King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Department of Computer Engineering

COE 540 – Computer Networks (T082)

<u>Homework # 01 (*due date: Sunday 10/05/2009 during class period*)</u>

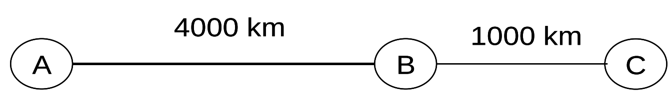
Problem # 1 (10 points): Suppose a channel has the ideal low-pass frequency response $H(f) = 1$ for $-f_0 \le f \le f_0$ and $H(f) = 0$ elsewhere. Find the time domain impulse response of the channel, $h(t)$. Identify the zero crossing points.

Problem # 2 (20 points): Consider a parity check code with three data bits and four parity checks following the structure shown below. Suppose that three of the code words are 1001011, 0101101, and 0011110. Find the rule for generating each of the four parity checks and find the set of all 8 code words. What is the minimum distance of this code?

s1	s2	s3	c1	c2	c3	c4

Problem # 3 (30 points): In the shown figure, frames are generated at node A and send to node C through node B. The following specifies the two communication links:

- The data rate between node B and node C is 150 kb/s
- The propagation delay is 5 μsec/km for both links
- Both links are full-duplex
- All data frames are 1000 bits long; ACK frames are separate frames of negligible length
- Between A and B sliding window protocol with a window size of 3 is used
- Between B and C, stop-and-wait is used.
- There are no errors (lost or damaged frames)



1. **(5 points)** Calculate both the utilization and the throughput for link BC.
2. **(20 points)** Calculate the minimum rate required between nodes A and B so that the buffers of node B are not flooded.
3. **(5 points)** What is the efficiency of the communication on link BC?

Problem # 4 (30 points; 10 points each):

a. Let T_t be the expected transmission time for sending a data frame. Let T_f be the feedback transmission time for sending an ACK or NAK frame. Let T_d be the expected propagation and processing delay in one direction (the same in each direction). Find the expected time T between successive frame transmissions in a stop-and-wait system (assume that there are no other delays and that no frames get lost).

b. Let p_t be the probability of frame error in a data frame (independent of frame length), and p_f the probability of error in a feedback ACK or NAK frame. Find the probability q that a data packet is correctly received and ACKed on a given transmission. Show that $1/q$ is the expected number of times a packet must be transmitted for a stop-and-wait system (assume independent errors on all frames).

c. Combining parts (a) and (b), find the expected time required per packet. Evaluate for $T_t = 1$, $T_f = T_d = 0.1$, and $p_t = p_f = 10^{-3}$.