Assignment 05

ⓘ This is a preview of the published version of the quiz

Started: Nov 12 at 4:08pm

Quiz Instructions

Fill out this assignment in Canvas. Most questions can be directly answered in Canvas. For some you have to fill out a free-form text field: make use of the HTML options and the equation editor, if you feel comfortable with it. The equation editor supports Latex in its advanced mode. Otherwise it is also possible to insert an image by first uploading it to your files and then embedding it in the text.

The quiz **saves itself automatically** whenever you change any input. You can quit the browser and return later to continue filling it out. However, you do **have to submit** once you are done with everything.

After submission, you can re-do this assignment as often as you like. However, it will not load your previous answers. The latest attempt is kept. We do not take the number of attempts into account, nor the time that you need to fill out the form.

Question 1 — 2 pts

Bilinear surfaces

Let the bilinear surface $\mathbf{x}(u, v)$ over the domain $[0,\ 1]\ \times [0,\ 1]$ be given by the Bézier points:

$$\mathbf{b}_{00} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \quad \mathrm{b}_{10} = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} \quad \mathrm{b}_{01} = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix} \quad \mathrm{b}_{11} = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$$

Determine the surface point at $\mathbf{x}(\frac{1}{2}, \frac{1}{2})$!

$\mathbf{x}(\frac{1}{2}, \frac{1}{2}) =$

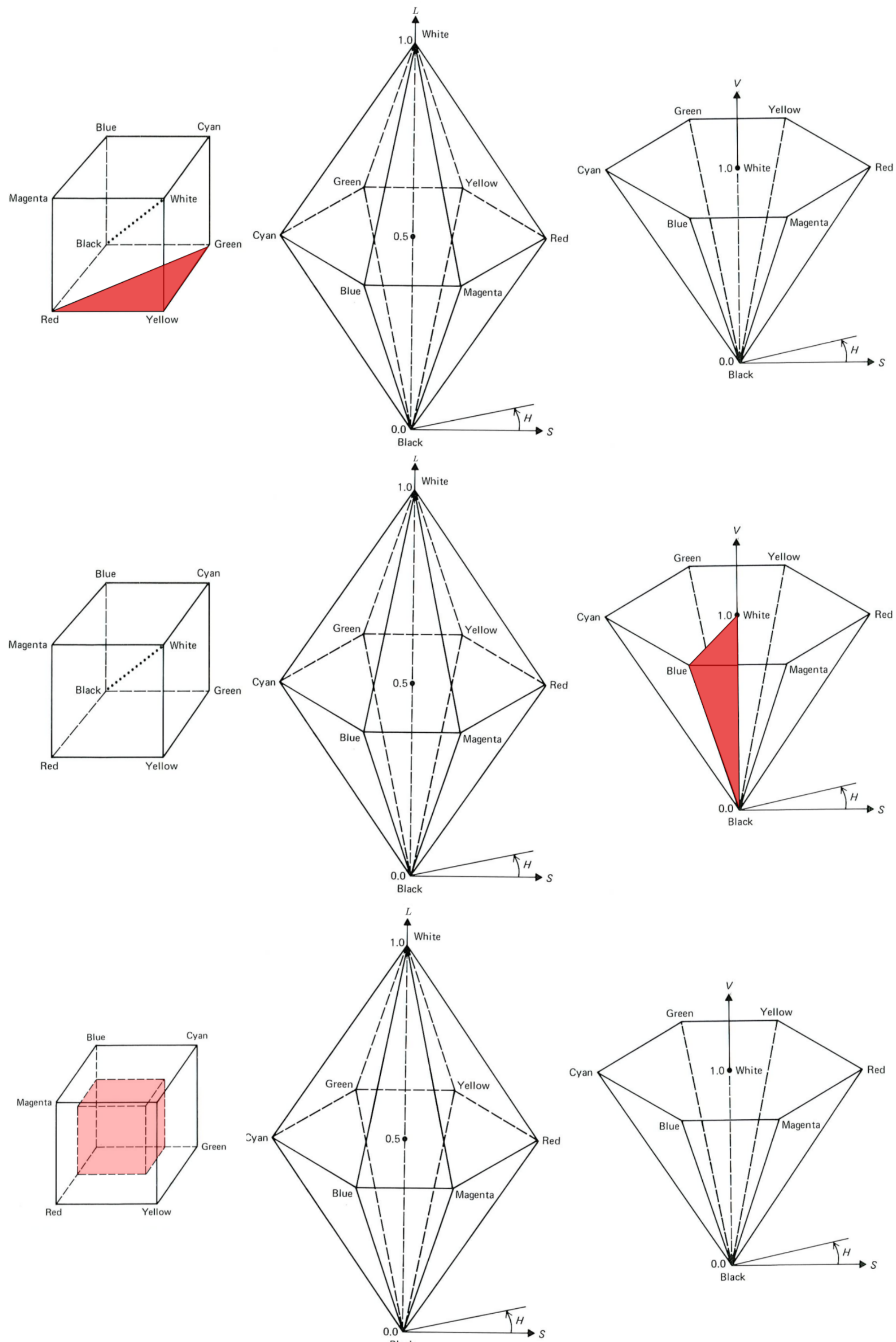
Question 2 — 12 pts

Correspondences between Color Schemes

In each row, a surface or volume is drawn in red. Mark the corresponding areas and volumina in the other color schemes.

Please submit an image as answer. We are fine with opaque polygons added with MS Paint or similar. However, make sure to show all edges of the resulting surfaces (see for example the dashed lines on the cube in row 3).

RGB HLS HSV



HTML Editor

Question 3

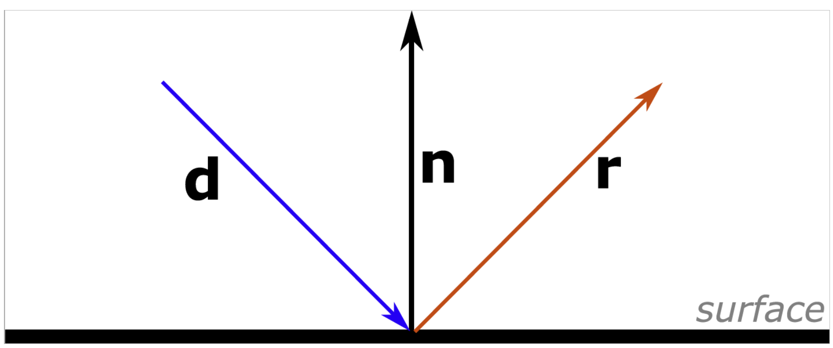
5 pts

Reflection

Consider a ray with direction vector $\mathbf{d}$ being reflected from a mirroring surface into the direction of the reflection vector $\mathbf{r}$. At the point of intersection, the surface has the normal vector $\mathbf{n}$. See the figure below for the setup.

(a) Given $\mathbf{d}$ and $\mathbf{r}$, determine the normal vector $\mathbf{n}$, of the surface at the point of reflection! (2P)

(b) Given $\mathbf{d}$ and $\mathbf{n}$, determine the direction vector $\mathbf{r}$ for the reflection of the ray! (3P)



HTML Editor

Question 4

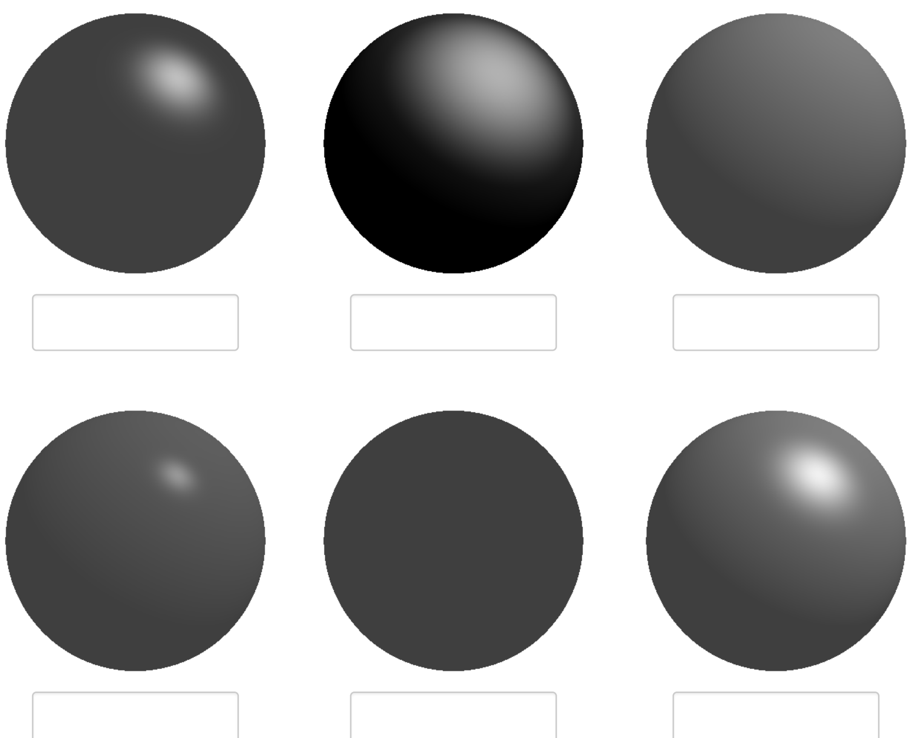
6 pts

Phong Illumination

The color value of an individual pixel in Phong illumination is determined by different parameters:

