CS 130
Exam II

Winter 2013

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	10	
Multiple Choice		
1	2	
2	2	
3	2	
4	2	
5	2	
6	2	
7	2	
Written		
1	5	
2	5	
3	10	
4	10	
5	10	
Total	64	

True/False (1 pt each)

1. (T/F) Any rotation in 3D space can be described using an angle and an axis.
2. (T/F) Any rotation representation may suffer from the problem of gimbal lock.
3. (T/F) Texture mapping adds detail without increasing the polygon count.
4. (T/F) Bump mapping can be used to give the object a bumpy appearance in the interior polygons of an object by perturbing vertex positions.
5. (T/F) Bilinear filtering reduces aliasing artifacts in texture mapping.
6. (T/F) Piecewise polynomial curves are preferable to high order polynomials because interpolating a large number of points with a single high order polynomial can create a very oscillatory curve.
7. (T/F) Blending functions provide a convenient basis for expressing curves in terms of the control points.
8. (T/F) An n^{th} order polynomial is uniquely determined by $n+1$ distinct control points.
9. (T/F) Reflection rays always point from an intersection point to the eye.
10. (T/F) Ray tracing is generally better suited for global illumination effects than the OpenGL 3D rendering pipeline.

Multiple Choice (2 pts each)

1. Texture mapping a) adds detail by increasing geometric complexity b) is supported by the OpenGL graphics pipeline c) will change object silhouettes d) none of the above e) both C and D
2. Given a ray tracing algorithm, if we add small random perturbations to each reflection ray, how will that change the resulting image? a) it will blur the image b) the image will be distorted beyond recognition c) it will appear grainy d) it will increase aliasing artifacts
3. Which of the following are true?

   I. In keyframe animation, character's motion is determined by both the shape of the interpolating curve and the time parameterization of the curve.

   II. If the hand of a robotic arm is to be positioned at a given point, the state of the joints leading to the hand must be determined by forward kinematics.

   III. The squash and stretch principle of animation would make a deformable squishy ball appear more realistic.

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

4. If a curve is C^1 continuous, then a) it can have sharp corners b) its tangent vectors are continuous c) A and B d) none of the above
5. This matrix

$$\begin{pmatrix} \cos\theta & -\sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

   a) rotates about the x-axis b) rotates about the y-axis using the right-hand rule c) rotates about the z-axis d) rotates about the y-axis but uses the left-hand rule instead of the right-hand rule.

1 Written Response

1. Imagine you want to rotate the object below θ degrees about an axis $\mathbf{u}$ about its center of mass $\mathbf{p}$ ($||\mathbf{u}|| = 1$).

   (a) How would you do this using a sequence of translations and rotations about the primary x, y, z axes?

   (b) Write down a quaternion that achieves the same rotation.

2. Consider the following snippet of code from a ray tracer.

```
for each pixel do
    compute viewing ray
    if ( ray hits an object with t in [0, inf] ) then
        compute n
        evaluate shading model and set pixel to that color
    else
        set pixel color to the background color
```

   (a) How would you modify this to add shadows?

   (b) How would you modify your pseduocode in part (a) to make the shadows soft shadows?

3. (5 pts) Consider a set of control points $\mathbf{p}_{ij}$, and the associated Bezier surface patch defined by

$$\mathbf{p}(u, v) = \sum_i \sum_j b_i(u) b_j(v) \mathbf{p}_{ij}.$$

   Develop an algorithm for calculating the normal vector to the patch at any point $\mathbf{p}(u, v)$.