Quiz 1 - 2008 - This is not meant to be a complete solution, rather a guide to the solution and a way for you to validate your answer.

From L1 to L3 — $\begin{pmatrix} 1 & 0 \\ -1/5 & 1 \end{pmatrix} \times \begin{pmatrix} 1 & 8 \\ 0 & 1 \end{pmatrix} \times \begin{pmatrix} 1 & 0 \\ -1/x & 1 \end{pmatrix} \times \begin{pmatrix} 1 & 20-x \\ 0 & 1 \end{pmatrix} \times \begin{pmatrix} 1 & 0 \\ -1/20 & 1 \end{pmatrix}$

$$= \begin{pmatrix} 0.05x & 20 + 160/x - x \\ -0.01x & -4 - \frac{12}{x} + 0.2x \end{pmatrix} = [O]$$

The rays hit L1 and form an image at FS, adding a translation of 5 cm to the L3,

$$\begin{pmatrix} 1 & 5 \\ 0 & 1 \end{pmatrix} [O] = \begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 0 & 100/x \\ -0.01x & -4 - 12/x + 0.2x \end{pmatrix}$$

$$\begin{Bmatrix} x_{out} \\ \theta_{out} \end{Bmatrix} = \begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{Bmatrix} x_{in} \\ \theta_{in} \end{Bmatrix} \qquad \begin{Bmatrix} x_{in} \\ \alpha \end{Bmatrix} \text{ — our case}$$

image is erect!

Given $x_{out} = \pm 50\alpha$ — $(100/x)\alpha = \pm 50\alpha$ — $\boxed{x = 2\text{ cm}}$

* Next best step is characterizing the imaging system,

$$[O] = \begin{pmatrix} 0.1 & 98 \\ -0.02 & -9.6 \end{pmatrix}$$

— $f = 50$ cm

$r = 530$ cm, $s = -45$ cm

$p = 480$ cm, $q = 5$ cm

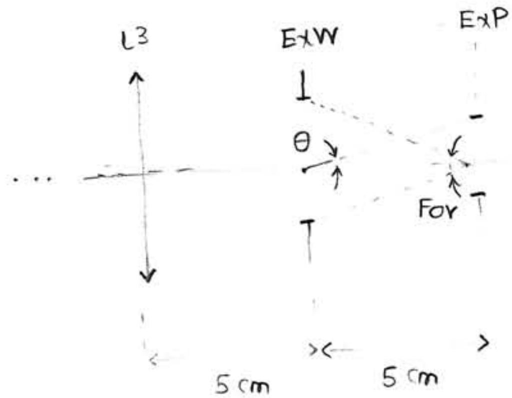
* These parameters allow us to find the location of EnW and ExP. The locations for EnP and ExW are already known!

EnW — $\frac{1}{S_o} + \frac{1}{50} = \frac{1}{50}$ — $S_o = \infty$ — EnP is at ∞ (left of the L1)

ExP — $\frac{1}{550} + \frac{1}{S_i} = \frac{1}{50}$ — $S_i = 55$ cm

$m = \frac{-55}{550} = \frac{y_i}{2}$ — $y_i = 0.2$ cm

size and location of ExP and ExW allows us to find NA and FOV,



$FoV = 2tg^{-1}\left(\frac{1}{5}\right) \simeq 22°$

$\theta = tg^{-1}\left(\frac{0.2}{5}\right) \simeq 2.29°$

* using problem's hint, see what happens when a parralel bundle of rays hit the sytem from the infinity:

$$\begin{pmatrix} 0.1 & 98 \\ -0.02 & -9.6 \end{pmatrix} \begin{Bmatrix} 2 \\ 0 \end{Bmatrix} = \begin{Bmatrix} 0.2 \\ -0.04 \end{Bmatrix}$$

Angle by which marginal ray leaves the L3 is then, — happens to be the same as the angle θ?! :)

$(0.04) \times \left(\frac{180}{\pi}\right) \simeq 2.29$ — $\boxed{\beta = 2.29°}$

2.71 / 2.710 Optics
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