

Computer Graphics Ph.D. Qualifying Exam, October 2009

1. (10%) (a) Explain what normals are. (b) What relationship do normals and tangents have?
2. (25%) (a) The Phong illumination model can be summarized by the following equation:

$$I = k_e + k_a I_a + \sum_i \left[I_{l_i} \left(k_d (\mathbf{N} \cdot \mathbf{L}_i)_+ + k_s (\mathbf{V} \cdot \mathbf{R}_i)_+^{n_s} \right) \min \left(1, \frac{1}{a_0 + a_1 d_i + a_2 d_i^2} \right) \right]$$

Draw a diagram to explain the main variables in the above formulation. What effects do the terms of the above formulation intend to model? (b) Describe how to shade a triangle using flat shading, Gouraud shading and Phong shading. Discuss their visual differences.

3. (25%) (a) Describe the rendering equation proposed by Kajiya in his classic SIGGRAPH 1986 paper. (10%) (b) Explain how to derive Whitted's model from the rendering equation. (10%) (c) Could you suggest a way to find the solution to the rendering equation without making assumptions. You can ignore the efficiency issue. (5%)
4. (40%) Ray tracing and radiosity are two popular approaches for global illumination. (a) Briefly describe both methods. (20%) (b) Describe their strengths and weaknesses. (10%) (c) Give one example for each that you will prefer one over the other and explain why. (10%)