Data Communications Final Exam

2016.12.15

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

Student ID: _____ Name: _____

1. What are the two conditions for non-blocking in Banyan switch? **(2×2pts)**

1. Input packets are applied in the increasing order of their desired output port numbers

2. There is no unused input port (gap) between those that are used

2. Suppose a generator polynomial used in CRC has a factor $(x+1)$. Namely, $g(x) = (x+1)T(x)$ for some $T(x)$. Prove that the generator can detect all errors $e(x)$ with an odd number of corrupted bits. [Hint: use proof-by contradiction] **(10pts)**

Let e(x) be a polynomial that represents an odd number of errors. Assume that e(x) has factor (x+1). Then e(x)=(x+1)T(x). When evaluated at x=1, the equality should hold. The left hand side is e(1)=1 since it has an odd number of errors. But the right hand side is (1+1)T(1)=0. The equality does not hold, so the assumption is wrong. Since e(x) is an arbitrarily chosen polynomial, it means that all odd number of errors cannot be divided by (x+1). Namely, they are detected by a generator polynomial that has (x+1) as a factor.

3. If the dataword to send is 000100 and the generator is 101, what is the CRC code? Show your derivation. **(5pts)**

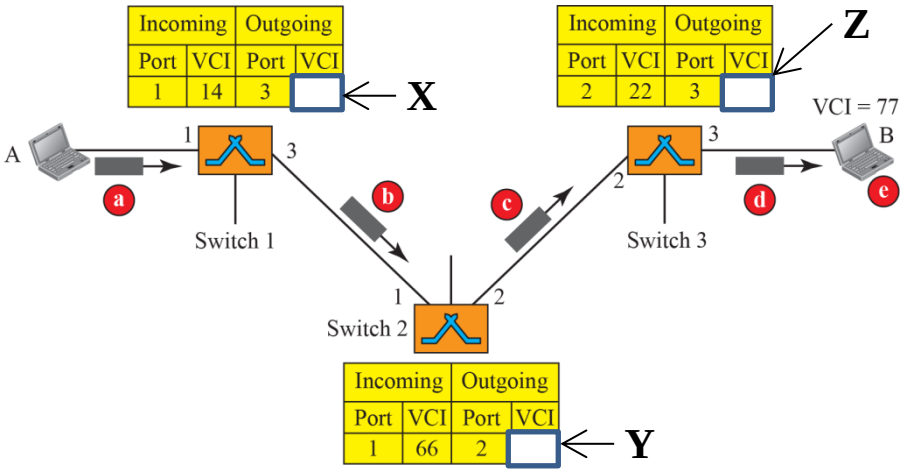
(Derivation omitted)

Ans = 01

4. Fill out the table with "Y" or "N" so that the three switching methodologies are correctly described. **(5pts)**

	Circuit switching	**Datagram**	**Virtual circuit**
Resource reservation	Y	N	Y
Packet-based	N	Y	Y
Waiting time at switch	N	Y	N
Uses destination address in data forwarding	N	Y	N
Uses connection setup	Y	N	Y

5. The following figure shows the last steps of connection setup in a virtual circuit network. What are the three VCIs X, Y, Z that should be filled in the tables? X= ___66____ Y= ___22____ Z= ____77____ **(3×2 pts)**



6. If a three-stage, space-division circuit switch has 200 input ports and 200 output ports, what is the minimum number of cross points under the Clos criteria? Assume that the 200 input lines are divided into 20 groups, each with n=10 lines at the first stage. Show your derivation. **(10pts)**

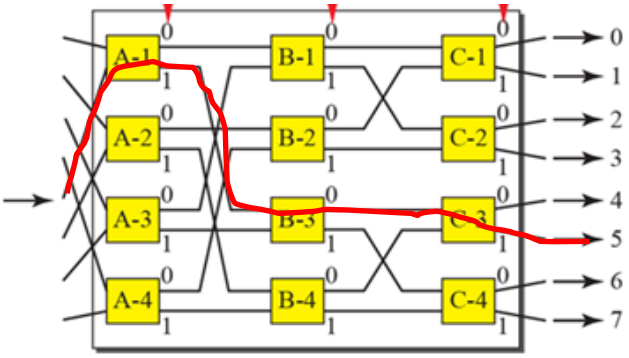
According to Clos criteria, k=2n-1=19 and N/n = 20.

1st and 3rd stages: N/n=20 crossbars, each with n x k=10x19 crosspoints

2nd stage: k=19 crossbars, each with N/n x N/n = 20x20 crosspoints.

In total, 2 x 20 x 10 x 19 + 19 x 20 x 20 = 15,200 crosspoints.

