CPE 348 Exam #1 (50 pts) March 03, 2021

Name Solution

1) (8 pts) Suppose a link layer frame has a data **M = 111011** to be transmitted from node A to node B. Please answer the following question. It is to be transmitted from node A to node B using CRC coding.

a) **(4 pts)** If you are asked to derive the CRC code for **M** given that the generator polynomial is $G(x) = x^2 + 1$, what is your answer?

G= 101

```
        110110
101 ) 11101100
      101
      ---
       100
       101
       ---
         111
         101
         ---
           100
           101
           ---
            10
```

$\boxed{10}$

b) **(2 pts)** If you are asked to derive the 3-bit checksum code for **M**, what is your answer? (Hint: In our project, we used 8-bit checksum. Here, operations will be the same and the only difference is the size.)

```
 111          010
 011          001
----   ->    ----   ->              
1010         011          100
carry  then        complementary
```

$\boxed{011}$ → complementary → $\boxed{100}$

c) **(2 pts)** If you are asked to derive the 1D even parity code for **M**, what is your answer? (Hint: Consider every 7 bits as a cohort. Pad 0s if less than 7 bits.)

1

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

a) **(2 pts)** Which layer in the OSI model does the HTTP protocol belongs to?

Application layer (or 7^{th} layer)

b) **(2 pts)** What are the **2** steps in the 4B/5B encoding?

(1) 4 bits are mapped to 5 bits

(2) encode use NRZI

c) **(2 pts)** The following bits are from the data payload field in a HDLC-based network frame. Please mark errored bits and stuffed bits if there are any.

...1011110001111101011011111101...

stuffed bit error bit

d) **(2 pts)** Why the sliding window protocol is advantageous over the stop-and-wait protocol?

Keep sending data while waiting for ACKs ;

OR

better ~~char~~ Bandwidth utilization efficiency.

e) **(2 pts)** How can hidden nodes be detected/informed by in 802.11 networks (a.k.a. WiFi)?

RTS/CTS

j) **(4 pts)** Consider that the sliding window protocol runs over a 40-km point-to-point fiber link. The speed of light is 2×10^8 m/s in the fiber and the bandwidth of this fiber link is 1Gbps (1,000,000,000 bits/s).

(1) What is a suitable timeout value for this protocol?

$$RTT = \frac{40\times10^3}{2\times10^8} \times 2 = 0.4ms \; ; \; \boxed{Timeout \geq 0.4ms}$$

(2) What is the maximum allowed sending window size? Assume frame size is 4Kb (4,000 bits). (Hint: maximum sending window size can make the pipe full)

$$RTT \times bandwidth = 0.4\times10^{-3} \times 10^9$$

$$= 4\times10^5 \text{ bits}$$

$$SWS = \frac{4\times10^5}{4\times10^3} = \boxed{100}$$

3) (8 pts) A **hypothetical network** has an end-to-end length of 1,000 meters with a propagation speed of 2×10^8 m/s. A store-and-forward switch sitting in the middle introduces a queuing delay of 2.5 µS to transmissions in both directions. The bandwidth of the link is 500 Mbps (500,000,000 bps). The maximum frame size for transmission on this network is 5000 bits.

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

$$t_{tx} = \frac{5000}{500\times10^6} = \boxed{10\,\mu s}$$

b) **(3 pts)** How long does it take to transmit a maximum sized frame from one end of the network to the other? (Hint: remember to include the switch's transmission time.)

$$t_{one\text{-}way} = t_{tx_1} + t_{prop} + t_{queue} + t_{tx_2}$$

$$= 10 + \frac{1000}{2\times10^8} + 2.5 + 10$$

$$= \boxed{27.5\ \mu s}$$

d) **(3 pts)** Assume CSMA/CD (carrier sense multiple access with collision detection) is used on this network. Using the answer your find in Part b), what is the minimum number of bits in a frame that can be used such that a transmitting node is guaranteed of detecting a collision?

$$RTT = 2\cdot(t_{prop} + t_{queue}) + t_{tx}$$

$$= 2\,(5 + 2.5) + 10$$

$$= 25\,\mu s$$

$$(\text{minimum})\ \text{frame size} \geq RTT \times BW = 25\times10^{-6} \times 500\times10^6$$

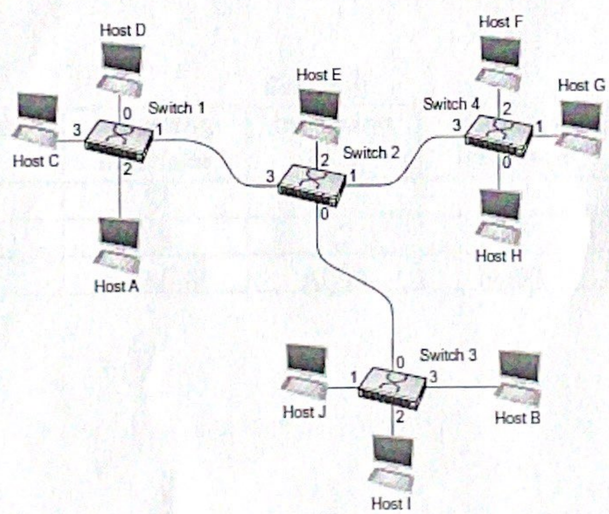
$$= \boxed{12{,}500\ \text{bits}}$$

5) (10 pts) Consider the following virtual circuit network. The network already has some existing connections which are not shown. In light of it, some Virtual Circuit Identifiers (VCIs) have been allocated. Note that the network follows the rule that the VCI assignment always picks the lowest available value. The following table shows that the next VCI to use for some interfaces that are of interest.

