Assignment 2

Due Friday, October 10. Show your work. Submit your assignment using the appropriate dropbox on the course web site. Assignments submitted after the solutions are made available will be given a mark of zero.

Question 1

Use the data sheets on the course web site[1] for Belden 1583A Cat-5 and Belden 9292 RG-11 co-ax cables to answer the following questions. Note that you may have to convert some values from US units to metric[2].

(a) using the specified velocity factor ("VP" in the data sheets) compute the relative dielectric constant (ε_r) for both types of cable. Why does does the co-ax have a higher VF?

(b) what is the specified attenuation at 100 MHz of a 100 m run of this cable?

(c) what is the specified 3 dB bandwidth of a 100 m length of this cable? Interpolate linearly between the two closest values in the table if necessary.

(d) draw the equivalent lumped-element circuit for a 1 m length of this cable including (DC) R, L and C (ignore G). For the twisted-pair cable you can use 525nH/m for L. Note that the DC resistance is specified per conductor while the resistance in the model is for both conductors in series.

(e) use the simplified equations given in the lecture notes to compute the characteristic impedance of the co-ax cable based on the specified conductor and insulation diameters and the dielectric constant computed above. How does the estimate compare to the specified value?

Question 2

Use the data sheets on the course web site for Belden GCAC fibre-optic cable to answer the following questions for the single-mode 9/125 G.655 fiber and the multi-mode 62.5/125 multi-mode fiber:

(a) what are the maximum dimensions of the core and cladding?

(b) What is the maximum loss *per km* at the lowest-loss wavelength? How does this compare to the loss of the RG-11 co-ax at a frequency of 100 MHz?

Question 3

A signal with a voltage of 300mVrms is measured at the receiving end of a transmission line that has a nominal impedance of 600 Ω. If the loss of the transmission line is known to be 5 dB/100m at the signal frequency, what is the length of the line if the power at the transmitting side was +20 dBm?

Question 4

0-gauge (zero gauge) AWG wire has a diameter of about 8.3mm. The wire diameter decreases by a factor of about 0.891 for each increase of 1 in wire gauge. What is the diameter of 1-gauge wire? Of 2-gauge wire? Of n-gauge wire?

Question 5

(a) What is the surface area of a sphere of radius d?

(b) If we transmit P_T Watts from an antenna that radiates equally well in all directions (an "omnidirectional" antenna), what is the power density (in W/m^2) at distance d from the antenna?

(c) If a transmitting antenna is made directional so that it concentrates all its power into a fraction of the sphere that is $1/G_T$ of the total area, what would be the power density in the "illuminated" area?

[1] Contents > Reference Material > Assignment 2

[2] There are 25.4 mm per inch and 12 inches per foot.

(d) If a receiving antenna collects all of the power "shining" on an area A_e on the surface of this sphere (the "effective area'), how much power would such an antenna collect?

(e) Set this power equal to the received power predicted by the Friis equation and solve for A_e as a function of G_R.

(f) What is the effective area of an omnidirectional antenna at a frequency of 2.4 GHz?

(g) What is the effective area of a satellite dish with a gain of 30 dB at 12 GHz?

A couple of other things to note:

- Antennas have the same gain whether transmitting or receiving.
- For certain types of antennas (such a those using reflectors) the effective area is approximately the same as the physical area. For others (such as wire antennas) the relationship is not as easy to establish and must be determined indirectly (usually from the gain).