

Computer Networks  
Spring 2020  
Midterm I  
2/21/2020  
Time Limit: 75 minutes

Name: Key

Computing ID \_\_\_\_\_

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This exam contains 11 pages (including this cover page) and 30 questions.

**Instructions:**

1. You have **75 minutes** to complete the examination. As a courtesy to your classmates, we ask that you not leave during the last fifteen minutes.
2. Feel use a **calculator** on this exam. If you don't have a calculator, you can use your phone on airplane mode. Remember you are on your honor.
3. Write your answers in this booklet. **please try to avoid writing on the backs of pages.**
4. There are 3 categories of questions: [C Questions] these are the easiest questions, [B Questions] these are more challenging questions and [A Questions] these question require the most thought and time. Answering A questions correctly demonstrates mastery of the material.
5. Please sign the below Honor Code statement.

I have neither given nor received aid on this exam.

Signature: \_\_\_\_\_

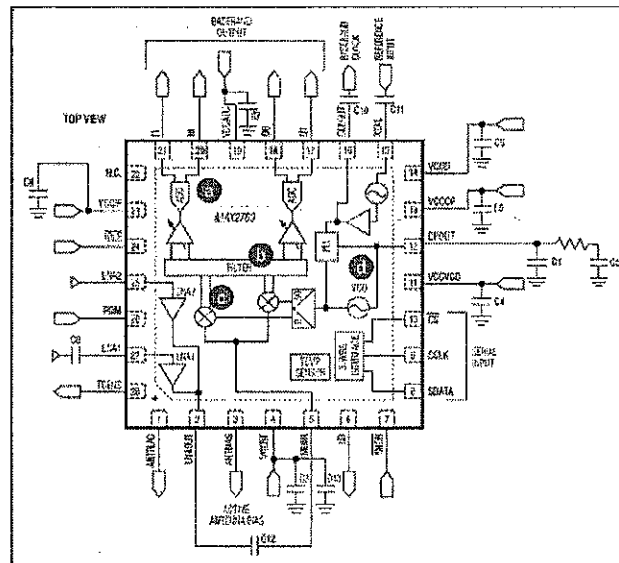


Figure 1: max2769 Universal GPS receiver

## 1 Physical Layer

Figure above is an schematic of MAX2769 universal GPS receiver. There are four components label in the figure. The following questions refer to this diagram and these components.

- (2 points) [C] Which of the components in the diagram is responsible for converting the analog signals to digital values?
  - [ADC]
  - [Filter]
  - [Mixer]
  - [Local Oscillator]
  - none of the above
- (2 points) [C] True or False the mixer labeled C in the diagram is being used to generate the Q signal in Quadrature signal pair. (Be careful and pay close attention to the phase, if you can't clearly see the diagram, the phase towards the top is  $90^\circ$  and phase towards the bottom is 0)
  - True
  - False

3. (4 points) [B] This chip is designed to receive 1575 MHz (Mega is  $10^6$ ) signals. Assuming that the ADC only samples at 50Msps (Mega samples per second). Which of the following is/are valid frequencies for the local oscillator? **Select all that apply if none apply don't select any options** [These numbers were taken directly from the datasheet for the Max2769]
- 1525
  - 1550
  - 1575
  - 1600
  - 1625
4. (2 points) [A] Assume that you are designing your own RF chip. That is going to be used to demodulate 8-bit values that were first amplitude modulated and then frequency modulated with a carrier frequency of 162 MHz (Mega is  $10^6$ ). How many quantization levels does your analog to digital converter need to support in order to recover the amplitude modulated signal.
- A. 3
  - B. 8
  - C. 128
  - D. 162
  - E. 256
  - F. 324
  - G. 512
  - H. None of the above
- 256 values need to encode as both sides of the wave*
5. (2 points) [C] Which of the following modulation schemes is the most resistant to noise?
- A. BPSK
  - B. QAM-16
  - C. QAM-128
  - D. QAM-256
6. (4 points) [B] Assuming information is encoded using a QAM-256 encoding scheme and is transmitted at a baud rate of 5000. What is the speed of the transmission in bps?
- A. 128 kbps
  - B. 40 kbps
  - C. 51.2 kbps
  - D. 1280 Mbps
  - E. none of the above

