KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

COE 540 – Computer Networks
Assignment 1 – Due Date Nov 23rd, 2010

Problem #	Points	
1	20	
2	20	
3	30	
4	30	
5	30	
6	30	
7	30	
Total	190	

Problem 1 (20 points): Error Detection and Control

Consider the scheme of horizontal and vertical parity check (textbook section 2.3.2).

a) Find an example of a pattern of six errors that cannot be detected by the scheme. Hint: each row with errors and each column with errors will contain exactly two errors.

b) Find the number of DIFFERENT patterns of four errors that will not be detected by the scheme. Assume K data bits per row and J data bits per column.

Problem 2 (20 points): Cyclic Redundancy Check

a) Assume the following data string: 1011 (MSB to the left), and divisor pattern is given by 10111. Compute the corresponding CRC for the data string using the divisor pattern using modulo 2 arithmetic (i.e. polynomial operations). Specify the binary polynomial corresponding to the transmitted frame.

b) Show that if $g(D)$ contains the factor $(1 + D)$, then all error sequences with an odd number of errors are detected.

Hint: Recall that a nonzero error polynomial $e(D)$ is detected unless $e(D) = g(D)z(D)$ for some polynomial $z(D)$. Look at what happens if 1 is substituted for D in this equation.

Problem 3 (30 points): On the channels and modems

A low-pass signal $s(t)$ of bandwidth $B/2$ Hz has a frequency representation (i.e. the corresponding Fourier Transform $S(f)$) as shown in figure. The signal is used to amplitude modulate a carrier of frequency $f_c > B/2$.

a) If $S(f)$ is the Fourier Transform for $s(t)$, then *show* (i.e. prove) that the Fourier Transform for $s_m(t) = s(t) \times \cos(2\pi f_c t)$ is $S_m(f) = [S(f - f_c) + S(f + f_c)]/2$.

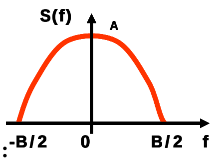
b) Compute the Fourier Transform for $s_o(t) = s(t) \times \cos^2(2\pi f_c t)$ in terms of $S(f)$.

c) Sketch the spectrum of the signal $s_m(t) = s(t) \times \cos(2\pi f_c t)$.

d) To retrieve the original $s(t)$, the signal $s_m(t)$ is multiplied by the carrier signal $\cos(2\pi f_c t)$ again to produce the signal $s_o(t)$. Sketch the spectrum of $s_o(t)$.

c) Provide a simple diagram for both the amplitude modulation (AM) transmitter and the receiver.

Spectrum for s(t):



Problem 4 (30 points): On the Subject of Framing

Suppose that the string 0101 is used as the bit string to indicate the end of a frame and the bit stuffing rule is to insert a 0 after each appearance of 010 in the original data. Thus 010101 would be modified by stuffing to 01001001. In addition, if the frame proper ends in 01, a 0 would be stuffed after the first 0 in the actual termination string 0101.

a) Show how the string 11011010010101011101 would be modified by this rule.

b) Describe the destuffing rule required at the receiver.

c) How would the string 11010001001001100101. be destuffed?

Problem 5 (30 points): On the subject of Automatic Repeat Request

(1) Prove the liveliness property of the generalized stop-and-wait algorithm described in textbook.

(2) Explain ARQ scheme utilized by ARPANET. How does it extend the conventional stop-and-wait algorithm to achieve higher efficiency?

(3) Selective Repeat request potentially is more efficient than Go-back N as it does not have to retransmit correctly received frames. However, Selective Repeat request must use a window size that is smaller than that for Go-back N protocol. Assume the protocol specifies 7 bits for sequence numbers:

a) Specify the maximum window size for Go-back N and Selective repeat request.

b) Explain why Selective Repeat request must use a window size that is smaller (the value specified in part (a)) than that for Go-back N protocol.

Problem 6 (30 points): On the subject of Maximum Frame Size

Consider a data link control using fixed-length packets of K bits each. Each message is broken into packets using fill in the last packet of the message as required. For example, a message of 150 bits is broken into two packets of 100 bit each; using 50 bits of fill.

a) In a manner similar to the development of equations 2.42 and 2.43 in the textbook, write an expression for the number of bit transmission times required for message delivery, TC.

b) Compute the expectation for the number of bit transmission times required for message delivery, $E\{TC\}$.

Hint: $E\{\lceil M/K \rceil\} = E\{M/K\} + 1/2$.

c) Find the value of K that minimizes $E\{TC\}$.

d) From the material in textbook section 2.5.5, discuss the pros and cons of using a fixed frame length.

Problem 7 (30 points): On the subject of Framing and Entropy

Assume frame length K, in bytes, is given by the distribution specified in the table shown below.

i	Frame Length (Bytes)	Pi
1	256	0.2
2	512	0.4
3	1024	0.3
4	2048	0.1

a) Compute the PGF $G_K(z)$ for the frame length variable.

b) Use the PGF to compute the mean and variance of the frame length variable.

c) Plot the cumulative distribution function for the frame length variable.

d) Compute the *minimum* number of bits required to encode the frame length information.

e) Use Hoffman coding scheme to encode the frame length information. What is the average number of bits needed? How does this average relate to the minimum number of bits computed in part (d).