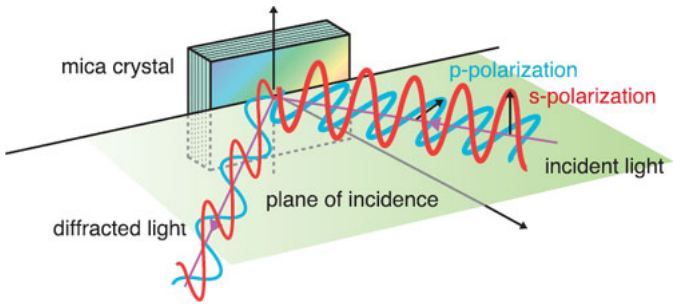
Problems to solve during the (out)break

PART 2

1. What amount of the light energy is reflected/transmitted, if the light hits the water surface by the angles 30° and 80°, respectively? Use the Fresnel equations for s- and p-polarized light in your computations.



Notes, additional questions and hints:

- Fresnel equations describe the amount of the reflected (transmitted) light energy.
- The amount is dependent on the viewing angle (with respect to the surface).
- How do we interpret the amount of the reflected/transmitted light visually?

Solution: The amount of the reflected light is 2.107% and 34.65%, respectively. The amount of the transmitted light is given directly by the law of conservation of energy.

2. Consider the scene with the golden ball and the point lamp. The viewer stands in the point $(-1, 0, 5)^\top$, and the position of the lamp is $(10, 0, 20)^\top$. The color of the light is $(1, 1, 1)$, and the ambient coefficient is 5%. Gold is characterized by the following values:

$$k_a = (0.247, 0.199, 0.075),$$
$$k_d = (0.752, 0.606, 0.226),$$
$$k_s = (0.628, 0.556, 0.366),$$
$$n_s = 51.2.$$

What color is seen in the point $(0, 0, 1)^\top$ with the normal vector $(0, 0, 1)^\top$, if we use the Phong illumination model?

Notes, additional questions and hints:

- The Phong illumination is the sum of the ambient, diffuse and specular part.

- The color is computed separately for each color channel. The computations may be facilitated by using the coordinate-wise multiplication of the color and the respective vectors.

Solution: The color is $(0.81, 0.654, 0.277) = RGB(207, 167, 71)$.

3. Consider a pyramid $V_0V_1V_2V_3$, where $V_0 = (0, 0, 0), V_1 = (0, 1, 0), V_2 = (1, 0, 0), V_3 = (0, 0, 1)$.

   (a) Determine the normal vectors in the vertices V_0, V_1, V_2, V_3.

   (b) Using the Phong illumination model, the colors of the vertices were calculated as follows:

   $$c(V_1) = (0.6, 0.1, 0),\ c(V_2) = (0.6, 0.2, 0),\ c(V_3) = (0.7, 0.15, 0).$$

   Calculate the color of the pixel $(4, 4)$ on the display of the triangle $V_1'V_2'V_3'$ (see the figure), if it is obtained by the projection of the pyramid onto the camera and the Goraud shading is used.

   (c) How would have been the color computed, if the Phong shading was used? Compute the normal vector in the pixel $(4, 4)$, which is used in the color calculation using the Phong shading.

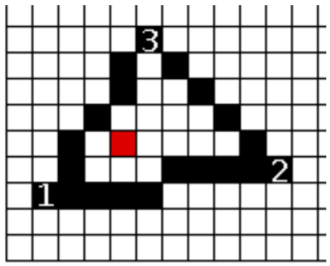


Fig. 1: The numbers correspond to the indices of the given vertices of the triangle.

Notes, additional questions and hints:

- To compute the face normals for this case, use the fact that the vertices lie on the coordinate axes. The vertex normal is then computed by simple averaging of the face normals of the incident faces. However, there are more advanced method of computing vertex normals from face normals.
- Keep in mind the difference between Goraud and Phong shading, i. e. in Gouraud we firstly shade, then interpolate, in Phong vice versa.

Solution: The color is $(0.63, 0.11, 0) = RGB(161, 28, 0)$ for Goraud shading.

To compute the color for the Phong shading we compute the normal vector for the given point using the bilinear interpolation an this is plugged into the computation of the Phong illumination (assuming we know the properties of the given material).