CS 324E Elements of Computer Graphics

Fall 2002

Second Exam

NAME:

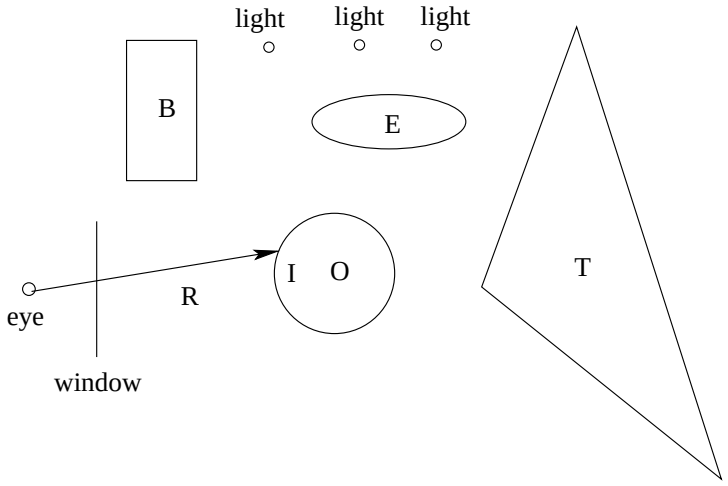
Please write your answers on THESE SHEETS. If you must turn in extra sheets, put your name on each one of them. You should not need substantial space beyond that provided here, but you should definitely show your work since partial credit will be given where appropriate.

Give short (one to two sentence) explanations for each answer. These could help you get partial credit in cases where you have given what would otherwise be considered a wrong answer. If an explanation is specifically asked for, you must give it in order to get credit for the problem.

If you do calculations to get an answer, CIRCLE the answer so that I won't fail to find it.

1. (10pts) You are ray tracing the scene shown below in two-dimensional cross section, and you have just calculated that primary ray **R** starting at the eye and passing through the window hits object **O** as shown. Object **O** is a transparent polished glass sphere which reflects light from its surface as well as passing transparent light through. It is also shiny, meaning it has a specular highlight, but it doesn't reflect any light diffusely and it doesn't reflect any ambient light. All other objects in the scene are opaque. Light sources are labelled as such. Sketch every ray which originates

at the intersection point **I** of **R** and **O** and which is needed to calculate the color of the intersection point **I**. Make sure to indicate clearly any object or light source that each ray hits. Do any objects cast shadows on **I**? If so, which ones?

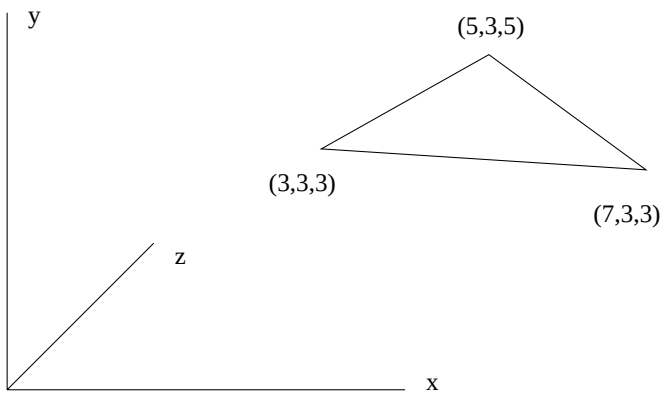


2. (10 pts) You are defining the polygon shown below in a rib file. The line in the rib file that defines the polygon is

```
Polygon "P" [ 5 3 5  7 3 3  3 3 3 ]
```

   a) Sketch the normal to the polygon that would result from this specification.

   b) Write the line to define the polygon in a rib file that you would use to replace this specification if you wanted to make other side of the polygon be the front face.


y
(5,3,5)
(3,3,3)
(7,3,3)
z
x

3. (10 pts) You are using the procedural texture defined (in Java like pseudocode) to be

```
Color WavyTexture(float u, float v) {
  float i = cos(pi * u) * cos(pi * v);
  Color c.Red = i;
  c.Green = i;
  c.Blue = i;
  return c;
}
```

where pi is a constant containing the value of pi. You are mapping this texture onto the bezier patch defined as follows in a rib file

```
WorldBegin

Surface  "WavyTexture"

# Patch control points specified in grid
Patch "bicubic" "P"
  [ 0.75 0.75 -0.3   0.25 0.75 -0.8   -0.25 0.75 -0.8   -0
    0.75 0.25 -0.8   0.25 0.25 0      -0.25 0.25 0      -0
    0.75 -0.25 -0.8  0.25 -0.25 0     -0.25 -0.25 0     -0
    0.75 -0.75 -0.3  0.25 -0.75 -0.8  -0.25 -0.75 -0.8  -0

WorldEnd
```

a) What color is the patch at u=0, v=0?

b) What color is the patch at u=1, v=1?

c) What three dimensional point does the patch pass through at u=0, v=0?

d) What three dimensional point does the patch pass through at u=1, v=1?

4. (10 pts) You are given the following definition of a CSG object in a rib file.

