CS 130
Midterm

Winter 2018

Name	
Student ID	
Signature	

You may not ask any questions during the test. If you believe that there is something wrong with a question, write down what you think the question is trying to ask and answer that.

Question	**Points**	**Score**
True/False		
1	2	
2	2	
3	2	
4	2	
5	2	
6	2	
7	2	
8	2	
9	2	
10	2	
Multiple Choice		
11	4	
12	4	
13	4	
14	4	
15	4	
Written		
16	8	
17	8	
18	8	
19	8	
Total	72	

1 True/False

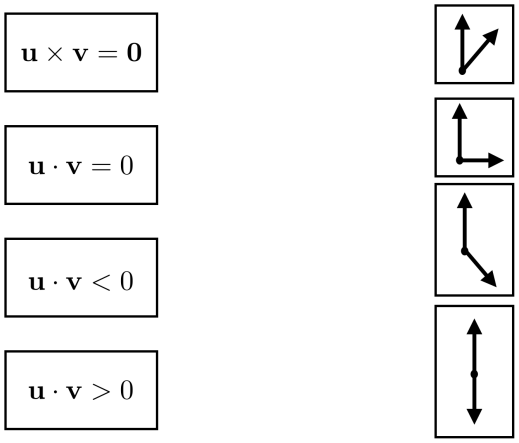
For each question, indicate whether the statement is true or false by circling T or F, respectively. You get 2 points for answering a question correctly, -0.5 points for answering the question incorrectly, and 1 point for leaving it blank. (It is statistically to your advantage to answer only if you are at least 60% percent confident that your answer is correct).

1. (T/F) For any vector $\mathbf{u}$, $\mathbf{u} \cdot \mathbf{u} \geq 0$.
2. (T/F) For any vector $\mathbf{u}$, $\mathbf{u} \times \mathbf{u} = \mathbf{0}$.
3. (T/F) In ray tracing, we recursively cast rays to test for shadows.
4. (T/F) Point light sources create soft shadows, where illumination transitions gradually from fully illuminated to fully in shadow.
5. (T/F) The Phong reflectance model is composed of ambient, diffuse, and specular terms.
6. (T/F) Textures can be used to add detail to a scene without increasing polygon count.
7. (T/F) The midpoint method for line rasterization can be written to use only integer arithmetic.
8. (T/F) Triangle rasterization refers to the process of clipping a triangle against the view volume.
9. (T/F) The barycentric coordinates of a point relative to a triangle always satisfy $\alpha + \beta + \gamma = 1$.
10. (T/F) In the OpenGL pipeline approach to rendering, triangles are rasterized independently, and a z-buffer is used to determine visibility.

2 Multiple Choice

For each question, circle exactly one of (a)-(e), unless otherwise stated.

11. For two vectors, $\mathbf{u}$, $\mathbf{v}$, match the expression in the left column with the illustration in the right column by drawing lines between the matching boxes.



12. Which of the following statements regarding ray tracing are true?

    I. It is well-suited for realtime applications containing complex scenes.

    II. View rays are cast to determine whether a point is in shadow or not.

    III. It requires computing the intersection of rays with objects in the scene.

    (a) I only
    (b) II only
    (c) III only
    (d) II and III only
    (e) None

13. The Phong reflectance model

    (a) gives a method to shade transparent surfaces.
    (b) uses surface normal information to capture three-dimensional effects.
    (c) cannot be used in the graphics pipeline because the necessary information is unavailable.
    (d) requires too much computation to be of practical value.
    (e) captures reflections of one object in another.

