CPE 348 **Exam #1 (50 + 3 pts)** **February 17, 2020**

Name Solution

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

1) (4 pts) A message **M = 101001** is to be transmitted from node A to node B using CRC coding. The CRC generator polynomial is G(x) = $x^3 + 1$ (bit sequence **1001**)

a) **(2 pts)** What is the transmitted code word? Perform the polynomial long division to find this result.

```
          101100
      ____________
1001 ) 101001000
       1001
       ----
         1101
         1001
         ----
          1000
          1001
          ----
           100
```

100

b) **(2 pts)** Assume node B receives the following code word: **11010001**. By using the CRC, does node B detect any bit errors introduced by the link? Use the generator polynomial from part a.

```
          11001
      __________
1001 ) 11010001
       1001
       ----
        1000
        1001
        ----
           1001
           1001
           ----
              0
```

No remainder!

No Error!

2) (11 pts) Answer the following short answer questions.

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

Baseline wander

clock sync.

b) **(2pts)** What is the difference between a connection-less service and a connection-oriented service?

Src. knows the route/path to dest. before data transmission in connection-oriened service.

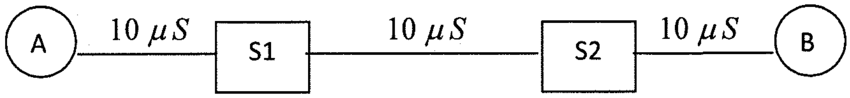
c) **(2 pts)** Explain the stop and wait ARQ (automatic repeat request) protocol. What is its main drawback?

efficiency is low

f) **(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	1	0	0	1
1	0	1	1	0	1
0	1	0	1	0	0
1	0	0	1	0	0
0	1	0	1	0	0

3) (12 pts) Consider the <u>hypothetical</u> **25Mbps (25,000,000 bps) network** shown



The propagation delay between any two hosts (A, B or a switch) is $10\,\mu s$. The frame to transmit from node A to node B consists of **2,000 bits**. Each switch can start retransmission of a frame $10\,\mu s$ **after receiving the <u>last</u> 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 transmitted by node A until last bit is received at node B)?

queueing

$$T = t_{tx} \times 3 + (10+10+10) + (10 \times 2)$$

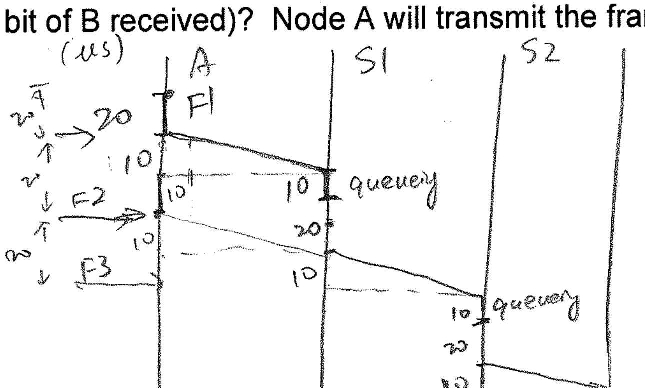
prop.

$$= \frac{2000}{25} \times 3 + 50 = 290\ \mu s$$

b) (**3 pts**) What is the effective data 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?

$$r = \frac{2000}{290 \times 10^{-6}} = 6.897\ \text{Mbps}$$

c) (**4 pts**) If the original frame is split into 4 frames so that each frame consists of **500 bits**, what is the time necessary to transmit all bits in all frames from A to B (time from first bit of A sent to last bit of B received)? Node A will transmit the frames one right after the other.



$$T_{base} = (20+10) + (10+20+10) \times 2 = 110\ \mu s$$

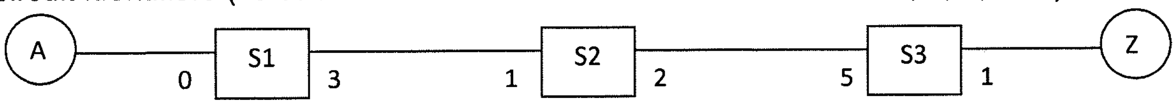
$$T_{tot} = 110 + 20 \times 3 = 170\ \mu s$$

d) (**3 pts**) For the four 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?

$$r = \frac{2000}{170 \times 10^{-6}} = 11.76\ \text{Mbps}$$

4) (10 pts) Consider the following virtual circuit network and the table showing the next Virtual Circuit Identifier (VCI) to use for each interface. The outgoing and incoming VCI's can be the same for a given interface/port (i.e. interface 3 on switch 1 can have a VCI of 5 for incoming packets and a VCI of 5 for outgoing packets). An interface is the same as port, and only the interfaces of interest for each switch are shown (i.e. interfaces 1 and 2 on switch 2).

Note: the network does not show all of the interfaces available on all switches, and it does not show all of the other nodes in the network. Lastly, each interface has its own set of virtual circuit identifiers (i.e each interface on a switch has its own VCI's 0, 1, 2, etc.)



