Name:_____

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ECSE-4750 Computer Graphics, Fall 1998
Handout final*
Final Exam

December 6, 1998

Rules

1. You may have two 2-sided 8.5 inch x11 inch note sheets, which may be mechanically printed.
2. You may have your blank paper, calculator, pens, etc.
3. You may not communicate with anyone, except Sutha or me.
4. Answer all questions. Brief, concise, answers are preferred.
5. Spend time on a question proportional to its number of points.
6. Note that the last page is number **final–11**.
7. Start immediately. You have until 1:50.
8. Try to write legibly.
9. Write your NAME on top of this page.
10. Try to write your answers on these question sheets, tho extra paper is allowed. If an answer is on an extra sheet, say so in the normal space on this sheet.
11. Not all questions can be answered by repeating a memorized answer. Some require actual thinking about the material covered in class.

12. Leave the small oval boxes blank; they're for our grade.

Exam

X

1. ( )/[3] For X/Motif and Tcl/Tk, pick which one best satisfies each criterion:
   (a) ease of use,
   (b) efficiency of execution,
   (c) availability of source code.

Intro

2. ( )/[1] What is the most important technical advance that made frame buffers feasible?

Algorithms

3. ____/[1] What should be done with people who colorize classic B&W movies?

4. ____/[1] What property of many modern CPUs makes *if* statements undesirable in tight loops?

5. ____/[2]

In this version of the Bresenham circle algorithm, look at the comment.

```
y=r;
d= -r;
pixel(0,r);
for(x=1;x<r/sqrt(2);x++)
{  d+= 2x-1;
   if (d>=0)
   {  y--;
      d -= 2y; /* Must do this AFTER y-- */
   }
   pixel(x,y);
}
```

Would we still get the right answer if we ignored the comment, and swapped the two statements thus:

```
...
   if (d>=0)
   {  d -= 2y; /* Must do this AFTER y-- */
      y--;

   }
...
}
```

Why (not)?

6. ____/[1] Is *PostScript bitmapped* or *outline*? (I mean in the usual case; PostScript can do both.)

7. ____/[2] Name two ways to make a type face harder to electronically eavesdrop via the CRT's radiation. Use at most 5 words for each way.

8. ____/[1] How many bits is an ISO-8859 character?

9. ____/[2] What is kerning? Give an example.

10. This is about the Sutherland-Hodgman paper and patent.

    (a) ____/[1] Why do you want to clip a line against a front (aka hither) clipping plane before

projecting?

(b) ____/[2] Draw an example where the original polygon is connected, but the clipped result isn't.

Hardware

11. ____/[1] How does an *active matrix* flat-panel display differ in design from a *passive matrix* one? I.e., what makes it more expensive and better looking?

12. ____/[1] Which hardcopy device might remind you of the movie *Animal House*?

13. Computer monitors tend to use an RGB color space, but color NTSC TVs do not.

(a) ____/[1] What space do they use?

(b) ____/[1] How does the choice of first axis make color NTSC more compatible with something or other?

14. ____/[1] In color NTSC, moving objects with sharp edges may exhibit *dot crawl*, which is little beads of color running along the edges. What's going on here?

Transformations

15. ____/[2] Suppose that the matrix $\mathcal{A}$ represents a rotation operation, and $\mathcal{B}$ represents a parallel projection. Remember that in this course we represent points as vertical vectors, and multiply them on the left by matrices. What is the matrix for the projection followed by the rotation?

16. ____/[1] Why can a rotation matrix never have an eigenvalue of 2?

17. ____/[2] I'm trying to rotate the square with opposite corners at (0,0) and (1,1) many times by a small angle, $\theta = 0.1^o$, by applying the usual 2D rotation matrix. $\cos\theta = 0.99984770$, and $\sin\theta = 0.00174524$, both to within 10^{-8}. Therefore,

$$M = \begin{bmatrix} 0.99984770 & 0.00174524 \\ -0.00174524 & 0.99984770 \end{bmatrix} \quad (1)$$

The problem is that after I use Matlab to apply this matrix 3600 times, which is one complete rotation, the area of the rotated square is only 0.3377, down from 1. What test on the matrix could have told me that this would happen, including giving the actual resulting area, without my having actually to rotate the points?

18. ____/[1] Give a homogeneous coordinate matrix for scaling any given homogeneous vector (x, y, z, w) to half its cartesian length.

19. ____/[2] Rotate the 3D point (0,1,0) about the axis (0.577, 0.577, 0.577) by 180 degrees.

20. ____/[2] Consider the function $F(p) = (a \times p)$, where a and p are 3-D Cartesian vectors, and $a = \begin{pmatrix} 7 \\ 6 \\ 5 \end{pmatrix}$. Find a 3x3 matrix M, such that $F(p) = Mp$.

21. ____/[1] Do 2D rotations commute, that is, if $\mathcal{A}$ and $\mathcal{B}$ are two 2D rotation matrices, is $\mathcal{AB} = \mathcal{BA}$ always, usually, occasionally, or never?

Projection

22. ____/[2] One advantage of homogeneous coordinates is that points at ∞ can be represented. What is the homogeneous coordinate representation for the point at ∞ on the line $y = x - 3$?

23. This question requires some original thinking about homogeneous coordinates. To keep it simple, I'll use 2-D points, which have 3 homogeneous components: (x, y, w).

    Pairs of cartesian points have equations of lines thru them, such as (1,0) and (0,1) are on the line $x + y - 1 = 0$. Similarly, a pair of homogeneous points has a line thru them, and it has an equation. (1,0,1) and (0,1,1) are on the line $x + y - w = 0$. Note the similarity. Note that (2,0,2)

and (10,5,15) work also, as they should. All homogeneous line equations can be written in the form $\alpha x + \beta y + \gamma w = 0$ for some α, β, γ.

(a) ____/[2] What would be the equation of the homogeneous line thru the homogeneous points (0,1,0) and (0,0,1)?

(b) ____/[2] What would be the point that is on that line and also on the line $x - y - w = 0$?

Visible Surface Determination

24. ____/[2] Draw an arrangement of polygons that the painters algorithm would not be able to handle, w/o some modification, such as splitting one polygoninto two parts.

25. ____/[1] Suppose that you have a scene with a lot of closed polyhedra that you are about to process with a Z-buffer algorithm. What's the simple technique that will double the speed?

26. ____/[2] How can antialiasing be added to raytracing?

Illumination and Shading

27. For Phong and Gouraud shading, which

    (a) ____/[1] represents highlights better?

    (b) ____/[1] is faster to execute, or similarly, uses less HW to implement?

28. ____/[2] What is bump mapping? Why is it useful?

Misc

29. ____/[1] *Weighted area sampling* is a solution to what problem mentioned in class?

30. ____/[1] What is *MathML*?

Total: 50 points
End of exam

Notes

1. Please return any books that you have borrowed from me.
2. Grades should be ready by next week. We'll email them, or you may phone Sutha or me.
3. You may examine your graded exam, but not keep it (you may have a copy if you want). We will gladly correct solid, definite, unambiguous, grading errors.
4. You're welcome to ask me graphics, or other, questions, in the future (if you can find me). I might even have answers.
5. Have a good vacation.
6. I might also be willing to sign off on independent reading courses on this next semester. The way that this works is that you do all the work on your own, then you write a report on what you did, and get a grade.