Data Communications Midterm Exam (2019.12.17)

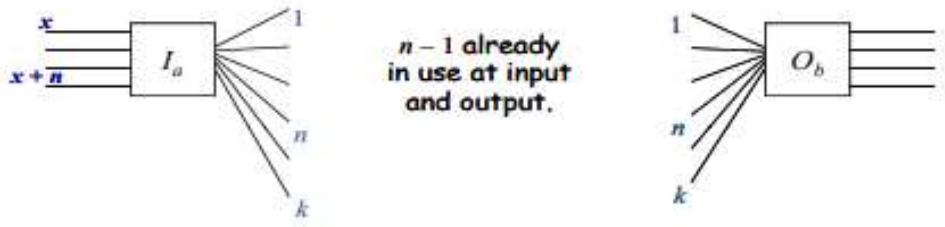
☞ You can answer either **in English or in 한글**.

☞ **Specify correct units (e.g. bps, Hz, bits, baud, dB)** for full credits!!! (부정확한 단위는 감점요인임!!!)

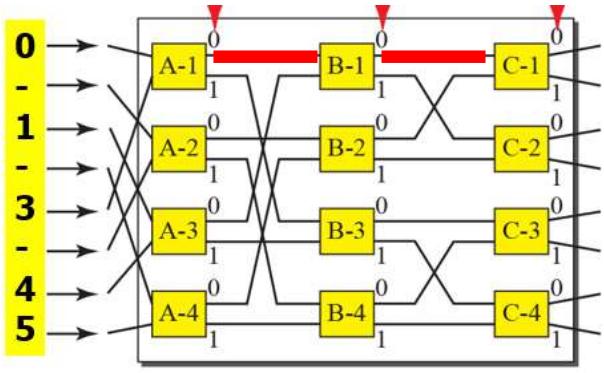
Student ID: _____ Name: _____

1. Consider a 3-stage switch. Each crossbar in the first and the last stage has $n \times k$ crosspoints. Clos non-blocking criteria says that k should be at least $2n - 1$. In the proof below, fill in each blank with an appropriate number. **(4pts)**

Proof. Suppose a first stage switch I_a is serving **n-1** calls already. Through the remaining input port, we want to place another call that goes out to O_b. Suppose O_b is also serving **n-1** calls. For this call to go through, the call should find a middle stage switch that has an idle input and from I_a and an idle output to O_b. Ongoing calls going through I_a, plus those going through O_b can be occupying at most **2n-2** middle stage switches. Therefore, it is enough to have one more than **2n-2** middle stage switches to make sure that the new call finds an idle path through a middle stage switch, which is our non-blocking condition.



2. In the following Banyan switch, what would be the link(s) that will cause the blocking when the data destined to **0-1-3-45** are applied to the input ports? Here, '-' means no input applied. Highlight the blocking link(s) by thickening it (them)**. (4pts)**



3. In the Slotted ALOHA system, "throughput" is given as $S(G) = Ge^{-G}$, where G is the average number of frames sent per unit time. Given that $e^{-1} = 0.37$,

   A. What is the value maximum throughput S? **0.37** **(3pts)**

   B. If there are 1,000 frame slots per unit time, how many packets (frames) actually go through at the maximum throughput? **370** **(2pt)**

   C. The maximum throughput does not necessarily maximize the number of packets that go through. Give an example of the number of attempted packets that leads to more surviving packets than at the maximum throughput. **1,000 < any number < 3,500** **(3pts)**

4. Bluetooth hops the frequency 1,600 times per second. Why does Bluetooth do this if not for security? **To avoid interference [from other ISM-band technologies]** [Hint: Wi-Fi] **(3pts)**

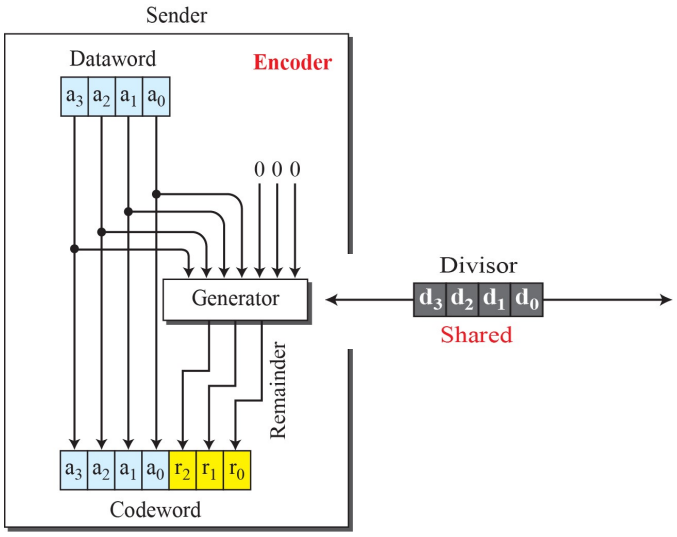
5. Consider the CRC operation in the following figure. Identify the terms used in the proof on the right with the illustrative example on the left: **(5pts)**

   A. d(x) =$a_3x^3 + a_2x^2 + a_1x + a_0$ (in polynomial: eg1: if the bit value is 0101, write $x^2 + 1$. eg2: If the bit values is $c_1c_2c_3$, write $c_1x^2 + c_2x + c_3$.)

