3 Introduction to Graphics (rkm38)

(*a*) The Phong reflection model is expressed as

$$I = I_\mathrm{a}\, k_\mathrm{a} + \sum_i I_i\, k_\mathrm{d}(L_i \cdot N) + \sum_i I_i\, k_\mathrm{s}(R_i \cdot V)^n\,. \tag{1}$$

(*i*) In which situation do the terms $L_i \cdot N$ and $R_i \cdot V$ become negative? How should this case be handled? [2 marks]

(*ii*) The equation above does not account for cast shadows. How can we simulate shadows in ray tracing? [1 mark]

(*iii*) How can we simulate soft shadows with blurry boundary in ray tracing? [3 marks]

(*iv*) You work on an accelerated rendering pipeline in which the results of shading computation can be stored in object's texture and then reused in future frames. We assume that only the Phong reflection model is used. Determine and enumerate which terms of the reflection model (ambient, diffuse and specular) can be reused in the future frames when the camera, objects or lights move. [4 marks]

(*b*) You came up with an idea to render shadows in rasterization. You first render the depth map of the scene from the point of view of the light source and store the result in a texture, which you call a shadow map. Then, when rendering the scene, you use the shadow map as a replacement for shadow rays.

(*i*) What condition needs to be met to determine that a fragment is in shadow? [2 marks]

(*ii*) How can you find the (u, v) coordinates in the shadow map for a fragment with the world coordinates p? You have view, V, and projection, P, matrices of the camera that rendered the shadow map. The model matrix is an identity matrix. [4 marks]

(*iii*) Discuss the artifacts that you are likely to see when rendering shadows with your method. [4 marks]