Name:_____

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# 35.475 Computer Graphics, Spring 1998
# Handout 19*
# Final Exam

April 28, 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 Helen 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 **19–9**.
7. Start immediately. You have until noon.
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. 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. (a) ☐/[1] What property of many modern CPUs makes *if* statements undesirable in tight

loops?

(b) ____/[1] How was the Bresenham line algorithm modified because of that?

4. ____/[2] Which of the following 3 methods will draw the most accurate circle $y = \sqrt{100 - x^2}$ over the interval $0 \leq x \leq 71$, given the same number of terms in the approximation? Which method will be second best?

   (a) a Taylor expansion about $x = 0$.

   (b) a Taylor expansion about $x = 35$.

   (c) a Chebyshev expansion over the interval $[0, 71]$.

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] Suppose that I draw a circle of radius 25 thus on a $1024 \times 1024$ display:

$$\begin{aligned} x &= 25\cos\theta \\ y &= 25\sin\theta \end{aligned}$$

What should $\Delta\theta$ be, in radians?

7. ____/[2] Name one advantage and one disadvantage of using outline character fonts instead of bitmapped chars.

8. Characters are normally typeset by assuming a rectangle around each char, and placing the rectangles adjacent to each other. That works well in most cases, such as this: **ABCDEFGHIK**. However, sometimes it causes apparent gaps, like between A and V here:
   **AVXAVXAVXAVX**.

   (a) ____/[1] What's the name of the fix in PostScript?

   (b) ____/[1] How does it work?

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

   (a) ____/[2] Draw an example of a polygon and a clip window, where the clipped polygon will have twice as many vertices as the original one.

## **H**ardware

10. ____/[1] What is the relevant property of liquid crystals that makes them useful in displays?

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] What limits the practical resolution of color CRT monitors?

13. ____/[3] Give three reasons why color printers have black ink in addition to magenta, cyan, and yellow, since those three should mix to make black?

## Transformations

14. Our vector formula for rotating a point $p$ about an axis $a$ is this:

$$p' = a \cdot p\, a + (p - a \cdot p\, a)\cos\theta + a \times p \sin\theta$$

(a) ____/[1] Does $p$ need to be normalized?

(b) ____/[1] Does $a$ need to be normalized?

15. Look at the following list of operations.

    (a) Rotation about the axis through (0,0,0) and ($\sqrt{2}$,2,$\sqrt{2}$).

    (b) Translation by a displacement of (-5,1,-1).

    (c) Orthographic projection onto the plane passing through (0,1,0), (1,1,1) and (1,0,1).

    (d) Perspective projection onto the plane through (1,0,0), (0,1,0), and (0,0,1) with origin as the view-point.

    (e) Rotation about the straight line through (0,1,0) and (1,1,1).

    (f) Reflection about the $xz$ plane.

    (a) ☐/[3] Which of them cannot be represented by a 3x3 matrix operator?

    (b) ☐/[3] Which ones can be represented by a 4x4 homogeneous coordinates matrix?

16. ☐/[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?

## **P**rojection

17. ☐/[3] Name 3 advantages of homogeneous coords.

18. ____/[2] Calculate the 4x4 homogeneous matrix for a perspective projection from the origin to the projection plane with equation $y = d$.

(a) ____/[3] Where would these Cartesian points project to?

i. $(1, 0, 3)$
ii. $(1, 1, 4)$
iii. $(0, 1, 5)$

(b) ____/[1] What point would the infinite homogeneous point (1,2,3,0) project onto?

19. ____/[1] Why should you clip before projecting an object?

## **V**isible Surface Determination

20. ____/[1] What's the biggest difficulty with implementing the painter's algorithm?

## **I**llumination and Shading

21. For Phong and Gouraud shading, which

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

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

Total: 45 points
*End of exam*

## Notes

1. Grades should be ready by next week. We'll email them, or you may phone Helen or me.
2. 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.
3. You're welcome to ask me graphics, or other, questions, in the future (if you can find me). I might even have answers.
4. Have a good summer.
5. I might also be willing to sign off on independent reading courses on this next fall. 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.

April 28, 1998, 22:44 /dept/ecse/graphics/ho19.tex