EECS X493
Homework - 1

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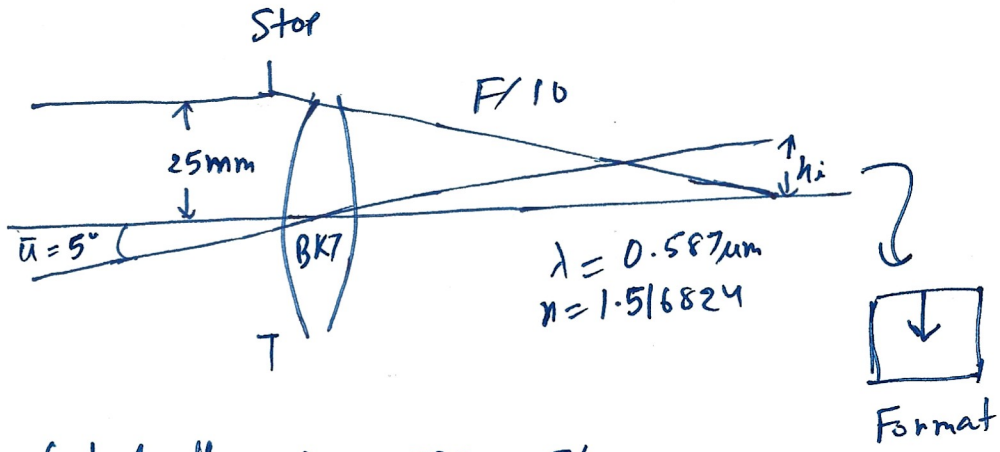
Problem 1



(a) Effective focal length, $f_E = EPD * F/\#$

Here, Entrance Pupil Diameter = Stop diameter = $25 \times 2\ mm = 50\ mm$

$F/\# = 10$

$\therefore f_E = 50 \times 10\ mm = \boxed{500\ mm}$

(b) power of lens, $\phi = \frac{1}{f_E} = \frac{1}{500\ mm} = \boxed{\frac{1}{0.5m} = 2D}$

(c) Assuming equiconvex lens if surface curvature is C

From thin lens equation, $\phi = (n-1)(C+C) = 2C(n-1)$

$\therefore C = \frac{\phi}{2(n-1)} = \frac{\frac{1}{500\ mm}}{2(1.516824 - 1)} = \frac{1}{516.824}\ mm^{-1}$

$\boxed{= 0.001935\ mm^{-1}}$

(d) Radius of curvature, $r = \frac{1}{C} = \boxed{516.824\ mm}$

(e) Image height $h_i = f_E \bar{u} = 500\ mm \times \frac{5 \times \pi}{180}\ rad = \underline{43.633\ mm}$

$\therefore$ Format size (assuming square) $= (2h_i)^2 = 4h_i^2 = 4 \times (43.633)^2\ mm^2$

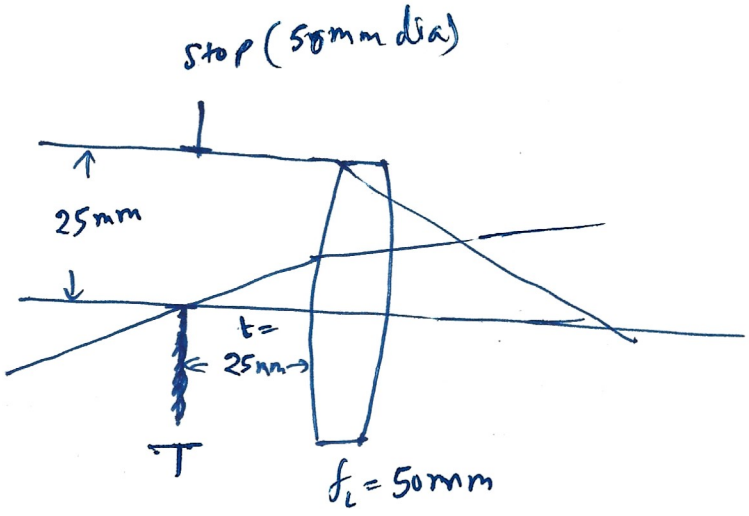
$= \boxed{7615.35\ mm^2}$

(f) Airy disk diameter $= 2.44 \lambda f/\#$

$= 2.44 \times 0.587\mu m \times 10$

$\boxed{= 14.3228\ \mu m}$

Prob 2



(a) Entrance pupil location

Since the aperture stop is located to the left of the lens and there are no other refracting element between object and aperture stop, hence Entrance pupil location and size is the same as the aperture stop.

EP location : 25mm to the left of the lens

EP size : 50 mm diameter

(b) Exit pupil location

Exit pupil is the image of aperture stop looking from the image space. Using the imaging equation

$\Phi = -\frac{1}{t} + \frac{1}{t'}$; t' is the distance from lens to the Exit Pupil (XP)

($t = -25$ mm by sign convention)

$$\Rightarrow \frac{1}{t'} = \frac{1}{f_L} + \frac{1}{t} = \frac{1}{50} - \frac{1}{25}$$

$$= -\frac{1}{50}$$

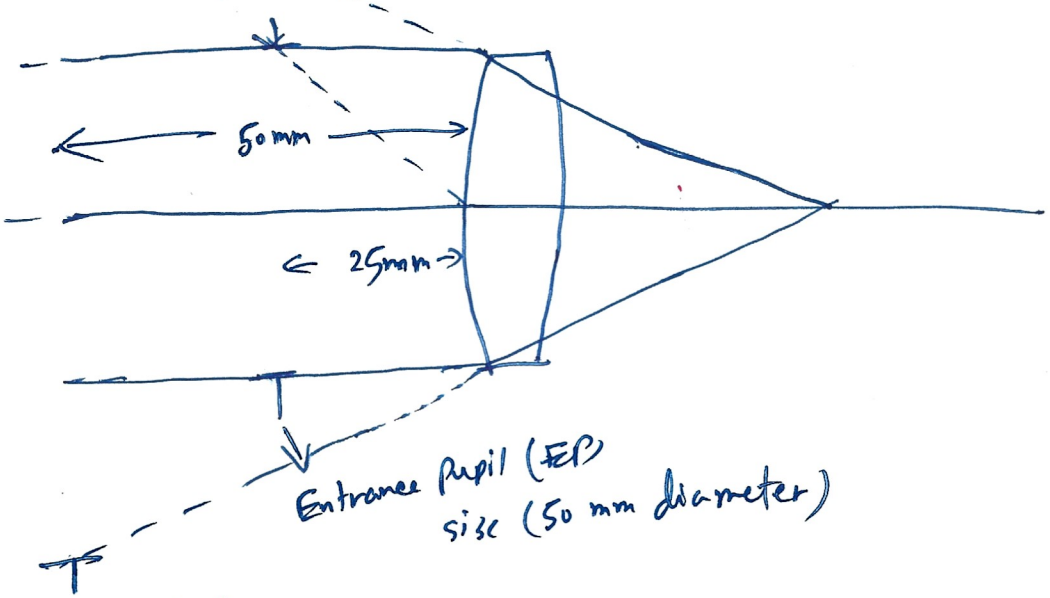
$\therefore t' = -50$ mm

$\therefore$ XP location : 50mm to the left of the lens

XP size : $\frac{t'}{t}$ × Stop diameter $= \frac{-50}{-25} \times 50$ mm $=$ 100mm

(c) $F/\# = \frac{f_L}{EPD} = \frac{50}{50} =$ 1

Sketch of EP & XP



Entrance Pupil (EP)
size (50 mm diameter)

Exit Pupil (XP)
size: 100 mm diameter