11, 1994.

Problem #0 (5 points) - Please give us some feedback.

Tell us something that you especially like about the course, lab, instructor, or TA's:

Tell us something about the course, lab, instructor, or TA's that could use improvement:

Problem #1 (10 points) - Circle the correct answer.

| TRUE | FALSE | In 3-space, mirroring on an arbitrary plane through the origin and uniform scaling with respect to the origin are commutative.

| TRUE | FALSE | In a right-handed coordinate system, a +90 degree rotation around the y-axis will take the +x-axis into the +x-axis.

| TRUE | FALSE | A rotation about an arbitrary axis and a translation along the same axis applied in any order yield the same result (are commutative).

| TRUE | FALSE | If we change the frustum specification, we see the same part of the object/world drawn at a different place on the display.

| TRUE | FALSE | In a perspective view in 3-space, as the observer moves forward along the line-of-sight (the -n-axis), the projected image appears to grow with uniform scaling (assuming that the observer stays far enough from the scene so that no points fall behind the viewers eye).

| TRUE | FALSE | Increasing the absolute distance between an object being viewed with a perspective projection and the image-plane, reduces the image of the object.

Problem # 2 (20 points) – Short Questions (Think before you write !).

(a) In what direction does the {+z}-axis point after a −90

° rotation around the x-axis (in a right-handed coordinate system)?

(b) The point at infinity in the direction (a,b,c) in 3-space can be expressed as { (t*a,t*b,t*c) for t -> infinity}. Express this point in homogeneous coordinates:

(c) What are the minimum and maximum number of clipping planes that a line segment may intersect, when it is clipped against the truncated viewing pyramid in 3D:

$-z$

$\leq x \leq z;\ -z \leq y \leq z;\ zB = -1 \leq z \leq zF < 0$?

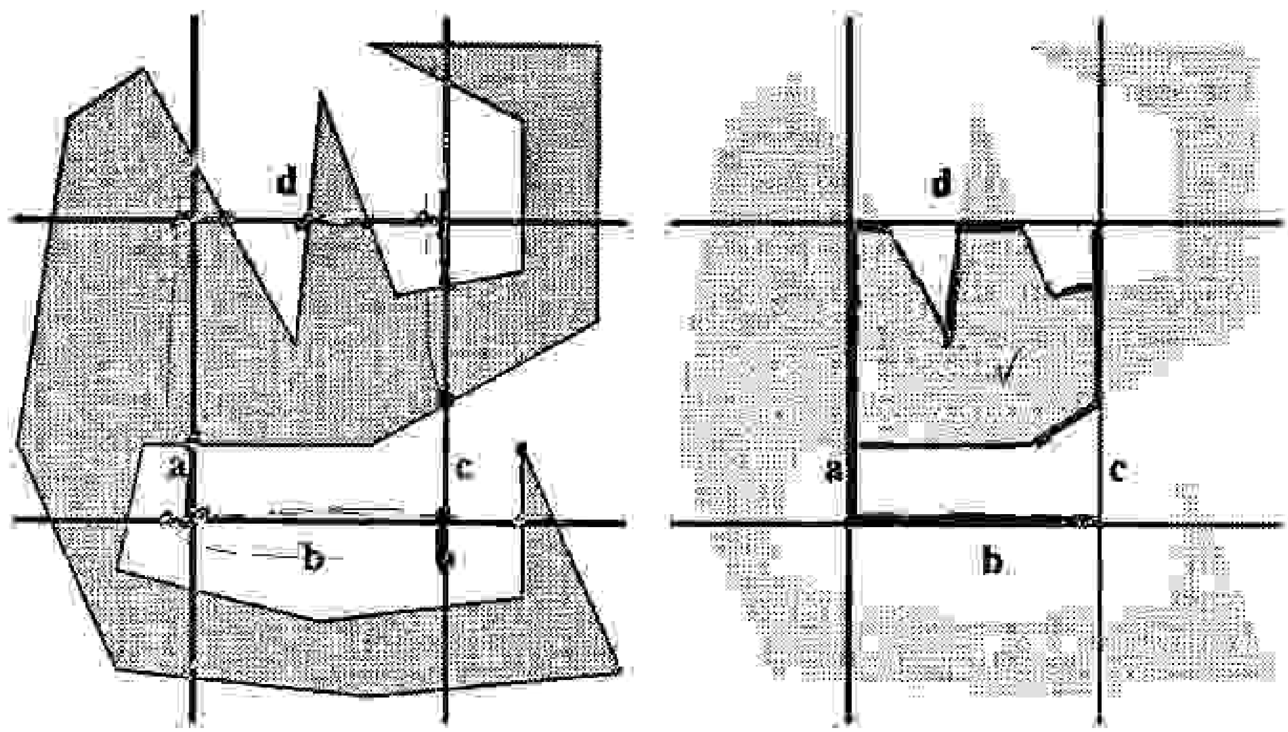
MIN: ______________________ MAX: ____________________________

