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

COE 540 –Computer Networks
December 18th, 2010 – Midterm Exam

Student Name:
Student Number:
Exam Time: 120 mins

- Do not open the exam book until instructed
- The use of programmable calculators and cell phone calculators is not allowed – only basic calculators are permitted
- Answer all questions
- All steps must be shown
- Any assumptions made must be clearly stated

Question No.	Max Points	
1	20	
2	30	
3	40	
4	40	

Total: 130

Q1.) (20 points) On the subject of OSI and TCP/IP network models

a) (14 points) Draw the OSI protocol stack indicating the position of each layer and briefly describe the functionality of each of the layers (one sentence).

b) (6 points) The OSI model specifies four service primitives that allow peer layers (on two communicating nodes) to exchange information. Specify these four service primitives.

Q.2) (30 point) On the subject of channels and modems

a) (**6 points**) What the three properties of Linear Time Invariant systems.

b) (**4 points**) If a system has an impulse response function $h(t)$, write an expression specifying the system output $r(t)$ as a function of $h(t)$ and the input signal $s(t)$. Write the equivalent relationship in the frequency domain.

c) (**6 points**) Let the input signal $s(t)$ be equal to an impulse $A\delta(t)$, where A is some constant. Plot the input signal in both the time-domain and frequency domain. What is the system output in response to this input?

d) (**4 points**) Bandpass channels are known to produce "ringing". Explain this phenomenon very briefly. For such channels is it better to use NRZ encoded data or Manchester encoded data and why?

e) (**10 points**) It is said that the sinc pulse and the raised cosine pulses satisfy Nyquist criteria. What does that imply mathematically and in terms of signaling? Which is the two pulses is used in practical modems and why?

Q.3) **(40 points)** On the subject of error control and framing

a) **(25 point)** Assume a sliding window protocol is used on a link that connects node A to Nod B where the link distance is 8000 km. Let the sliding window size, W, be 3 and the frame length, L, equal to 256 Bytes. Ignoring the ACK and processing times it is required to:

(1) (17 points) Plot the throughput of the link AB (in kb/s) as a function of the bit rate R offered by the service provider.

(2) (8 points) What is the limit of the link AB utilization as the link bit rate R goes to infinity? Why?

b) (**15 points**) Consider the CRC procedure explained in class and illustrated in the textbook. Let $s(D)$ be the polynomial of degree K-1 representing the data string while $g(D)$ be the generator polynomial of degree L. The transmitted frame, denoted by $x(D)$, is constructed as $s(D)D^L + c(D)$, where $c(D)$ is a polynomial of degree L-1 at most.

(1) (6 points) How is the polynomial $c(D)$ calculated?

(2) (9 points) Show that if $g(D)$ has at least two non-zero terms (i.e. D^L and 1), then all single bit errors are be detected.

Q.4) (**40 points**) On the subject discrete time Markov Chains:

Data in the form of fixed-length packets arrive in slots on the **two** input lines of a multiplexer. A slot contains a packet with probability *p*, independent of the arrivals during other slots or on the other line. The multiplexer transmits one packet per time slot and has the capacity to store **one** packet only. If no room for a packet is found, the packet is dropped.

a) **(6 points)** Let *N* be the number of packets arriving to the multiplexer in a given time slot. Specify the probability distribution for *N* and its name. Compute the mean for *N*.

b) **(6 points)** Draw the state transition diagram and specify the transition matrix **P** – The state is taken to be the number of packets in the multiplexer.

c) **(8 points)** Compute the steady state pmf for the system in terms of the arrival probability p.

d) **(5 points)** Compute the mean number of packets in the MUX at any time slot.

e) **(5 points)** Compute the mean MUX throughput in packets per time slot.

f) **(5 points)** Compute the probability that a drop event from the MUX buffer.

g) **(5 points)** Compute the mean number of dropped packets at any time slot.

Hint: for parts (d) and onwards, you can assume that the steady state distribution $\Pi = [\pi_0 \quad \pi_1]$ is known.