CSC 471 TAKE HOME midterm 2
Winter 2017

Name:_____

READ ME FIRST

- Don't spend too much time on any one problem. This exam should take approximately 80-100 minutes.
- Note that the amount of points vary per question.
- Be neat
- **Show how you got your answers!**
- Write down your assumptions
- Access to your class notes and a calculator is allowed.
- NOT open Web and NO copying and sharing answers

1	20 pts	Graphics Pipeline short answer	
2	10 pts	Geometric Relationships	
3	10 pts	Transforms	
4	20 pts	Shading	
5	20 pts	Camera	
6	10 pts	Geometric Relationships	
	0-5 pts	Extra credit	
	90 pts	Grand total	

This is a take-home test. Do NOT copy/share answers. It is DUE Friday 3/17 by 12:00 noon. Please write the below sentence in your own writing and sign your name:

I did not take unfair advantage of any of my classmates. Signed, <your name>

_____

_____

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1) Graphics pipeline multiple choice and short answer (20 pts)
Please answer the following multiple-choice questions about the graphics pipeline (2 points each unless specified):

a) Diffuse reflections look the same no matter where they are viewed from:
1) True 2) False

b) Rendering your scene into a FBO (Frame Buffer Object) is useful for effects like Gaussian blur:
1) True 2) False

c) A 'virtual camera' can be simulated by transforming the entire geometry of your virtual world to various 'views' by applying translation, and rotation to the entire world's geometry:
1) True 2) False

d) Strong specular reflections (or specular highlights) are more common in surfaces with microstructure that is very rough:
1) True 2) False

e) In order to view the most digital models it is a good idea to set the near plane of the view frustum to 0 (zero).
1) True 2) False

g) (4 pts) Assume in your game the circle defined by:
$f(x,y) = (x - x_c)^2 + (y - y_c)^2 - r^2$
with {xc, yc} = {-1, 3} and a radius of 4, is shielded from the highly contagious measles virus. If you place your child at point {0.5, -0.5} are they safe? (show your work with math):

f) (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 **0.5 and a far plane of 8** and the point **p={1, 2, 10},** assuming that there are no other transforms. What are the perspective corrected {x, y} coordinates of **p – that is the point in normalized device coordinates which range from -1 to 1**?

Extra Credit g) (2.5 pts possible) What is the most challenging part of graphics programming?

2) Geometric Relationships (10 points)

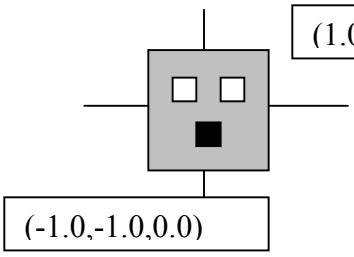
Assume that Aaron Keen can debug code on any computer within 2 units away from his body and Aaron is currently located at {-2, 0, 4}. Assume a CPE 357 student's laptop is currently located at {-1, 1, 3}

(a) **(7 pts)** Can Aaron help the student? SHOW YOUR WORK MATHEMATICALLY!

(b) **(8 pts)** Now assume there is an extremely large wall (much like a plane) (specified by the equation: 3*x+0*y+4*z–15=0). And there is a zombie located at {1, 0, 4}. Which character (if any) is protected by the wall (plane)? SHOW YOUR WORK MATHEMATICALLY!