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

At one moment, some new connections are about to be initiated. Assume that the sequence of connections is cumulative; that is, the first connection is still up when the second connection is established, and so on. Please provide the VC table for all the switches after each of the following uni-directional connections is established.

1) From Host A to Host J
2) From Host B to Host E
3) From Host E to Host A



Please fill out the following table. If a connection does not pass that switch, please fill **N/A**. A sample work has been done for Switch 1, and you can use it for a start. **Hint:** remember the chain effect, that is the outgoing VCI of a switch should be equal to the incoming VCI of another switch.

Switch 1:

Connection	Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
1)	2	3	1	4
2)	N/A	N/A	N/A	N/A
3)	1	1	2	0

Switch 2:

Connection	Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
1)	3	4	0	0
2)	0	2	2	3
3)	2	5	3	1

Switch 3:

Connection	Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
1)	0	0	1	2
2)	3	0	0	2
3)	N/A	N/A	N/A	N/A

6) (10 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 3 and Frame 6 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 1.5 Round Trip Times (1.5 RTT)
- Timing diagram is on the next page.

a) **(4 pts)** At what time the first timeout expires?

3 ½ RTT

b) **(3 pts)** What are inside the sending window (the frame numbers) at time instant 5 RTT?

3, 4, 5

c) **(3 pts)** What is the **SeqNumToAck** at time instant 5 RTT?

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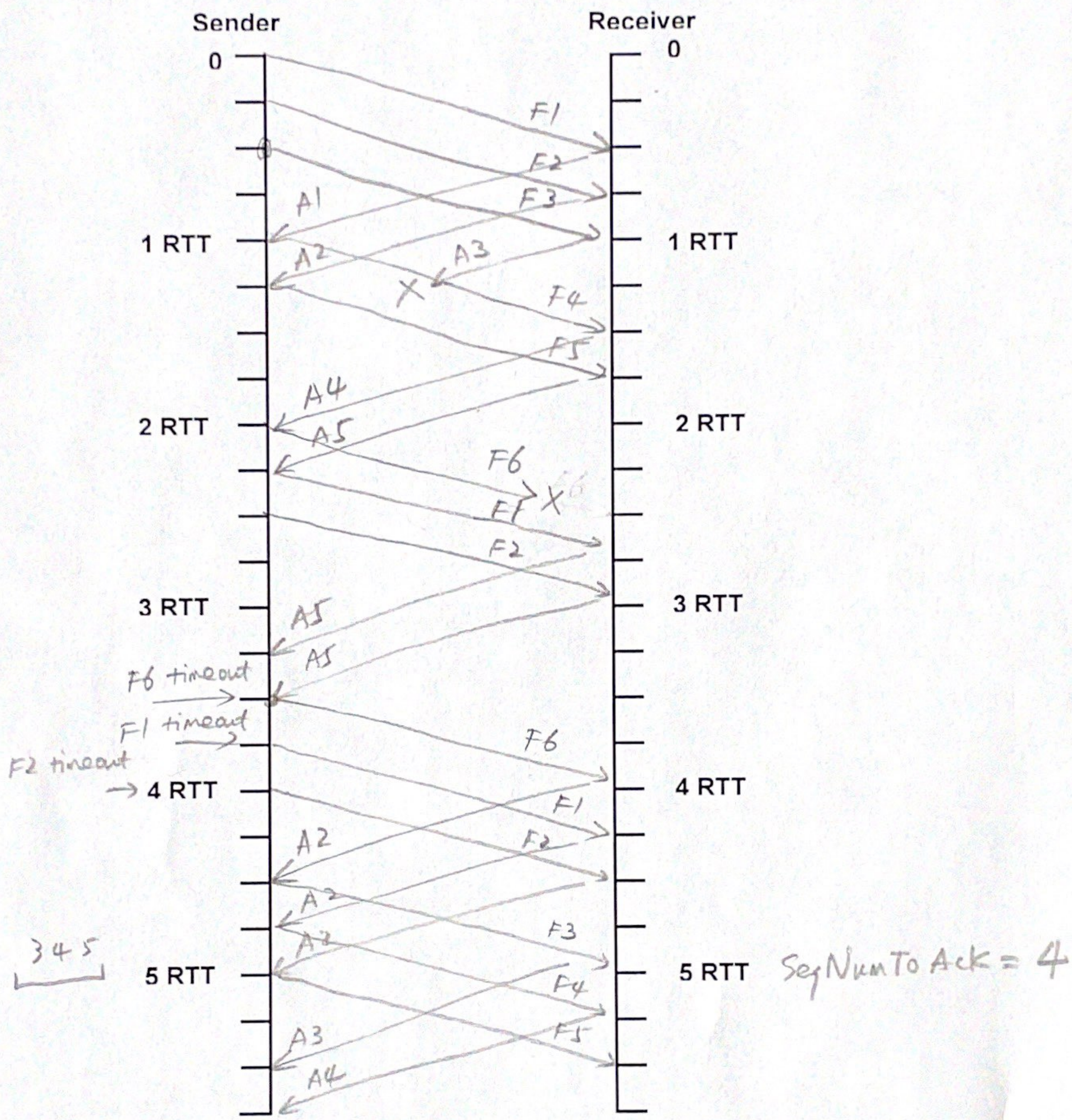
Name ____



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