ELEX 3525 : Data Communications
Term 201310

FINAL EXAMINATION
8:00 – 11:00 AM
May 22, 2013

This exam has seven (7) questions. The marks for each question are as indicated. There are a total of 30 marks. Answer all questions. Write your answers in the exam book provided. Show your work. You may answer the questions in any order. Books, notes and calculators are allowed. You may keep this exam paper.
Show your work.

Question 1 (4 marks)

The diagram below shows a transfer function that includes the effect of the transmitter, channel and receiver:
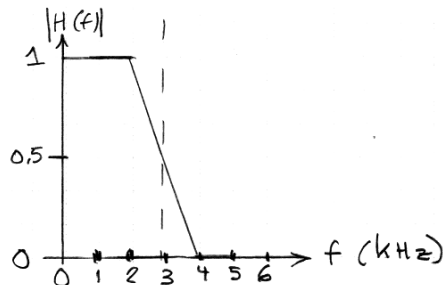
(a) What symbol rate will result in no inter-symbol interference (ISI)?

(b) What is the bit rate if 3 bits per symbol are transmitted?

(c) Additive White Gaussian Noise (AWGN) with a power of 0 dBm is being received. What is the minimum received signal power that would allow error-free transmission? Give your answer in dBm.

Hint: For part (c) you may use the 3 kHz as the channel bandwidth.

Question 2 (4 marks)

2) The ASCII code for the character 'E' is transmitted using the following parameters:

- 8 bits per character, no parity
- most-significant-bit (MSB) first
- Manchester line coding (using the conventions used in this course)
- a baud rate of 10 MHz

(a) Draw the waveform using signal voltage levels of 0 and 5 volts.

(b) What are the minimum and maximum times between signal level transitions?

(c) What is the bit rate?

Question 3 (5 marks)

A frame containing the seven bits 0111 001 is received. The last 3 bits (001) is a CRC generated using the generator polynomial $G(x) = x^3 + x^2 + 1$. Does this frame contain an error? Show your calculations.

Question 4 (5 marks)

A system uses a stop-and-wait ARQ protocol to detect frames that are missing or have errors. The bit rate in both directions is 10 Mb/s. Each data frame contains 1000 bytes of data and 20 bytes of overhead (a preamble and CRC). Each ACK frame contains a total of 30 bytes.

(a) What is the duration of the data frame in bits? In milliseconds? What is the duration of the ACK frame in bits? In milliseconds?

(b) Assuming there are no errors and the round-trip delay of the channel is 1 ms, what is the throughput in bits per second? Do not count the overhead or ACK bits as data.

(c) Name two common ARQ protocols that would provide a higher throughput over this channel.

Question 5 (2 marks)

A signal is defined by the following equation:

$$s(t) = A\cos(\omega_c t) + B\sin(\omega_c t)$$

where A and B can each take on the values $-3, -1, +1$ and $+3$.

(a) What type of modulation is defined by this equation?

(b) How many bits are transmitted per symbol?

Question 6 (5 marks)

An FEC block code encoder outputs one of four possible 5-bit codewords:

$$00110$$
$$01101$$
$$10010$$
$$11001$$

(a) How many data bits and how many parity bits are transmitted by each codeword?

(b) If this code was described as an (n, k) code, what are the values of n and k?

(c) If the bits 11000 are received, what codeword was most likely transmitted? How many bit errors would be corrected? Show your work.

Question 7 (5 marks)

Each numbered statement below may have zero, one, or more answers that are true. For each question below, mark down in your exam book the letters corresponding to all choices that are true.

1. Reed-Solomon Codes are efficient for channels with:
   (a) bursty errors
   (b) random errors

2. LDPC codes have the advantage(s) that they:
   (a) are simple to implement
   (b) can achieve close to Shannon capacity

3. A "null modem" connects:
   (a) DTE to DCE
   (b) DCE to DCE
   (c) DTE to DTE

4. An open-collector output can be connected to:
   (a) another open-collector output
   (b) a pull-up resistor
   (c) a conventional logic output

5. Differential signalling is commonly used because it:
   (a) has lower cable costs
   (b) causes less interference to other systems
   (c) has lower propagation delay