KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

COE 540 – Computer Networks / ICS 570 Advanced Computer Networking

Assignment 1 – Due Date March 21st, 2011 - Solution Key

Problem 1 (10 points): On the subject of signals and channels

Suppose that a channel has the ideal low-pass frequency response $H(f) = 1$ for $-f_0 \leq f \leq f_0$ and $H(f) = 0$ elsewhere.

a) Compute the impulse response for the channel.

b) If the channel is excited by a train of impulses spaced by f_0. In other words, compute the channel response, $r(t)$, for an input equal to $s(t) = \delta(t - \frac{n}{f_0})$, where $\delta(t)$ is the unit impulse signal.

Problem 2 (10 points): On channel capacity (Nyquist and Shannon Theorems)

Consider a GSM mobile channel whose bandwidth is equal to 200 kHz. The current implementation of GSM uses a modem technology that achieves a channel bit rate equal to 273. kb/s.

a) Ignoring noise and interference, what is the theoretical capacity limit on the GSM channel?

b) Accounting for noise and interference and considering a working GSM system whose SNR is equal to 14 dBs, what is the theoretical capacity limit on the GSM channel?

c) Given the limit specified in (b), what is the efficiency of the current implementation?

d) One important figure of merits for transmission on channels is the "spectral efficiency". This is simply the number of bits per second achieved per hertz. Compute this figure for current implementation and for the theoretical limit computed in (b).

Problem 3 (15 points):

Consider a CRC error detection scheme with $g(D) = D^4 + D + 1$.

a) Encode the bits 10010011011.

b) Suppose the channel introduces the error pattern 100010000000000 (i.e. a flip from 1 to 0 or from 0 to 1 in the positions 1 and 5). What is the received frame? Can the error be detected?

c) Repeat part (b) with error pattern 100110000000000.

Show the computation for all parts.

Problem 4 (10 points):

Consider simple parity checking depicted in figure.

s1	s2	...	s*n*-1	s*n*	c

The n data bits $s_1s_2...s_n$ are used to generate the parity bit c such that the number of ones in the string $s_1s_2...s_nc$ is even. It is desired to evaluate the strength of this simple parity code. Assume that any bit of the string $s_1s_2...s_nc$ can be in error with probability $0 < p < 1$ and that errors in bits are independent.

a) Compute (or count) the fraction of erroneous code words that will *not* be detected for $n = 1, 2,\ 3, 7,$ and 15.

a) Plot the probability that an erroneous code word will not be detected by this simple parity scheme. Give your plot as a function of the bit error probability p for n = 3, 7, 15, 31 and 63. Consider the range of p from 10^{-2} to 1.

c) State your conclusions regarding the strength of this parity code and its relation to n and channel error probability, p.

Hint: Part (a) is a counting problem. In part (b) it is required to compute a probability number. Remember that the probability of k bits in error in a string of m bits is given by the binomial distribution $\binom{m}{k} p^k(1-p)^{m-k}$.