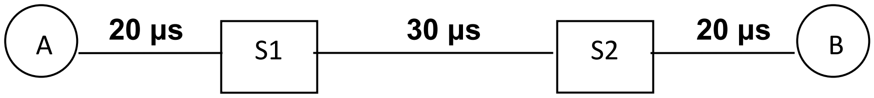
Name ________________________________ **Class: CPE348-01**

1) (10 pts) A message M = 101011 is transmitted from node A to node B using the CRC code. The CRC generator polynomial is $G(x) = x^3 + x^2 + 1$

a) (5 pts) What is the transmitted code word – perform the polynomial long division to find this result

b) (5 pts) Node A transmits a code word to node B. The link used for transmission introduces bit errors into the original code word, and node B receives the code word: **111000110.** If the CRC generator polynomial being used is the one described above, does node B detect the bit errors introduced by the link? Explain your answer.

2) (10 pts) Consider the **10 Mbps (10×10^6 bps) Ethernet shown**



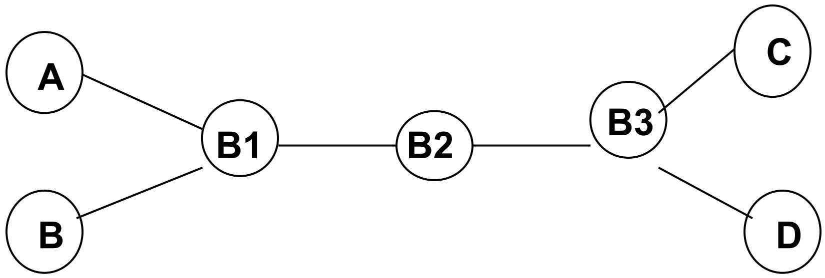
The propagation delay between any two hosts (A, B or a switch) is shown above. The data to transmit from node A to node B consists of **2000 bits**. Each switch is a store and forward switch that starts retransmission of a packet $10\,\mu s$ after receiving the last bit of a packet.

a) **(5 pts)** The data is split by host A into 5 packets so that each packet to be transmitted consists of **400 bits** of data. Node A will transmit the packets one right after the other. Switches can buffer packets if necessary. What is the time necessary to transmit all of the data from A to B (time from transmission of first bit transmitted by A until the last bit is received at B)?

b) **(2 pts)** What is the effective data throughput rate in bits per second (bps) for the method analyzed in part a?

c) **(3 pts)** Suppose switch S1 and S2 have finite buffer and they employ the random early drop (RED) mechanism for congestion avoidance. S1 has a larger buffer size so it applies **p1=0.05** to drop any received packet whereas S2 has a smaller buffer size so **p2=0.1** is used to drop any received packet. What are the chances that B can receive all 5 packets intact?

3) (12 pts) Consider the following network where A, B, C and D are nodes and B1, B2 and B3 are learning bridges.



Assume that the forwarding tables for the three bridges are all empty before the four transmissions below are made. After each transmission is made in the order indicated, determine whether a node can overhear that transmission. For example, when A transmits to B, A will not hear the transmission because it is the transmitter, while B will overhear the transmission because it is the destination. Therefore, we will type in **N** for A and **Y** for B after transmission (1). **Note that you still need to figure out whether C and D can overhear the transmission (1).**

Transmission:
(1) A transmits to B (2) C transmits to B (3) D transmits to C (4) B transmits to D

Fill in the table below. If a node can overhear the transmission, please type in **Y**. Otherwise, type in **N**.

Node	Transmissions			
	(1)	(2)	(3)	(4)
A	**N**			
B	**Y**			
C				
D				

4) (12 pts) Answer the following short answer questions.

a) (2pts) Please explain what problem(s) of NRZI encoding scheme can be addressed by the Manchester encoding.

b) (2pts) At least how many errored bits can 2D parity code guarantee to detect?

c) (2pts) Why CSMA/CD cannot be used in the wireless environment?

d) (2pts) Explain one potential problem of relying on the home agent to find a travelling user in the mobile IP.

e) (2pts) List a couple of mechanisms for TCP congestion avoidance.

e) (2pts) List a mechanism to schedule the fair transmission among multiple queues in a router.

5) (12 pts) Host A sends a file consisting of 9 segments to Host B using TCP. Assume that the 4th segment in the transmission is lost. Assume the retransmission timeout is T, the one-way propagation time is d, and that T = 4*d. Ignore the transmission time of the segments and acknowledgements. Also, ignore any processing or queueing time. Suppose that the TCP three-way handshake has completed. No flow control or congestion control need to be considered. Sequence number has infinitely large space that starts from 1. A's sending window starts from 1.

Note that Host B keeps a pointer **SeqNumToAck.** An ACK is sent to represent that all segments with smaller sequence number are well received. If error happens, Host B holds ACK till the segment of **SeqNumToAck** is received**.** For example, firstly, segments 1, 2 and 3 are sent, and segment 1 is received (ACK1 is returned), segment 2 is lost and segment 3 is received. Then, Host B returns ACK1 again upon receiving segment 3.

a) (4 pts) Assume AIMD is used (sending window is incremented by 1 when ACK is received while reduced to 1 when timeout fires). Draw the time diagram showing each segment and acknowledgement until the entire file is transferred.

b) (4 pts) Assume fast retransmit and fast recovery is used (sending window is incremented following the slow start mechanism when ACK is received while reduced by half when receiving 3 same ACKs). Draw the time diagram showing each segment and acknowledgement until the entire file is transferred.

c) (4 pts) Calculate how much extra time efficiency (in percentage) is gained in the approach (b) compared with approach (a).

