CSE 3213: Communication Networks
Midterm Exam
Instructor: Foroohar Foroozan

Monday, 1 March 2010

Time Allowed: 80 Min

Name: ____

Student Number: ____

INSTRUCTIONS

1. This is a **80 Min**, **Close Book** test. One letter size crib sheet (8 ½ x 11") and a non-programmable calculator may be used, but no other material will be allowed including blank paper.
2. Put your name, student number on your test paper in the space provided above. Don't turn this page until instructed to.
3. Use the test paper for all work (including scratch work) and you may use the back of pages; Do not tear out pages. Hand in the test paper at the close of the test.
4. Do all questions. You must show your work and explain clearly what you are doing. Answers without explanation or shown work where appropriate will receive low or zero points.
5. Keep your York photo ID (or other acceptable photo ID) on the desk in front of you so that the instructor may inspect it without disturbing you.
6. No questions will be allowed during the exam. Write your answers in pen.

	Maximum	Score
Problem 1	30	
Problem 2	10	
Problem 3	10	
Problem 4	15	
Problem 5	15	
Problem 6	15	
Problem 7	5	
Total	100	

1. Multiple Choice

time: 15 min

Circle the letter beside the choice that is the best answer for each question. For each question choose only ONE answer

(1.1) In the OSI model, as a data packet moves from the lower to the upper layers, headers are ________.

(a) added
(b) subtracted
(c) rearranged
(d) modified

(1.2) When a host on network A sends a message to a host on network B, which address does the router look at?

(a) port
(b) logical
(c) physical
(d)) none of the above

(1.3) The ___________ layer is responsible for delivering data units from one station to the next without errors.

(a) transport
(b) network
(c) data-link
(d) physical

(1.4) When data are transmitted from device A to device B, the header from A's layer 4 is read by B's ________ layer.

(a) transport
(b) physical
(c) application
(d) none of the above

(1.5) A periodic signal can always be decomposed into ______________________________ .

(a) exactly an odd number of sine waves
(b) a set of sine waves
(c) a set of sine waves, one of which must have a phase of 0º
(d) none of the above

(1.6) What is the bandwidth of a signal that ranges from 40 KH to 4 MHz?

(a) 36 MHz
(b) 360 KHz
(c) 3.96 MHz
(d) 396 KHz

(1.7) A signal is measured at two different points. The power is P_1 at the first point and P_2 at the second point. The attenuation between the two points is 0 dB. This mean ________________________.

(a) P_2 is zero.
(b) P_2 equals P_1
(c) P_2 is larger than P_1
(d) P_2 is smaller than P_1

(1.8) ________________________________ is a type of transmission impairment in which the signal loses strength due to the different propagation speeds of each frequency that makes up the signal
(a) attenuation
(b) distortion
(c) noise
(d) none of the above

(1.9) If the frequency spectrum of a signal has a bandwidth of 500 Hz with the highest frequency at 600 Hz, what should be the sampling rate, according to the Nyquist theorem?

(a) 500 samples/sec
(b) 600 samples/sec
(c) 1000 samples/sec
(d) none of the above

(1.10) In _______________ , the change or lack of change in the level of the voltage determines the value of the bit.

(a) NRZ-L
(b) NRZ-I
(c) both (a) and (b)
(d) neither (a) nor (b)

(1.11) The signal rate is sometimes called the _____ rate.

(a) baud
(b) bit
(c) signal
(d)) none of the above

(1.12) When propagation speed is multiplied by propagation time, we get the
(a) throughput
(b) wavelength of the signal
(c) distance a signal or bit has traveled
(d) distortion factor

(1.13) Given two sine waves A and B, if the frequency of A is twice that of B, then the period of B is ________________ that of A.

(a) one-half
(b) twice
(c) the same as
(d) cannot be determined

(1.14) The minimum bandwidth of Manchester and differential Manchester is _____ that of NRZ.

(a) one-half
(b) twice
(c) the same as
(d) cannot be determined

(1.15) Which of the following is an example of digital-to-analog conversion?

(a) AM
(b) PSK
(c) PCM
(d) all of the above

2. Layering *time: 10 min*

Problem 2 [10 points]

Given the following packet

foo header	fing header	yaya header	user data field	foo trailer
5 bytes	10 bytes	20 bytes	Maximum of 150 bytes	4 bytes

(a) [4 points] Sketch the layered protocol model that applies to this packet by labelling each layer in the figure below with the appropriate layer name. Your choices are foo, fing, yaya, and user data.

_______**user data** Layer
______**yaya**_____ Layer
_______**fing**____ Layer
______**foo**__ Layer

(b) [3 points] If the maximum length for the user data field is 150 bytes, what is the overhead (as a percentage) to send a 1600 byte user message?

