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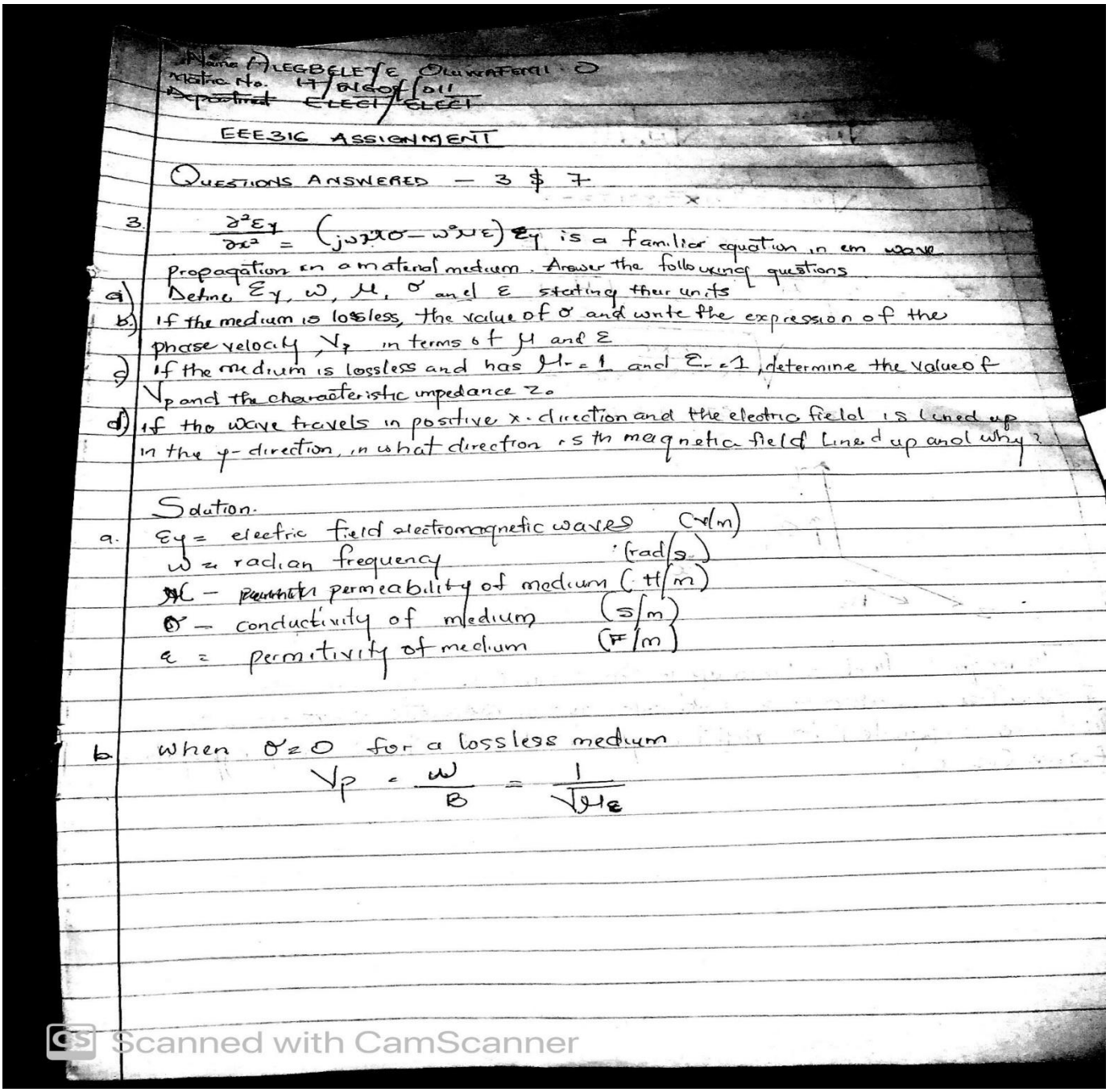
**EEE 316 ASSIGNMENT**



