Q- Write down expression for the electric and magnetic fields of a sinusoidal plane electromagnetic wave having a frequency of 3.00 GHz and traveling in the positive x-direction. The amplitude of the electric field is 300 V/m.

The electric and the magnetic fields in a sinusoidal plane electromagnetic wave at a point as a function of its x coordinate at instant of time t are expressed as

$$E(x,t) = E_m \sin(kx - \omega t)$$

And $$B(x,t) = B_m \sin(kx - \omega t)$$

The electric and magnetic fields are mutually perpendicular to each other and both are in the plane normal to the direction of wave motion.

Here E_m and B_m are the maximum values of the fields called amplitudes, ω is the angular frequency and K is the wave number. The frequency of the wave is denoted by f and the wave velocity by c.

Now $\omega = 2\pi f = 2\pi * 3.00 * 10^9 = 1.885 * 10^{10}$ radians/s
$K = 2\pi/\lambda = 2\pi f/c = 62.83\ m^{-1}$ [$c = 3 * 10^8$ m/s]

Hence the expression for electric field can be written as

$$E(x,t) = (300)\sin(62.83x - 1.885 * 10^{10} t)\ \text{V/m}$$

As in electromagnetic waves the magnetic and electric fields are related as E = c*B the amplitude of the magnetic field is given by

$B_m = E_m/c = 300/(3 * 10^8) = 10^{-6}$ T

And thus the expression for the magnetic field will be

$$B(x,t) = 10^{-6} \sin(62.83x - 1.885 * 10^{10} t)\ \text{T}$$