ENGN1930B HW3

Name: Kuan-Min Lee

Instructor: Dr. Jonghwan Lee

Problem 1.7.

$f = 100\,mm$, $z_{img} = 300\,mm$, $\Delta x_{img} = 10\,\mu m$

For fulfilling Nyquist Sampling Rate,

$$\Delta x_{samp} = \frac{\Delta x_{img}}{2} = \frac{10\,\mu m}{2} = 5\,\mu m$$

$$\Delta x_{samp} = \frac{z_{samp}}{z_{img}} \times \Delta x_{img} = \frac{z_{samp}}{300\,mm} \times 10\,\mu m = 5\,\mu m$$

$$z_{samp} = \frac{1}{2} \times 300 = \boxed{150\,mm} \#$$

Same as the position of focal plane.

Problem 2.1. :

For monochromatic plane wave,

$$\mathcal{E}(x, y, z, t) = \mathcal{E}_0 \cdot \cos(kr - \omega t + \delta)\,\hat{x}$$

amplitude: $\mathcal{E}_0$, angular freq. $= \omega$,

$\delta = 0$

$$\mathcal{E}(x, y, z, t) = \mathcal{E}_0 \cdot \cos(kr - \omega t)\,\hat{x}$$

$$\cos(g(x)) = \frac{e^{g(x)i} + e^{-g(x)i}}{2}$$

$$\mathcal{E}(x, y, z, t) = \boxed{\mathcal{E}_0 \cdot \frac{e^{(kr-\omega t)i} + e^{-(kr-\omega t)i}}{2}} \#$$

$$= \boxed{\mathcal{E}_0 \cdot \frac{e^{(x+2y+3z-\omega t)i} + e^{-(x+2y+3z-\omega t)i}}{2}} \#$$

Problem 2.2.

$\mathcal{E}_0 = 1.0\ V/m$, $n = 1.7$, $\varepsilon_0 = 8.854 \times 10^{-12}\ F/m$,
$c = 3 \times 10^8\ m/s$

$$I(\vec{r}) = \frac{1}{2} \times n \times c \times \varepsilon_0 \times \vec{\mathcal{E}}(\vec{r})\ \vec{\mathcal{E}}^*(\vec{r})$$

$$= \frac{1}{2} \times 1.7 \times 3 \times 10^8\ m/s \times 8.854 \times 10^{-12} \times$$

$$1.0\ V/m \cdot e^{i(kr+\delta)} \cdot 1.0\ V/m\ e^{-i(kr+\delta)}$$

$$\simeq 2.258 \times 10^9 \cdot e^0 = \boxed{2.258 \times 10^9\ J}$$