

# Data Communications CS420/520 Fall 1999

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## Midterm 1

Last Name: \_\_\_\_\_ Student ID: \_\_\_\_\_

This is an *closed* book, *closed* note exam. You may use a calculator but **no computers**. Show **ALL** your work to get full or partial credit for the problem. You have 50 minutes.

**Show all derivations. Answers without derivations are not acceptable.**

Problem	Total	-Points
1	14	
2	19	
3	10	
4	10	
5	12	
6	11	
7	12	
8	12	
<b>Total:</b>	100	



2. (19 pts) With respect to error correction and CRC error detection:

a) (3) What is the Hamming distance of the following code?

000000 111111 000111 111000

b) (3) How many errors can be corrected when using the code in part a)?

c) (3) Now we add the word 101010 to the code of part a). Does this change how many errors can be corrected? Justify your answer.

d) (5) Compute the FCS for the message 111000 assuming generator polynomial  $G(x) = x^4 + x^3 + 1$ .

e) (5) Draw the hardware implementation for  $G(x) = x^4 + x^3 + 1$ . Clearly identify the register cells and the mod 2 adders (e.g. XOR).

3. (10 pts) Encode the following bit stream

Bit stream:	0	1	0	0	1	1	1	0
NRZ-L								
Bipolar AMI								
Manchester								
Differential Manchester								

4. (10 pts) We want to use Huffman encoding of the characters A,B,C,D,E and F, which have respective relative occurrences of 0.25, 0.25, 0.125, 0.125, 0.125 and 0.125.
- a) (5pts) Derive the Huffman tree for this code.
- b) (5pts) Given the message AABBCDEF, what saving in terms of bits does using Huffman encoding result in, compared to a 7 bit ASCII representation of the characters?

5. (12 pts) This question deals with amplitude, frequency and phase shift keying:
- a) (5) Draw the frequency spectrum for ASK and label all frequency components assuming we use the fundamental and 3rd harmonic. Label the fundamental frequency  $f_0$ .
  
  - b) (3) What is the difference between ASK and PSK with respect to the frequency spectrum? (No math needed here).
  
  - c) (4) Sketch the modulated signal of the sequence 01001 using (i) ASK and (ii) FSK. (You can define the amplitude and frequencies).

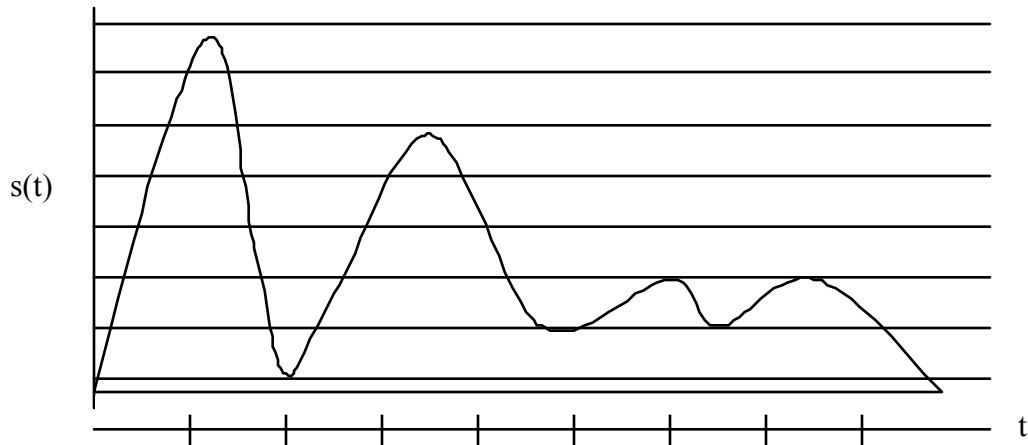
0            1            0            0            1            1

ASK \_\_\_\_\_

\_\_\_\_\_ FSK



8. (12 pts) With respect to analog to digital conversions
- a) (7) Assume we use pulse code modulation (PCM) and we use 3 bits (which lets us differentiate 8 levels). Give the PCM output of the signal below assuming that sampling points are as indicated to the t-axis. (This is a sequence of bits – of course).



- b) (5) Even though the above signal is just a rough sketch, what would you say about the choice of sample points? Is this enough or did I violate an important principle?