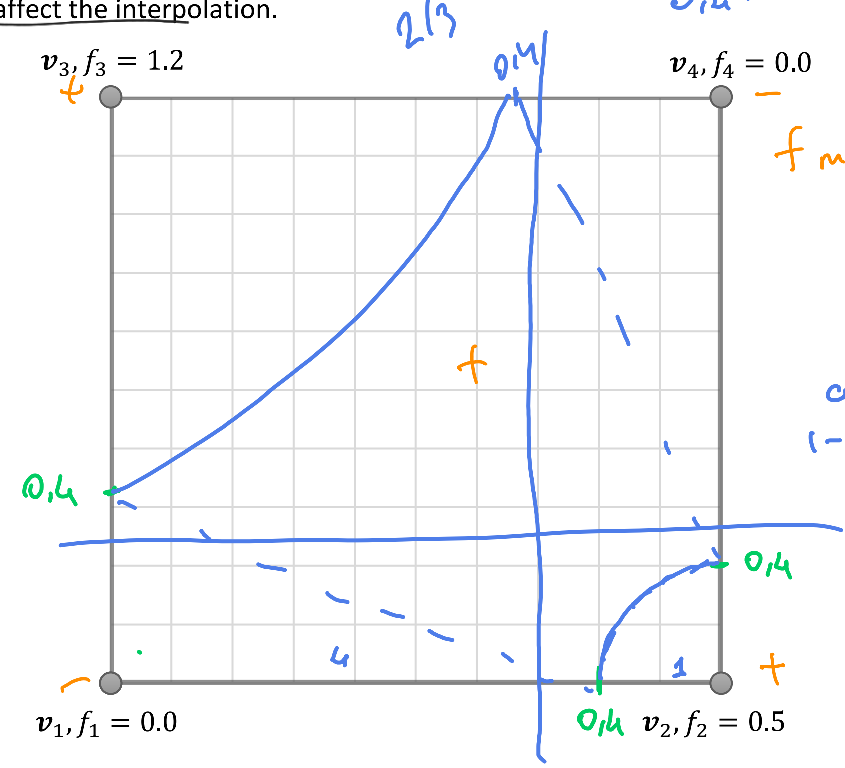
***Disclaimer:** Below you find some example questions, which should help you prepare for the exam. However, note that the actual questions at the exam can be very different and can cover all material presented in the lecture!*

Isolines & Isosurfaces

a) Given is the following quadrilateral cell with its four vertices $\boldsymbol{v}_1, \boldsymbol{v}_2, \boldsymbol{v}_3, \boldsymbol{v}_4$ and the corresponding scalar values f_1, f_2, f_3, f_4. A grid is shown for orientation purpose, i.e., it does not affect the interpolation.

0,4.0,4.0



$f_{mid} = \frac{1}{4}(1.2 + 0.5)$

$= 0{,}425$

$a = 0{,}4$

$1 - a = 0{,}6$

$2/3$

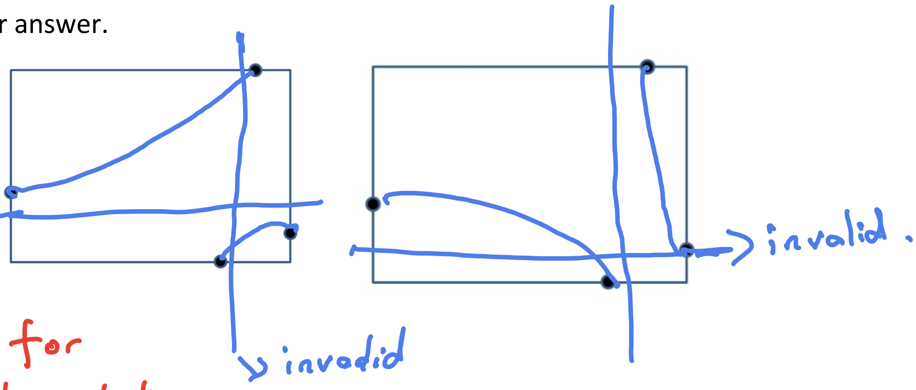
Draw the approximated iso-lines (dashed) for the iso-value 0.4 into the illustration using the *marching squares algorithm*. Use the *mid-point decider* for ambiguous cases.

Also, draw the true iso-contour (bold) for the iso-value 0.4 into the same illustration, i.e., all points in the interior of the cell which have a value equal to 0.4. Bi-linear interpolation is assumed for interpolation.

b) In the figure below, a quadrilateral cell is shown. Scalar values are given at the cell corners and bi-linear interpolation of these values is used to reconstruct scalar values across the cell. Is it possible that at the four edge points marked by dots the same scalar value is reconstructed? Explain your answer.

There is 2 options
but of the options
can not reconstruct

We can not draw
valid asymptotes for
hyperbolic



c) Name the three components of the Phong illumination model.

