

1) Find the characteristics impedance of a transmission line of 1600 Hz if the following measurements have been made on the line at 1600 Hz. $Z_{oc} = 750 \angle 30^\circ \Omega$
 $Z_{sc} = 600 \angle -20^\circ \Omega$.

Soln

$$\begin{aligned} Z_0 &= \sqrt{Z_{oc} Z_{sc}} \\ &= \sqrt{750 \angle -30^\circ \times 600 \angle -20^\circ} \\ &= \sqrt{750 \times 600 \angle -30^\circ - 20^\circ} \end{aligned}$$

$$\begin{aligned} &= \sqrt{450000 \angle -50^\circ} \\ &= 670.8 \angle \frac{-50^\circ}{2} \\ &= 670.8 \angle -25^\circ \Omega \end{aligned}$$

2) Calculate the Characteristics impedance, the attenuation constant and phase constant of a transmission line if the following measurement have been made on the line.

$$Z_{oc} = 550 \angle -60^\circ \Omega \text{ and } Z_{sc} = 500 \angle -14^\circ \Omega.$$

Soln

$$Z_0 = \sqrt{Z_{oc} Z_{sc}} \\ = 524.4 \angle -37^\circ$$

$$\tanh \gamma = \sqrt{\frac{Z_{sc}}{Z_{oc}}} \\ = \sqrt{\frac{500 \angle -14^\circ}{550 \angle -60^\circ}}$$

$$\tanh \gamma = \sqrt{\frac{500 \angle -14 + 160^\circ}{550}} \\ = \sqrt{0.909 \angle 46^\circ}$$

$$\tanh \gamma = 0.953 \angle 23^\circ$$

Polar to Rectangular
(γ, ϕ)

$$X = r \cos \phi \\ Y = j r \sin \phi \\ = r \cos \phi + j r \sin \phi$$

$$\tanh \gamma = 0.953 \cos 23^\circ + j 0.953 \sin 23^\circ$$

$$\tanh \gamma = 0.877 + j 0.370 \quad \text{--- (1)}$$

$$\tanh \gamma = \frac{e^{2\gamma} - 1}{e^{2\gamma} + 1}$$

$$\textcircled{1} \Rightarrow \frac{e^{2\gamma} - 1}{e^{2\gamma} + 1} = 0.877 + j 0.370$$

$$e^{2\gamma} - 1 = (0.877 + j 0.370)(e^{2\gamma} + 1)$$

$$\underline{e^{2\gamma}} - 1 = 0.877 \underline{e^{2\gamma}} + 0.877 + j 0.370 \underline{e^{2\gamma}} + j 0.370$$

$$\underline{e^{2\gamma}} - 0.877 \underline{e^{2\gamma}} - j 0.370 \underline{e^{2\gamma}} = 1 + 0.877 + j 0.370$$

$$e^{2\gamma} [1 - 0.877 - j 0.370] = 1 + 0.877 + j 0.370$$

$$= 1.877 + j 0.370$$

$$e^{2v} [0.123 - j0.370] = 1.877 + j0.370$$

$$e^{2v} = \frac{1.877 + j0.370}{0.123 - j0.370} \quad \text{--- (2)}$$

Rect = $x + jy$ Rect to polar

$$r = \sqrt{x^2 + y^2} \quad \phi = \tan^{-1}\left(\frac{y}{x}\right)$$

$$r = \sqrt{(1.877)^2 + (0.370)^2} \quad \phi = \tan^{-1}\left(\frac{0.370}{1.877}\right)$$

$$r = 1.913 \quad \phi = 11.2^\circ$$

$$= 1.913 \angle 11.2^\circ$$

$$r = \sqrt{(0.123)^2 + (-0.370)^2}$$

$$= 0.39$$

$$\phi = \tan^{-1}\left(\frac{-0.370}{0.123}\right)$$

$$\phi = -71^\circ$$

$$= 0.39 \angle -71^\circ$$

$$(2) \Rightarrow e^{2v} = \frac{1.913 \angle 11.2^\circ}{0.39 \angle -71^\circ}$$

$$e^{2v} = 4.91 \angle 82.2^\circ$$

finden (n m both side

$$2\gamma = \ln[4.91 \angle 82.2^\circ]$$

$$\ln[a \angle b] = \ln a + j b$$

$$2\gamma = \ln 4.91 + j 82.2$$

$$\gamma = \frac{1}{2} \ln 4.91 + j \frac{82.2}{2}$$

$$\gamma = \frac{1.59}{2} + j 41.1$$

$$\gamma = 0.795 + j 41.1$$

$$\alpha = 0.795 \text{ Neper/km} \quad \checkmark$$

$$\beta = 41.1 \text{ rad/km} \quad \checkmark$$

3) A coil of 500 turns wound on a iron ring of median radius 10cm and cross section area of 3cm^2 . Find the self inductance of the winding if the relative permeability of iron is 800.

