# *CIS 736*
# *Computer Graphics*
Spring, 2002

Midterm Exam (Closed-Book, Closed-Notes)
Wednesday 13 March 2002

## Instructions and notes

- **Do not open this exam until instructed to.**
- You have 100 minutes for this exam.
- You should have a total of 7 pages; write your name on each page.
- Use only the front side of pages for your answers; you may request additional pages if needed.
- Circle exactly one answer for each true/false and multiple choice question.
- Show your work on problems and proofs.
- No calculators or computing devices are needed or permitted on this exam.
- You may use a straight-edge or measuring device on Problem 5.
- In the interest of fairness, **no individual questions shall be answered during the exam**. You may notify the instructor if you believe there is a typographical error. If you are unsure of a definition, or believe a question is ambiguous, write down your assumptions.
- There are a total of 150 possible points in this exam and 15 points of extra credit.

**Instructor Use Only**

| | |
|---|---|
| 1. | _____ / 30 |
| 2. | _____ / 30 |
| 3. | _____ / 30 |
| 4. | _____ / 30 |
| 5. | _____ / 30 |
| EC | _____ / 15 |

**Total _____ / 150**

**1. True/False (10 questions, 3 points each)**

**a) T F** The canonical parallel projection view volume is a truncated pyramid.

**b) T F** A *Bézier curve* has control polygons with 4 points each.

**c) T F** Interpolation of *Hermite curves* is generally faster than interpolation of comparable *Bézier curves*.

**d) T F** *Catmull-Rom splines* are designed for controlling motion paths in animation.

**e) T F** The term *sweep* refers to an object in ($d$ - 1)-dimensional Euclidean space $\mathbf{R}^{d-1}$ that can be subjected to transformations in $\mathbf{R}^{d}$ to generate an object in $\mathbf{R}^{d}$.

**f) T F** An interior (non-leaf) *quadtree* node must have type "partially full".

**g) T F** In volumetric graphics or volume graphics, *adaptive spatial partitioning* provides a representation for fast, array-parallel rendering.

**h) T F** The *Painter's Algorithm* is a type of conservative visible-surface determination.

**i) T F** A *binary space partitioning (BSP) tree* is a decision tree whose interior nodes classify points as lying inside, outside, or on a solid.

**j) T F** The *ambient* component of an illumination equation is used to model interobject reflections in the absence of explicit calculations.

**2. Multiple Choice (6 questions, 5 points each)**

**a) Which of the following matrix transformations is <u>not</u> used in the perspective-projection normalizing transformation $N_{per}$?**

A) Translate
B) Rotate
C) Shear
D) Scale
E) All are used in $N_{per}$

**b) Which of the following clipping algorithms uses outcodes?**

A) I. Cyrus-Beck
B) II. Liang-Barsky
C) III. Cohen-Sutherland
D) I and II but not III
E) I, II, and III

**c) Which of the following is a type of oblique projection?**

A) I. Cabinet
B) II. Cavalier
C) III. Axonometric
D) I and II but not III
E) I, II, and III

**d) Back-face culling is a type of**

A) Hidden-line removal
B) Surface detailing
C) Conservative visible-surface determination
D) Image-precision visible-surface determination
E) Object-precision visible-surface determination

**e) Which of the following are global terms in the Phong illumination model?**

A) Ambient
B) Diffuse
C) Specular
D) All of the above are global
E) None of the above are global

**f) Which argument to glShadeModel() turns on Gouraud shading?**

A) GL_INTENSITY
B) GL_GOURAUD
C) GL_SMOOTH
D) GL_SHADE
E) GL_FLAT

**3. Fill-In-The-Blank (15 items, 2 points each)**

**a) The process of synthesizing images from models is called _____.**

**b) The function call (and *GLEnum* argument) used to prepare for drawing a single, *n*-vertex convex polygon in *OpenGL* is _____.**

**c) The perspective view volume, bounded by near and far clipping planes, is called a(n) _____.**

**d) In addition to near and far clipping plane distances, the gluPerspective() takes as arguments the specified field of view and _____.**

**e) To simulate the behavior of glFrustum(), one would compute the view transformation matrix for perspective projection and call _____ to combine it with the current matrix (contraining the normalizing transformation).**

**f) The problem of displaying data, objects, and processes in a representation that is comprehensible to human users is called _____.**

**g) A type of axonometric projection where the angles between the projection of the axes are equal (120º) is called _____.**

**h) _____ are a family of cubic curves that achieve $C^1$ continuity and have control polygons with the convex hull property.**

**i) _____ continuity is continuity in the direction but not necessarily the magnitude of tangents to piecewise-differentiable curve segments.**

**j) Edge tables or winged edges are data structures for _____ representations of 3-D objects.**

**k) A(n) _____ is an adaptive spatial partitioning representation for 2D scenes.**

**l) The gluUnProject() function maps _____ coordinates to object coordinates.**

**m) Each interior node in a constructive solid geometry (CSG) tree combines objects using _____.**

**n) Gouraud shading tends to underemphasize specular highlights that occur at the _____ of a polygon and overemphasize those that occur at its _____.**

**o) Phong shading interpolates the _____ of a polygon.**

**4. Short Definition / Illustration (3 items, 10 points each)**

**a) Define: *oblique projection***

**Draw: an illustration of the difference between oblique and orthographic projections**

**b) Define: *Constructive Solid Geometry (CSG) tree***

**Draw: CSG tree for the object below, supposing you have cylindrical primitives (note the indentation on one side) – label all nodes**

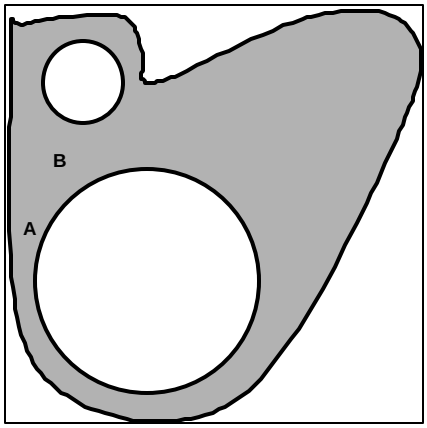

**c) Define: *subdivision-based rendering of cubic curves***

**Draw: A figure explaining *deCasteljau's subdivision algorithm* for evaluation of a Bézier curve segment. Explain how the recursion is handled in words, pseudocode, or using matrices.**

**5. Construction (30 points)**

**Construct a quadtree for the following 2D scene. Draw both the adaptive subdivision on the scene itself and the quadtree (showing full, partially full, and empty nodes) to a <u>maximum</u> depth of *3 subdivisions*. Use the quadrant numbering:**

**2 3**
**0 1**



**Extra Credit**

**a) (5 points) Using the quadtree you drew in Problem 5, *classify* the points labeled A and B (show which leaf to which each point is mapped). Show your work here or on Problem 4, but write the resulting classifications here.**

**b) (5 points) Illustrate how to find a *2-D translational sweep* given the 3-D object it produced.**

**c) (5 points) Explain in a short paragraph: what is recursive about *recursive ray tracing*?**