Department of Electrical & Computer Engineering
Prairie View A&M University

Doctoral Preliminary Examination

Computer Networks
Fall 2017

Name of the student: _____

Signature of the student: _____

1	20	
2	20	
3	15	
4	25	
5	20	
Total	100	

Instructions:

This is a CLOSED BOOK Examination. You can use approved calculator. You can access the Formulae sheet provided by the Graduate Coordinator who is administering the examination.

Question 1: [20 points]

(a) The probability of bit error (P_b) versus bit energy over noise spectral density (E_b/N_0) is commonly used as the reference measure when characterizing the digital communication network performance at the physical (PHY) layer. Explain why the E_b/N_0 metric is more desirable than the measured signal-to-noise ratio (SNR) measure? **[3 points]**

(b) Suppose that the bit error probability characterizations for binary phase-shift-keying (BPSK) and quadrature phase-shift-keying (QPSK) in a given communication channel reveals that the required E_b/N_0 to achieve P_b of 10^{-4} and 10^{-7} are 8.2 dB and 11.2 dB, respectively. What is the bandwidth efficiency for BPSK and QPSK for a bit error probability of 10^{-7} on that communication channel with a SNR of 12 dB? Compare the bandwidth efficiency of QPSK at $P_b = 10^{-4}$ and $P_b = 10^{-7}$ on that communication channel with a SNR of 12 dB. **[7 points]**

(c) A telephone line with a bandwidth of 300 Hz is known to have a loss of 25 dB. The input signal power is measured as 0.2 W, and the output signal noise level is measured as 2.5 μW. Using this information, calculate the channel capacity for the telephone channel. What does this quantity reveal? **[10 points]**

Question 2: [20 points]

(a) Briefly list and describe four design considerations in the selection of line codes (data encoding in pulse code modulation). **[12 points]**

(b) Given the incoming data stream 1 0 0 1 1 0, sketch the binary line codes for the following two encoding schemes:

(i) Bipolar Alternate Mark Inversion **[4 points]**

(ii) Split-Phase (Manchester code) **[4 points]**

Question 3: [15 points]

(8 pts) (3.1)

(i) Please briefly explain 5-layer Internet TCP/IP reference model. Sketch those layers and also sketch the associated packet (showing headers, payload, and Encapsulation concept.

(ii) Assuming TCP/IP reference model is adopted, what layers of a protocol stack are used on a router? How about a host?

(7 pts) (3.2)

(i) Do applications need to exchange UDP control messages before exchanging data?

(ii) How about TCP? What packets are exchanged between two hosts when establishing a TCP connection (Show the packet flows for TCP connection establishment)?

Question 4: [25 points]

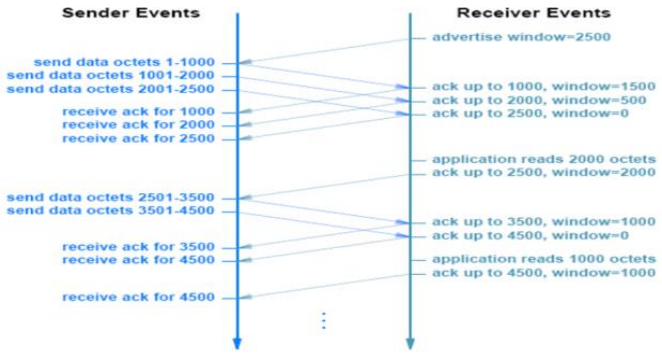
(6 pts) (4.1) What are the techniques a transport protocol uses to handle the problems? Fill the table and briefly explain.

Techniques	**Problem**
parity bits, a checksum, or a cyclic redundancy check (CRC)	Detect error (track transmission error)
	duplicates and out-of-order delivery
	lost packets
	prevent data overrun
	avoid congestion

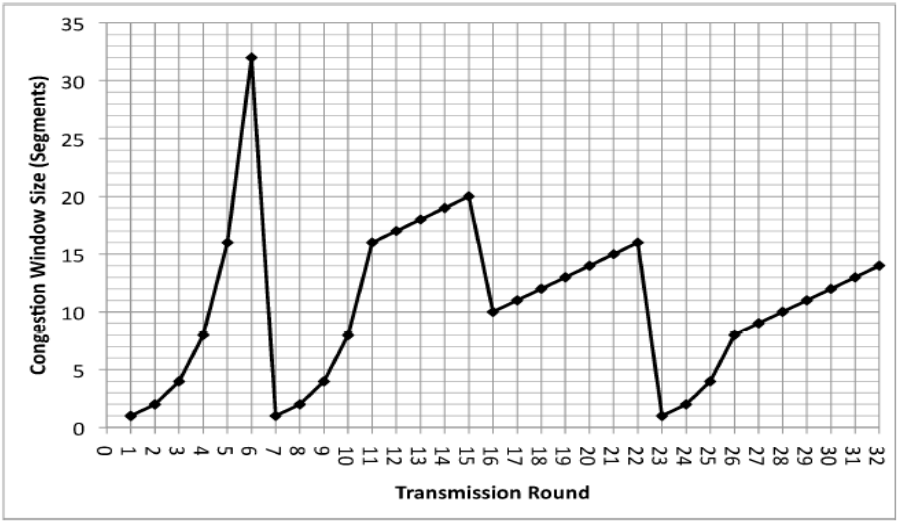
(6 pts) (4.2)

(i) What is the difference between congestion control and flow control?

(ii) Please briefly explain how to make the final decision of the window size for TCP based on Flow Control and Congestion Control (an example of flow control window is attached for reference).



(13 pts) (4.3) The Transmission Control Protocol (TCP) uses a method called congestion control to regulate the traffic entering the network. The behavior of TCP congestion control can be represented as a graph in which the x-axis indicates the time, and the y-axis indicates congestion window size. Please use the graph shown below to the answer the following questions. Note that the graph does not explicitly show timeouts, but you should be able to figure out when timeouts happened based on the events shown (assume TCP Reno is used).



(5pts) (i). Slow Start: give some reason why slow start is used, and explain why it does a better job than congestion avoidance for that function. Identify the intervals of time when TCP slow start is operating.
(4pts) (ii). Congestion Avoidance: identify the intervals of time when TCP congestion avoidance is operating. Why should congestion avoidance be used instead of slow start during these intervals?
(4pts) (iii). Could you summarize the mechanism used in TCP Congestion control and briefly explain it.

Question 5: [20 points]

(2 pts) (5.1) What are the main functions of Network Layer.

(5 pts) (5.2)Why do we need hierarchical routing in Internet? What is an autonomous system (AS)?

(4 pts) (5.3)The process of using a forwarding table to select a next hop for a given datagram is called "forwarding". To handle ambiguity that arises from overlapping address mask, Internet forwarding uses a "longest prefix match". Please briefly explain "longest prefix match" and fill the table accordingly following that algorithm.

Suppose the couple rows from a forwarding table are

Prefix	Next hop
192.24.0.0/18	D
192.24.12.0/22	B

If the datagram has the following destination IP address, please fill in the next hop information (the first row is given as an example)

Destination IP address	Next hop
192.24.6.0	D
192.24.14.32	
192.24.54.0	

(9pts) (5.4) Assume an ISP has a CIDR address block 135.211.160.0/21 ,

(i) What is the network address?

(ii) How many hosts can the network accommodate? What will be the address range?

(iii) Suppose the ISP has one customer, who needs 500 IP addresses. Could you help the ISP assign the addresses to the customer, explain how.