7. (4 points) [B] The following IQ samples (expressed as complex numbers) were taken from a QPSK modulated signal (four states). Assume that the state with the lowest value is in the top right hand corner and state values increase counter clockwise). Which of the following binary sequences represent the encoded signal below:

$1 + 1j, -1 + 1j, 1 + 1j, -1 - 1j$

A. 11101100

B. 00010011

C. 10111000

D. 01110100

E. none of the above

00 01 00 10

↙  
recd

8. (2 points) [A] Assume that we want to design a system that can transmit 10Mbps using a QAM-128 encoding scheme. Given that each symbol needs to be transmitted for one cycle. What frequency does the carrier need to be to achieve this?

A. 7.8 Hz

B. 12.8 MHz

C. 1.43 MHz

D. 7 MHz

E. 14 Hz

F. 2.84Hz

G. None of the above

10 Mbps

7 bits per symbol

1.428 symbols per second

## 2 Link Layer

9. (2 points) [C] Consider the following packet 00010011001000111, If the last bit represents the parity bit, which of the following is true?

- A. Assuming Even parity the packet has been corrupted.
- B. Assuming Even parity the packet has not been corrupted.
- C. Assuming Odd parity the packet has been corrupted.
- D. Assuming Even parity the packet has not been corrupted.

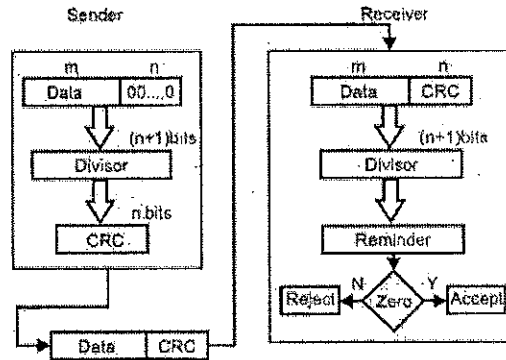


Figure 2: CRC flow

10. (4 points) [B] Consider a 2D parity scheme what is the maximum number of bits flips that you can detect on  $N \times N$  grid?
- A.  $N$   
 B.  $N^2$   
 C.  $2^N$   
 D.  $N!$
11. (4 points) [B] Refer to figure 2 for an overview of CRC. Assuming that we have a generator function of 101 and packet value of 110101. What is the value of the CRC code for the packet?
- A. 001  
 B. 000  
 C. 010  
 D. 11  
 E. 01  
 F. 00
12. (2 points) [A] Given the following generator 1011 and packet 1010101001 which of the following corrupted packets will be incorrectly marked as uncorrupted. Select all that apply if none apply leave blank
- A. 1010101011  
 B. 1111101011  
 C. 1011010111  
 D. 1010110110  
 E. 1010111001

Dropped

13. (2 points) [C] Which of the following are **disadvantages** of the slotted aloha protocol. Select all that apply if none apply leave blank

- Wasted Time slots
- Requires Clock Synchronization
- Single Node can transmit continuously on empty channel
- Decentralized

14. (4 points) [B] The Ethernet Collision detection algorithm uses binary exponential back-off by randomly selecting the number of time slots to wait from the set  $\{0, 1, 2, \dots, 2^m - 1\}$  where  $m$  is the number of collisions detected so far. Assuming that we are transmitting on 1 Mbps Ethernet, with a max frame size of 512 bits. What is the maximum amount of time we would have to wait before we could re-transmit given that there have 8 previous collisions.

- A. 13 ms
- B. 256 ms
- C. 1us
- D. 512 ms
- E. none of the above

131 ms

$$\frac{(2^8 - 1) \times 512}{10^6} = 0.13s$$

15. (2 points) [A] For the collision detection scheme to work we need to design our packets so that the minimum packet length is equal to  $2d_{prop} * R$ , where  $d_{prop}$  represent the propagation delay and  $R$  represents the transmission rate. Assuming that the minimum packet size is 512bits and the speed of light in our medium is approximately  $2^{28}$ . What is the maximum length Ethernet cable we should use in a system with a data rate of 1Gpbs

- A. 64m
- B. 1000m
- C. 100m
- D. 32m
- E. none of the above

$2d \times R = 512$     let  $d = \ell / s$   
 $\ell = \frac{512}{2R} \times s$   
 $= \frac{512}{2 \times 2^{30}} \times 2^{28} = \boxed{64}$

16. (2 points) [A] Suppose you have three active nodes (A,B,C) which are competing for access to a channel using slotted ALOHA. Assume that each node has a finite number of packets to send and that each each node attempts to send with probability 0.5. What is the probability that node A succeeds for the **first time** in slot 4? Select the answer is closest by 2 decimal places.