(d) What test would you apply to determine whether a face on a convex polyhedral solid is illuminated by parallel light shining in the direction (dx,dy,dz)?

(e) Explain why backforce elimination in an orthographic parallel projection is easier than in a perspective projection:

Problem # 3 (10 points)

Show the polygon contour(s) that will be output from the Sutherland-Hodgman polygon clipping algorithm for the polygon shown below. Assume that the clipping sequence is : a,b,c,d. Use the left figure as your working space. Show the final result in the right figure by strongly tracing out all output line segments.



Problem #4 (10 points)

We want to perform an orthonormal parallel projection down the z-axis onto the xy-plane, so that the four points {A,B,C,D} defined in homogenous coordinates "fill" the viewport, (i.e., the viewport boundary forms an axis-aligned bounding box around the projected points):

A=(-1,0.3,2,0.1); B=(-4,12,-16,2); C=(6,12,18,6); D=(2,-1,1,0.5);

Fill in the relevant fields in the following GLIDE statements:

camera MagicShooter

```
projection _ _ _ _ _

frustum ( , , )( , , )

endcamera

group CameraGrp

camerainstance MagicShooter

           id Magic123

           translate ( , , )

endcamerainstance

endgroup
```

Problem #5 (10 points)

How many degrees of freedom (DOF) for the following systems? (Fill in the table).

SYSTEM	DOF
Any Possible Triangle in 2D	
Infinite Planes in 3D	
Unit Quaternions	
Circular Discs in 3D	

Problem #6 (15 points)

In a two-dimensional world two tame guinea pigs, "Alfy" and "Beady", sit on the xy-plane, Alfy at (-20,0) and Beady at (+20,0). They face each other. Alfy's coordinate system is parallel to WORLD; Beady's is rotated 180 degrees. Both individually follow the command sequence:

Turn right 62

° --> go forward 35 --> turn left 87° --> go forward 16

Express the following relative positions as a string of basic transformation matrices for use with points expressed in ROW VECTOR notation, use the symbols T(dx,dy),S(sx,sy), R(

α).