14. Consider the OpenGL graphics pipeline. Which statements are true?

    I. Processing vertices indpendently allows the pipeline to be highly parallel.

    II. It is designed to achieve GPU-accelerated rendering.

    III. In modern OpenGL, the user may supply shaders which will execute on the GPU.

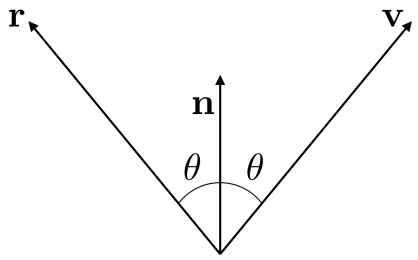
    (a) II only
    (b) I and II only
    (c) I and III only
    (d) II and III only
    (e) I, II, and III

15. Which statement about textures is false?

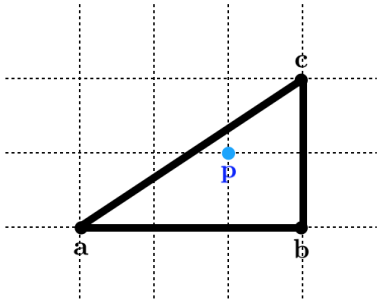
    (a) They may be two-dimensional or three-dimensional.
    (b) The can be precomputed images or functions computed on the fly.
    (c) They can be used to store normal maps.
    (d) They tend to change the appearance of object silhouettes.
    (e) They can be a cheaper alternative to increased geometric detail.

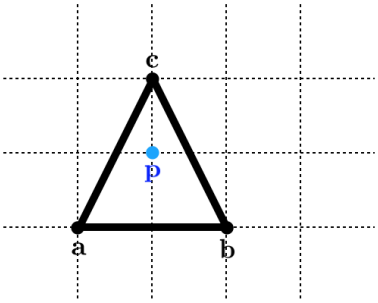
3 Written Response

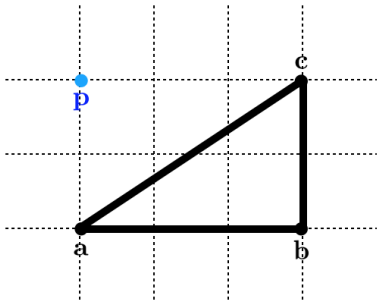
21. In the figure below, the vector **r** is the reflection of the vector **v** about the unit vector **n**. Write an expression for **r** in terms of **v** and **n**.

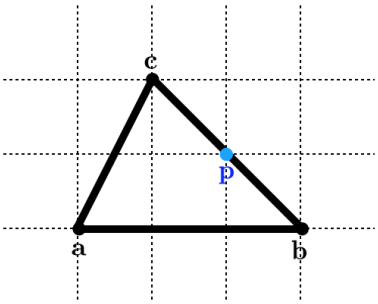


22. Next to each triangle, write the values of the barycentric coordinates α, β, γ for the point $\mathbf{p}$ with respect to the triangle with vertices $\mathbf{a}, \mathbf{b}, \mathbf{c}$. pictured.

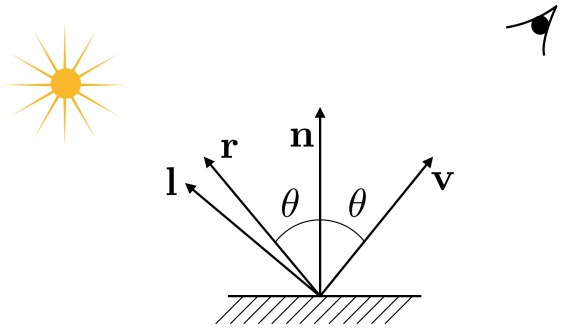








23. Consider the figure below, depicting a point to be shaded using the Phong Reflectance Model, where **l** is the light vector, **v** is the view vector, **r** is the reflected vector, and **n** is the normal vector.



(a) Write down the ambient, diffuse, and specular components of the Phong Reflectance Model.

(b) How does changing the Phong exponent change the appearance of the object?

24. Consider the Midpoint algorithm given here for rasterizing a line segment with endpoints (x0,y0) and (x1,y1), and slope $m < 1$:

```
 (1)  x = x0, y = y0
 (2)  d = f(x0+1,y0+1/2)
 (3)  while x <= x1
 (4)  do
 (5)    draw(x,y)
 (6)    if(d < 0)
 (7)    then
 (8)      y = y + 1
 (9)      d = d + (y0-y1) + (x1-x0)
(10)    else
(11)      d = d + (y0-y1)
(12)    end
(13)    x = x + 1
(14)  end
```

Write down the Midpoint algorithm modified to work for a line with slope $m > 1$.