   B. g(x) = $d_3x^3 + d_2x^2 + d_1x + d_0$ (in polynomial)

   C. e'(x)= $r_2x^2 + r_1x + r_0$ (in polynomial)

   D. n − k = **3**



Let $x^{n-k}d(x) + 0 = g(x)q(x) + e'(x)$

Then

$$\frac{x^{n-k}d(x) + e'(x)}{g(x)} = \frac{g(x)}{g(x)}q(x) + \frac{e'(x) + e'(x)}{g(x)} = 0$$

6. Tell whether the following statement is generally true ("O") or false ("X")**: (1pt each)**

   A. In bit stuffing, bit "1" functions similarly to the ESC character in byte stuffing. **X**

   B. Stuffing increases the packet size. **O**

   C. When the channel is error-prone, large frames help. **X**

   D. When the channel is error-free, the positive ACK is more efficient. **X**

   E. The ESC-ESC-Flag in the data field is not grammatical. **O**

   F. Simple and Stop-and-Wait protocols are not problematic when the bandwidth-delay product is small. **O**

   G. ACK is an unnumbered frame according to the HDLC classification. **X**

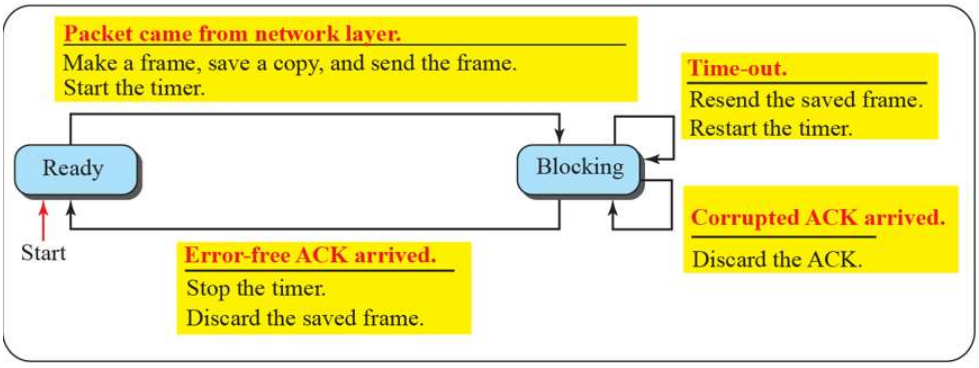
   H. A real example of Normal Response Mode communication can be found in automobiles. **O**

7. Choose as many keyword(s) as relevant for each generation of mobile communication technology. **(8pts)**

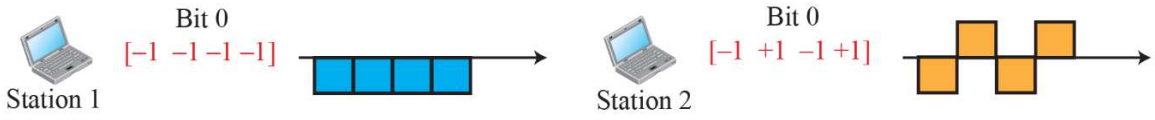
   A. 1G: **g**
   B. 2G: **a, b**
   C. 3G: **d, h**
   D. 4G: **c**
   E. 5G: **e, f**

a. digital voice for the first time	b. SMS for the first time	c. IP core for the first time		
d. DSSS	e. URLLC	f. IoT	g. analog voice only	h. voice regarded as data for the first time

8. Answer the following questions about the finite state machine (FSM) for a sender.
   A. What flow+error control protocol does the figure illustrate? **Stop-and-Wait** **(2pt)**
   B. In the "Corrupted ACK arrived" arc, what computation takes place? **CRC** **(1pt)** [Hint: 3-letter acronym]
   C. Does this FSM assume error correction? (Y/N) **N** **(1pt)**
   D. In the spurious retransmission takes place in this protocol, how many bits in the sequence number solve the duplicate reception problem? **1 bit** **(2pts)**



