Professor Viviana Bibin Koshy

Transmission Systems

Homework #1

* 1. Calculate the free-space wavelength in meters for the following frequencies:

1. 2 kHz
2. 2000 kHz
3. 20 MHz
4. 2 GHz
   1. Calculate the free-space wavelength in meters for the following frequencies:
5. 80 kHz
6. 8 MHz
7. 800 MHz
8. 8 GHz
   1. Calculate the free-space wavelength in miles for a frequency of 400 Hz.
   2. Calculate the free-space wavelength in miles for a frequency of 1.5 kHz.
   3. A sinusoidal signal has a free-space wavelength of 80 m. Calculate the frequency.
   4. A sinusoidal signal has a free-space wavelength of 6 m. Calculate the frequency.
   5. A digital signal utilizes pulse whose minimum widths are about 3 ns. Assuming the speed of light, determine the longest lengths of wire-pairs that can be allowed based on the 10% rule.

t = 0.1 \* 3 ns =300 ps

d= c\* t 1 = (3 \* 108 ) \* (300 ps) = 9 cm

* 1. The longest connecting wires in a digital system are about 20 cm. Assuming the speed of light, determine the shortest acceptable pulse width based on the 10% rule.

t == 6.67 \*10-10

pulse width= = 6.67 \* 109 s

* 1. A communication system operates at a frequency of 800 MHz. Assuming the speed of light, determine the length of connecting line that could be used without considering frequency-domain effects based on the 10% rule.
  2. The length of a connecting cable between two points in a radio-frequency system is 50 cm. Assuming the speed of light, determine the highest operating frequency that should be used without considering frequency-domain effects based on the 10% rule.
  3. In a coil, a current of 100 mA results in a magnetic flux of 50 Determine the inductance.
  4. A current of 4 mA is flowing in a 20- H coil. Determine the magnetic flux.

= Current \* Inductance = (4 mA \*20 H) = 8\* 10-8 H

* 1. In a capacitor, a voltage of 20 V results in charge storage of 5 C. Determine the capacitance.
  2. A capacitance of 40 F is charged to a voltage of 12 V. Determine the electric charge.
  3. A lossless transmission line has an inductance of 320 nH/m and a capacitance of 57 pF/m. Determine the characteristic impedance.
  4. A lossless transmission line has an inductance of 1.2 H/m and a capacitance of 15 pF/m. Determine the characteristic impedance.
  5. The dielectric constant of mica is 6. Determine the permittivity.

ε=εr\*ε0= 6\*8.842 = 53.02 \*10-12 F/m

* 1. The permittivity of a material is 14 \*10 -12 F/m. Determine the dielectric constant.

εr = = =1.58

* 1. The relative permeability of nickel is 800. Determine the actual permeability.

**=\***0

1.05 mH/m= (800\* ()

* 1. The permeability of a ferromagnetic material is 10-4 H/m. Determine the relative permeability.

**= = =79.58**

* 1. Determine the velocity of propagation of the transmission line of Problem 1-15.

=2.34 \*108 m/s

* 1. Determine the velocity of propagation of the transmission line of Problem 1-16.

=2.36 \*108 m/s

* 1. The dielectric constant in a transmission line is 4.7, and =0. Determine the velocity of propagation.

**V**= = =1.38 \* 108 m/s

* 1. The dielectric constant in a certain transmission line is 3, and =0.  Determine the velocity of propagation.

**V**= = =1.73\* 108 m/s

* 1. A coaxial cable has the following specifications: R0 = 73, and velocity of propagation =2.1 \*108 m/s. Determine L and C.

= =347 \*10-9

= =

* 1. A coaxial cable has the following specifications: R0 = 150, and velocity factor =0.8. Determine L and C.

= =625

= = 8

* 1. The lower end of the commercial amplitude-modulation (AM) band is about 550 kHz. AM stations use “ quarter-wave” vertical antennas whose lengths are .25. Determine he length in meters of a vertical antenna operating at the lower end.

=545.45

.25 =.25\*545.45 = 136.36 m

* 1. The upper end of a commercial AM band to in Problem 1-27 is about 1610 kHz. Determine the length in meters of a vertical antenna operating at the upper end.

=186.34 \* 103 m

* 1. One popular simple antenna is the “half-wave” horizontal antenna whose theoretical length is .5λ at the operating frequency. In practice, however, the antenna is usually shortened by about 5% due to end effects. Determine the practical length in meters for a half-wave antenna to provide optimum reception at the lower end of the commercial FM band, which is about 88 MHz.

=3.409 m

.5\*3.409 = 1.705 m

1.705-(1.7045\*.05) =1.6193 m

* 1. Based on the discussion of problem 1-29, determine the practical length in meters for a half-wave antenna to provide optimum reception at the upper end of the FM band, which is about 108 MHz.

=2.78 m

.5\*2.78 = 1.4 m

1.4-(1.4\*.05) =1.33 m

* 1. Show that the free-space velocity light in feet/second is very close to c=984 \*10­6 ft/s.
  2. Show that the free-space wavelength in feet can be expressed as

you may use the result of Problem 1-31.