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QUESTIONS ANSWERED — 3 & 7

3. $\frac{\partial^2 E_y}{\partial x^2} = (j\omega\mu\sigma - \omega^2\mu\varepsilon)E_y$ is a familiar equation in em wave propagation on a material medium. Answer the following questions

a) Define $E_y$, $\omega$, $\mu$, $\sigma$ and $\varepsilon$ stating their units

b) If the medium is lossless, the value of $\sigma$ and write the expression of the phase velocity, $V_p$ in terms of $\mu$ and $\varepsilon$

c) If the medium is lossless and has $\mu_r = 1$ and $\varepsilon_r = 1$, determine the value of $V_p$ and the characteristic impedance $z_o$

d) If the wave travels in positive x-direction and the electric field is lined up in the y-direction, in what direction is the magnetic field lined up and why?

Solution.

a. $E_y$ = electric field electromagnetic wave (V/m)
$\omega$ = radian frequency (rad/s)
$\mu$ – permeability of medium (H/m)
$\sigma$ – conductivity of medium (S/m)
$\varepsilon$ = permitivity of medium (F/m)

b. When $\sigma = 0$ for a lossless medium

$$V_p = \frac{\omega}{\beta} = \frac{1}{\sqrt{\mu\varepsilon}}$$

c. $v_p = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu_0 \varepsilon_0 \varepsilon_r}}$

$= \frac{1}{\sqrt{4\pi \times 10^{-7} \times 8.854 \times 10^{-12}}}$

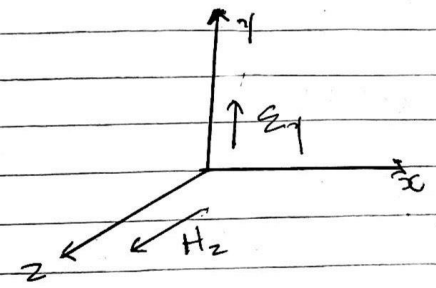
$= 299795637.7 \text{ m/s}$

$z_0 = \sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{\mu_r \mu_0}{\varepsilon_0 \varepsilon_r}}$

$= \sqrt{\frac{1 \times 4\pi \times 10^{-7}}{1 \times 8.854 \times 10^{-12}}}$

$z_0 = 376.73\,\Omega$

d.




The magnetic field is lined up in the z-direction because the ELECTRIC FIELD is always perpendicular to the MAGNETIC WAVE and both fields are separated at right angles to the directions of propagation of wave (i.e x).

An air filled coaxial transmission Line has an outer conductor inside diameter, b = 10mm and an inner conductor outside diameter a = 3mm. Calculate the.

a) Capacitance per meter, C
b) Inductance per meter, L
c) Characteristic impedance, $z_o$
d) Phase velocity, $V_p$ of an em wave propagate through it

Solution.

$b = 10mm = 0.01m$

$a = 3mm = 0.003m$

$\varepsilon_o = 8.854 \times 10^{-12}$

$\mu_o = 4\pi \times 10^{-7}$

a) $$C = \frac{2\pi \varepsilon_o}{\log_e \frac{b}{a}}$$

$$= \frac{2\pi \times 8.854 \times 10^{-2}}{\log_e \frac{0.01}{0.003}}$$

$$C = \frac{5.563 \times 10^{-11}}{1.20397}$$

$$C = 4.6205 \times 10^{-11} \ F/m$$

b. $L = \frac{\mu_0}{2\pi} \log_e \frac{b}{a}$

$\frac{4\pi \times 10^{-7}}{2\pi} \log_e \frac{0.01}{0.003}$

$2 \times 10^{-7} \times 1.20397$

$L = 2.4079 \times 10^{-7}\ Hm^{-1}$

$L = 2.4079 \times 10^{-7}\ Hm^{-1}$ //

c. $Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{2.4079 \times 10^{-7}}{4.6205 \times 10^{-11}}}$

$= 5212.12\ \Omega$

c. $Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{2.4079 \times 10^{-7}}{4.6205 \times 10^{-11}}}$

$Z_0 = 72.1896\ \Omega$

d. $V_p = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.4079 \times 10^{-7} \times 4.6205 \times 10^{-11}}}$

$= 2.99791863.2$

$2.998\ m/s$