ANALOG 12.8 8

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Question 8:
Suppose that the electric field amplitude of an electromagnetic wave is E_0 = 120N/C and that its frequency is f = 50.0 MHz.
(a) Determine, B_0, ω, k and λ
(b) Find expressions for **E** and **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 x 10^8 m/s
$\mathbf{e_2}$, $\mathbf{e_3}$	Standard basis unit vectors	$\lvert\mathbf{e_2}\rvert = \lvert\mathbf{e_3}\rvert = 1$

General representation of electric and magnetic field is:

$$\mathbf{E} = E_0 sin(kx - \omega t)\mathbf{e_2} \quad (1)$$
$$\mathbf{B} = B_0 sin(kx - \omega t)\mathbf{e_3} \quad (2)$$

$$B_0 = \frac{E_0}{c} = \frac{120}{3x10^8} = 400nT \quad (3)$$
$$\omega = 2\pi f = 3.14x10^8 rad/s \quad (4)$$
$$k = \frac{\omega}{c} = 1.05 rad/m \quad (5)$$
$$\lambda = \frac{c}{f} = \frac{3x10^8}{50x10^6} = 6.0m \quad (6)$$

Solution (b):

from the above equations,

$$\mathbf{E} = 120 sin[1.05x - 3.1x10^8 t]\mathbf{e_2} \quad (7)$$
$$\mathbf{B} = (4x10^{-7}) sin[1.05x - 3.14x10^8 t]\mathbf{e_3} \quad (8)$$

TABLE II
OUTPUT PARAMETERS

Output parameters		
Symbol	Description	value
B_0	Magnetic field strength	400nT
ω	Angular frequency	3.14 x 10^8m/s
k	Propagation constant	1.05rad/s
λ	Wavelength	6.0m
E	Electric field vector	120 sin[1.05x - 3.1 x 10^8t]$\mathbf{e_2}$
B	Magnetic field vector	(4 x 10^{-7})sin[1.05x - 3.14 x 10^8t]$\mathbf{e_3}$

Fig. 1. Graphs of **E** and **B**