Solutions to exam in Optical Physics 121019

1-2

If the focussing is made so that the outer limit for sharp image (image smaller than d= blur circle diameter) the inner limit of sharp imaging will be as close to the camera as possible.
Let s_{hyp} be the distance at which to focus and the image distance related to that be f + ε.
Proportional triangles then give

$$\frac{\varepsilon}{d} = \frac{f+\varepsilon}{D} \approx \frac{f}{D} \quad \text{(D = lens diameter)}$$

Lens formula:

$$s_{hyp} = \frac{s' f}{s'-f} = \frac{f(f+\varepsilon)}{\varepsilon} \approx \frac{f^2}{\varepsilon} = \frac{f^2 D}{df} = \frac{f^2}{d\left(f/D\right)} = \frac{f^2}{d(f-number)}$$

The inner limit will then be half this distance.
For f= 20 mm, pixelsize = 6 µm and f-number 4 that will give 16,7 m i e the image is sharp from 8,3 m to infinity.

3

The border line case is when the Brewster angle is at the critical angle for TIR.

$$\sin\theta = \frac{1}{n_0} \Rightarrow \cos\theta = \sqrt{1-\frac{1}{n_0^{\ 2}}} \Rightarrow \frac{1}{\tan\theta} = \sqrt{n_0^{\ 2}-1} \quad \text{from critical angle}$$

$$\frac{1}{\tan\theta} = n_0 + \Delta n \quad \text{from Brewster angle. Combining gives}$$

$$\Delta n = \sqrt{n_0^{\ 2}-1} - n_o$$

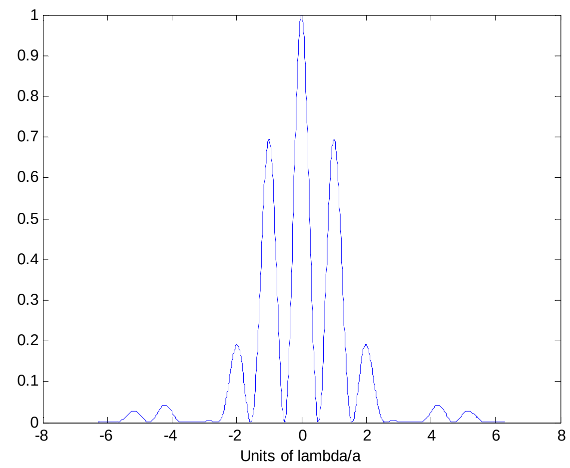
If Δn i negative there is no such angle

4

The first zero of the coherence function for a circular source will be at

$$\theta = \frac{1{,}22\lambda}{h} = \frac{D}{L} \Rightarrow L = \frac{Dh}{1{,}22\lambda} = 75\ \text{m (for green light)}$$

5



6

$$R_1 = \left(\frac{2{,}4-1}{2{,}4+1}\right)^2 = 0{,}17 \qquad R_2 = \left(\frac{2{,}4-1{,}5}{2{,}4+1{,}5}\right)^2 = 0{,}05$$

Two reflections $R_1 + R_2 + 2\sqrt{R_1R_2} = 0{,}318$

Entire series:

First contribution: $E_1 = r_1 E_{in}$

The rest: $E_{subtotal} = t_1 t_1' r_2 E_{in} - t_1 t_1' r_1 r_2^{\ 2} E_{in} + \ldots = \dfrac{Tr_2 E_{in}}{1+r_1 r_2}$