

## Interactive Computer Graphics Ph.D. Written Exam March 2007

1. (15%) **A** and **B** are  $3 \times 3$  rotation matrices. Let **C** be a matrix created by a convex linear combination of them ( $\mathbf{C} = \alpha\mathbf{A} + (1 - \alpha)\mathbf{B}$ ). Under what circumstances will **C** be a rotation matrix?
2. (20%) The Phong illumination model can be summarized by the following equation:

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

Draw a diagram to explain the main variables in the above formulation. What effects do the terms of the above formulation intend to model?

3. (10%) For the above formulation, Blinn and Newell have suggested that, when **V** and **L** are assumed to be constants, the computation of  $\mathbf{V} \cdot \mathbf{R}$  can be simplified by associating with each light source a fictitious light source that will generate specular reflections. The second light source is located in the halfway direction **H** between **L** and **V**. The term  $\mathbf{V} \cdot \mathbf{R}$  is then replaced by  $\mathbf{N} \cdot \mathbf{H}$ . Under what circumstances might **L** and **V** be assumed to be constant and how does the new equation using **H** simplify shading equations?
4. (15%) (a) Describe Flat shading, Gouraud shading and Phong shading. (b) Discuss their visual differences.
5. (10%) Give 2 or 3 advantages that BSP trees have over a Z-buffer.
6. (10%) Please describe a method of generating shadows for point light sources in local shading.
7. (10%) Please describe a method to speed up the ray-scene intersection finding for ray tracing.
8. (10%) Despite its weaker graphics capability than PS3 and XBox 360, Wii has gained more popularity than its competitors. Please give your explanations on this fact.