FINAL EXAM: Introduction to Computer Graphics
CS480/580

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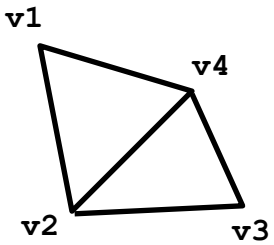
Your NAME:

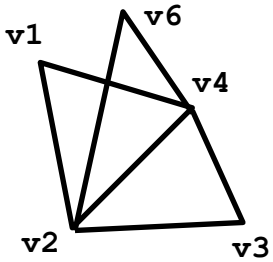
Do all FIVE questions. If you have any questions, please raise your hand and I will get to you. If you need more space to write the answer then use the back of the page.

Question 1 (a): (10 points) (Hidden Surface Removal) Briefly explain the painters algorithm. Explain how the *piercing* polygons will be handled. Are they a special case that must be treated explicitly, or are they accommodated by the basic algorithms. **Explain your answer**.

Question 1 (b): (15 points) (DCEL) For the following planar graph in Fig (a) G=(V,E), give the doubly-connected-edge-list (DCEL) data structure.



(a)



(b)

Can the DCEL data structure handle the graph in Figure (b)? Why or why not? **Explain your answer**.

Question 2 (a): (5 points) (Continuity) What do we mean by C^0 and C^1 parametric continuity? How do they differ from G^0 and G^1 geometric continuity? Give examples of the curves.

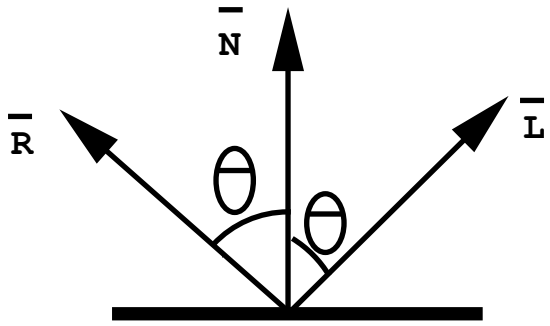
Question 2 (b): (15 points) (Joining Curves) Equations of two curves Q and R are given as follows:
$Q(t) = (1-t)^3 P_1 + (3t^3 - 6t^2 + 4)P_2 + (-3t^3 + 3t^2 + 3t + 1)P_3 + t^3 P_4$.
$R(t) = (1-t)^3 P_2 + (3t^3 - 6t^2 + 4)P_3 + (-3t^3 + 3t^2 + 3t + 1)P_4 + t^3 P_5$.
For both the curves $0 \leq t \leq 1$.

Are both the curves C^0 continuous at Q(1) and R(0)? Why or why not? Are they both C^1 and G^1 continuous at Q(1) and R(0)? Are they both C^2 and G^2 continuous at Q(1) and R(0)? Why or why not? Explain your answers.

Question 3 (a): (10 points) (Gouraud and Phong Shading Models) Explain the Gouraud and Phong Shading models for polygons.

Question 3 (b): (5 points) (Gouraud and Phong Shading Models) Give an example where both (Gouraud and Phong) shading models result in unsatisfactory shading.

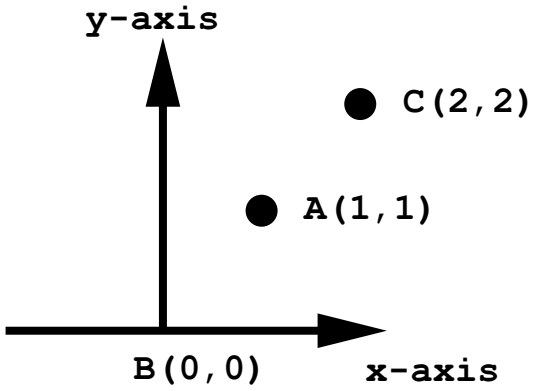
Question 4 (a): (5 points) (Phong Model) Calculate the reflection vector in terms of N and L as shown in the following figure.



Question 4 (b): (15 points) The intensity (I) at a point due to diffuse (Lambertian) reflection and ambient light can be estimated using the following equation:

I = $I_a k_a + f_A I_p k_d\ (\bar{N} \cdot \bar{L})$.

Explain the terms in the above equation. Given the constants $I_a = 2$, $k_a = .2$, $I_p = 10$, $k_d = .4$, and one light source at point p= (1,1), and f_A = Inverse of the distance of point B from the location of light source (See the 2D Figure below). Calculate the intensity at point B of the figure using the above information. What will be the intensity at point B using the above equation when the light source is moved from point A to C as shown in the Figure below.



Question 5 (a): (10 points) (Ray Tracing algorithm) Explain the basic idea of the ray tracing algorithm.

Question 5 (b): (10 points) (Radiosity equation interpretation) Given the following equation:

$$B_i = E_i + \rho_i \sum_{i=1}^{n} B_j \, F_{j->i} \frac{A_j}{A_i}$$

Eplain how the above equation captures the basic idea of radiosity.