Ceil (1600/150) = 11 packets
Each packet has 39 bytes overhead. Overall overhead: 11 * 39 = 429 bytes

Overhead = 429 / (1600 + 429) = 21.14 %

(c) [3 points] What is the likely function of the **foo trailer** field?

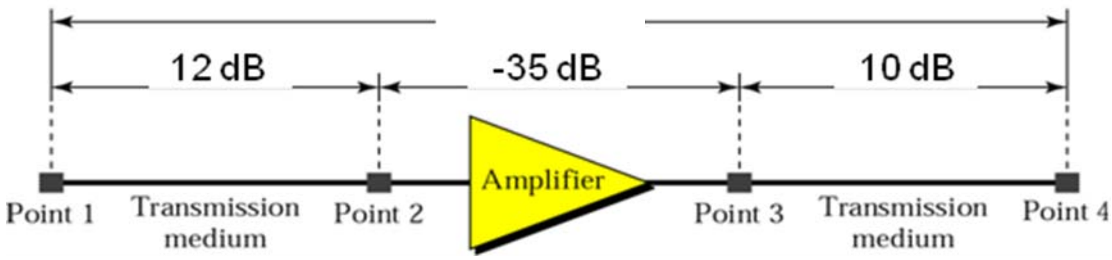
Check bits (Error Detection / Correction)

3. Attenuation *time: 10 min*

Problem 3 [10 points]

Consider a series of transmission elements as shown in the figure below. The input signal has the power of P_1 = 4 mW. The 1st element is a transmission line with a 12 dB loss, the 2nd element is an amplifier with a 35 dB gain, and the 3rd element is a transmission line with a 10 dB loss.

Calculate the output power P_4 in (mW) .



P_4 = ???

P_1 = 4 mW

$$10 \cdot \log \frac{P_{in}}{P_{out}} = -13 \text{ [dB]}$$

$$P_{out} = \frac{P_{in}}{10^{-1.3}} = P_{in} \cdot 10^{1.3} = 4 \cdot 19.95 = 79.8 \text{ [mW]}$$

4. Sampling and PCM *time: 10 min*

Problem 4 [15 points]

The waveform

$$x(t) = 10\cos(1000t + \pi/3) + 20\sin(2000t + \pi/4)$$

is uniformly sampled for digital transmission.

(a) [5 points] Determine the maximum allowable time interval between two consecutive sample values that will ensure perfect reconstruction of the analogue signal.

Max Freq : 2000 (radian/s) = 2 * pi* f => f = 1000/pi = 318.3099 Hz

Sampling frequency   f_s> = 2 * f = 636.6198 Hz

Sampling Interval: Ts = 1/f_s = 1.6 msec

(b) [5 points] If 8 bits are used to quantize each sample values obtained in (a), determine the data rate in bits per second of the PCM stream produced by the above signal.

R = 8 (bits/ sample) * 636.6198 (sample/sec) = 5.0930 kbps

(c) [5 points] The PCM data stream of (b) is transmitted through a noisy channel with a SNR of 20 dB. Determine the minimum bandwidth of the channel to ensure an arbitrarily small probability of transmission errors.

