資格考試科目：計算機圖形 99. 3. 11

# Computer Graphics Ph.D. Qualifying Exam, March 2010

1. (20%) (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.

2. (20%) (a) Describe the rendering equation proposed by Kajiya in his classic SIGGRAPH 1986 paper. (12%) (b) Suggest a way to find the solution to the rendering equation without making assumptions. You can ignore the efficiency issue. (8%)

3. (20%) Given a triangle $T$ with vertices $V_1$, $V_2$, $V_3$ and a ray $R$ with origin $O$ and direction $d$, (a) use a parametric equation to describe all points lying on the ray (5%), (b) what is the plane equation where $T$ lies? (5%), (c) what is the intersection of $R$ and that plane? (5%) and (d) how to check whether $R$ and $T$ intersect? (5%)

4. (20%) **Radiosity**. There are $n$ patches, $P_i$, in the scene. Patch $P_i$ has its area $A_i$, reflectivity $R_i$ and emitted energy $E_i$. The form factor between two patches $P_i$ and $P_j$ is denoted as $F_{ij}$. The goal of radiosity algorithms is to solve for the radiosity $B_i$ for each patch. (a) Write down the radiosity equation. (5%) (b) How to solve the radiosity equation? (5%) (c) Explain what form factor is. (5%) (d) Suggest a way for evaluation of the form factors. (5%)

5. (20%) Assume a very simple scene, the inside of a uniformly emitting Lambertian sphere with emittance $E$ and reflectance $\rho$. What is the radiance for each point inside the sphere when the scene reaches equilibrium.