Afocal System - Pupils

An afocal system is constructed out of two positive thin lenses. The first lens has a focal length of 200 mm, and the magnitude of the lateral magnification is 0.1:

\[ |m| = 0.1 \]

a) Determine the focal length of the second lens and the spacing between the two lenses.

b) The first lens serves as the aperture stop of this afocal system, and the diameter of the first lens (or stop) is 50 mm. Determine the locations and diameters of the Entrance Pupil and the Exit Pupil. Use Gaussian methods.

Solution:

a) Focal length and separation:

Two Positive lenses \( \rightarrow \) \( m = -0.1 \) \( f_1 = 200\text{mm} \)

\[ m = -\frac{f_2}{f_1} = -\frac{f_2}{200\text{mm}} = -0.1 \]

\[ f_2 = 20\text{mm} \]

\[ t = f_1 + f_2 = 220\text{mm} \]
b) Pupils

EP: is at the first lens with the same diameter \( D_{EP} = 50\text{mm} \)

XP: Image the stop(first lens) through the second lens

\[
\begin{align*}
\frac{1}{z'_{XP}} &= \frac{1}{z_{STOP}} + \frac{1}{f_2} \\
\end{align*}
\]

\( z_{STOP} = t = -220\text{mm} \)

\( z'_{XP} = 22\text{mm} \) to the right of \( f_2 \)

\[
\begin{align*}
\frac{z'_{XP}}{z_{STOP}} &= \frac{22\text{mm}}{-220\text{mm}} = -0.1 \\
\end{align*}
\]

\( D_{XP} = |m_{XP}| D_{STOP} = 0.1 \times 50\text{mm} = 5.0\text{mm} \)

Or use the magnification \( m \) of the afocal system:

\[
D_{XP} = |m| D_{EP} = 5.0\text{mm}
\]