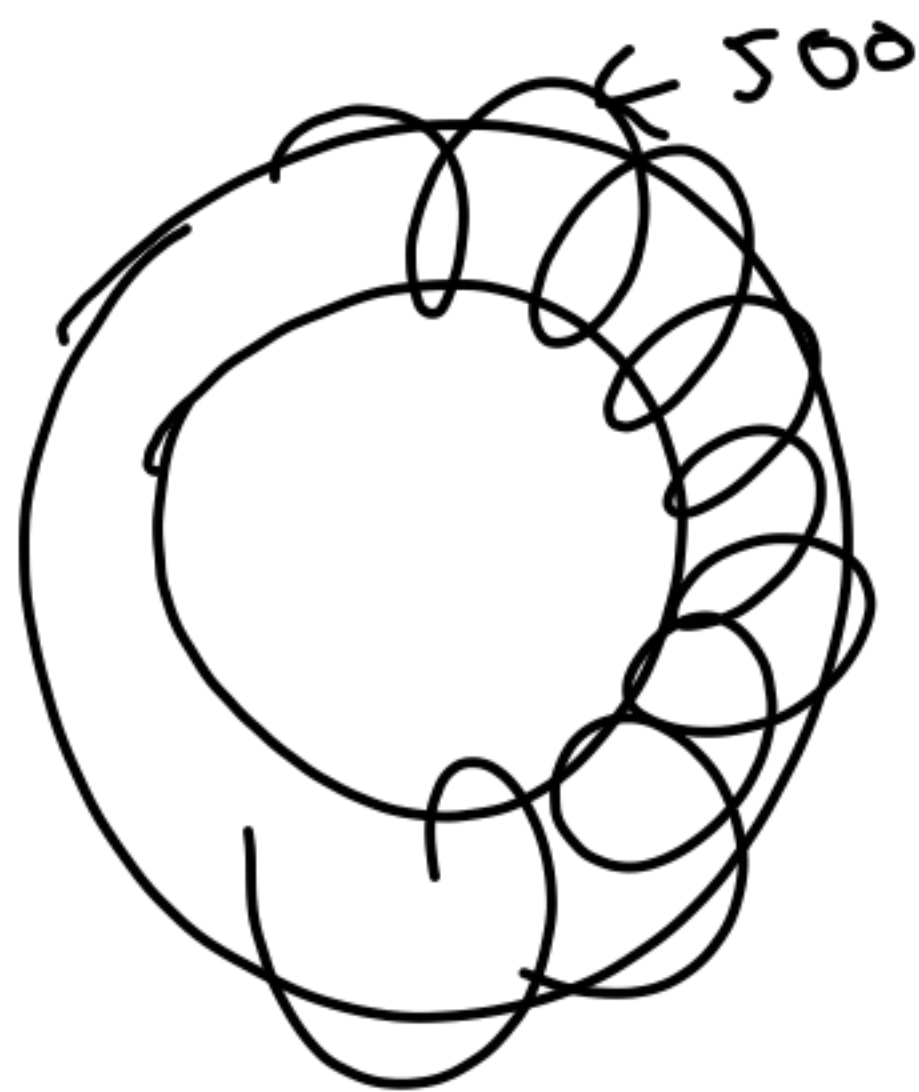
Soln

$$N = 500 \text{ turns.}$$

$$R = 10\text{cm}$$

$$A = 3\text{cm}^2$$

$$\mu_r = 800$$



$$L = \frac{\mu_0 \mu_r N^2 A}{2\pi R}$$

$$= \frac{4\pi \times 10^{-7} \times 800 \times (500)^2 \times 3 \times 10^{-6}}{2\pi \times 10 \times 10^{-2}}$$

$$L = 0.12\text{H}$$

4) Find the inductance per unit length of
a co-axial cable of radius of inner
and outer conductors are 1mm and 3mm.

