

ANALOG 12.8 8

EE23BTECH11054 - Sai Krishna Shanigarapu*

Question 8:

Suppose that the electric field amplitude of an electromagnetic wave is $E_0 = 120\text{N/C}$ and that its frequency is $f = 50.0\text{ MHz}$.

- (a) Determine, B_0, ω, k and λ
 (b) Find expressions for \mathbf{E} and \mathbf{B}

Solution (a):

TABLE I
INPUT PARAMETERS

Input Parameters		
Symbol	Description	value
f	frequency of source	50.0 MHz
E_0	Electric field amplitude	120 N/C
c	speed of light	$3 \times 10^8\text{ m/s}$
$\mathbf{e}_2, \mathbf{e}_3$	Standard basis unit vectors	$ \mathbf{e}_2 = \mathbf{e}_3 = 1$

General representation of electric and magnetic field is:

$$\mathbf{E} = E_0 \sin(kx - \omega t)\mathbf{e}_2 \quad (1)$$

$$\mathbf{B} = B_0 \sin(kx - \omega t)\mathbf{e}_3 \quad (2)$$

TABLE II
FORMULAE

Symbol	Description	Formula
B_0	Magnetic field strength	$B_0 = \frac{E_0}{c}$
ω	Angular frequency	$\omega = 2\pi f$
k	Propagation constant	$k = \frac{\omega}{c}$
λ	Wavelength	$\lambda = \frac{c}{f}$

$$B_0 = 400\text{nT} \quad (3)$$

$$\omega = 3.14 \times 10^8 \text{ rad/s} \quad (4)$$

$$k = 1.05 \text{ rad/m} \quad (5)$$

$$\lambda = 6.0\text{m} \quad (6)$$

Solution (b):

from the above equations,

$$\mathbf{E} = 120 \sin[1.05x - 3.1 \times 10^8 t]\mathbf{e}_2 \quad (7)$$

$$\mathbf{B} = (4 \times 10^{-7}) \sin[1.05x - 3.14 \times 10^8 t]\mathbf{e}_3 \quad (8)$$

TABLE III
OUTPUT PARAMETERS

Output parameters		
Symbol	Description	value
B_0	Magnetic field strength	400nT
ω	Angular frequency	3.14×10^8 rad/s
k	Propagation constant	1.05 rad/s
λ	Wavelength	6.0m
\mathbf{E}	Electric field vector	$120 \sin[1.05x - 3.1 \times 10^8 t] \mathbf{e}_2$
\mathbf{B}	Magnetic field vector	$(4 \times 10^{-7}) \sin[1.05x - 3.14 \times 10^8 t] \mathbf{e}_3$

Fig. 1. Graphs of \mathbf{E} and \mathbf{B}

