NAME:

Computer Science 426 Midterm
5/4/06, 1:30PM-2:50PM

This test is 5 questions. Do all of your work on these pages (use the back for scratch space), giving the answer in the space provided. This is a closed-book exam -- you may use one-page of notes with writing on both sides during the exam. **Please write out and sign the Honor Code pledge before turning in the test.**

``I pledge my honor that I have not violated the Honor Code during this examination.''

Question	Score
1	
2	
3	
4	
5	
Total	

Q1: Coherence (20 Points)

a) Please give a definition for “coherence.” (one sentence)

b) Please give three examples of how coherence is utilized in the OpenGL rendering pipeline. (three phrases)

c) Please explain how *coherence between neighboring pixels* can be utilized to accelerate ray-scene intersections in a ray tracer. (one sentence)

d) Please explain how *spatial coherence* can be utilized when detecting collisions in a particle system. (one sentence)

e) Please explain how *temporal coherence* can be utilized when detecting collisions in a particle system. (one sentence)

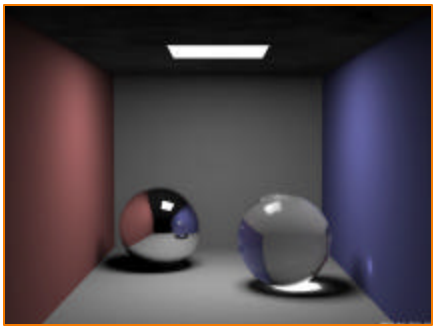
Q2: Rendering Equation (20 Points)

a) Please write the rendering equation. Please provide a brief description of each variable and term, and support your answer with a drawing containing labels for the main variables. (one equation, one drawing, and a phrase for each variable and term in the equation).

b) Please write an equation describing the simplified form of the rendering equation that is solved by the ray tracing algorithm. What simplifying assumptions are being made? (an equation, a list of assumptions, and possibly a drawing)

c) Please describe a rendering algorithm that could provide a full solution to the rendering equation without approximation when given infinite computing resources. How does the algorithm consider all light paths? (a few sentences).

d) Write a list of all the path types (e.g., LDE) included in the rendered image shown below (note that the bright white square at the top of the box is the only light source in the scene).



Q3: 3D Object Representations (20 Points)

a) True or False: “All 3D object representations are able to perform all the same operations.” Please explain your answer. (True/False and one sentence)

b) Please describe the most **concise** way to store a 3D model representing the surface of a pencil. Please explain your answer. (one or two sentences)

c) Please describe the best way to store a 3D model representing the surface of a pencil if your only concern is fast rendering with OpenGL. Please explain your answer. (one sentence)

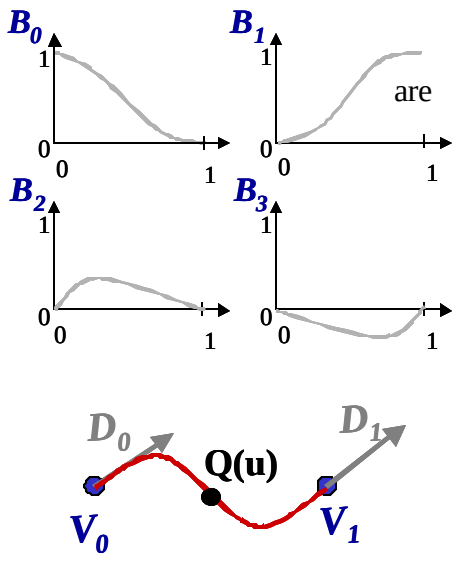
d) Please describe the best way to store a 3D model representing the surface of a pencil if your only concern is collision detection in an animation system. Please explain your answer. (one sentence)

e) Please describe the “winged-edge” mesh representation – i.e., provide a short list of the main data and pointers associated with every vertex, edge, and face? (three short lists)

f) When/why is it a good idea to use the winged-edge representation rather than a simpler representation based only on “vertex and face tables” (i.e., a table of (xyz) coordinates for every vertex and a table of vertex ids for every face)? (one sentence)

Q4: Parametric Curves (20 Points)

a) The blending functions for a cubic Hermite curve are shown to the right. Please explain how they are used to determine the point, Q(u), shown on the curve below (an equation with one or two sentences explanation).



b) What input is provided to specify a "natural cubic Hermite spline?" (some phrases)

c) What are the two main advantageous properties of a "natural cubic Hermite spline?" (two phrases)

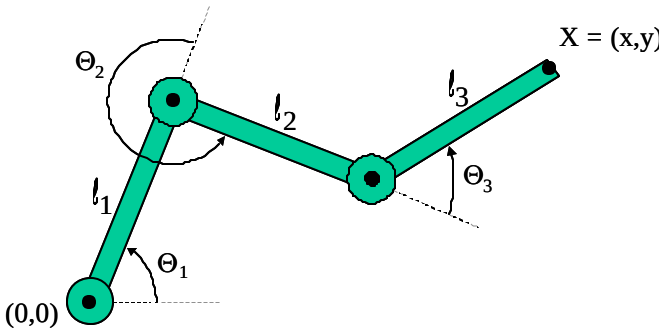
d) What is the main disadvantageous property of a "natural cubic Hermite spline?" (one phrase)

e) Please describe another piecewise cubic spline construction (e.g., Bezier, B-Spline, etc.) that does not have this disadvantageous property and explain the difference (one or two sentences).

f) Joe Shmoe at "Curves R Us" advertises that he has a piecewise cubic spline that interpolates its control vertices, has C2 continuity at every joint, and provides local support for every control vertex. Please give the main idea for an argument that could prove that Joe is falsely advertising. (a few sentences)

Q5: Kinematics and Dynamics (20 Points)

(a) Consider the 2D mechanical arm shown to the right. Please draw a hierarchical scene graph representing this arm, depicting shapes as rectangular nodes and transformations as circular nodes. For each transformation, please label it with a symbolic expression -- e.g., $R(\Theta_1)T(l_1,0)$.



b) True or False: the position X at the end of the arm on the right is uniquely determined by the angles (Θ_1, Θ_2 , and Θ_3) and lengths (l_1, l_2, and l_3), assuming the base point on the left is fixed at (0,0). Please explain your answer. (True or False and one sentence)

c) True or False: the angles (Θ_1, Θ_2 , and Θ_3) and lengths (l_1, l_2, and l_3) are uniquely determined by the position X at the end of the arm on the right, assuming the base point on the left is fixed at (0,0). Please explain your answer. (True or False and one sentence)

d) If there is not a unique solution to either answer to part (c) or (d), please explain how animation systems select a solution. (one sentence)

e) What is the main difficulty with Euler integration for solving equations of motion? (one sentence)

f) Please describe at least one method to address this difficulty. (one or two sentences)