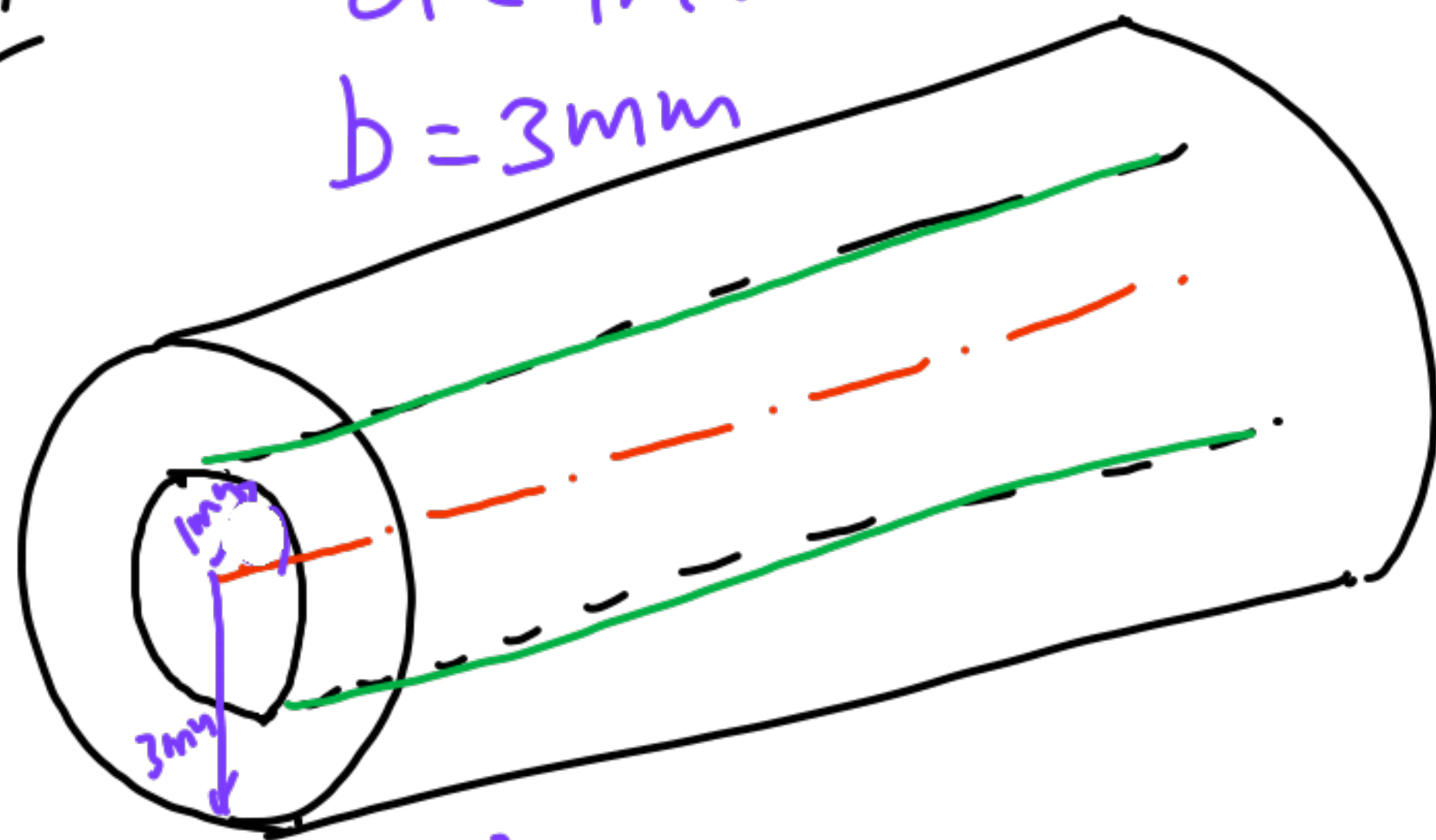
$$\mu = \mu_0 \mu_r$$

Assume Relative permeability as unity

56m

$$a = 1\text{mm}$$

$$b = 3\text{mm}$$



$$\frac{L}{d} = \frac{\mu \odot}{2\pi} \ln\left(\frac{b}{a}\right)$$

$$= 0.2197 \mu\text{H/m}$$

$$\frac{L}{d} = \frac{\mu}{2\pi} \ln\left(\frac{b}{a}\right)$$

5) A plane EM wave travelling in space has $E_{\max} = \frac{1500 \text{ V}}{\text{m}}$. Find the accompanying $H_{\max}$ and the

power transmitted.

$$H_{\max} = \frac{E_{\max}}{\eta_0}$$

$$H_{\max} = 3.96 \times 10^{-6} \text{ A/m}$$

$$\text{Power} = \frac{E_{\max}^2}{2\eta_0}$$

$$P = 0.3 \times 10^{-8} \text{ W/m}^2$$

6) A plane wave has a power density of 12 W/m^2 in a medium with $\epsilon_r = 3$, $\mu_r = 1$. Find E and H

Soln

$$\text{Power} = \frac{E_{\max}^2}{2\eta} = 12 \text{ W/m}^2$$

$$\eta = \sqrt{\frac{\mu_0 \mu_r}{\epsilon_0 \epsilon_r}}$$

$$E_{\max} = 72.26 \text{ V/m}$$

$$H_{\text{mon}} = 0.332 \text{ } \underline{\text{Terda}}$$