SNRdB = 10 log10(SNR) = 20 => SNR = 100

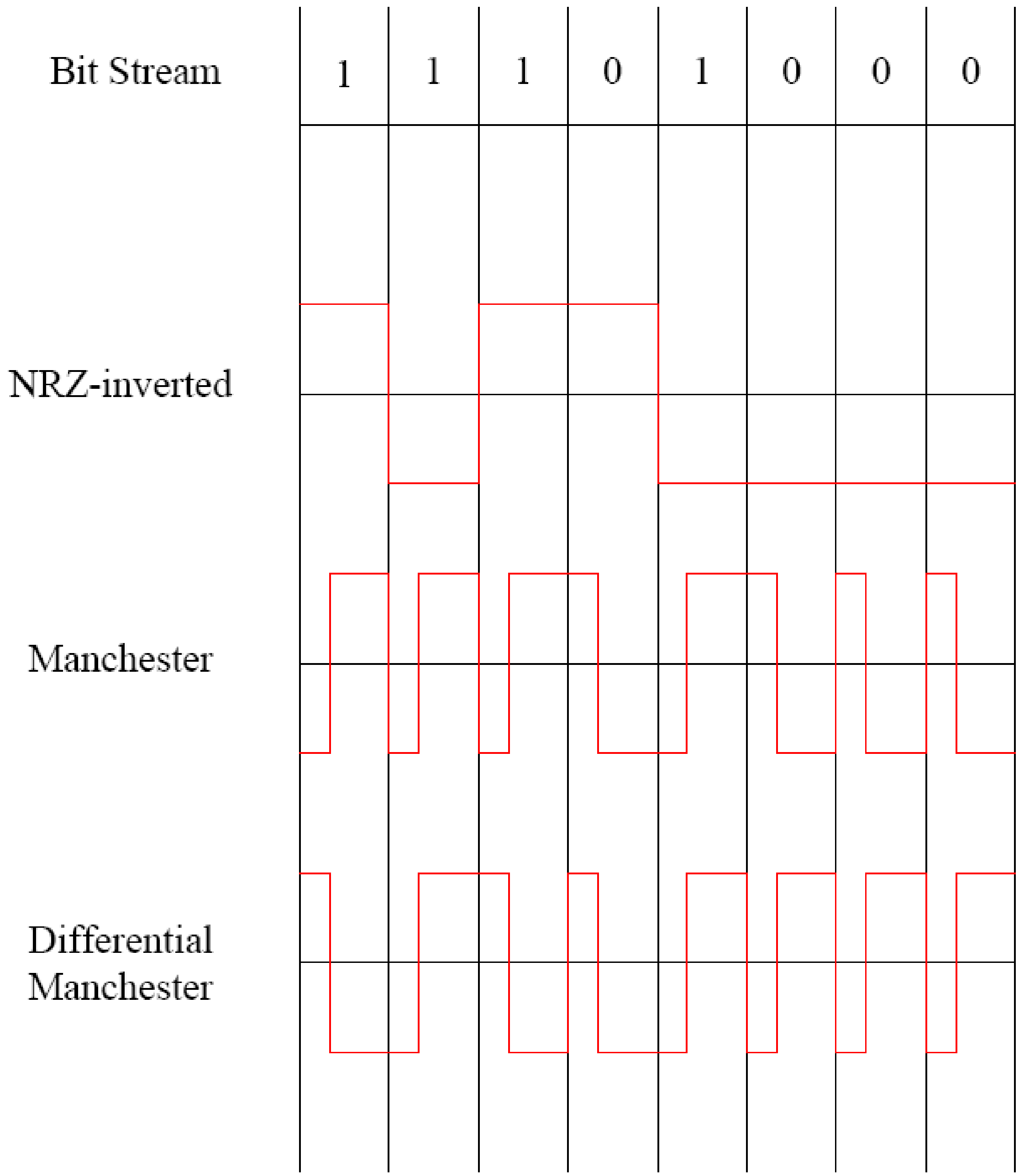
C = B log2 (1 + SNR) => B_min = R/(log2 (1 + SNR))

B_min = 764.9215 Hz

5. Line Coding *time: 10 min*

Problem 5 [15 points]

(a) [6 points] Encode the following bit stream.



(b) [3 points] What is the main advantage of Manchester over NRZ-inverted coding?

Manchester encoding provides perfect synchronization for any sequence of 0-s and 1-s.

(c) [3 points] What is the main advantage of NRZ-inverted over Manchester coding?

NRZ-inverted has lower pulse-rate, i.e. requires ½ of the bandwidth required by Manchester encoding.

(d) [3 points] Assume the following sequence: 10101010101010101. The sequence should be encoded using either Manchester or Differential Manchester scheme. Which of the two encoding techniques is more suitable for the given sequence? Justify your answer!

The given sequence encoded with Manchester scheme results in a signal that has ½ of the pulse rate compared to the signal that is obtained by encoding the same sequence using Differential Manchester scheme. Hence, Manchester scheme is more appropriate in this case.

6. Modulation *time: 15 min*

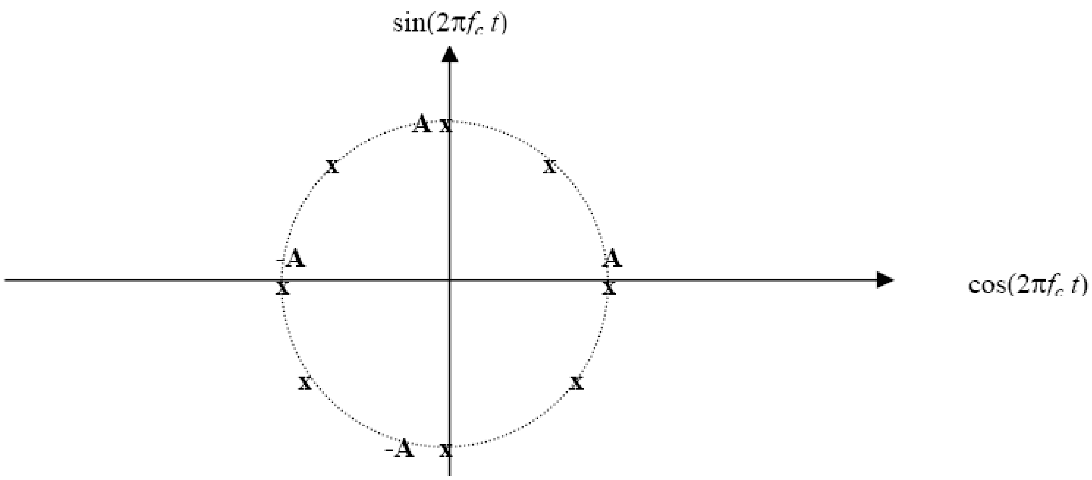
Problem 6 [15 points]