- A. 0.08
- B. 0.06
- C. 0.125
- D. 0.33
- E. none of the above

probability of success  $P(1-P)^{N-1}$   
 $= 0.5(1-0.5)^2$   
 $= \frac{1}{2} \times \frac{1}{4}$   
 $= \frac{1}{8}$   
 probability of failure  $1 - \frac{1}{8} = \frac{7}{8}$

$\boxed{F} \quad \boxed{F} \quad \boxed{F} \quad \boxed{S}$

$\frac{7}{8} \cdot \frac{7}{8} \cdot \frac{7}{8} \cdot \frac{1}{8} = 0.8$

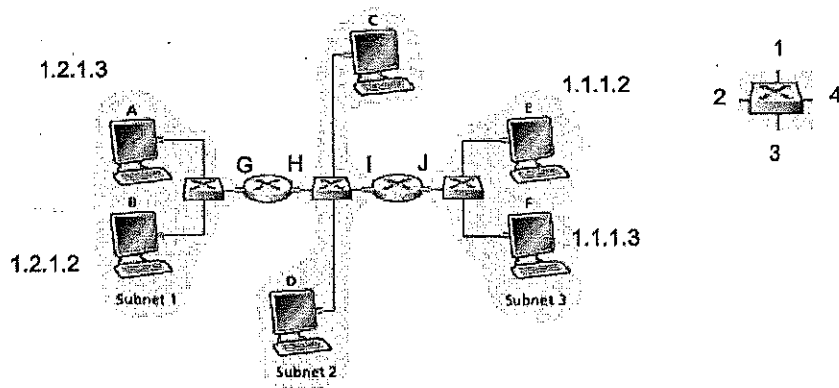


Figure 3: Network Topology

17. (2 points) [C] Consider the topology shown figure 3. MAC-addresses are shown in letters A-J. Assume that the switch on Subnet 1 is a self learning switch. Interface are always numbered based on their orientation as shown in the switch on the top right side of figure 3. When the machine at 1.2.1.3 sends a packet to the machine 1.2.1.2 what gets added to the switches table.
- 1.2.1.3 on interface 1
  - 1.2.1.2 on interface 3
  - A on interface 1
  - B on interface 2
  - none of the above
18. (4 points) [B] If the machine at 1.2.1.2 sends a packet to the machine at 1.1.1.2. What MAC-address will the receiver see as the sending address? **Select all that apply if none apply leave blank**
- A  
 E  
 G  
 I  
 J
19. (4 points) [B] The Machine at IP 1.2.1.2 sends a packet to machine at IP 1.1.1.3, which of the following are valid entries in subnet 2's switch **Select all that apply if none apply leave blank**
- A on interface 2  
 F on interface 4  
 H on interface 2  
 I on interface 4  
 none of the above

