Asil Koç
040100523

Electromagnetic Waves Midterm #1

(12 November 2013)

1. Explicit expression of the Gaussian beam is given with:

$$E(x,z) = \frac{1}{2\pi}\int_{-\infty}^{\infty} E_0(\zeta) e^{i\left(\zeta x + \sqrt{k^2-\zeta^2}z\right)} d\zeta$$

Prove that the Gaussian beam satisfies the Helmholtz equation. (20)

2. Phasor (complex) domain expression of an electric field vector of a monochromatic plane wave propagates in free space is given as:

$\vec{E}(y,z) = e^{i20\pi(2y-\sqrt{3}z)}(E_0\vec{e}_y + 2\vec{e}_z)$. ($E_0$ is a real constant.)

a.) Find E_0 constant. (5)

b.) Find the direction of propagation, phase and equiphase surfaces of this wave. (5)

c.) Find the frequency, period, wavelength, wave number and phase velocity of this wave. (5)

d.) Find the complex (phasor) expression of the magnetic field vector. (10)

e.) Find the expressions of electric and magnetic field vectors in time domain. (10)

f.) Find the average of the Poynting vector over one period. (5)

3. A monochromatic wave is excited in a lossless and homogenous medium with electromagnetic parameters $\varepsilon = 4\varepsilon_0, \mu = \mu_0$ and frequency is f=3 GHz. The direction of propagation of the wave is known to be in +x direction and the electric field vector of this wave is always parallel to the z-axis.

a.) Find the wavenumber, wavelength and phase velocity of this wave. Calculate the characteristic impedance of this medium. (5)

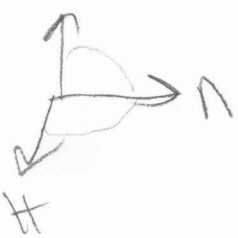
b.) Write the expressions of electric and magnetic field vectors in complex form. (10)

c.) Write the expression of complex Poynting vector. (5)

d.) Find the time domain expressions of field vectors (both electric and magnetic fields). (10)

e.) Write the expression of Poynting vector in time domain. (5)

f.) Express the average of Poynting vector over one period in terms of complex Poynting vector. (5)



GOOD LUCK!

Assist. Prof. Dr. Mehmet Çayören

May the Force be with you!

Can Suer B.Sc.