University of Toronto

Faculty of Applied Science and Engineering

Final Examination, December 2001

Third Year – Program 7

ECE 320 H1F – Fields and Waves

Examination Type: A

Examiner – S. Dmitrevsky

All questions are of equal value and any five constitute a complete paper.
Write in ink!

Aids: $\varepsilon_o = 8.85 \times 10^{-12} F/m$, $\mu_o = 4\pi \times 10^{-7} H/m$.

1. A 50 Ohm, 2 x 10^8 m/s transmission line delivers a 400 MHz signal to an unknown load impedance. At a point A on the line, 6.25 cm away from the load the total signal voltage is $4\angle 60^o$ Volt RMS. The reflected current at a point 12.5 cm away in the direction of the generator from the point A is $40\angle 90^o$ m A RMS.

   Determine:
   (i) the load impedance and,
   (ii) power delivered to the load.

2. The standing wave ratio on a 50 Ohm, 2 x 10^8 m/s transmission line is 3.31. The separation between an adjacent voltage minimum and maximum is 50 cm. The distance between the load terminals and closest minimum is 25 cm.

   Determine:
   (i) the lowest possible frequency,
   (ii) the load impedance and,
   (iii) power delivered to the load.

3. The EMF of a 50 Ohm internal impedance generator is a single 5 μ sec long pulse of 4 Volt amplitude. The generator drives a 20 km long section of a 50 Ohm, 2 x 10^8 m/s transmission line terminated in a 50 Ohm load. An unknown resistor is connected across the line at an unknown location. Reflected pulse of –0.22 Volt amplitude is observed at generator terminals. The delay between the launching time of the leading edge of the outgoing pulse and the arrival of the leading edge of the return pulse is 50 μ sec.

   Determine:
   (i) the location of the unknown resistor and,
   (ii) the value thereof.

4. A 30 MHz vertically polarized (electric field) plane wave propagates in free space in horizontal direction 30^o west of north. The power density in the wave is 10^{-12} Walt/m^2. The magnetic field of the wave is monitored by two ten turn circular loops A and B of 5 cm radius lying in a north-south vertical plane. Loop A is located 1.92 m north of loop B.

   Determine:
   (i) the RMS EMF induced in each of the loops and,
   (ii) the phase (magnitude and sign) of the EMF in loop A with respect to that in loop B.

5. Two horizontally polarized (electric field) plane waves propagate in horizontal direction, one 30° east of north, the other 30° west of north. The power densities of the two waves are equal. At a point A in space the two waves are in phase and the total electric field points in the east-west direction.

   Find a point closest to A such that the waves there are 180° out of phase, and the direction of the total electric field there.

6. A 500 MHz signal propagating horizontally in free space in normally incident on a vertical wall of dielectric of relative permitting 2.25.

   What is the smallest thickness of the wall such that there is no reflection of the incident signal?