The next VCI to use for interfaces on the switches

Switch	Incoming Interface	Next VCI to Use
S1	0	1
S1	3	3
S2	1	4
S2	2	0
S3	1	2
S3	5	5

Host A starts a connection to Host Z by sending a **setup message**. A short while later (after connection from A to Z has been established), Host Z starts a connection with Host A by sending a setup message. Use the table above to complete the switch tables below **to show the new entries created** during these virtual circuit setups. Assume that all previous connections remain active during the setups. **Use a next VCI of ~~3~~ 6 for Host A (as the receiver) and a next VCI of ~~4~~ 2 for Host Z (as the receiver).**

Virtual Circuit Table for Switch 1 (S1)

Setup message creating entry	Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
A to Z	0	1	3	4
Z to A	3	3	0	6

Virtual Circuit Table for Switch 2 (S2)

Setup message creating entry	Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
A to Z	1	4	2	5
Z to A	2	0	1	3

Virtual Circuit Table for Switch 3 (S3)

Setup message creating entry	Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
A to Z	5	5	1	2
Z to A	1	2	5	0

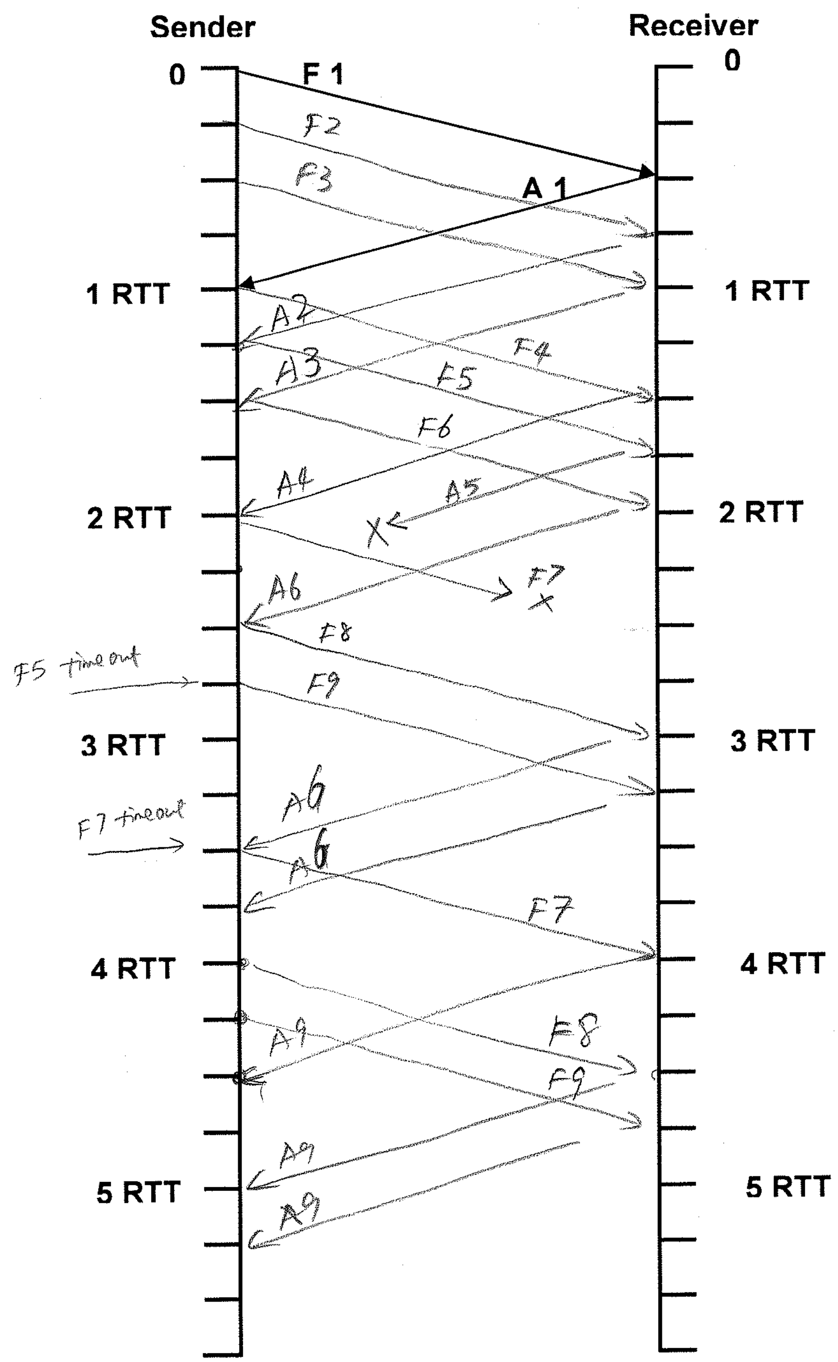
5) (13 pts) a particular ARQ protocol is being implemented with a sending and receiving window size of 3 frames (SWS = RWS = 3). Frames are sequenced using numbers 1, 2, 3, etc. Acknowledgments are sent for each frame that is received in order. If a higher sequence numbered frame is received out of order, that frame is not acknowledged until all earlier frames have been acknowledged. For example, frames 1, 2 and 3 are sent, and frame 1 is received (ACK1 sent back), frame 2 is delayed and frame 3 is received. Upon receiving Frame 3, the receiver retransmits ACK1. When frame 2 arrives, ACK3 is transmitted (acknowledges frames 2 and 3 being received).

Complete the timeline for this protocol given the following information:

- Sender needs to send 9 frames only with sequence numbers 1 through 9. **Show all transmissions (frames and acks) that will occur when transmitting these nine frames and ack9 is received by the sender**
- **During transmissions, ACK 5 and Frame 7 are lost on 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) (Frame 1 and ACK 1 are shown) and processing time is instantaneous.
- 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)
- If the receiver receives a frame that it has already acknowledged, the receiver repeats its most recent acknowledgment. For example, the last ACK sent by the receiver is ACK6. If frame 5 is received again, ACK6 is repeated.
- **The timeout period is 1.5 Round Trip Times (1.5 RTT)**
- **Timing diagram is on the next page.**

❖ **The grading is based on checking the action at 1RTT, 2RTT, ..., 5RTT in both sender and receiver; partial credits will be given for correctness at other time instants.**

Name ______________________________



Timeout = 1.5RTT
Ack5 and F7 are lost

6) (Bonus 3pts) What do you expect the course to change in the following semester to better facilitate your learning?