ELEX 3525 : Data Communications
2016 Winter Term

Assignment 1

Due Wednesday, February 15~~March 23~~. 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

Look up the (Simplified) Chinese character for "rabbit" (translate.google.com can do this). Compute the UTF-8 encoding. How many byte are required? What are their values in hex?

Question 2

PIC microcontrollers store integers in little-endian order. The value 1234 (decimal) is stored as a 16-bit value at memory location 0x1000. What are the values, in hexadecimal, of the bytes at memory locations 0x1000 and 0x1001?

Question 3

A communication system transmits data using pulses that can be either 1 μs or 2 μs in duration. The amplitude of each pulse can be -3, -1 +1 or +3 volts. The signal does not return to zero (NRZ) in-between each pulse.

(a) How many different symbols are used?

(b) How many bits can be transmitted per symbol?

(c) Assuming both pulse durations are equally likely, what is the average data rate (in bits/second)? *Hint: be careful what you average.*

(d) What is the baud rate?

Question 4

A voice over IP (VoIP) communication system continuously samples speech waveforms at 8 kHz. Each sample is quantized into 8 bits. Each VoIP packet contains 20ms of speech.

(a) How many bytes and how many bits are transmitted in each packet?

(b) If each VoIP packets contains 20 bytes of header overhead, what fraction of each packet is payload?

(c) How many speech channels could be accommodated over a system with a data rate of 100 Mb/s if the packets could be transmitted with no gaps between them?

(d) Assuming no lost packets, what is the throughput per channel in bits/second?

Question 5

Many microcontrollers have built-in UARTs. The pins used for the UART use logic levels rather than the bipolar RS-232 levels. If the level on the UART output pin is L when no data is being transmitted, what logic level (H or L) does this interface use for the RS-232 mark level? Explain.

Question 6

This UART pin described above is labelled TxD on the PCB. Is this meant to be a DTE or DCE interface? Why?

Question 7

How many parallel strands of 24-gauge wire would have the same resistance as one 12-gauge wire?

Question 8

You are given a 300 m roll of unmarked coaxial cable and are asked to determine its characteristic impedance. Unfortunately, you only have access to one end. You use calipers to measure the diameter of the center conductor as 1.0 mm and the diameter of the shield as 4.6 mm. An LCR meter tells you the capacitance between the inner and outer conductors

is 20 nF. What is the relative permittivity of the dielectric? What is the characteristic impedance of the cable?

Hint: the capacitance of a cylindrical capacitor is:

$$C = \frac{2\pi\varepsilon_0\varepsilon_r L}{\ln(D/d)}$$

where d and D are the inner and outer conductor diameters respectively, L is the length and $\varepsilon_0 \approx 8.85$ *pF/m.*

Question 9

Find an on-line ad for a 1000-foot roll of distribution (not breakout), single-mode ("9/125", not multimode), 12-fiber (not simplex) cable. What is the price per foot? Include the URL or a link in your answer.

Question 10

(a) What is the area (in square meters) of a sphere of radius d m? If a transmitter of power P_T Watts is connected to an antenna that radiates equally well in all directions ($G_T = 1$), what is the power density (in Watts/square meter) at a distance d? How much power is received by an antenna of area A_e? Starting from the Friis equation, derive an equation for G_R in terms of A_e and λ.

(b) Assuming the physical area of a parabolic reflector is equal to A_e, what is the gain of a parabolic reflector satellite dish that has an area of 1 m^2 at a frequency of 30 GHz?

Question 11

(a) What is the difference between OFNR and OFNP cable? (b) Which type would you find in the ceiling of a classroom at BCIT (e.g. in SW1)?

Question 12

A channel has a transfer function given by the following equation:

$$H(f) = \sqrt{\frac{1}{1 + j\left(\frac{f}{3000}\right)^4}}$$

where f is in Hz.

What are the magnitude and phase of this transfer function at 300 Hz, 3 kHz and 30 kHz?

Question 13

(a) Plot the phase response of a channel with a 0.2 ms delay over the frequency range 0 to 20 kHz. Show the phase over the range $-\pi$ to π. (b) Is this a linear-phase channel?

Question 14

A channel extends from 50 to 55 MHz. The minimum group delay over this frequency range was found to be 10.75 μs and the maximum was found to be 11.25μs. (a) If we want to limit the dispersion due to group delay variation to 10% of the symbol period, what is the maximum symbol rate we can use on this channel? (b) Is this a linear-phase channel?

Question 15

A 100 kHz sine wave is input to an amplifier and the output is measured with a spectrum analyzer. The only significant harmonics present at the output are at 200 kHz and 300 kHz and are 20 dB and 23 dB lower than the output at 1 kHz. What is the THD in percent?

Question 16

Measurements show that the path loss due to shadowing by buildings has a Gaussian distribution if the path loss is expressed in dB.

If the mean path loss is 30 dB and the shadowing loss has a standard deviation of 8 dB, (a) what is the probability that the path loss will be less than 18 dB? (b) What is the probability that it exceeds 38 dB?

Question 17

A 10 Mb/s Ethernet interface transmits data on one pair of a Cat5 cable and receives data on another pair. When the interface is receiving data but not transmitting data would you expect to see NEXT, FEXT, both or neither on the receiving pair? What if the interface was both transmitting and receiving data? Explain.