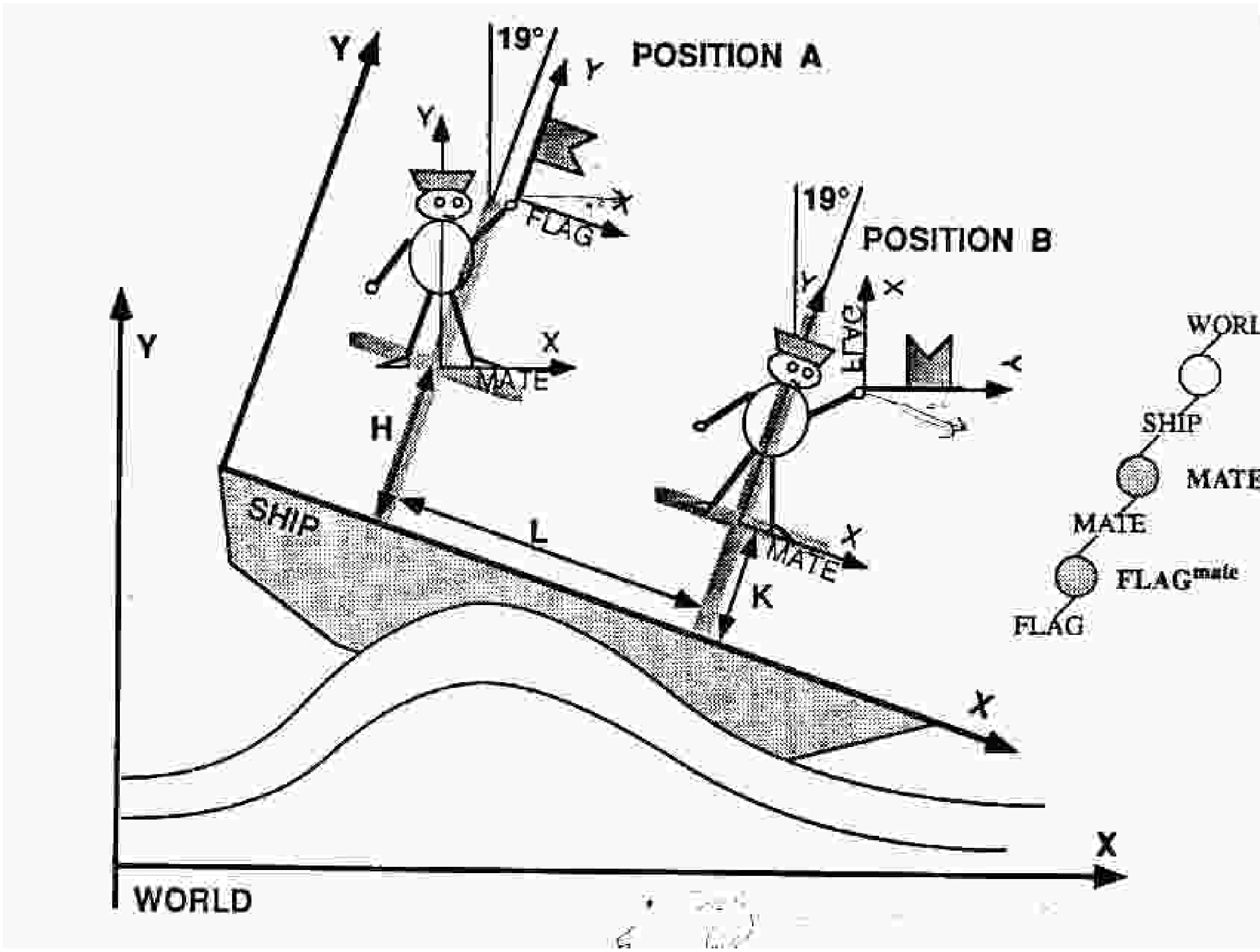
* Describe Alfy's poistion with respect to world: $ALFY^{WORLD}$

* Describe Beady's position with respect to world: $BEADY^{WORLD}$

*Describe Beady's position with respect to Alfy: $BEADY^{ALFY}$

Problem #7 (15 points)

For the two-dimensional scene below, describe the relative change in positioning for the MATE and for the FLAG from POSITION A to POSITION B, expressed as a modification of the old matrices: $FLAG^{MATE}$ and $MATE^{SHIP}$. Employ a minimal concatenation of additional matrices composed of strings of simple matrices of type T(dx,dy),S(sx,sy), and R(a), using as parameters only the dimensions and angles shown in the figure. (Assume the use of homogeneous ROW coordinate triple.) {HINT: Pay careful attention to the rotation of the FLAG ! }



MATE^{SHIP} (modified) = _ _ _ _ _ _ _ _ _ _ _ MATE^{SHIP} (old)_ _ _ _ _ _ _ _ _ _ _

FLAG^{MATE} (modified) = _ _ _ _ _ _ _ _ _ _ _ FLAG^{MATE} (old)_ _ _ _ _ _ _ _ _ _ _

Problem # 8 (20 points)

A tourist with a camera rides upwards in the glass elevator of the SF Hyatt Regency Hotel. We assume that the elevator shaft defines the +z-axis and the "up"-direction of WORLD. Thus the COP as a function of time will be located at: (0,0,z(t)), where z(t) = 10 units/sec * t(in seconds), and this should be the center of the View-Reference coordinate system.

The tourist keeps her camera focused on a rare plant on the hotel lobby at the WORLD coordinates (800,600,0). This plant is the center of attention and defines the VRP.

First define a suitable GLIDE lookat transformation for the camera.

Then write down a product of homogeneous 4by4 matrices with time-dependent components that express the View-Orientation Matrix for points expressed in COLUMN vectors.

{No need to multiply out the various matrices!}

Explain your approach in a couple of sentences.

Problem #9 (10 points)

Prove (with a few mathematical equations) that 2D rotation and 2D scaling commute if $s_X = s_Y$, and that otherwise they do not. Keep your proof simple (3 to 4 lines)!
