Problem 1:

$D, \; W \gg D.$

(a) $R = \frac{W}{\sigma A} = \frac{W\,4}{\sigma D^2 \pi} \;\Omega$

(b) I flowing through the device.

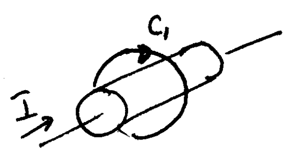
$\bar{H}(r) = ?$

$\bar{D} \to \varepsilon \bar{E}$

$$\nabla \times \bar{H} = \bar{J} + \boxed{\frac{\partial \bar{D}}{\partial t}} = 0$$

$$\Rightarrow \nabla \times \bar{H} = \bar{J} \;\rightarrow\; \oint_{C_1} \bar{H} \cdot d\bar{l} = \int_A \bar{J} \cdot d\bar{a} = I$$

the current flowing in the device



$d\bar{l} = r \, d\phi \, \hat{\phi}$

$$\Rightarrow \bar{H}(r) = H_\phi(r) \, \hat{\phi}$$

$$\Rightarrow \int_0^{2\pi} H_\phi(r) \cdot r \, d\phi = I$$

$$H_\phi(r) \cdot r \cdot (2\pi) = I$$

$$H_\phi(r) = \frac{I}{2\pi r}$$

$$\Rightarrow \bar{H}(r) = \hat{\phi} \, \frac{I}{2\pi r}.$$

Problem 2:

a) $V(t)\Big|_{\alpha t<2\times10^{-8}} = \frac{4 \cdot Z_0}{Z_0 + 300} = 1$ ($\because$ voltage divider)

$\Rightarrow \quad Z_0 + 300 = 4 Z_0$

$Z_0 = 300\ \Omega$

b) $\mu = \mu_0$; $\varepsilon/\varepsilon_0 = \varepsilon_r$? $\quad v = \frac{1}{\sqrt{\varepsilon\mu}} = \frac{l}{t_{traverse}} = \frac{1}{1\times10^{-8}}$

$\Rightarrow v = 1\times10^{8}$ m/s $\longrightarrow \frac{1}{\sqrt{\varepsilon\mu}} = \frac{c}{\sqrt{\varepsilon_r}} \doteq 1\times10^{8}$

$\frac{1\times10^{8}}{3\times10^{8}} = \frac{1}{\sqrt{\varepsilon_r}} \longrightarrow \varepsilon_r = 9$

c) L? $\quad v = \frac{1}{\sqrt{LC}} \qquad Z_0 = \sqrt{\frac{L}{C}}$

$(300)^2 = \frac{L}{C}$ ...① $\qquad (1\times10^{8})^2 = \frac{1}{LC}$ ...②.

$\frac{Z_0}{v} = \sqrt{\frac{L}{C}\Big/\frac{1}{LC}} = L \rightarrow L = \frac{300}{1\times10^{8}} = 3\times10^{-6}$ H/m

Problem 3:

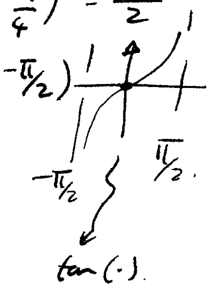
Sinusiodal Steady State impedances are sought.

(a) $$Z_{th} = \frac{Z_0(\underline{Z_L} - jZ_0 \tan kz)}{Z_0 - j\underline{Z_L}\tan kz}$$

$\underline{Z_L} = 2Z_0$

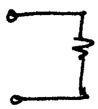
$kz = \left(\frac{2\pi}{\lambda}\right)\cdot\left(-\frac{\lambda}{4}\right) = \frac{-\pi}{2}$

$\Rightarrow \tan kz = \tan(-\pi/2) \rightarrow -\infty$



$$\boxed{\cancel{\Rightarrow Z_{th} = \frac{Z_0(+jZ_0(+\infty))}{+j\underline{Z_L}(+\infty)} = \frac{Z_0^2}{}}}$$

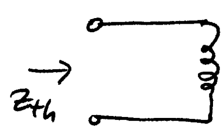
$$\Rightarrow Z_{th} = \frac{Z_0(-jZ_0(-\infty))}{-j\underline{Z_L}(-\infty)} = \frac{Z_0^2}{2Z_0} = \frac{Z_0}{2}$$



$Z_{th} = Z_0/2$

(b) $$\underline{Z_L} = \frac{1}{j\omega C} = \frac{-j}{\omega C}$$

$$\Rightarrow Z_{th} = \frac{Z_0(-jZ_0(-\infty))}{-j\underline{Z_L}(-\infty)} = \frac{Z_0^2\,\omega C}{-j} = j\underbrace{}_{\text{positive}}Z_0^2\,\underbrace{\omega}_{\text{positive}}\,\underbrace{C}_{\text{positive}}$$



$Z_{th} = jZ_0^2\omega C$ and $L = Z_0^2\omega C$