Saturday, 15 October 2022

Total marks: 100

Duration: 1 hour

CSE 333/533 - Computer Graphics
Mid-semester Examination, Monsoon 2022

Calculators are allowed to use. Use of mobile devices/ computers/tablets are not permitted except for video sharing with the invigilator. Attempt all questions. Show all of your working.

Question 1:

(a) Describe the half-edge data structure. Clearly mention all the structures (you may write pseudocode) and explain. [10 marks]

(b) Write pseudocode for 1-ring traversal in the half-edge data structure. What is the complexity of this traversal? Your code should be self-explanatory and documented. [10 marks]

Question 2:

(a) Show the affine invariance property of a Bézier curve. That is, an affine transformation of a curve is equivalent to the curve produced from equally transformed control polygon. Recall that an affine transformation is a combination of translation, rotation and scaling (possibly non-uniform). [20 marks]

(b) Show that if the vertices of a geometry are transformed by a matrix M, then $(M^{-1})^T$ would correctly transform the normals associated with each point. [10 marks]

Question 3:

(a) What is a BRDF (use a diagram to support your answer)? Write properties of a BRDF. [20 marks]

(b) Give examples of BRDFs of diffuse, specular and glossy surfaces with illustrative diagrams. [8 marks]

(c) Write the Phong-Blinn reflection model and explain each term. [14 marks]

Question 4:

(a) What are barycentric coordinates for a triangle? Explain with properties. [10 marks]

Total marks: 100

Saturday, 10 December 2022

Duration: 2 hours

CSE 333/533 - Computer Graphics
End-semester Examination, Monsoon 2022

*Calculators are allowed to use. Use of mobile devices/ computers/tablets are not permitted. Attempt **all** questions. Show all of your calculations and derivations. Answers without full solution/steps will not receive any marks. Mention assumptions that you make in your solution and draw diagrams to support your answer wherever appropriate.*

Question 1:

Consider two rotation matrices R_1 and R_2 where R_1 represents rotation about axis $\hat{v}_1$ by an angle θ_1, and R_2 represents rotation about axis $\hat{v}_2$ by an angle θ_2. Show that $R_1 \cdot R_2 \neq R_2 \cdot R_1$. Do not assume any particular values of the rotation parameters/types in your proof. [20 marks]

Question 2:

Design a cubic curve $f(t)$ with following constraints:

$f(0) = (0,1), f(0.5) = (0,0), f(1) = (1,0)$, and $f'(0) = (1,0)$.

(a) Derive the matrix form of $f(t)$ as well as write its polynomial form. [15 marks]

(b) What are the derivates at $t = 0.5$, and $t = 1$? [5 marks]

You may ask the instructor/invigilator to provide you with inverse of the 4x4 matrix.

Question 3:

(a) Devise an arc-length parameterization for the curve represented by the parametric function $r(t) = \langle -\sin(t), \cos(t), 1 \rangle$ by its arc-length starting from (-1, 0, 1). [10 marks]

(b) Show that the inverse of the matrix for an affine transformation (one that has all zeros in the bottom row except for a one in the lower right entry) has the same form. [10 marks]

Question 4:

(a) What is Linear Blend Skinning? What is the primary problem associated with it? Give example. [10 marks]

(b) How can you use quaternions to rotate a point $p(x,y,z)$ by an angle θ anti-clockwise about an axis $\hat{a}(u,v,w)$? [10 marks]

Question 5:

(a) Explain the BSP-tree data structure. Describe the rendering algorithm with a BSP-tree. Write pseudocode to support your answer. [10 marks]

(b) Explain mathematically how bilinear interpolation works. [10 marks]