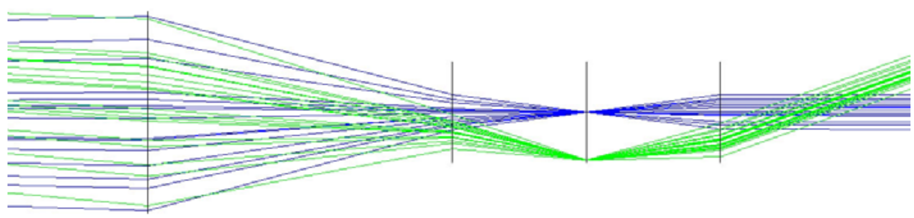
Solutions to exam in Optical Physics 120113

1-2

General
An object at distance 500 mm gives an image at z=55,5 mm. Object distance to lens 2 is then -10 mm (virtual object) giving an image 20 mm after lens i e at z = 65,5 mm. Lens 3 is the obviously a field lens and construction shows it is the field stop. Lens 4 is the a lens which generates a final image in infinity.
Exit pupil
First lens is AS and is imaged to z= 31.3 (M_2= 31.6/45,5=0,695)
Object distance to lens 3 is then 65,5 mm - 31,3 mm = 34,2 mm, giving an image distance of 48,2 mm (M_3= 48,2/34,2=1,41).
Object distance to lens 4 is -28,2 mm giving a final image 11,7 mm after last lens (M_4= 11,7/28,2 = 0,41)
D_{exitp}= 0,40 D_{AS} = 12 mm
Angular magnification
Angular size of image: Assume object size h, gives h'= 0,111 h. Gives h" = 2 h'= 0,222 h. This is also the size of the last intermediate image giving an angular size of image as 0,222 h / 20 mm = 0,0111 h



Without instrument the angular size is h/ (500 mm + 85,5 mm + 11,7 mm) = 0,00167 h. **The magnification is 6,6**
Field size = diameter of FS divided by magnification before **Field Size = 15 mm /((0,111 * 2) = 67,5 mm**

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All TM light will be transmitted.
The brewster angle is 14,00° giving a refracted angle of 76,00°
Reflectance for TE is then

$$R = \left(\frac{\sin(65°)}{\sin(90°)}\right)^2 = 0{,}821 \Rightarrow T = 0{,}179 \Rightarrow T^2 = 0{,}032$$

Last operation because light is transmitted twice. The ratio is 0,032 : 1

4

One rotation direction is reflected twice and the other in transmitted twice:

$$I_1 = R^2 I_{in} \quad I_2 = (1-R)^2 I_{in} \Rightarrow I_{\max} - I_{\min} = 4R(1-R)I_{in} \text{ and } I_{\max} + I_{\min} = 2\left[R^2 + (1-R)^2\right]$$

The modulation becomes

$$M = \frac{2R(1-R)}{R^2 + (1-R)^2}$$ which can be checked to yield M=1 for R = 0,5

5 and 6