6) (8 pts) A router has the following (CIDR) entries in its routing table

Address/mask	Next Hop
135.46.64.0/20	Interface 0
135.46.176.0/20	Interface 1
135.46.208.0/20	Router 1
135.46.240.0/20	Router 2
Default	Router 3

What is the next hop that the router selects when it receives IP packets with the addresses shown below. **Show all of your work or explain how you determined the next hop.**

a) 135.46.136.10 a) Next Hop _______________

b) 135.46.255.22 b) Next Hop _______________

c) 135.46.73.240 c) Next Hop _______________

d) 135.46.183.79 d) Next Hop _______________

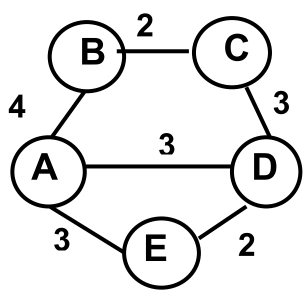
7) (12 pts) Consider a network where the sliding window protocol is in use with SWS = RWS = 2 frames and a one-way delay of 100ms (i.e. for a frame sent at time t, it arrives at t + 100ms). Assume that when multiple frames are all able to be sent according to the window size, that they are sent 20ms apart (i.e., frame 1 starts at time t, and frame 2 starts at time t + 20ms).

a) (4 pts) What would be a reasonable timeout value for this link? Why not something smaller? How about larger?

b) (4 pts) Can the selection of window size (i.e., SWS=RWS=2) fully utilized the link? If yes, please explain. If not, what is the channel utilization efficiency?

c) (4 pts) Now, assume that by sending a frame every 5ms we can saturate the link. In this case, determine the smallest SWS and RWS that maximizes throughput (i.e., keeps the pipe full).

8) (12 pts) The Distance Vector Routing Algorithm is to be performed to derive routing tables. Entries in the table are in the form of cost/next hop. Cost is measured in **throughput**. Fill in the tables below for the results after one exchange of vectors and after two exchanges. Give entries in the table in the **form of cost/next hop** as shown in the initial table. For each of the distance vector tables, complete the known routing table for node A.



Info at Node	Distance to reach node – initial table				
	A	B	C	D	E
A	---	4/B	∞	3/D	3/E
B	4/A	---	2/C	∞	∞
C	∞	2/B	---	3/D	∞
D	3/A	∞	3/C	---	2/E
E	3/A	∞	∞	2/D	---

Node A Routing Table		
Destination	Cost	NextHop
B		
C		
D		
E		

Info at Node	Distance to reach node – after 1 exchange				
	A	B	C	D	E
A	---				
B		---			
C			---		
D				---	
E					---

Node A Routing Table		
Destination	Cost	NextHop
B		
C		
D		
E		

Info at Node	Distance to reach node – after 2 exchanges				
	A	B	C	D	E
A	---				
B		---			
C			---		
D				---	
E					---

Node A Routing Table		
Destination	Cost	NextHop
B		
C		
D		
E		

9) (12 pts) Suppose that the TCP connection between A and B goes through router R (A to R then R to B). **Bandwidth on all links is infinite** which means packets travel as a single point(it takes 0 seconds to place/receive a packet on/from the link).

- Packets are instantly transmitted from A to the router or from the router to A.
- It takes 1 second for a packet to completely cross the link from the router to B (data packets) or B to the router (ACKs).
- The router transmits one packet to B every second and upon receipt of a packet, B immediately starts transmission of an ACK back to the router.
- Host A processes information in the following order: first process any ACKs, then process any timeouts and then send more packets if possible**. The whole processing takes 0 second.**
- ACK does **not** occupy the buffer space of the router.
- Host A sets its sending window size equal to the congestion window size.
- For the link between the router and Host B, the router has enough **buffer space to hold two packets in addition to the one it is transmitting (total of three packets at the router).** When buffer overflows, router starts to drop packets of high SeqNum till buffer goes back to normal. Router applies FIFO queueing discipline.
- Host A is using an algorithm that **increments its congestion window by 1 packets for each ACK received**.
- The initial congestion window is 1 packet.
- **The timeout time is 4 seconds**. When a timeout occurs the congestion window is reset to 1.

The first packet (P1) sent by Host A occurs at time t=1 second. Host A has 9 packets to transmit, draw a time diagram to show all the processes before completing all transmissions. **Answers without the time diagram will receive zero credits.**

a) (4pts) At what time does a timeout of a packet first occur?

b) (4pts) What is the congestion window value (value before being reduced to 1) when this timeout occurs? (according to rules above, if an ACK has been received at the same time the timeout occurs, the window is incremented before the timeout is processed)

c) (4pts) At what time does Host B receive all 9 packets?