Ambient light, Speculer Reflactor
diffuse Reflactor

d) How can a perfect mirror be simulated via the Phong illumination model?

if $n \to \infty$ in Speculer reflection

e) Let L be an incoming light ray and M a diffusely reflecting material. Complement the illustration on the right in Figure 7 according to the illustration on the left. Hint: Take into account the direction and strength of the reflection.

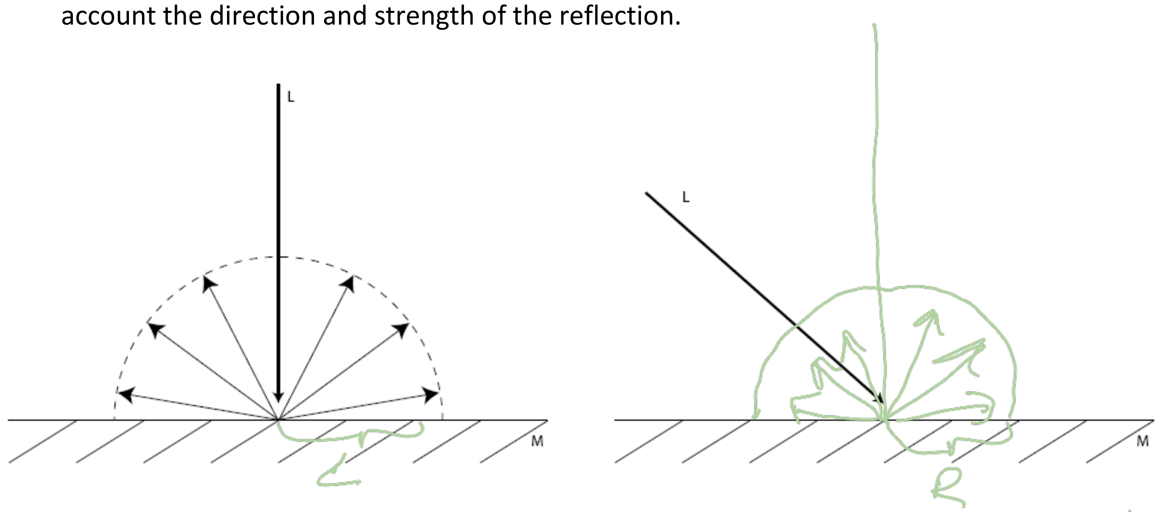
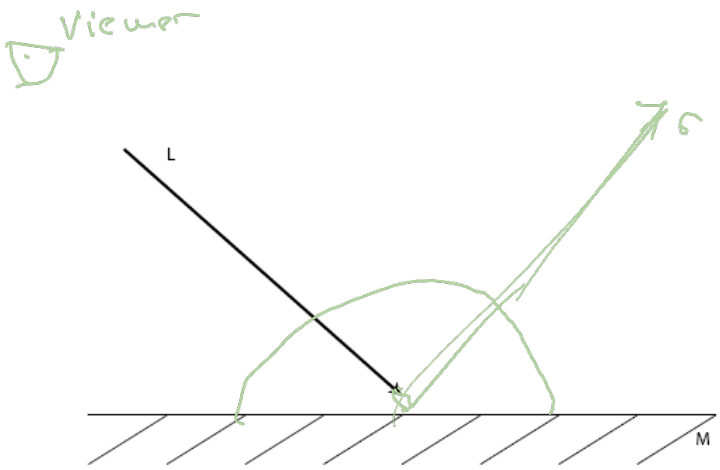


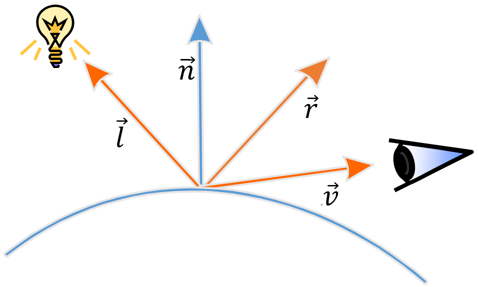
Figure 7

L>R because in the Left side reflection is more strong

f) Let L be an incoming light ray and M a specular reflecting material. The viewer is positioned at the light source and is looking along L. Complement Figure 8 according to Figure 7.



g) Below is an illustration of the Phong illumination model. All indicated vectors are normalized (i.e., their length is one). Answer whether the following statements are true or false:

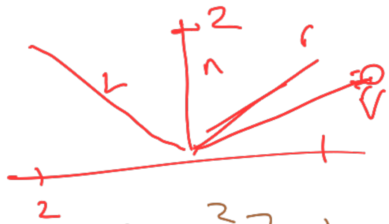


$\vec{n}$ … Normal vector of the surface
$\vec{l}$ … Vector pointing to the light source
$\vec{r}$ … Reflected light ray
$\vec{v}$ … Vector pointing to the viewer (view vector)

