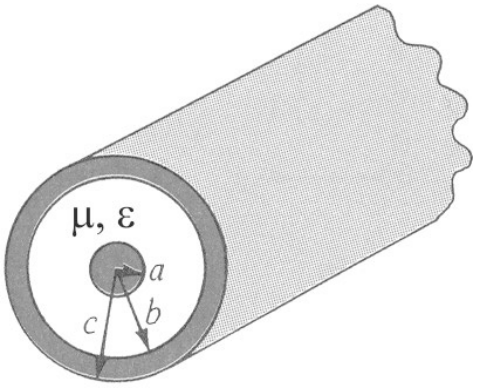
EE 381 Electric and Magnetic Fields Quiz #1 (Fall 2025)

Name KEY A

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A coaxial transmission line is made with perfect electrical conductors. The center wire diameter is 5 mm and the shield diameters are 30 mm (inner) & 31 mm (outer). Between the conductors is a lossless, non-magnetic, dielectric ($\varepsilon = 4\,\varepsilon_0$). If the transmission line is operated at 380 MHz, find the inductance and capacitance per-unit-length (L and C), phase velocity, characteristic impedance, and phase constant for this transmission line.



$2a = 5$ mm $\Rightarrow a = 2.5$ mm

$2b = 30$ mm $\Rightarrow b = 15$ mm

insulation: $\mu = \mu_0$ and $\varepsilon = 4\varepsilon_0$

From Table 11.1 $L = \dfrac{\mu}{2\pi}\ln(b/a) = \dfrac{4\pi\times10^{-7}}{2\pi}\ln(15/2.5) \quad \Rightarrow \quad L = 3.583519 \times 10^{-7}$ H/m

$C = \dfrac{2\pi\varepsilon}{\ln(b/a)} = \dfrac{2\pi(4)8.8541878\times10^{-12}}{\ln(15/2.5)} \quad \Rightarrow \quad C = 1.24196 \times 10^{-10}$ F/m

(11.21b) $u = 1/\sqrt{LC} = 1/\sqrt{3.583519\times10^{-7}(1.24196\times10^{-10})} \quad \Rightarrow \quad u = 1.49896 \times 10^{8}$ m/s

(11.21c) $Z_0 = \sqrt{L/C} = \sqrt{3.583519\times10^{-7}\,/\,1.24196\times10^{-10}} \quad \Rightarrow \quad Z_0 = 53.7156\ \Omega$

(11.21c) $\beta = \omega/u = 2\pi(380\times10^{6})/1.49896\times10^{8} \quad \Rightarrow \quad \beta = 15.928$ rad/m

$L = 358.352$ nH/m $\quad C = 124.196$ pF/m $\quad$ phase vel. $= 1.499 \times 10^{8}$ m/s

characteristic impedance $= 53.716\ \Omega$ $\quad$ phase constant $= 15.928$ rad/m

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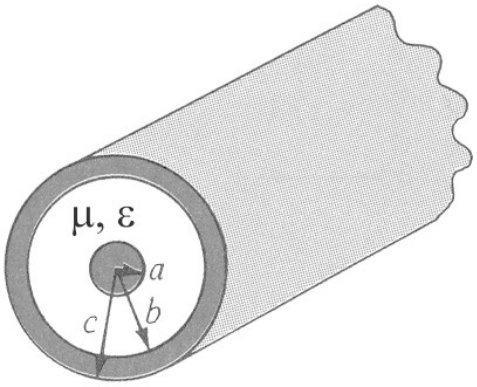
Name KEY B

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A coaxial transmission line is made with perfect electrical conductors. The center wire diameter is 8 mm and the shield diameters are 35 mm (inner) & 36 mm (outer). Between the conductors is a lossless, non-magnetic, dielectric ($\varepsilon = 5\,\varepsilon_0$). If the transmission line is operated at 480 MHz, find the inductance and capacitance per-unit-length (L and C), phase velocity, characteristic impedance, and phase constant for this transmission line.



$2a = 8$ mm $\Rightarrow a = 4$ mm

$2b = 35$ mm $\Rightarrow b = 17.5$ mm

insulation: $\mu = \mu_0$ and $\varepsilon = 5\varepsilon_0$

From Table 11.1 $L = \dfrac{\mu}{2\pi}\ln(b/a) = \dfrac{4\pi\times10^{-7}}{2\pi}\ln(17.5/4) \quad \Rightarrow \quad \underline{L = 2.9518 \times 10^{-7}\ \text{H/m}}$

$$C = \frac{2\pi\varepsilon}{\ln(b/a)} = \frac{2\pi(5)8.8541878\times10^{-12}}{\ln(17.5/4)} \quad \Rightarrow \quad \underline{C = 1.88469 \times 10^{-10}\ \text{F/m}}$$

(11.21b) $u = 1/\sqrt{LC} = 1/\sqrt{2.9518\times10^{-7}(1.88469\times10^{-10})} \quad \Rightarrow \quad \underline{u = 1.3407 \times 10^{8}\ \text{m/s}}$

(11.21c) $Z_0 = \sqrt{L/C} = \sqrt{2.9518\times10^{-7}\,/\,1.88469\times10^{-10}} \quad \Rightarrow \quad \underline{Z_0 = 39.5753\ \Omega}$

(11.21c) $\beta = \omega/u = 2\pi(480\times10^{6})/1.3407\times10^{8} \quad \Rightarrow \quad \underline{\beta = 22.495\ \text{rad/m}}$

$L =$ 295.18 nH/m $\qquad C =$ 188.47 pF/m $\qquad$ phase vel. = 1.3407×10^{8} m/s

characteristic impedance = 39.575 Ω $\qquad$ phase constant = 22.495 rad/m