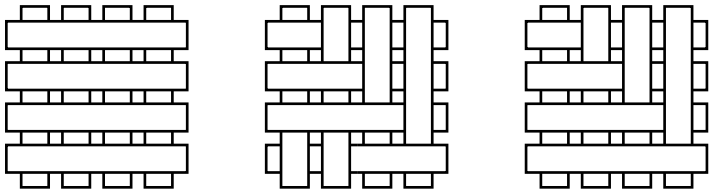
CS 417 Final Exam

Friday, May 9, 2003

Problem 1 (15 pts): Which of the following scenes would cause problems for the Painter's Algorithm?



(a) (b) (c)

(These drawings are in image space; each rectangle is a single primitive.)

Problem 2 (15 pts): Suppose we begin with the square (in 2D) that has vertices at $(\pm 1, \pm 1)$ and subdivide using the B-spline subdivision masks, which are 1–6–1[1] for even points and 1–1 for odd points. What are the coordinates of the vertices of the resulting polygon? Note that this question is about curve subdivision, not surface subdivision.

Problem 3 (15 pts): Match the following texture coordinate functions with the shapes being projected onto.

1. $u = \mathrm{atan2}(x, z); v = y$
2. $u = x; v = y$
3. $u = \mathrm{atan2}(x, z); v = \mathrm{atan2}(y, \sqrt{x^2 + z^2})$

(i) Plane

(ii) Cylinder in longitude/height parameterization

(iii) Sphere in longitude/latitude parameterization

[1] That is, $\frac{1}{8}$–$\frac{3}{4}$–$\frac{1}{8}$.

Problem 4 (20 pts):

Consider the following ray/surface intersection function.

```
function IntersectX(Point p, Vector d)
   t = (1 - (p.x + p.y + p.z)) / (d.x + d.y + d.z)
   if (t > 0) return t;
   else return PLUS_INFINITY;
```

1. With what surface does this function return the intersection?

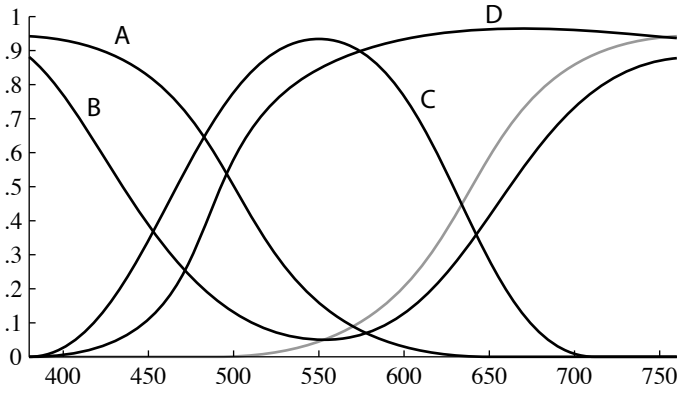
The following function returns the intersection of a ray with a cube:

```
function IntersectCube(Point p, Vector d)
   tx1 = (1 - p.x) / d.x;
   tx2 = (-1 - p.x) / d.x;
   ty1 = (1 - p.y) / d.y;
   ty2 = (-1 - p.y) / d.y;
   tz1 = (1 - p.z) / d.z;
   tz2 = (-1 - p.z) / d.z;
   t1 = max(min(tx1, tx2), min(ty1, ty2), min(tz1, tz2));
   t2 = min(max(tx1, tx2), max(ty1, ty2), max(tz1, tz2));
   if (t1 > 0) return t1;
   else if (t2 > 0) return t2;
   else return PLUS_INFINITY;
```

2. Adapt this pseudocode to intersect a ray with an octahedron using a similar approach.

Problem 5 (15 pts):

Consider the spectral power distributions plotted on this graph:



1. What colors are these spectra? I'm looking for plain old color names; for instance, the unlabeled gray curve is red.

2. Define *metamer*.

3. What role do metamers play in the reproduction of color?

Problem 6 (20 pts):

Assume you are given the following functions:

- a spectral power distribution $s(\lambda)$ that we wish to match,
- three primary lights $p_r(\lambda)$, $p_g(\lambda)$, and $p_b(\lambda)$ that we can combine additively using scale factors R, G, and B,[2] and
- the response functions $r_s(\lambda)$, $r_m(\lambda)$, and $r_l(\lambda)$ of the cones in the human eye.

1. Is it always possible to match the color of s by mixing the three primary lights? Why or why not?

2. What values of R, G, and B will produce a color match with s? Your answer should be in terms of the functions given above, and you should use matrix and calculus operations as needed.

3. How would the answer change if you were given the standard color matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, and $\bar{z}(\lambda)$ instead of the cone response functions?

[2] The spectra are absolute, rather than relative: for example, $r(\lambda)$ is the spectrum that will result from setting $R = 1$ and $G = B = 0$.