Solutions to exam in Optical Physics 051024

1

The eye piece is two 20 mm-lenses 20 mm apart, separated another 140 mm from the objective.
The object is placed 10mm before the first lens in the eyepiece, meaning 30 mm from the principal plane, giving an image distance of 60 mm from the other principal plane of the eyepiece. Magnification in this step = -2.
The intermediate image is now placed 100 mm from the objective that has a focal length of 140 mm. This gives a final image that is virtual and situated 350mm from the objective (and the viewer eye). Magnification in this step = 3,5 and the total magnification is -7.

2

It should be placed in Brewster angle, and the the reflectance for TM is zero.
The Brewster angle is given by

$$\tan\theta_B = \frac{n_2}{n_1} \Rightarrow \theta_{i,B} = 78{,}46° \Rightarrow \theta_{t,B} = 11{,}53°$$

The first reflectance, R, is then 0,846 to which the reflectance from the second surface can be added

$$R_2 = (1-R)^2 R = 0{,}0199 \Rightarrow R_{tot} = 0{,}866$$

10 mm is far to thick to give any thin layer interference effects.

3

The 0, +-1 and +-2 max are large. The third is close to the diffraction envelope minimum and therefore not so large.
The max are at

$\sin\theta = \frac{m\lambda}{3D}$ and have a width of $\Delta\theta = \frac{\lambda}{300D}$

4-5

$$n(x) = n_1 + \frac{n_2 - n_1}{l}x \Rightarrow \frac{dn}{dx} = \frac{n_2 - n_1}{l} \quad dE_{refl} = E_{in}dr = E_{in}e^{2ikx}\frac{dn}{2n} = E_{in}e^{2ikx}\frac{1}{2n}\frac{dn}{dx}dx$$

If you make it to this point, you have 1,6p
To get the total rest reflectivity you integrate over 100 wavelengths. If the boundary values are correctly chosen the contributions from each period in the exp factor vanishes, and the maximum rest reflectivity is

$$E_{refl} \approx \int_{99{,}5\lambda}^{100\lambda} E_{in}e^{2ikx}\frac{1}{2n_2}\frac{n_2 - n_1}{l}dx \approx E_{in}\cdot\frac{1}{1600}$$

The rest reflectivity is the square of this; R = 0,4ppm

6

Elongate the incoming and the outgoing ray and see where they cross! Back Principle Plane! Distance between Back Focal Plane and this is 73 mm (71 to 75 admissible)
Back Vertex Focal length is the distance from last glass surface to BFP = 36 mm.
Aperture stop is the fifth lens.