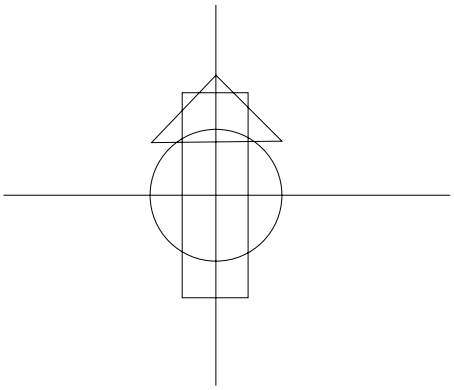
```
WorldBegin
SolidBegin  "union"
  SolidBegin  "intersection"
    SolidBegin  "primitive"
      Sphere 1.0 -1.0 1.0 360
    SolidEnd
    SolidBegin  "primitive"
      Cylinder 0.5 -1.5 1.5 360
      Disk -1.5 0.5 -360
      Disk 1.5 0.5 360
    SolidEnd
  SolidEnd
  AttributeBegin
    Translate 0 0 .9
    SolidBegin  "primitive"
      Cone 1.0 1.0 360
    SolidEnd
  AttributeEnd
SolidEnd
WorldEnd
```

A two dimensional cross section of the component objects is shown below.

a) Label the two coordinate axes with x, y or z as appropriate to indicate what two dimensional cross section is shown.

b) Shade the region of the drawing that corresponds to the two dimensional cross section of the object defined by the specification above.

c) Draw normal vectors for each surface of the object cross section shaded in (b) that would result from the specification given.



5. (10 pts) True or False. You are looking down the z axis at a unit cube 3 units away from your viewpoint. The projection plane and window are 1 unit from your viewpoint as usual. If the perspective projection of the cube is in the center of the window, the orthographic projection of the same cube will also be centered in the window and will cover more of the screen (be larger) than the perspective projection.

6. (10 pts) True or False. Making your field of view larger will make objects look closer to you.

7. (10 pts) Consider the three rib file fragments below.

A:
```
Translate 5 2 3
AttributeBegin
Rotate 90 1 0 0
AttributeEnd
```

B:
```
Translate 5 2 3
TransformBegin
Rotate -90 -1 0 0
TransformEnd
```

C:
```
Translate 5 2 3
Rotate -90 1 0 0
```

Pick the single statement that best characterizes the situation.

a) They all perform the same transformation.

b) A and B perform the same transformation

c) B and C perform the same transformation

d) A and C perform the same transformation

e) All of them do different things

8. (5 pts) A matte surface in a scene you are creating has a pnormal vector of (1,1). If you forget to normalize this vector before using it to calculate the diffusely reflected light, what will happen? (choose all that apply)

a) The diffuse reflected light will be too bright.

b) The diffuse reflected light will be too dim.

c) The diffuse reflected light will be correct.

d) The diffuse reflected light will be the wrong hue.

e) There will be no diffuse reflected light.

9. (5 pts) A matte surface in a scene you are creating has a normal vector of (1,1). If you forget to normalize this vector before using it to calculate the ambient reflected light, what will happen? (choose all that apply)

   a) The ambient reflected light will be too bright.

   b) The ambient reflected light will be too dim.

   c) The ambient reflected light will be correct.

   d) The ambient reflected light will be the wrong hue.

   e) There will be no ambient reflected light.

10. (10 pts) You have a scene described as a rib file below.

```
...
ObjectBegin 1
    Sphere 1.0 -1.0 1.0 360
ObjectEnd
ObjectBegin 2
  TransformBegin
    Translate 0 0 1
    ObjectInstance 1
  TransformEnd
  TransformBegin
    Translate 0 0 -1
    ObjectInstance 1
  TransformEnd
ObjectEnd

WorldBegin

AttributeBegin
  Surface "plastic"
  AttributeBegin
    Color 1 0 0
    ObjectInstance 2
    AttributeBegin
        Color 0 1 0
        Translate 1 0 0
        ObjectInstance 2
        Translate -2 0 0
```

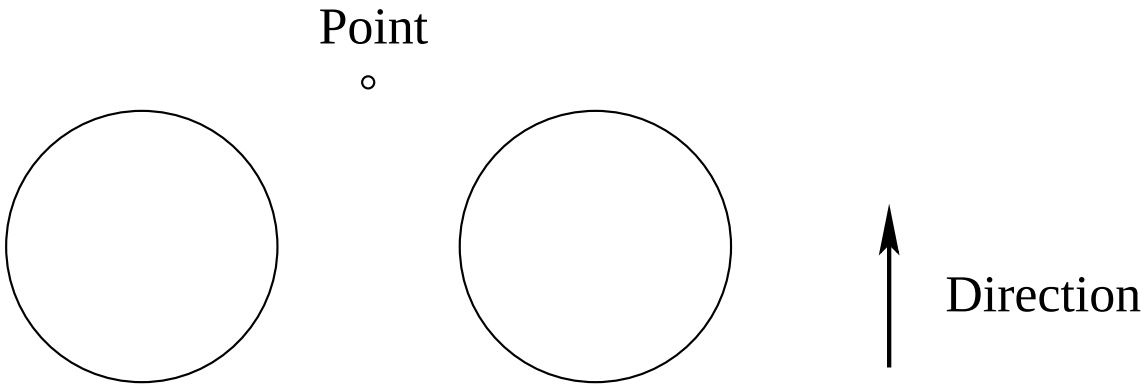
```
        ObjectInstance 2
    AttributeEnd
    AttributeBegin
        Color 0 0 1
        Translate 0 1 0
        ObjectInstance 2
        Translate 0 -2 0
        ObjectInstance 2
        Translate 0 4 0
        ObjectInstance 2
    AttributeEnd
  AttributeEnd
AttributeEnd

WorldEnd
```

a) How many red spheres will appear in the scene?

b) How many green spheres will appear in the scene?

c) How many blue spheres will appear in the scene?

11. (10 pts) In the two dimensional cross section of a scene shown below, there are two lights, one point light and one directional light, as shown.



a) If the two spheres are assumed to have matte surfaces, indicate the brightest spot on the each sphere if the directional light is the only one turned on by placing an "d" at that spot on each sphere.

b) If the two spheres are assumed to have matte surfaces, indicate the brightest spot on the each sphere if the point light is the only one turned on by placing an "p" at that spot on each sphere.

c) Shade the portion of each sphere, if any, that will be completely unlit if both lights are on but there is no ambient light.