ELEX 3525 : Data Communications
2015 Winter Session

Assignment 2

Due Tuesday, April 28. 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

What is the total cross-sectional area of stranded 7x22 wire (7-strands of 22-gauge wire)?

The AWG rating of stranded wire is usually specified as the AWG of a solid wire having the same cross-sectional area. What is the AWG of 7x22 wire?

Question 2

What is is the velocity of propagation in a co-ax cable with a characteristic impedance of 100 Ω, a 24-gauge inner conductor diameter and a 2.5mm outer conductor diameter?

Question 3

Above a certain frequency, the "cut-off" frequency, RF signals can propagate along co-ax cables in modes other than TEM. This is undesirable because the different modes have different propagation delays and this results in multipath propagation and, for example, ISI.

The cut-off frequency is inversely proportional to the outer diameter of the co-ax, assuming the same dielectric and characteristic impedance.

If the cut-off frequency for a 1.2 mm diameter co-ax is 110 GHz, what is the cut-off frequency for co-ax with a 5 mm diameter and the same Z_0 and dielectric?

Question 4

You have been asked to design a co-ax cable run between two buildings. The length of the run is 480 m. The attenuation at 150 MHz must be less than 25 dB. For practical reasons a run can only be installed in lengths of 200 m or less. Assuming each splice requires an additional 1 m of cable and adds 0.35 dB loss, select the least expensive LMR-series cable from the table in the document below:

http://www.timesmicrowave.com/downloads/tech/LMRIntl.pdf

that will meet the requirements. Use the price per meter in the table.

How much will the cable cost if your supplier only sells the cable in lengths that are multiples of 50m?

Question 5

The Friis equation only applies to free-space propagation. Wireless systems often operate over non-line-of-sight (NLOS) paths where the signal propagates primarily by diffraction around the edges of obstructions and reflection from surfaces such as the ground and the sides of buildings.

It has been experimentally determined that the path loss (ratio of received power to to transmit power) for NLOS paths can be approximated by the formula:

$$\frac{P_R}{P_T} = L_0 \left(\frac{d}{d_0} \right)^{-n}$$

where d_0 is a reference distance where the path loss is L_0. The exponent n depends on the type of environment. Typical values are between 2.5 and 4.

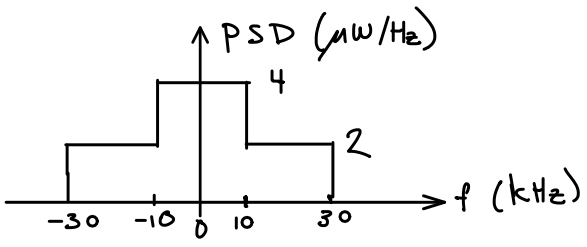
If the path loss for a particular system is found to be $L_0 = 60$ dB for $d_0 = 50$ m and the path loss exponent has been determined to be $n = 3.3$, what would be the predicted loss at 1 km?

Question 6

Is a terminated transmission line a high-pass, low-pass or band-pass channel?

Question 7

The diagram below shows the power spectral density of a signal. What is the total power? What is the 90% power bandwidth?



Question 8

Plot the phase response over a frequency range of 0 to 4 kHz of a channel whose only effect is to delay the input by 1 ms. Show the scale on both axis.

Question 9

Does a full-wave rectifier cause linear or non-linear distortion?

Question 10

An amplifier's specifications state that each of the third-order IMD products are 30 dB "down" (less) relative to the desired output signal. If the input is composed of two signals at frequencies of 1.0 and 1.2 MHz with equal levels of 0 dBm, what and the amplifier gain is 20 dB, what are the frequencies and levels of the third-order IMD products?

Question 11

An amplifier is being tested for distortion. The input waveform is a sinusoid at 1 kHz. The output power is 1 W. When a notch filter that absorbs all of the signal power at 1 kHz is placed on the output, the measured output power drops to 10 mW. What is the THD?

Question 12

What is the SNR at the output of an 8 dB gain amplifier with a noise figure of 2 dB if the input signal level is -100 dBm and the bandwidth is 10 MHz?

Question 13

The time that students arrive for a lecture has a Gaussian distribution with a mean of $\mu = -5$ minutes relative to the lecture start time and a standard deviation of $\sigma = 1.5$ minutes. What fraction of students arrive late?

Question 14

Draw the RS-422 waveforms used to transmit the byte value 0x33 assuming a differential voltage of 5 V, a common-mode voltage of 2.5 V, 9600 bps, 7 data bits, and no parity.

If these voltages appear on pins labelled TxD+ and TxD-, is this a DTE or DCE interface?

Question 15

Draw the magnitude of the transfer function of a channel that has a raised-cosine transfer function with an excess bandwidth parameter of $\alpha = 0.5$. This channel can be used to signal at a maximum symbol rate of 1MHz without ISI. At what frequency (approximately) does the magnitude of the transfer function have a value 0.71 of the maximum?

Question 16

What is the subcarrier spacing for an OFDM signal with $N = 256$ and a sampling rate of 256 kHz?