- light colors (ambient $\mathbf{c}_a$, diffuse $\mathbf{c}_d$, specular $\mathbf{c}_s$)
- material colors for each light variant ($\mathbf{m}_a, \mathbf{m}_d$ and $\mathbf{m}_s$) and a
- specular coefficient p.

We consider a sphere with constant material colors $\mathbf{m}_a = \mathbf{m}_d = 0.5, \mathbf{m}_s = 1.0$ and otherwise varying light properties. For simplicity, all colors are in grayscale.



Match the spheres and settings by writing the letter of the corresponding setting below the sphere.

A: $\mathbf{c}_a = 0.5, \quad \mathbf{c}_d = 0.0, \quad \mathbf{c}_s = 0.0, \quad p = 1.5$

B: $\mathbf{c}_a = 0.0, \quad \mathbf{c}_d = 0.5, \quad \mathbf{c}_s = 0.5, \quad p = 1.5$

C: $\mathbf{c}_a = 0.5, \quad \mathbf{c}_d = 0.0, \quad \mathbf{c}_s = 0.5, \quad p = 8$

D: $\mathbf{c}_a = 0.5, \quad \mathbf{c}_d = 0.5, \quad \mathbf{c}_s = 0.0, \quad p = 32$

E: $\mathbf{c}_a = 0.5, \quad \mathbf{c}_d = 0.5, \quad \mathbf{c}_s = 0.5, \quad p = 8$

F: $\mathbf{c}_a = 0.5, \quad \mathbf{c}_d = 0.25, \quad \mathbf{c}_s = 0.25, \quad p = 32$

Note: This notation differs from the lecture slides, There, the same color $\mathbf{c}_l$ is used for both diffuse and specular light and the same material $\mathbf{c}_r$ is used for both ambient and diffuse material colors. This reflects how things are often done in practice. For this task, we follow the equations below.

$$\mathbf{c}_{\text{ambient}} = \mathbf{m}_a \circ \mathbf{c}_a$$

$$\mathbf{c}_{\text{diffuse}} = \mathbf{m}_d \circ \mathbf{c}_d \cdot \langle \mathbf{n}, \mathbf{l} \rangle$$

$$\mathbf{c}_{\text{specular}} = \mathbf{m}_s \circ \mathbf{c}_s \cdot \left\langle \frac{\mathbf{v}}{\|\mathbf{v}\|}, \frac{\mathbf{r}}{\|\mathbf{r}\|} \right\rangle^p$$

$$\mathbf{c}_{\text{final}} = \mathbf{c}_{\text{ambient}} + \mathbf{c}_{\text{diffuse}} + \mathbf{c}_{\text{specular}}$$

Question 5

10 pts

Shading Interpolation Variants

Given is a triangle with vertices

$$\mathbf{p}_0 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \quad \mathbf{p}_1 = \begin{pmatrix} 4 \\ 0 \\ -3 \end{pmatrix}, \quad \mathbf{p}_2 = \begin{pmatrix} -4 \\ 3 \\ 3 \end{pmatrix}$$

and respective vertex normals

$$\mathbf{n}_0 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \quad \mathbf{n}_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \quad \mathbf{n}_2 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}.$$

The triangle is illuminated by purely diffuse lighting. Assume the light direction to be

$\mathbf{l} = \begin{pmatrix} 2 \\ 2 \\ 2 \end{pmatrix}$ and the material and light color to be $\mathbf{c}_d = \mathbf{m}_d = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$.

We want to to compute the color (see the equation for $\mathbf{c}_{\text{diffuse}}$ in the previous question) at the midpoint of the face, that is

$$\mathbf{p}_m = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}.$$

Remember to always **normalize** all vectors that represent **directions** and compute the lighting for the side of the triangle that is facing the light.

a) Compute the normal of the triangle. [1p]

b) Compute the color at $\mathbf{p}_m$ when using flat shading (using the face normal). [3p]

c) Compute the color at $\mathbf{p}_m$ when using Gouraud shading (i.e. calculate the color at the vertices and interpolate). [3p]

d) Compute the color at $\mathbf{p}_m$ when interpolating the normals. [3p]

HTML Editor

Not saved

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