Thursday, 28 September 2023

Total marks: 100

Duration: 1 hour

CSE 333/533 - Computer Graphics
Mid-semester Examination, Monsoon 2023

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*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:

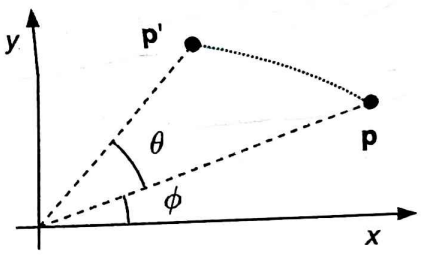
(a) Describe the half-edge data structure. Clearly mention all the structures (you may write pseudocode) and explain. [10 marks]

(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]

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

Question 2:

Find out a 2D transformation matrix that moves a point along the Archimedean spiral $r = \phi$. This can be written in cartesian form as $x = \phi \cos \phi$, and $y = \phi \sin \phi$. While calculating the transformation matrix $\mathbf{M}$, consider moving point $\mathbf{p}$ (that makes an angle ϕ with x-axis) to point $\mathbf{p}'$ by an angle θ along the spiral such that $\mathbf{p}' = \mathbf{M}\mathbf{p}$ (see figure). [30 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. [5 marks]

(c) Write the Phong-Blinn reflection model and explain each term. [15 marks]

Total marks: 100

Thursday, 7 December 2023

Duration: 2 hours

CSE 533/333 - Computer Graphics

End-semester Examination, Monsoon 2023

Calculators are allowed to use. Use of mobile devices/computers/tablets are not permitted. Attempt **all** questions. Show all of your working.

Question 1:

(a) In 2D, any sequence of rotations and translations can be replaced by a single rotation about the origin followed by a translation:

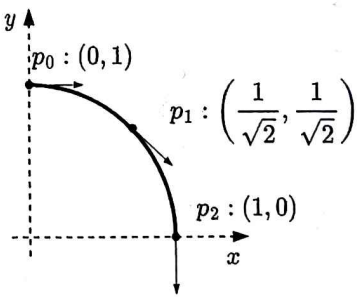
$$\mathbf{T}(t_1)\mathbf{R}(\theta_1)\cdots\mathbf{T}(t_k)\mathbf{R}(\theta_k)\cdots\mathbf{T}(t_n)\mathbf{R}(\theta_n) = \mathbf{T}(t)\mathbf{R}(\theta)$$

where $\mathbf{R}$ is the transformation matrix for rotation about origin and $\mathbf{T}$ is the transformation matrix for translation, θ_k for $k \in \{1\cdots n\}$ are rotation angles, t_k for $k \in \{1\cdots n\}$ are translation vectors, θ is the effective rotation angle, and t is the effective translation vector. Calculate θ and t. [30 marks]

(b) How are rotations in 3D represented using quaternions. Explain and write expressions. [10 marks]

Question 2:

(a) Design a quintic (a degree 5) polynomial ~~Bezier~~ curve that closely resembles a circular arc in the first quadrant (see adjoining figure). Use the Hermite form to incorporate first derivative constraints. How would you measure error between your curve and the arc? [20 marks]



Question 3:

(a) Write the hemispherical formulation of the rendering equation. Explain various terms and energy balance. [10 marks]

(b) Convert the hemispherical formulation to the area formulation. Explain all steps in detail along with mathematical expressions. [20 marks]

Question 4:

Explain Bump Mapping. Derive expressions for modified (or perturbed) normal at a point $\mathbf{p}(u, v)$ on the surface given a displacement function $\mathbf{d}(u, v)$. [10 marks]
