EEL 4436C/5437C Microwave Engineering

Homework #1 Solution

1. (15 points) Derive the vector wave equation for magnetic field from Maxwell’s equations. (Hint: follow the procedure for E field vector wave equation)

Solution:

start from Ampere’s Law in free space

=> (1)

We have Faraday’s Law in free space

(2)

Substitute (2) into (1),

(3)

Using identity, (3) can be written as:

(4)

According to gauss’ law: , (4) can be written as:

1. (20 points) A uniform plane wave (UPW) in free space is given by:
   1. Find : , is defined as
   2. Find :
   3. Find : GHz
   4. Find :
   5. Find :
   6. Find in phasor form (You can directly write the expression if otherwise stated):
   7. Find

1. (30 points) A UPW with a frequency of 150 MHz propagates in +x direction in free space. The E field expression is given by:

.

* 1. Find :
  2. Find : (I should use k since it is in x direction)



* 1. Find : (m)
  2. Find : (m/s)
  3. Find :
  4. Find
  5. Use Maxwell equations to find . (Hint: follow the lecture notes)

and

=>

=>

=>

Since

1. (15 points) A UPW propagating in +z direction in silicon () is given by:
   1. What type of polarization is this wave? : Linear Polarization (LP)
   2. Find in phasor form.



* 1. Decompose this wave into a RHCP wave and a LHCP wave.



* 1. Compare the amplitude of both the RHCP and the LHCP waves.



Amplitudes of both RHCP and LHCP are 2.5.

* 1. What is the phase difference between the two circular polarized waves?

I mean the phase difference between and . It is 2×tan-1(4/3).

1. (20 points) a UPW propagating in +z direction in air is given by:
   1. What type of polarization is this wave?

=> Ey is leading Ex in terms of phase => LHCP

* 1. If there is a mirror made of perfect metal () at z=0, write the reflected E filed at z=0.

* 1. Find the total H field at z=0.

* 1. What type of polarization is the reflected wave?

For the reflected wave , Ey is leading Ex in terms of phase, but the propagation direction for the reflection wave is in –z direction. Thus the reflected wave is RHCP.