(a) [5 points] In the space provided, plot the signal constellation for an 8-ary Phase Shift Keying (PSK) where the data bits are grouped together in 3-bit sequences. Recall an 8-ary PSK is defined as:

PSK: $s_k(t) = A\sin(2\pi f_o t + \phi_k)$ for $k = 1,2,\ldots,4$ $(k-1)T \le t \le kT$

where the amplitude A is constant and the phase ϕ_k is selected based on the following table

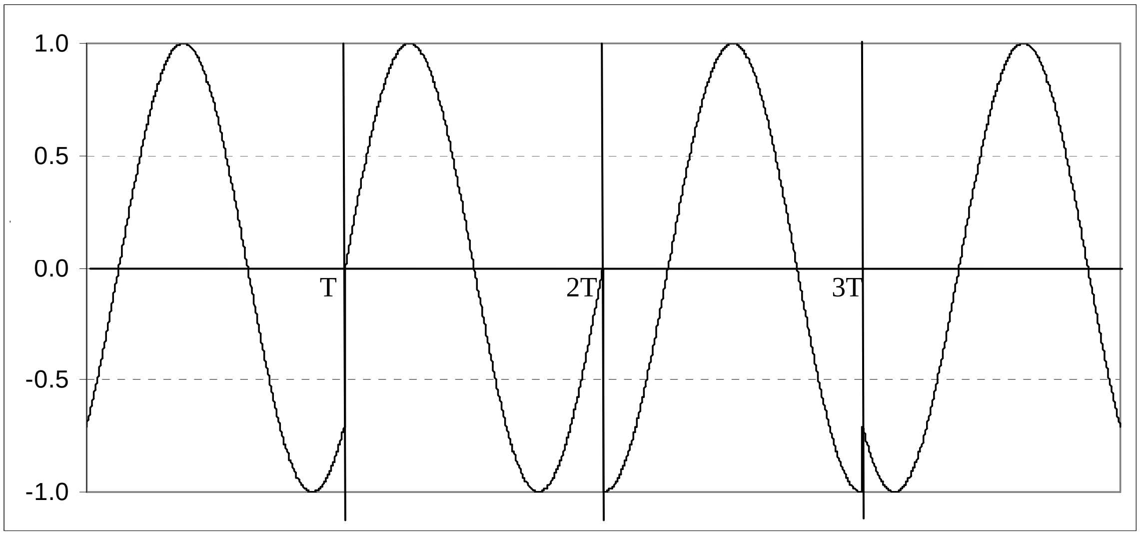
3-bit sequence	000	001	010	011	100	101	110	111
Phase ϕ_k	0	$\pi/4$	$\pi/2$	$3\pi/4$	π	$5\pi/4$	$3\pi/2$	$7\pi/4$



(b) [2 points] Complete the following table by calculating the entries for the phase ϕ_k, and the modulated signal $s_k(t)$ if the information data to be transmitted is 111000110101 where the order of transmission starts from the left.

Index (k)	3-bit info sequence	Phase ϕ_k	8-PSK Signal $s_k(t)$	Duration
1	111	$7\pi/4$	$A\sin(2\pi f_o t + 7\pi/4)$	$0 \le t \le T$
2	000	0	$A\sin(2\pi f_o t)$	$T \le t \le 2T$
3	110	$3\pi/2$	$A\sin(2\pi f_o t + 3\pi/2)$	$2T \le t \le 3T$
4	101	$5\pi/4$	$A\sin(2\pi f_o t + 5\pi/4)$	$3T \le t \le 4T$

(c) [8 points] Plot the 8-PSK waveform $s_k(t)$ obtained in (b) for the duration $0 \le t \le 4T$. Carefully select the carrier frequency f_o such that you have at least one or complete multiple periods of the carrier within duration *T*. To receive full credit, label the amplitude axis.



7. Error Detection *time: 10 min*

Problem 7 [5 points]

An early code used in radio transmission involved using codewords that consist of binary bits and contain the same number of 1s. Thus, the 2-out-of-5 code only transmits blocks of 5 bits in which 2 bits are 1 and the others 0.

a. [2 points] List the valid codewords.

11000
10100
10010
10001
01100
01010
01001
00110
00101
00011

b. [1 points] What pattern does the receiver check to detect errors?

Each received codeword should have exactly two bits that are ones and three bits that are zeros to be a valid codeword.

c. [2 points] What is the minimum number of bit errors that cause a detection failure?

A valid codeword can be changed into another valid codeword by changing a 1 to a 0 and a 0 to a 1. Therefore, two bit errors can cause a detection failure.