9. There are two stations in a network, where Station 1 uses $[+1\ +1\ +1\ +1]$ as its code and Station 2 uses the code $[+1\ -1\ +1\ -1]$. Bit 0 is encoded as $\mathbf{-1}$ and Bit 1 is encoded as $\mathbf{+1}$. When they both transmit Bit 0 simultaneously,
   A. What is the data on the channel? [Hint: as a chip sequence] $[-2\ \ 0\ -2\ \ 0]$ **(2pts)**
   B. When decoding what Station 2 sent, what is the value after integration? **– 4** **(3pts)**
   C. In (B), in order to find the bit that Station 2 sent, you should divide the integration by what? **4** **(2pts)**
   D. According to your answer for (C), what is the number of codes used in this system? **4** **(2pts)**
   E. These stations are half-duplex. Can two different nodes transmit at the same time and yet allow decoding of either by other nodes? (Y/N) **Y** **(1pt)**



10. Answer the following questions regarding Ethernet
   A. In an Ethernet MAC layer frame, what is the first transmitted bit if the frame is a multicast frame? **1** **(1pt)**
   B. Considering the role of the least significant bit in the most significant byte of a MAC address, what is the maximum possible number of unicast MAC addresses? 2^{47} **(3pts)**
   C. Among the three persistent protocols, what did Standard Ethernet use for its MAC? **1-persistent** **(2pts)**
   D. What feature does today's switched Ethernet use to do without CSMA/CD? **full-duplex** **(2pt)**
   E. One function of the Ethernet physical layer preamble is alerting the receiver of the incoming Ethernet frame. What is the other function? **synchronization** **(2pts)** (Hint: it alternates between 0 and 1 a lot)

11. How does FDM differ from FDMA (or TDM from TDMA) in terms of the physical layer device used? Write the name of the device that FDM (or TDM) uses. **multiplexer** **(2pts)**

12. In the following Wi-Fi frame format, answer with the name of an appropriate field.

A. Where does the NAV value appear? **D** **(1pt)**

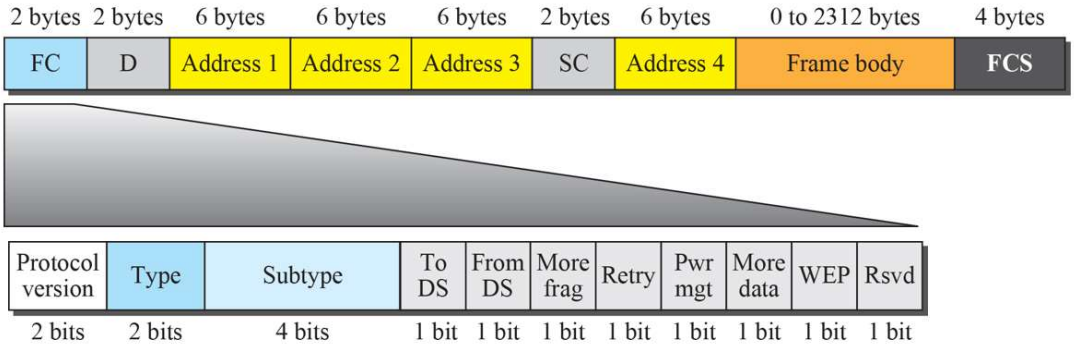
B. Where does the wireless sender's MAC address appear? **Address 2** **(1pt)**

C. From which field do you know that the frame is a management frame? **Type** **(1pt)**

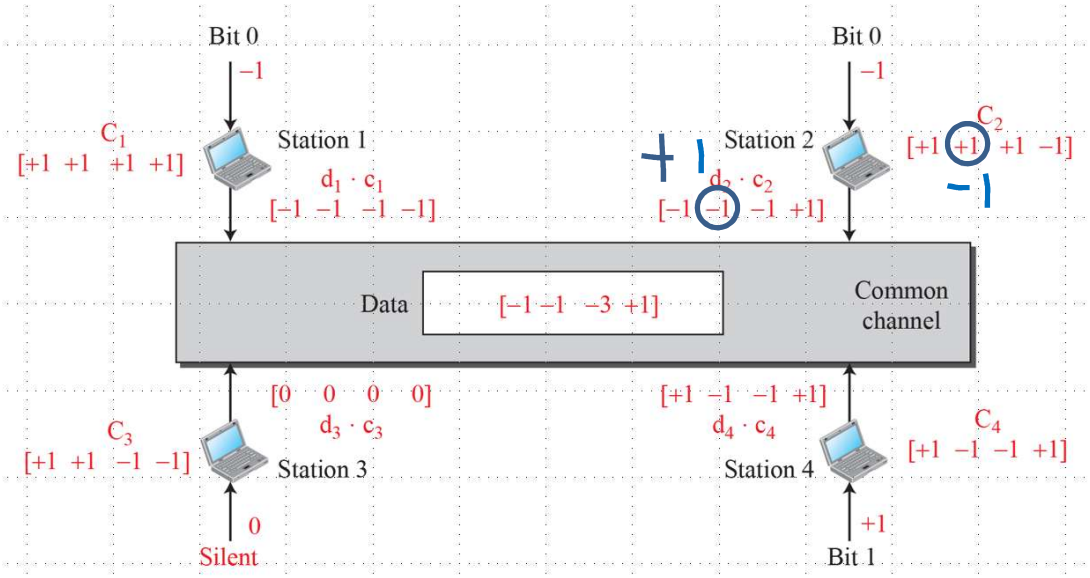
D. From which field do you know that there is still data queued at the access point (AP)? **More data** **(1pt)**

