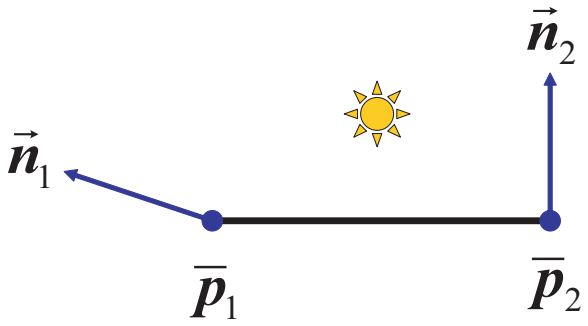
CSCD18 Computer Graphics, Fall 2007
Assignment 3

Part B, Written: Due at the drop-box by 11:59pm on Monday, November 26 [50 marks]

1. *[17 marks]* Suppose that we are doing lighting and shading in 2D (for simplicity) in the scene illustrated bellow. The scene consists of a single line segment, illustrated by the dark black line, with normals at the two vertices and a single light source.



   (a) *[12 marks]* Describe how the line segment will look shaded by each one of the following models: Flat, Phong, and Gouraud. In each of these three cases tell where the brightest point will be and why. For simplicity assume that the properties of the line are such that it does not reflect any ambient or specular light (*i.e.* only consider diffuse component). 1-2 sentences for each one of the models will suffice.

   (b) *[5 marks]* Now consider the same scenario, but with different material properties for the line, where specular component is also present. For simplicity assume that we have a very narrow specularity. Which of the three models will be effected by this change? Why?

2. *[20 marks]* Derive an intersection algorithm for ray with a cylindrical *vase*. Assume that the cylinder (in the form of which the *vase* is made) has an equation of $x^2 + y^2 = 1$ for $0 \leq z \leq 5$. Since the surface is a *vase*, it has a single cap at the bottom (at $z = 0$) and an open top. First, derive the equation for the *hit point(s)*. Second, enumerate all the special cases, and describe what needs to be done for each one (*i.e.* is the *hit point* visible, which of the *hit points* needs to be rendered, *etc.*). Note that we have done this in class for a sphere. (Hint: the basic algorithm for doing this was already discussed in class and is outlined in the lecture notes; all you need to do is fill in the missing details).

3. *[13 marks]* Recall that the radiant intensity I of a point light source is defined as the flux per solid angle: $I = d\phi/d\omega$. Solid angle is measured in steradians; radiant intensity is measured in Watts per steradian.

   (a) *[4 marks]* Consider a spotlight modeled as a point light source that radiates light over a restricted solid angle of c steradians. Derive the total power output of this spotlight, as measured in Watts. What is the power if $I = 6W/sr$ and $c = 1sr$?

   (b) *[4 marks]* Suppose the spotlight is placed at the center of a sphere with radius r. Derive the surface area of the region of the sphere illuminated by the spotlight.

(c) *[5 marks]* What is the irradiance $H(\bar{p})$ at a surface point $\bar{p}$ inside the region of the sphere illuminated by the spotlight? You may assume that the inward-facing surface normal $\vec{n}$ at this point is given.