ELEX 3525 : Data Communications
2015 Winter Session

Assignment 3

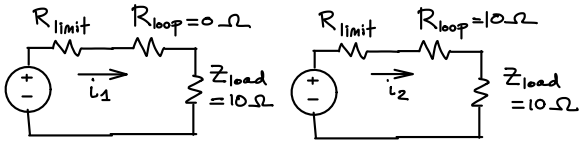
Due Tuesday, May 4. Show your work. Submit your assignment using the appropriate dropbox on the course web site. Assignments submitted after the solutions are made available will be given a mark of zero.

Question 1

An inexpensive approximation to a current source is a voltage source in series with a large resistance ("large" defined relative to the load).

A current-loop signaling system is being designed to operate with a receiver whose input impedance is 10 ohms.

What current-limiting resistance would you need to use in order to ensure the voltage swing varies less than 20% for loop resistances between 0 and 10 ohms? In other words, to ensure that in the following circuits $i_2/i_1 = 0.8$.



What supply voltage difference would you need to use to ensure the receiver saw a voltage swing of 1 V?

Question 2

A differential receiver sees a square-wave input signal with a common-mode voltage of 300 mV and a differential voltage of 200 mV. Draw the voltage waveforms, relative to ground, on the two input pins. Label the voltage axis.

Question 3

You apply a 1 Vpp 100 kHz signal to the primary of an isolation transformer and measure 0.25 Vpp on the secondary. The secondary is connected to a 10 ohm termination resistance. What is the impedance seen at the primary of the transformer?

Question 4

Draw the waveform used to transmit the byte value 0x73 in MSB-first order using differential Manchester line coding and voltage levels of 0 and 5V.

Question 5

The following sequence of bits has had bit-stuffing applied to it to prevent runs of 4 or more consecutive ones. What was the original sequence?

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110011101010
```

Question 6

A communication system operates on 4-bit words (nybbles). An escape word with value 0xA is used. The escape word is used twice to escape the escape word. The escape word is transmitted followed by 0x1 to start a frame and by 0x2 to end it.

Generate a frame using the above rules that contains the following sequence of nybbles: 0x1, 0x2, 0xA, 0x4.

Question 7

A 1000-bit frame is being transmitted using 64-QAM modulation. How many padding bits need to be added before the modulator?

Question 8

A code uses the following codewords:

```
111000
000111
111111
000000
```

What are n, k, and $n - k$? What is the code rate?

What is the minimum distance of this code? How many errors can be detected by this code? How many errors can be corrected by this code? If the codeword 000011 was received, what bit(s) were most likely in error?

Question 9

A communication system that does not use FEC requires an SNR of 13 dB to operate at a data rate of 1 GB/s with a bit error rate of 10^{-9}. The use of rate-1/2 FEC provides a coding gain of 2 dB at the same BER. What SNR is required when this FEC code is used? *Hint: work with* E_b/N_0.

Question 10

A rate-1/2 convolutional encoder outputs the sequence of bits 1001001110. This sequence is then punctured by dropping the second and third of every six consecutive encoded bits. What is the transmitted sequence? What is the code rate after puncturing?

Question 11

Compute the CRC for the message 1111 using the generator polynomial $x^2 + 1$. Show your work.