 Nome _____ Número _____

COMPUTER GRAPHICS AND INTERFACES

MIEI/FCT/UNL - 2015/2016
Test 2 – 2015.12.14

Notice

In case you need to correct some answer and the alloted space is not enough, you can use the back, as long as the appropriate mentions are made.
Do not remove the staples!
The test has a duation of **1H45**!

1. (4/20)

Classify as True (T) or False (F) each of the following sentences. Each wrong answer will deduct 25%.

When using the Phong illumination model, in conjunction witht Phong shading:

The evaluation of the illumination is performed by the vertex shader.	
When the projection is parallel, the **V** vector could be a **uniform** variable.	
When the projection is parallel, the **L** vector could be a **uniform** variable.	
If the illumination is performed in the World Coordinate System, the camera position has to be provided as a **uniform** variable.	

When mapping 2D textures to polygonal geometric models:

When using classic mapping methods (orthogonal, spherical, etc.), the geometric model may not have previously assigned texture coordinates to each vertex.	
The use of mipmaps is advantageous when the textures are magnified.	
The actual access to the texture map is performed by the vertex shader.	
Texture coordinates (s and t) associated with each vertex need to be specified in the range [0,1].	
Bump mapping is a technique that allows us to perturb the surface and that is visible in the silhouete of the objects.	

2. (5/20)

a) Considering the diffuse reflection model: $I_{rgb}=I_p\ K_d.\ \cos(\theta)$, justify how (if possible) an object with the color RGB(0.5, 1.0, 1.0) can be perceived as having the following colors:

a1) RGB(0,4, 0.4, 0.4)

a2) RGB(0.6, 0.4, 0.4)

b) What does θ represent in that model? Justify your answer in terms of the vectors that you consider important, defined at the point P where the illumination is being evaluated.

c) By applying only geometric transformations to the object, how/when is the reflected light maximized?

d) Let us now consider the specular reflection model $I_{rgb}=I_p.K_s.\cos^{\alpha}(\phi)$. What does ϕ represent in this model? Justify your answer in terms of the vectors that you consider important, defined at the point P where the illumination is being evaluated.

e) Why is the exponent α important? Justify your answer by explaining the diferent results as its value is changed.

3. (6/20)

To the polygon P=[A,B,C,D,E,F,G,H,I,J] we will apply the FILL AREA (Scanline) algorithm to paint its interior. We know that points D and E have the same ordinate ($y_D=y_E$), as well as points G and H ($y_G=y_H$).

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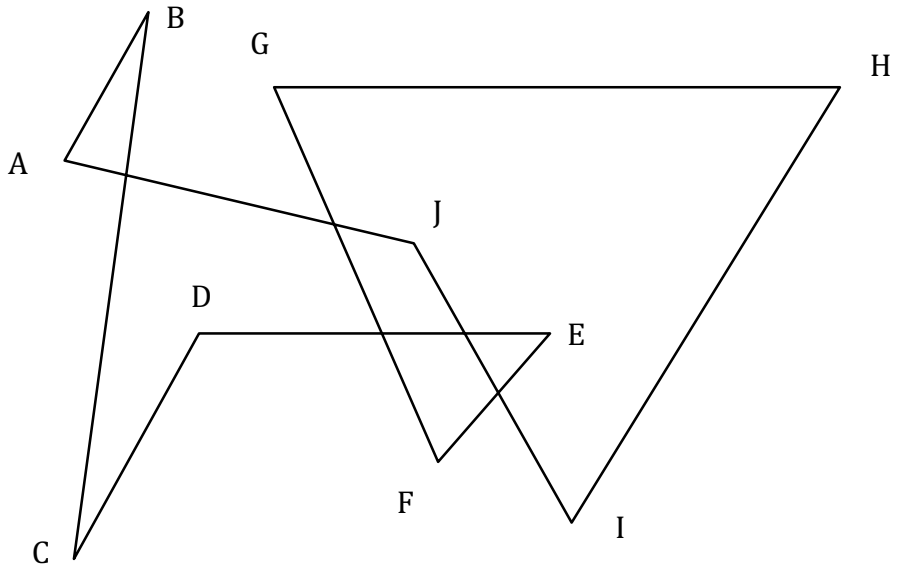

a) Paint, in the figure above, the regions that would be filled!

b) Write all the non empty entries of the edges table, showing their contents, as well as the associated entry index.

c) Write the contents of the active edges table immediatly before painting the scans of pixels for the following scanlines:

y_F:

y_D:

y_J:

d) Knowing that the polygon's vertices have integer coordinates, say (yes/no) if the corresponding pixels would be filled by the algorithm. **Note**: each wrong answer will deduct its entire value!

A: _____; C: _____; D: _____; E: _____; G: _____; J: _____

e) The polygon edges are later rasterized using the midpoint algorithm (or the equivalent Bresenham algorithm). State one visual artifact that could result from the application of this algorithm alone?

f) In which ways could an implementation of the Fill Area algorithm be simplified if it were to be used only for triangles? Be as complete as possible!

4. (5/20)

The following piece of code is part of an application that models a crane's arm. The primitives are represented by the calls to the functions `draw_cylinder()` and `draw_cube()`, whose details are omitted.

```
function draw_telescopic_arm()
{
    multRotZ(-psi);
    pushMatrix();
        multScale([1.2,1.2,1.2]);
        multRotX(90);
        draw_cylinder();
    popMatrix();
    pushMatrix();
        multScale([1,5,1]);
        multTranslation([0,0.5,0]);
        draw_cube();
    popMatrix();
    pushMatrix();
        multTranslation([0,d,0]);
        multScale([0.7,5,0.7]);
        multTranslation([0,0.5,0]);
        draw_cube();
    popMatrix();
}
```

```
function draw_arm()
{
    multRotY(theta);
    pushMatrix();
        multTranslation([0,1.5,0]);
        multScale([2.5,1,2.5]);
        multTranslation([0,0.5,0]);
        draw_cylinder();
    popMatrix();
    pushMatrix();
        multTranslation([0,2.5,0]);
        pushMatrix();
            multScale([1,10,1]);
            multTranslation([0,0.5,0]);
            draw_cube();
        popMatrix();
        pushMatrix();
            multTranslation([0,10,0]);
            draw_telescopic_arm();
        popMatrix();
    popMatrix();
}
```

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a) Using the convention followed in the classes, present the scene graph corresponding to the call to `draw_arm()`. **Note**: Consider the call to `draw_telescopic_arm()` as a sub-graph, which you will not need to detail.

b) Strike trough, in the code given, the lines of code that are not strictly needed to properly model the object.

c) Imagine that in the implementation of a certain system, in each scene graph node we could associate a triple of transformations T.R.S, always applied in the same exact order (scale applied first and translation last). What would be the minimum number of nodes needed to represent the given crane model in that system?

Answer: _____ Nodes.

Good luck!