The specular reflection is based on the scalar/dot product of $\vec{\boldsymbol{n}}$ and $\vec{\boldsymbol{v}}$	F
The diffuse reflection is based on the scalar/dot product of $\vec{\boldsymbol{n}}$ and $\vec{\boldsymbol{l}}$	T
The ambient light is based on the scalar/dot product of $\vec{\boldsymbol{l}}$ and $\vec{\boldsymbol{r}}$	F
The specular reflection is independent of the view vector $\vec{\boldsymbol{v}}$	F

h) Compute the specular reflection at a surface point $P = (3, 1, -2)^T$ using the Phong lighting model. The normal at the point is $\vec{n} = (0,1,0)^T$. Moreover, the specular reflection coefficient of the surface is $k_s = 0.5$ and the specular exponent is $n = 2$. The position of a point light source is $L_{pos} = (1, 3, -1)^T$ and the camera position is at $E_{pos} = (5, 2, -2)^T$. Both the point light source and the surface color are white with RGB-values $(1, 1, 1)$.
Hint: You can compute the reflected light ray as $\vec{r} = 2(\vec{n} \cdot \vec{l})\vec{n} - \vec{l}$, where $\vec{n}$ and $\vec{l}$ need to be normalized.

$$C = \underbrace{kd}_{0.5} \cdot Cp \cdot Od \cdot (\underbrace{\cos\Theta}_{S(r \cdot v)})^n$$



Light Vector

$$\begin{pmatrix}1\\3\\-1\end{pmatrix} - \underbrace{\begin{pmatrix}3\\1\\-2\end{pmatrix}}_{P} = \begin{pmatrix}-2\\2\\1\end{pmatrix} = \sqrt{9} = \boxed{3}$$

$$\vec{l} = \frac{1}{3} \cdot \begin{pmatrix}-2\\2\\-1\end{pmatrix}$$

$$\vec{r} = 2 \cdot \left[\begin{pmatrix}-2/3\\2/3\\1/3\end{pmatrix} \cdot \begin{pmatrix}0\\1\\0\end{pmatrix}\right] \cdot \begin{pmatrix}0\\1\\0\end{pmatrix} - \begin{pmatrix}-2/3\\2/3\\1\end{pmatrix}$$

$$= 2 \cdot \frac{2}{3} \cdot \begin{pmatrix}0\\1\\0\end{pmatrix} - \begin{pmatrix}-2/3\\2/3\\1/3\end{pmatrix}$$

$$\vec{r} = \begin{pmatrix}2/3\\2/3\\-1\end{pmatrix}$$

View Vector

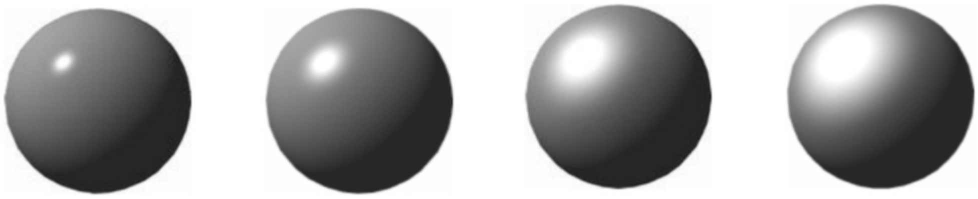
$$\underbrace{\begin{pmatrix}5\\2\\-2\end{pmatrix}}_{E_{pos}} - \underbrace{\begin{pmatrix}3\\1\\-2\end{pmatrix}}_{P} = \begin{pmatrix}2\\1\\0\end{pmatrix} \quad \sqrt{5} \quad \vec{v} = \frac{1}{\sqrt{5}}\begin{pmatrix}2\\1\\0\end{pmatrix}$$

$$\vec{r} \cdot \vec{v} = 1/3 \cdot \begin{pmatrix}2\\2\\-3\end{pmatrix} \cdot \frac{1}{\sqrt{5}}\begin{pmatrix}2\\1\\0\end{pmatrix} = \frac{1}{3\sqrt{5}} \cdot 6 = \frac{2}{\sqrt{5}}$$

$$c = \frac{1}{2} \cdot \begin{pmatrix}1\\1\\1\end{pmatrix} \cdot Cp \cdot \left(\frac{2}{\sqrt{5}}\right)^2$$

$$= \left(\frac{2}{5}\right) \cdot \begin{pmatrix}1\\1\\1\end{pmatrix} \cdot Cp = \begin{pmatrix}0,4\\0,4\\0,4\end{pmatrix} \cdot Cp\ ?$$

i) In the four images below, a sphere is rendered using the Phong illumination model. Four different specular exponents (2, 4, 16, and 64) were used to create the specular reflection. Write the specular exponent that was used to create the rendering below each image.



64	16	4	2

$\cos^n \theta$

since cos is $0 < \cos\theta < 1$

Larger n → smaller c