CSC 471 midterm 2
Winter 2014

Name:_____

READ ME FIRST

- Don't spend too much time on any one problem. This exam should take approximately 80 minutes.
- Note that the amount of points vary per question.
- Be neat
- **Show how you got your answers!**
- Write down your assumptions
- A single sheet of notes and a calculator is allowed.

1	25 pts	Graphics Pipeline short answer	
3	15 pts	Geometric Relationships	
4	13 pts	Transforms	
5	20 pts	Shading	
7	17 pts	Camera	
8	1-5 pts	Extra credit	
	90 pts	Grand total	

1) Graphics pipeline multiple choice and short answer (25 pts)
Please answer the following multiple-choice questions about the graphics pipeline (2 points each unless specified):

a) Specular shading should change as you move your camera around to look at the (specularly reflected) object from different angles.
1) True 2) False

b) Using orthographic projection, the z-buffer is not necessary because objects appear the same 'depth' regardless of where they are in the scene:
1) True 2) False

c) Standard clipping and culling will remove all the vertices from the scene that are not seen by the viewer:
1) True 2) False

d) Hierarchical models use a matrix stack in order to apply matrix transforms with respect to an arbitrary frame (i.e. not with respect to the world frame)
1) True 2) False

e) "varying" data that is passed from a vertex shader to a fragment shader is linearly interpolated.
1) True 2) False

f) (3 pts) In one sentence please precisely describe the difference between Phong and Gaurad shading:

g) (3 pts) Given two boids of the same size (with a radius of 2.6 units) if they are located at
b1 = {6, 2, 5} and **b2={2, 2, 8}** are they colliding?
1) Yes 2) No

h) (3 pts) Given an application defined geometric object (say a tree) that is specified in world coordinates as being 1 unit tall and is 5 units away from the camera and a view plane that is 1 units away from the camera, how tall will the tree be using perspective projection:
1) 0.4 unit
2) 1.4 unit
3) .5 unit
4) not enough information to determine

i) (6 pts) Given the following perspective transform matrix:

$$\begin{matrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{(n+f)}{n} & -f \\ 0 & 0 & \frac{1}{n} & 1 \end{matrix}$$

and given a near plane of **2 and a far plane of 10** and the point **p={1, 4, 10},** assuming that there are no other transforms. What are the perspective corrected {x, y} coordinates of **p**?

3) Geometric Relationships (15 points)

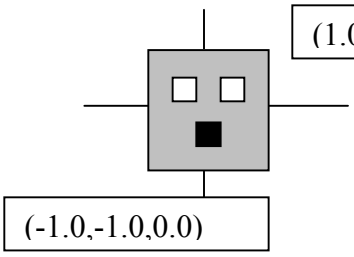
Assume that Emmet (the main character in the Lego movie) can throw a brick anywhere within 5 units away from his body. Assume the character, Lord Business is currently located at {1, 2, 1} and Emmet is located at {-2, -1, 0}

(a) **(7 pts)** Can Emmet hit Lord Business with a brick? SHOW YOUR WORK MATHEMATICALLY!

(b) **(8 pts)** Now assume there is an extremely large wall (much like a plane) (specified by the equation: 6*x+8*y+0*z+5=0). And there is a zombie located at {1, 0, 10}. Which character can the zombie eat first? SHOW YOUR WORK MATHEMATICALLY!

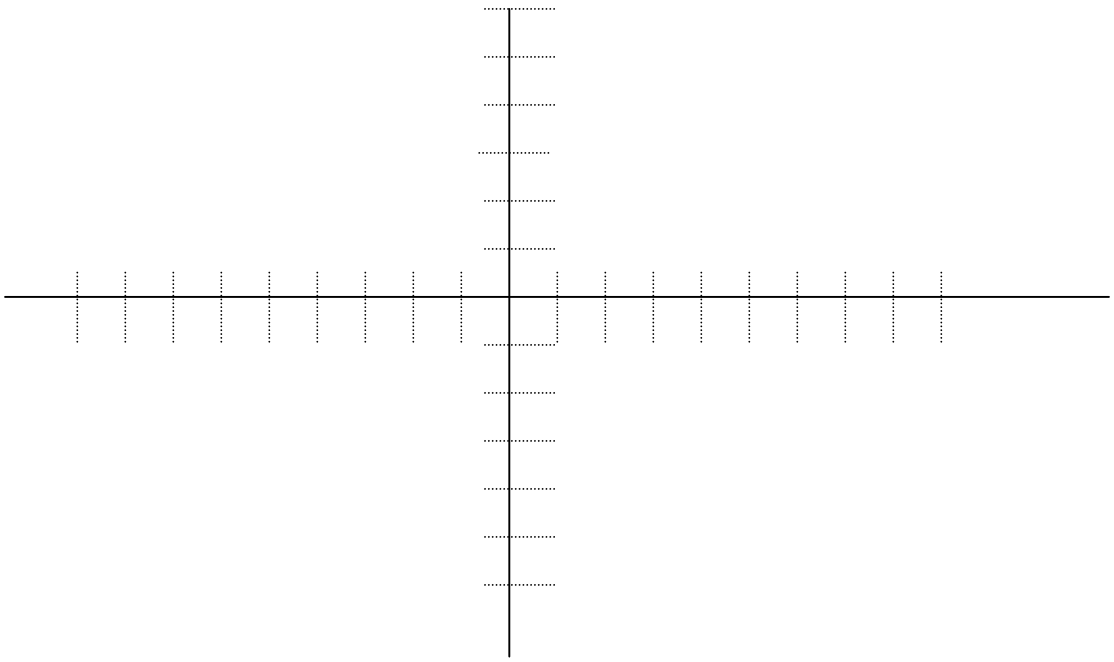
4) Transforms (13 pts)

