This is a 60 minute, CLOSED notes, books, etc. exam. You are allowed one 8.5x11 "cheat sheet".

Strategy: Scan the entire exam first. Work on the easier ones before the harder ones. Don't waste too much time on any one problem. Length of problems is not necessarily proportional to the points.

BE NEAT. We cannot give you points for something that we can't read. Write down your assumptions. Don't just write your answers, **show how you got them.** Show all your work on the space provided and clearly mark your answers.

Write your name on each page. Check to make sure you have 5 pages.

1	25 points	Lighting	
2	25 points	Viewing Coordinates	
3	25 points	Texture Mapping	
4	25 points	Parametric Curves	
	100 points	GRAND TOTAL	

For your exam to be graded, you need to read and sign the statement below:

I certify that I worked independently, did not cheat nor receive/give any help in this exam. I understand that any infraction will result in my failing this class. In addition, a record of any infraction will be reported to the School of Engineering, to my College provost, and that I may also be suspended or expelled from the University.

Signature: _____

1. **Lighting (25 points)**

   Let the material properties of an object be Ka = (0, 0, 1), Kd = (1, 0, 0), and Ks = (0, 1, 0). Assume we have a white light source.

   (a) (**5 points**) What color do we see in the *unlit* portions of the object?

   (b) (**5 points**) If we are only interested in the diffuse lighting component, what color do we see in the *lit* portions of the object? Assume that $\hat{N} \cdot \hat{L}$ (the cosine term) is 0.5.

   (c) (**5 points**) If we are only interested in the specular lighting component, what color do we see as specular highlights? Assume that $(\hat{R} \cdot \hat{E})^{glossiness}$ term is 0.5.

   (d) (**5 points**) If the white light is changed to a *yellow* light, what color do we see that's due to diffuse lighting only? Again, you can assume that $\hat{N} \cdot \hat{L}$ (the cosine term) is 0.5.

   (e) (**5 points**) If the white light is changed to a *blue* light, what color do we see that's due to diffuse lighting only? Again, you can assume that $\hat{N} \cdot \hat{L}$ (the cosine term) is 0.5.

2. **Viewing Coordinates (25 points)**

   A person wants to create a 360 degree panoramic image of the scenery by stitching 4 images taken at 90 degrees with respect to each other. Assume that the person is at location L:(10,10,0) in the world i.e. on the "ground" at location 10,10.

   Provide a *sketch* of where the user is in the world coordinate system. Be sure to label your axes (**5 points**). Specify the 4 viewing coordinate systems for each of the 4 images. That is, specify Vx, Vy, and Vz for each one. (**5 points** each).

3. **Texture Mapping (25 points)**

A texture T(u,v) is to be mapped to a cylinder C(s,t) defined by:

$x(s,t) = 2cos(2\pi s)$

$y(s,t) = 2sin(2\pi s)$

$z(s,t) = 2t - 1$

where s:[0..1] and t:[0..1], and u:[0..1] and v:[0..1].

The texture is to be mapped to the cylinder using the following conditions:

T(0,0) == C(0,0)

T(1,0) == C(1,0)

T(1,1) == C(1,1)

T(0,1) == C(0,1)

(a) (**5 points**): Where is T(0.5, 0.5) mapped to on the cylinder? Provide the x,y,z coordinates.

(b) (**5 points**): What texture coordinate is mapped to the cylinder at the coordinate (0,2,0)? Provide the u,v coordinates.

In the next 2 questions, a 2000 x 8000 pixel image is used as the texture map. The values at each pixel of this image is defined by:
$I(i,j) = (i+j) * 0.025$, where i:[1..2000] and j:[1..8000].

(c) (**10 points**): Define a mapping of the image I(i,j) to texture space T(u,v). That is, find an expression for u in terms of i and another expression for v in terms of j.

(d) (**5 points**): What *pixel value* is mapped to the cylinder at the coordinate (0,2,0)?

4. **Parametric Curve (25 points)**

   Given three points P_0, P_1 and P_2, design a *quadratic* parametric curve $P(t)$ such that: $P(0) = P_0$, $P(\frac{1}{2}) = P_1$, and $P(1) = P_2$. Recall that a quadratic parametric curve has the form: $P(t) = at^2 + bt + c$. Express your answer in matrix form i.e. $P(t) = TMG$ form, where $T = [t^2 \quad t \quad 1]$.

   Hint: Write down the 3 equations with 3 unknowns and set it up as a system of linear equations of the form $Ax = b$. You will also need to invert a 3x3 matrix but this should be quick (nice numbers).

   Be neat and make sure your solution is clear and understandable in order to earn credit. Make sure you specify both M and G.