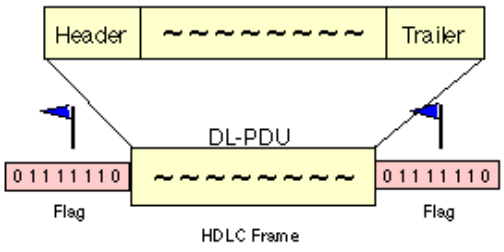
Name _____

All answers must have supporting work. Any answer without support will receive no credit

1) (8 pts) Suppose a link layer frame has a header **H = 10011** and a payload **M = 1110110.** It is to be transmitted from node A to node B using CRC coding. The CRC generator polynomial is $G(x) = x^3 + x + 1$

a) **(2 pts)** What is the generated CRC code? (Hint: Error detection algorithm only applies to the payload.)

b) **(2 pts)** Suppose only CRC code is added to the frame as the tail (**T**) and now we have the frame as **H+M+T** (i.e., DL-PDU in the following figure). If we use HDLC protocol to transmit it, what is the transmitted code? (Hint: remember the bit-stuffing.)



c) **(4 pts)** Assume the last two bits of payload **M** are flipped (10→01) during transmission. By using the CRC, does node B detect any bit errors introduced by the link? Show step by step of what operations are run at node B after it receives a HDLC frame with an errored **M**. (Hint: excluding asking for retransmission.)

2) (14 pts) Answer the following short answer questions.

a) **(1 pts)** What is the name of 3rd layer in the OSI model? (Hint: counting from bottom)

b) **(2 pts)** What are the **2** problems of the Non-Return to Zero (NRZ) encoding?

c) **(2 pts)** What is the efficiency of Manchester encoding and 8B/10B encoding? (Hint: number of useful bits divided by number of actual transmitted bits)

f) **(2 pts)** Explain why CSMA/CD cannot be used in wireless environment?

g) **(5 pts)** In the following 2 dimensional parity problem, 6 bit words are used. If even parity is being used, fill in the missing bit values with a 1 or 0. If it is not possible to correctly determine the bit, put a ? in the box.

0	0		0	0	1
	0	1	1	0	1
0	1	0		0	0
1	0		1	0	
0	1	0	1	0	0

j) **(2 pts)** Explain the hidden node problem in a wireless network? How to overcome it?

4) (8 pts) A **hypothetical network** has an end to end length of 5000 meters with a propagation speed of 2.5×10^8 m/s. The bandwidth of the link is 40 Mbps (40,000,000 bps). The maximum frame size for transmission on this network is 2400 bits.

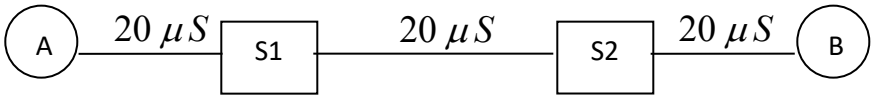
a) **(2 pts)** What is the transmission time for a maximum sized frame on the network?

b) **(2 pts)** What is the **one way** (from one end to the other) propagation delay for the network?

c) **(2 pts)** How long does it take to transmit a maximum sized frame from one end of the network to the other?(This time is the time from when the first bit is transmitted to the last bit received)

e) **(2 pts)** For this network, is the maximum frame size sufficient for CSMA/CD? Explain

5) (14 pts) Consider the **10Mbps (10,000,000 bps) network** shown



The propagation delay between any two hosts (A, B or a switch) is $20\,\mu s$. The frame to transmit from node A to node B consists of **1,000 bits**. Each switch can start retransmission of a frame $10\,\mu s$ **after receiving the last bit** of a frame.

a) **(4 pts)** What is the time necessary to transmit the data as a single frame from A to B (time from the first bit of the frame transmitted by node A until last bit of the frame is received at node B)?

b) **(3 pts)** What is the effective data throughput rate for this one frame from A to B (number of bits sent divided by time to send the bits) in bits per second(bps) for the network as analyzed in part a? (answer is less than 10 Mbps)

Continued on Next Page

5 cont) c) (4 pts) If the original frame is split into 2 frames so that each frame to be transmitted consists of **500 bits** of data, what is the time necessary to transmit both frames from A to B? Node A will transmit the frames one right after the other.

d) **(3 pts)** For the two frames sent from A to B in part c, what is the effective data throughput rate in bits per second(bps) for the network as analyzed in part c?

6) (6 pts) a particular ARQ protocol is being implemented with a sending and receiving window size of 3 frames (SWS = RWS = 3). Frames are sequenced using numbers 1, 2, 3, 4, 5, 6, 1, ... Receiver keeps a pointer **SeqNumToAck.** An ACK is sent to represent that all frames with smaller sequence number are well received. If error happens, receiver holds ACK till the frame of **SeqNumToAck** is received**.** For example, firstly, frames 1, 2 and 3 are sent, and frame 1 is received (ACK1 is returned), frame 2 is lost and frame 3 is received. Then, **SeqNumToAck=2** and the receiver returns ACK1 again upon receiving frame 3. After timeout, the sender retransmits frame 2 and the receiver returns ACK3 to indicate frame 2 and 3 have correctly received.