Carefully draw the result of the following OpenGL/glm code assuming that the DrawRobotFace() function draws the complete image below (i.e. one grey box with sides of length 2 with three small sub-boxes inside with sides of length 0.5: white eyes and a black mouth). Recall that rotations are specified as counter-clockwise. **Carefully** read all the code below before drawing and be sure that it is clear what the final drawing will look like:




```
/*Set up the first matrix */
glm::mat4 Rot = glm::rotate( glm::mat4(1.0f), -90, glm::vec3(0, 0, 1));
 glm::mat4 Trans = glm::translate( glm::mat4(1.0f), glm::vec3(1, 1, 0);
  glm::mat4 Model = Rot*Trans
  safe_glUniformMatrix4fv(h_uModelMatrix, glm::value_ptr(Model));
 /* Draw */
 DrawRobotFace ();

/*Set up the second matrix */
 glm::mat4 Trans = glm::translate( glm::mat4(1.0f), glm::vec3(-1, 1, 0);
 glm::mat4 Rot = glm::rotate( glm::mat4(1.0f), 90, glm::vec3(0, 0, 1));
 glm::mat4 Model = Trans *Rot
 safe_glUniformMatrix4fv(h_uModelMatrix, glm::value_ptr(Model));
/* Draw */
DrawRobotFace ();
```



5) Shading (20 pts)

Given a light with the following {r, g, b} ambient, diffuse and specular terms:
light_color= {1, 1, 1}
and a material with the following ambient, diffuse and specular terms:
material_diffuse = {0.6, 0.6, 0.8}
material _ambient = {0.2, 0.2, 0.2}
material _specular= {0.0, 0.5, 0.5}
material_shininess={2}
Assuming that the light is **located at is {10, 10, 4}**. For a **point located at {10, 0, 4}** with the normal is {0, 8, 6} and the **camera is located at** {10, 3, 8}, what is the reflected color {r, g, b}, computed using the Phong model? (Assume there is no distance attenuation). **Show your work!**

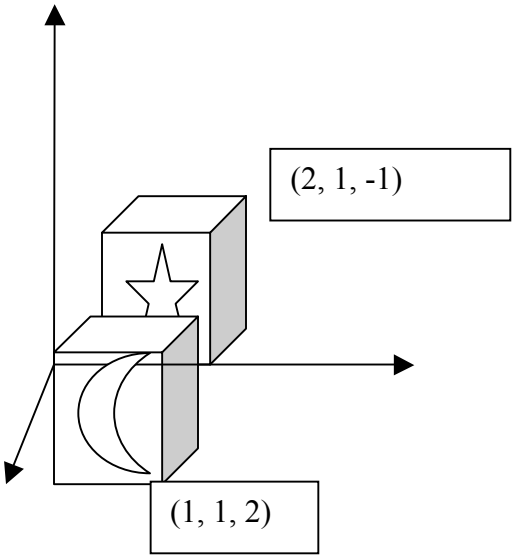
7) Camera transforms (17 pts) Given the below world frame figure (with coordinates listed for the center of the objects) – and a camera specified using glm as LookAt(1, 4, 2, 1.0, 1.0, 2.0, -1, 0, 0}.

a. (2 pts) **Draw** the camera (and its frame) in the below world frame and clearly specify what it is looking at, the star or the moon?

b. (5 pts) Compute and draw the gaze vector. **Gaze =**

c. (5 pts) If you wanted to 'zoom' out the camera, one unit along the gaze vector, what is the value of the new 'eye' position of the camera?

d. (2 pts) Why is the "up" vector different then our usual {0, 1, 0} vector?



8) Extra credit (1-5 pts)

Odyssey of the Mind verbal (to be written): Common responses will receive 1 point and creative responses will receive 5 points.

Your problem is: Name things that people keep on hand just in case they are needed.

Your responses must be given in the form " _____ just in case _____."

For example, you could say, "Ice just in case I want a cold drink."

(FYI: JUDGES ONLY: Common: I keep candles just in case the power goes out. (Everyone does this so it is a common response.) Creative: Kryptonite just in case Superman goes on a rampage. Marbles just in case I lose mine. Forks just in case a pie rolls by. Laughter just in case I hear a joke.)