

## Assignment 3

Due Monday, December 14. 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.

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### Question 1

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- (a) A channel does not cause ISI to a signal transmitted at 8000 symbols/second. However, it delays the signal by 1 ms. Draw the phase response over the frequency range 0 to 4 kHz.
- (b) This channel has very high attenuation for frequencies above 6 kHz. Can we transmit over this channel at a rate of 4000 symbols/second? At a rate of 5000 symbols/second? Explain.

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### Question 2

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Based on Figure 14-10 of the IEEE 802.3 specification (reproduced on page 4 of the lecture notes for Ethernet), approximately what is the slew rate of the differential voltage for a 10 Mb/s Ethernet transmitter?

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### Question 3

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A logic family guarantees a maximum low output voltage of 0.3 V and a minimum high output voltage of 2.7 V. Input voltages below 0.8 V are guaranteed to be recognized as low and input voltage above 1.6 V are guaranteed to be recognized as high. What is the noise margin for this logic family?

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### Question 4

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Look up the datasheet for the Pulse J0011D01BNL Ethernet jack with magnetics.

- (a) What is the maximum insertion loss at 65 MHz?
- (b) Is there a simple reason we cannot ignore the manufacturer's recommendation and use it for 1000Base-T Ethernet?
- (c) What is the maximum voltage (Hi Potential) rating?

- (d) What pin numbers is the green LED connected to?

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### Question 5

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ADSL systems use OFDM to transmit data to telephone company subscribers over twisted-pair cables.

- (a) The subcarrier spacing is 4.3125 kHz and the sampling rate is 2.208 MHz. How many samples are there per OFDM symbol?
- (b) A cyclic prefix is inserted between symbols. The duration is long enough to prevent ISI caused by a bridge tap with a length up to 1450 m, assuming a propagation velocity of 200 m/ $\mu$ s. How many samples are there in the cyclic prefix?

*Hint: A bridge tap will cause ISI with a duration of twice the propagation delay through the tap.*

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### Question 6

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- (a) Is the MLT-3 line code polarity insensitive?
- (b) What is the long-term average (DC) value?
- (c) How could you mark the end of an MLT-3-encoded signal using line coding violations?

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### Question 7

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- (a) What data bit sequence results in the most overhead added by HDLC framing?
- (b) What is the throughput of a system using HDLC framing assuming the data consists of 240 of these (max-overhead) bits per HDLC frame. Assume frames are transmitted with no gaps between them and only a single flag between frames. Assume no HDLC headers or CRCs are included. Give your result as a fraction of the channel bit rate.

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### Question 8

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SLIP is a simple way to mark the boundaries of IP frames transmitted over asynchronous serial (“RS-232”) links. It is much simpler than PPP and is appropriate for very simple devices that need to communicate using IP.

Look up the definition of SLIP (on Wikipedia and/or in RFC1055) and use it to frame the following data:

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0x00 0xdb 0xaa 0xc0 0x1b
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### Question 9

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You want to transmit the bits 10011 using the generator polynomial 1011 to compute the CRC.

- (a) Compute the CRC and the message plus CRC.
- (b) Add two zero bits at the start of the message and re-compute the CRC. Is the receiver able to detect zero bits if they are added or removed at the start of a message?
- (c) Now invert the first four bits of the message and compute the CRC. Prepend two zeros and re-compute the CRC. Is the receiver able to detect added or missing leading zeros now?
- (d) Append two zeros to the original message plus CRC. Does the CRC change?

*Practical (e.g. IEEE CRC-32) algorithms do both of these.*