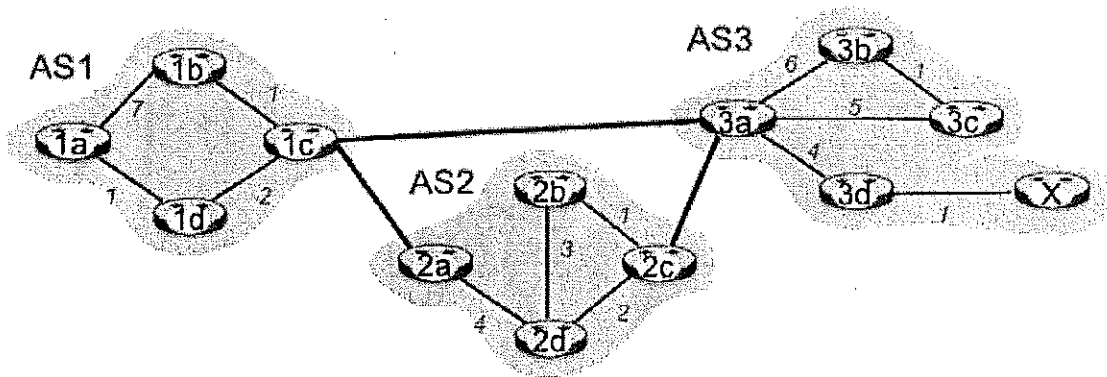


Figure 4: Example Autonomous System Topology with Weights

### 3 Network Layer

20. (2 points) [C] What is the first distance vector sent by router 1a.

- A.  $[1a : 0, 1b : 7, 1d : 1]$
- B.  $[1a : 0, 1b : 4, 1d : 1]$
- C.  $[1a : 0, 1b : \infty, 1d : \infty]$
- D.  $[1a : 0, 1b : 0, 1d : 0]$
- E. none of the above

21. (4 points) [B] Assuming all distance vectors are in their initial state and that the only messages that are sent are the following:

- $t_0 A \rightarrow B$
- $t_1 C \rightarrow B$
- $t_2 D \rightarrow A$

What is 1b's new distance vector?

- A.  $[1a : 7, 1b : 0, 1c : 1, 1d : 8]$
- B.  $[1a : 7, 1b : 0, 1c : 1, 1d : \infty]$
- C.  $[1a : 7, 1b : 0, 1c : 1, 1d : 3]$
- D.  $[1a : 7, 1b : 0, 1c : 1, 1d : 3]$  *same*
- E.  $[1a : 4, 1b : 0, 1c : 1, 1d : 3]$
- F. none of the above



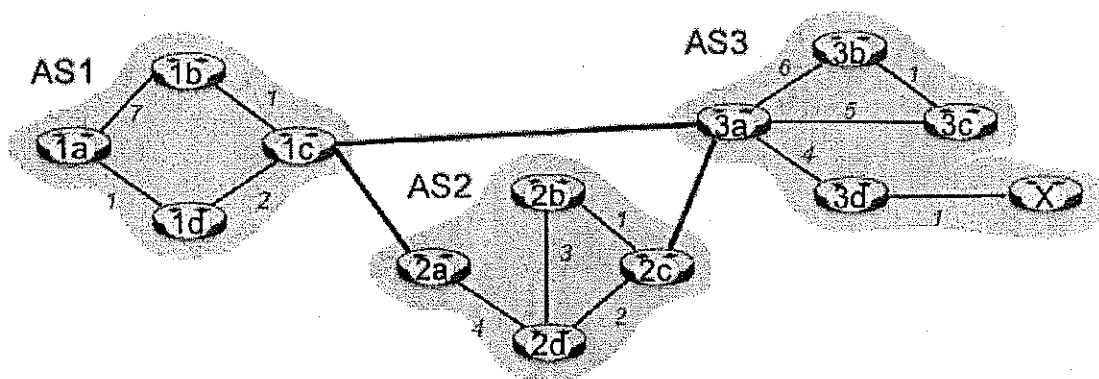


Figure 5: Copy of same diagram for convince

22. (2 points) [A] Assuming that distance vector algorithm has converged, what happens if the link cost between 1d and 1c increases to 74. What is/are the appropriate message(s) that need(s) to be sent if the poison reverse strategy is correctly implemented. Select all that apply if none leave blank

- distance vector from 1a to 1d says that 1a's cost to 1c is infinite  
 distance vector from 1c to 1d says that 1c's cost to 1a is infinite  
 distance vector from 1d to 1a says that 1d's cost to 1c is infinite  
 distance vector from 1d to 1c says that 1d's cost to 1a is infinite

*Because a routes through D*

*Because c routes through d*

23. (2 points) [C] What AS path vector(s) does gateway router 2a receive for the subnet attached to X. Remember that these path vectors are propagated inside of the Autonomous System.

- A. [AS1, AS3, X]  
 B. [AS3, X]  
 C. [AS1, AS3, X], [AS3, X]  
 D. none of the above



24. (4 points) [B] Router 2d has a packet that is destined for the subnet attached to router X. If hot potato routing takes precedence over all other routing policies. What the next hop router be?