7. In a Banyan packet switch, show how the packet on the input (the arrow on the left) is routed if the destination is 5? Highlight the path that the packet takes. **(3 pts)**



8. Suppose (0111), (0110), (0000), (0001) are data blocks to be transmitted, and 1's complement checksum is used.

   A. What is the 4-bit checksum value? ____0001_____ **(3 pts)**

   B. What is the value that the checker at the receiver side produces? ____1111_____**(2 pts)**

9. In HDLC, suppose the sender has sent packet #1, #2, #3, #4, and #5. Among these, #3 was lost, so the receiver received only #1, #2, #4 and #5. Depending on the S-frame from the receiver, the sender may retransmit different packets. **(3×1 pts)**

   A. What is/are the retransmitted packet(s) if the receiver sends REJ(#3)? ___3,4,5____

   B. What is/are the retransmitted packet(s) if the receiver sends SREJ(#3)? __3_____

   C. What is the acknowledgement number after the successful retransmission(s) in (B)? ____6_____

10. What are the three categories of media access control protocols? **(3 pts)**

1. Random access	**2. Controlled (centralized) access**	**3. Channelization**

11. What is the most central idea to reduce the chances of packet collisions in the following schemes? **(2×3 pts)**

    A. ALOHA _____random backoff after collision_____

    B. CSMA _____carrier sense_____ (in addition to what ALOHA already does in (A))

12. The throughput in ALOHA is given as $S(G) = G \times e^{-2G}$, where G is the average number of frames collectively generated by wireless stations during one frame transmission time. On a shared channel of 200 kbps, an ALOHA station transmits 200-bit frames. [Hint: Use $\frac{1}{e^2} = 0.135$, and $\frac{1}{e} = 0.368$.]

    A. What is the value of G that produces the maximum throughput? ___1/2__ **(2 pts)**

    B. How many frames survive if the stations send 1000 frames per second? __135_____**(3 pts)**

    C. How many frames survive if the stations send 500 frames per second? ____92_____ **(2 pts)**

13. A network using CSMA/CD has a bandwidth of 100 Mbps. If the maximum propagation delay is 2.56 μs, what is the minimum size of the frame? Show your derivation. **(5 pts)**

Round-trip delay = 5.12 μs.

At 100 Mbps, the sender can transmit 10^8 b/s x 5.12 x 10^{-8}s = 512 bits (or 64 bytes).

14. What are three channelization protocols? (**3×1 pts)**

1. TDMA	**2.** CDMA	**3.** FDMA

15. Codes in CDMA are chosen so that $c_i \cdot c_j = 0\ (i \neq j)$ and $c_i \cdot c_i = N$, where N is the number stations. Using this fact, show how a station can recover d_2, the data transmitted by station 2, by using the code c_2. Assume that there are N=4 stations that transmit their packets at the same time. [Hint: In this case, the (mixed) data on the channel is $d_1.c_1 + d_2.c_2 + d_3c_3 + d_4.c_4$.] (**5 pts)**

Apply c_2 and divide by N=4. Namely,

$C_2 . (d_1.c_1 + d_2.c_2 + d_3c_3 + d_4.c_4)/4 = d_1.c_2 \cdot c_1 + d_2.c_2 \cdot c_2 + d_3 \cdot c_2 \cdot c_3 + d_4.c_2 \cdot c_4 \ /4$

$= d_2.c_2 \cdot c_2/4 = 4\ d_2\ /4 = d_2$

16. What are the three functions of datalink control (DLC) layer? (**3×1 pts)**

1. Framing	**2.** Error control	**3.** Flow control

17. Fill in the blanks with protocol names in Bluetooth for the given layers. (**3×1 pts)**

Layers	**Bluetooth protocol**
DLC (or LLC)	L2CAP
MAC	Baseband
Physical	Radio

18. Answer the following questions regarding Bluetooth. (**3×1 pts)**

A. What is the bandwidth of a Bluetooth channel? _____1 MHz_____

B. How many channels are there? _____79_____

C. How many times Bluetooth "hops" channels in a second? ____1600_____

19. Answer the following questions regarding wireless LAN.

A. What packets are used to prevent the hidden terminal problem? ___RTS_____ and ___CTS____**(2×1 pts)**

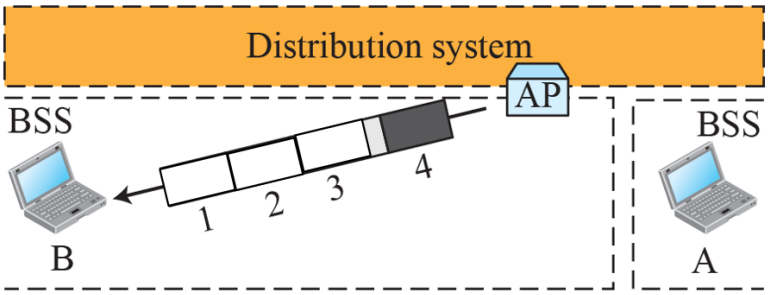
B. Take three examples of control frames: ___RTS_____, ___CTS_____, ____ACK_____ **(3×1 pts)**

C. Take an example of management frame: _____Beacon_____ **(1 pt)**

20. If A sends a frame to B in the following figure,

A. What will the three addresses (1, 2, 3) be? 1=___B___2=__AP____3=___A____ **(3×1 pts)**

B. What will be FromDS and ToDS flags be? FromDS=___1___ ToDS=___0___ **(2×1 pts)**



한 학기 동안 수고 많았습니다... Merry Christmas and Happy New Year!