E. What field is omitted if your computer sends a data frame to another computer without using the AP? **Address 4** **(1pt)**

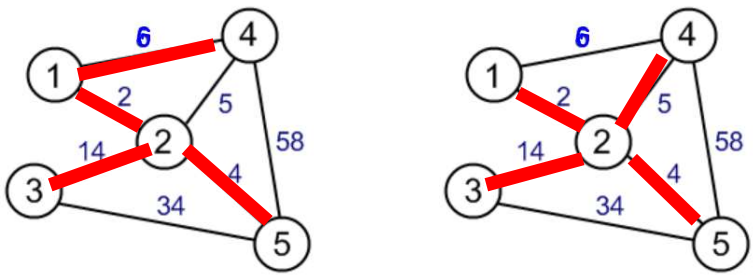
F. Which field is set to 1 if your computer frequently sleeps the transceiver to save battery? **Pwr mgt** **(1pt)**



13. Correct all incorrect numbers in the following figure that exemplifies the CDMA operation. [Hint: this system uses the Walsh code that starts from $W1 = [+1]$] **(4pts)**



14. On the left, show the shortest path tree rooted at Node 1. On the right, show the minimum spanning tree. **(6pts)**



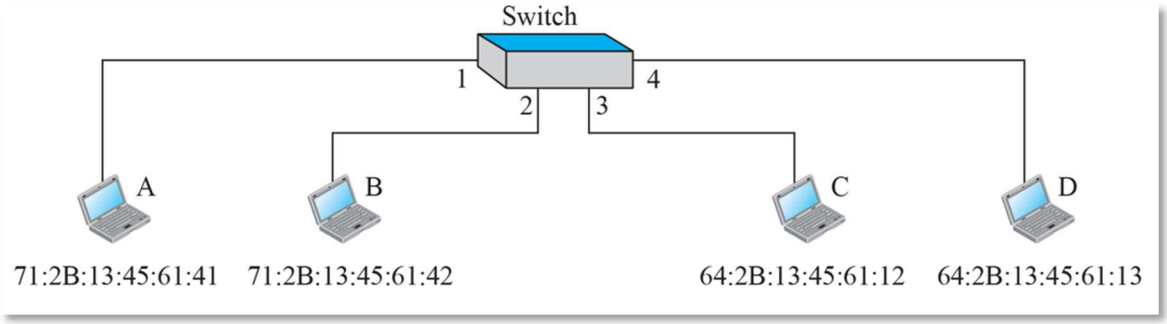
15. When should the probability of actual transmission, p, decrease in the p-persistent system? **When collisions are too many / when maximum backoff is reached frequently / when throughput is low** **(3pts)**

16. Answer the following questions regarding the learning switch shown in the following figure

A. Fill in the two lines of the switch table after A sends to B, then C sends to D. **(2pts)**

Address	*Port*
71:2B:13:45:61:41	**1**
64:2B:13:45:61:12	**3**

B. How many frames will B have received in total if D sends three frames to 64:2B:13:45:61:12 after the first two frames in (A) ? **2** **(2pts)** How many frames will C have received? **5** **(2pts)**



17. What are the three major functions that the datalink layer performs regardless of the type of the link layer technology? **(3pts)**

A. **framing**
B. **flow control**
C. **error control**

18. Is the code in the table on the right

A. Linear code? (Y/N) **Y** **(1pt)**

B. Cyclic code? (Y/N) **Y** **(1pt)**

C. What is its minimum Hamming distance? **3** **(2pts)**

D. How many code vectors can be used for error detection? **112** **($=2^7 - 2^4$)** **(1pt)**

E. How many error bits can this code correct per codeword? **1** **(2pts)**

Messages	Code vectors
0000	0000000
0001	1010001
0010	1110010
0011	0100011
0100	0110100
0101	1100101
0110	1000110
0111	0010111
1000	1101000
1001	0111010
1010	0011001
1011	1001011
1100	1011100
1101	0001101
1110	0101110
1111	1111111

한 학기 동안 수고 많았습니다 ...