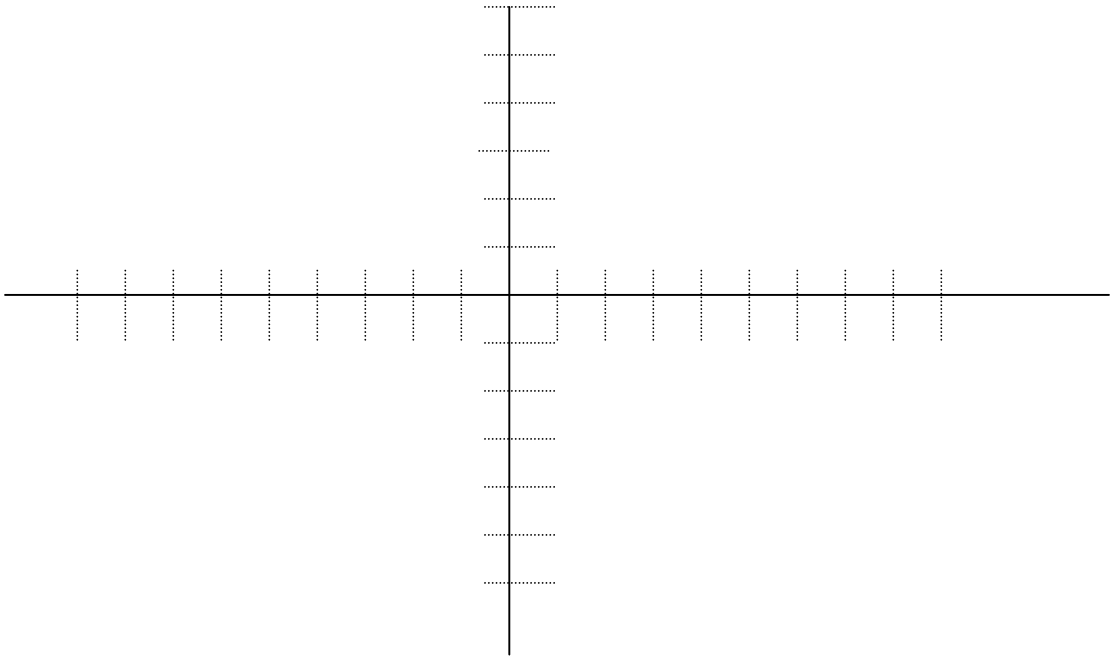
3) Transforms (10 pts)

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), 45 glm::vec3(0, 0, 1));
 glm::mat4 Trans = glm::translate( glm::mat4(1.0f), glm::vec3(3, 0, 0);
glm::mat4 Scale = glm::scale( glm::mat4(1.0f), glm::vec3(2, 2, 1);
 glm::mat4 Model = Trans*Scale* Rot
  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(-3, 0, 0);
 glm::mat4 Rot = glm::rotate( glm::mat4(1.0f), -45, glm::vec3(0, 0, 1));
glm::mat4 Scale = glm::scale( glm::mat4(1.0f), glm::vec3(2, 2, 1);
 glm::mat4 Model = Trans*Rot*Scale
 safe_glUniformMatrix4fv(h_uModelMatrix, glm::value_ptr(Model));
/* Draw */
DrawRobotFace ();
```



4) Shading (20 pts)

Given a light with the following {r, g, b} ambient, diffuse and specular terms:
light_color= {0.5, 0.5, 0.5}
and a material with the following ambient, diffuse and specular terms:
material_diffuse = {0.1, 0.2, 0.2}
material _ambient = {0.1, 0.1, 0.1}
material _specular= {0.1, 0.3, 0.3}
material_shininess={2}
Assuming that the light is **located at is {-10, 5, -10}**.
For a **point located at {-2, 1, -1}** with the normal is {-6, 0, 8}
and the **camera is located at** {-2, 1,1}, what is the reflected color {r, g, b}, computed using the **Blinn-Phong** model (use the H, half vector), etc. for specular)? (Assume there is no distance attenuation). **Show your work!**

5) Camera transforms (20 pts) Given the following glm call:
LookAt(-1, 2, 2, -1, 2, 4, 0, 1, 0)

a) (6 points). What are the **u**, **v**, **w** (camera basis vectors) for this setting?

b) (4 pts) What is the camera transform (please write it as two matrices, the translation and rotation, not as a single composite matrix):

Recall that:

$$\begin{bmatrix} u_x & u_y & u_z & 0 \\ v_x & v_y & v_z & 0 \\ w_x & w_y & w_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & -e_x \\ 0 & 1 & 0 & -e_x \\ 0 & 0 & 1 & -e_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

5) continued

c) (6 pts) What are the coordinates of the point in the world {-1, 2, 3} in the camera space?

d) (4 pts) If you had WASD keys enabled, and the user hit the “w” key and wanted to move forward, what are the updated values sent to the “lookat” function? (Assume you move one unit each key stroke - be specific)

6) Geometric relationships and vectors (10 pts)

(a) If you wanted the iris of a CG creatures eyeball to track the mouse movement (i.e. appear to follow where the user currently has the mouse located), but always draw right at the rim inside the creatures eye, which is defined by a sphere with the following equation:

$$f(x,y) = (x - x_c)^2 + (y - y_c)^2 + (z - z_c)^2 - r^2$$

with {xc, yc, zc} = {2, 5, 7} and a radius of 2, what should the iris' {ix, iy, iz} location be (for an iris of radius 0.5), if you are given mouse coordinates transformed into world coordinates as follows: {mx, my} = {-2, 8} – assume the z value should be the same as the eye's z values?(show your work with math)

{ix, iy, iz} =

Extra Credit. b) (2.5 pts possible) Draw the creature in part (a)