Answer the following questions and (or) complete the timeline for partial credits.

- **During transmissions, ACK 4 and Frame 5 are lost at their first transmission attempt ←**

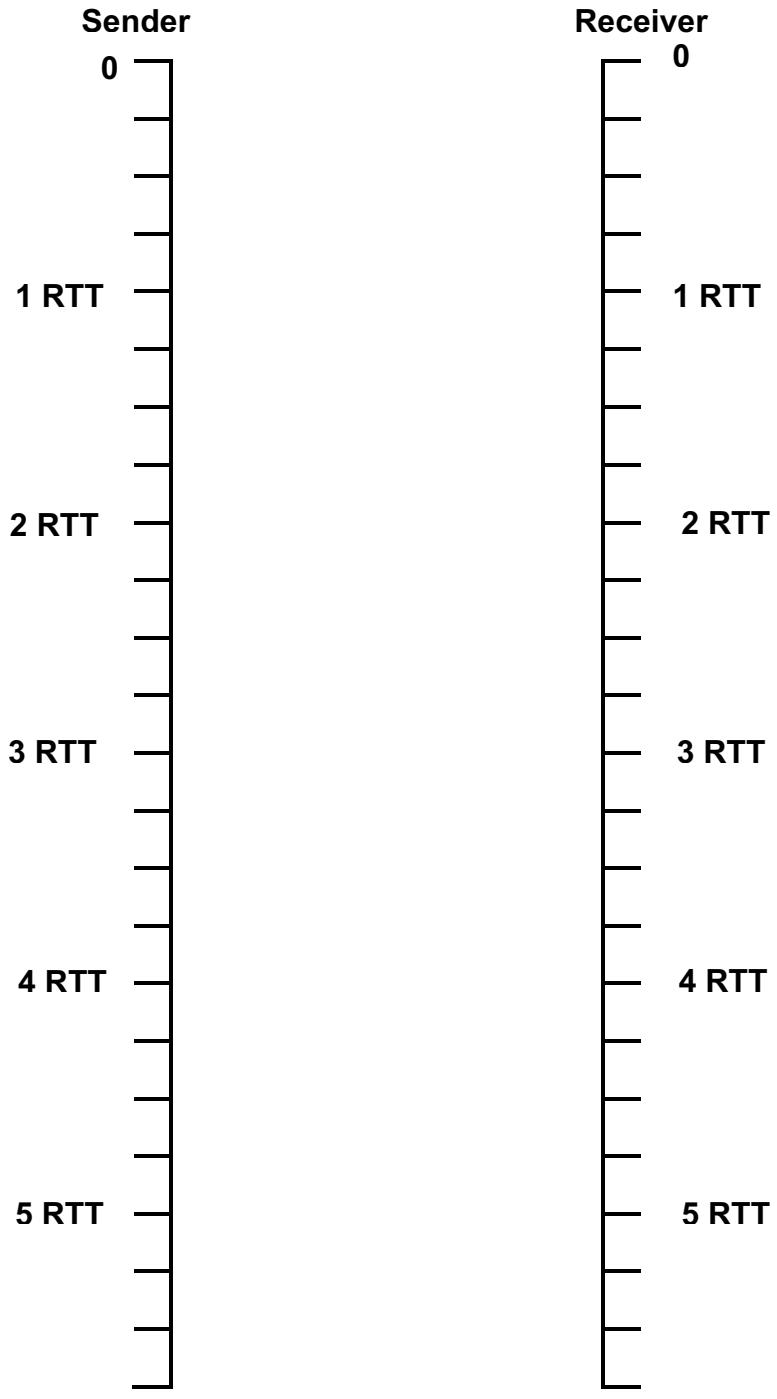
- Bandwidth is infinite, so transmit time of frames is instantaneous (Frames are transmitted and received instantly – though they still have a propagation time)
- The sender (when allowed) will transmit one frame every ¼ of a RTT – transmission time is instantaneous, but the sender can only perform one transmission every ¼ of a RTT
- A frame experiencing no delay is received ½ of a RTT after transmission starts (propagation delay) and processing time is zero.
- At a specific time, frames or ACKs are received and processed (instantly) before a transmission decision occurs
    - receiver receives a frame and then sends the ACK if required
    - sender receives an ACK and then determines if a timeout has occurred; it then determines the next frame to transmit (provided the SWS has not been exhausted)
- The timeout period is 2 Round Trip Times (2.0 RTT)
- Timing diagram is on the next page.

a) **(2 pts)** At what time the first timeout expires?

b) **(2 pts)** What are inside the sending window (the frame numbers) at time instant 5 RTT?

c) **(2 pts)** What is the **SeqNumToAck** at time instant 5 RTT?

Name _____



7) (2 pts Bonus) What do you expect the course to change in the following semester to better facilitate your learning?