Question 1 (16 points): Short Questions/Brief Descriptions

Give brief descriptions of the following:

a. (4 points) Which of the following shader units is used for doing tessellation in real time (vertex shader, fragment shader or geometry shader)?

b. (4 points) What is the luminance of an image?

c. (4 points) What is Percentage Closer Filtering used for?

d. (4 points) In OpenGL 4.0, list TWO stages of the graphics pipeline that are implemented in hardware and NOT programmable
Question 2 (11 points): Ray Tracing

(6 points) On a small cell phone screen, we render the same scene separately using OpenGL and then with ray tracing and measured their running times. We then calculate the ratio (OpenGL running time/ray tracing running time) as $x$. We then try an experiment. On the same screen size, we add more objects into the scene such that the total number of polygons is increased ten fold. Would you expect the ratio $x$ to increase or decrease? Explain.

(5 points) What is participating media? Give one example
Question 3 (20 points): Clipping

a. (10 points) You decided to implement the Cohen-Sutherland algorithm. You got the algorithm working. Then, your roommate decided to play a prank on you and deleted the tests for trivial accept and trivial reject in the Cohen-Sutherland clipping algorithm while you were away. You continued to work on the program without knowing (since it compiled okay) and turned it in. Will the algorithm still perform correctly without these tests? Why? Describe in some details the effects of this attempted sabotage on your program.

b. (10 points) Given a rectangular clipping window bounded by points (4, 2) and (12, 8), what are the results of clipping the edge that goes from (-1, 3) to (8, 6) using Cohen-Sutherland clipping
**Question 4: (12 points) Curves**

a. (4 points) What does the “R” in NURBS stand for? Why is this “R” important for certain shapes?

b. (8 points) We have used Bezier curves to model a large ship by specifying a series of control points. Then we decide to make a minor change at the tip of the ship by moving one of the control points. What inherent problems of Bezier curves will we run into? What alternate representations can reduce this problem? Explain briefly.
**Question 5 (16 points): Visual Realism**

a) (6 points) In ___________________ mapping, normals are stored as local distortions of the face orientation, while in ___________________ mapping, normals stored combine face orientation and a distortion about the local face.

Fill in the two blanks above.

b) (5 points) _______________ is a technique that uses the velocity buffer to simulate the effect of moving objects.

Fill in the two blanks above.

c) (5 points) Describe the blended LoD strategy for transitioning from a displayed mesh at one Level of Detail (LoD1) to another Level of Detail (LoD2)
a. (5 points) If \( m \) is the slope of a line, give one value of \( m \) that will not generate jaggies (aliasing) and when the line is drawn on a screen.

b Region Filling (20 points)
Using the following flood-fill algorithm pseudocode, for each white square in Figure 1, write the number that indicates the order in which it will be filled. The "seed" pixel is denoted by a '1'.

```c
void RunFill{
    Push the address of the seed pixel on the stack;
    While(stack not empty){
        Pop the stack to provide the next seed;
        Fill in the run defined by the seed;
        In the row above find interior runs reachable from this run;
        Push the addresses of the rightmost pixels of each such run;
        Do the same for the row below the current run;
    }
}
```

Figure 1: Run-fill region-filling