- A. 2a  
 B. 2b  
 C. 2c  
 D. none of the above

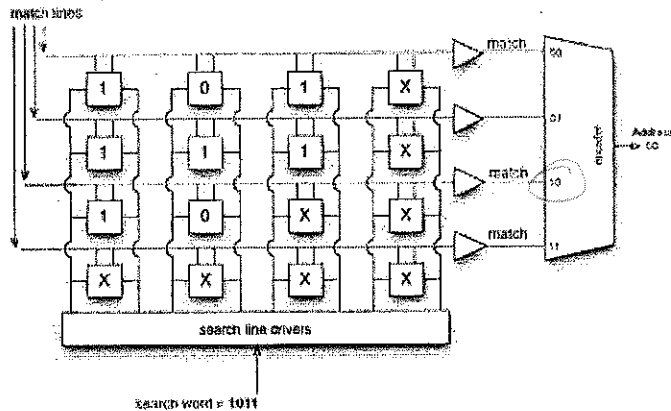


Figure 6: Ternary Content addressable memory

25. (2 points) [A] Assuming that subnet 1.4.1.8/15 is attached to router 1a, which of the following subnets would 3a need to advertise if it wanted to intercept traffic intended for 1.5.1.5

A. 1.4.1.8/24

B. 1.5.1.8/25

C. 1.5.2.18/47

D. 1.4.1.8/16

*Want a longer match than 15*

*This was a mistake it should have been 17, but does not change answer*

26. (2 points) [C] Which of the following are on the same subnet, given the following subnet mask: 201.23.16.0/23. Select all that apply is none apply select none

201.23.16.1

201.23.17.1

201.23.18.1

201.23.22.5

27. (4 points) [B] Consider the image of a TCAM shown in figure 6. Which of the following packets would get forward on the 3rd port? Select all that apply is none apply select none

1010

1000

1001

1011

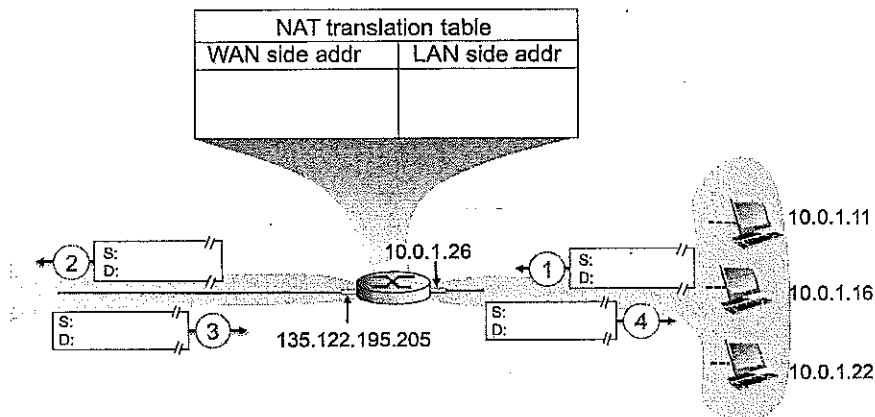


Figure 7: Network address Translation

28. (2 points) [A] Consider an  $N \times N$  cross bar-switch, which formula below represent the number of possible ways to configure the switch

- A.  $N + 1$
- B.  $N^2 + N$
- C.  $2^{N+1} - 1$
- D. none of the above

*None of these work*

29. (4 points) [B] Consider Figure 7. If the machine at 10.0.1.16 has an application running on port 45 which sends a packet to 128.18.46.12 on port 80. If the Nat table assigns a port of 3000 to the application running on port 45, what is the value of source on the Step 2?

- A. 135.122.195.205 : 5000
- B. 10.0.1.16 : 45
- C. 10.0.1.26 : 50
- D. 128.18.46.12 : 80
- E. none of the above

*was a typo but so answer should have been 3000 as none of the above*

30. (4 points) [B] Consider Figure 7 After the server at 128.18.46.12 responds what will be source address and port of packet at step 4?

- A. 135.122.195.205 : 5000
- B. 10.0.1.16 : 45
- C. 10.0.1.26 : 50
- D. 128.18.46.12 : 80
- E. none of the above

*source does not change*

