CSC358: Principles of Computer Networking

Sample Midterm Exam – Solution – 75 Minutes

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UTORid:

First and Last Name:

Instructions.

- This exam is closed book and closed notes. Non-programmable calculator is allowed.
- Make sure to put your name and UTORid on every page.
- Show your reasoning clearly. If your reasoning is correct, but your final answer is wrong, you will receive most of the credit. If you just show the answer without reasoning, and your answer is wrong, you may receive no points at all.

Question	Score
Question 1	/10
Question 2	/10
Question 3	/6
Question 4	/6
Question 5	/16
Question 6	/10
Total	

Question 1. [10 points]. What do you need to do manually for a network with IP over Ethernet to work, if you don't have the following protocols/features working? For example, your answer might be in the form of "give each _____ a table mapping _____ to _____," "determine _____ for each _____," or "nothing." For your reference, we completed the answer for part b.

(a) ARP:

Answer. Give each host and router a table mapping IP addresses to MAC addresses

(b) DHCP:
determine IP address, Network Mask, DNS server IP address, and default gateway IP address for each node in the network.

(c) Routing Protocols:

Answer. Give each router a table mapping IP prefix to outgoing interface.

(d) MAC Learning (at the switches):

Answer. Nothing. Note that even without MAC Learning, frames will be delivered to destination as switches use flooding for frames with unknown destinations.

To improve the efficiency, we can give each switch a table mapping MAC address to outgoing interface/port number.

Question 2. [10 points]. As we have seen in the lecture, the checksum is the ones' complement of the summation of all 16-bit words in the message in ones' complement arithmetic. In this problem, we define a (N, K) coding scheme, named *CSC358 block coding*, which relies on the checksum. *CSC358 block coding* transform any 10-byte message into a codeword by appending the checksum bits to the end of the original message.

(a) **[2 points]**. Specify the value of N and K for this (N, K) coding scheme, *i.e.*, CSC358 block coding.

$N =$ $K =$

(b) **[8 points]**. What is the Hamming distance of this coding scheme? Justify your answer.

Answer. See Worksheet 4 Solution – Q2.

Question 3. [6 points] Compare the following pair(s) of terms/concepts in at most 4-6 sentences. Explain the key differences – the context they are defined at, protocol(s) they are related to, and the pros and cons of each of them.

Non-Return to Zero (NRZ) Encoding vs. Manchester Encoding:

Answer.

- They are implemented in physical layer.
- They are two different encoding schemes by which digital information in a binary bit stream is converted into electrical signals for transmission.
- Manchester was the line coding used in Ethernet.
- NRZ encodes 1 as high, 0 as low signal.
- Manchester encodes 0 as a low to high transition and 1 as a high to low transition.
- NRZ struggles with baseline wandering (i.e., consecutive 0's and 1's are problematic), while Manchester resolves this issue by keeping the DC of the transmitted signal fixed and independent of the binary information.
- NRZ struggles with "bit slip" due to sender and receiver clock being not synchronized. Having to many consecutive 0's or 1's makes clock recovery very difficult for NRZ. Manchester resolves this issue by merging the clock with signal.
- Manchester's bandwidth utilization is 50% of NRZ bandwidth utilization.

Question 4. [**6 points**] Consider the router and the three subnets A, B, and C attached to it, illustrated in the figure 1. The number of hosts in subnet A, B, and C are 120, 29, and 9, respectively. The subnets share the 24 high-order bits of the address space: 38.240.108.0/24. Assign subnet addresses to each of the subnets (A, B, and C) so that the amount of address space assigned is minimal, and at the same time leaving the largest possible contiguous address space available for assignment if new subnets were to be added. Then, answer the following questions.

(a) [**1.5 points**] What is the subnet addresses of subnet A in CIDR notation?

(b) [**0.5 points**] What is the broadcast address of subnet A?

(c) [**1.5 points**] What is the subnet addresses of subnet B in CIDR notation?

(d) [**0.5 points**] What is the broadcast address of subnet B?

(e) [**1.5 points**] What is the subnet addresses of subnet C in CIDR notation?

(f) [**0.5 points**] What is the broadcast address of subnet C?

Answer. See Problem Set 1 Solution - Q8.

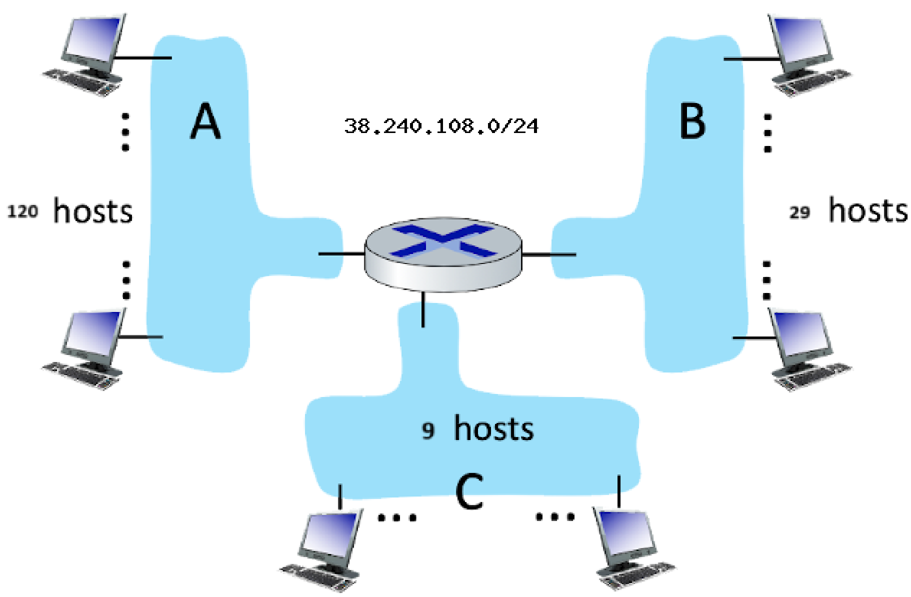

Figure 1: A Router with three subnets.

Question 5. [16 points]. In class, we discussed an algorithm to create a spanning tree for a network of switches. Consider the network topology given in figure 2, where each square node represents a switch and each circle node represents a host. Assume that each switch's ID is equal to its number (*i.e.*, switch #k's ID is set to k). Answer the following questions for the network topology given below, where cost of each edge is 1.

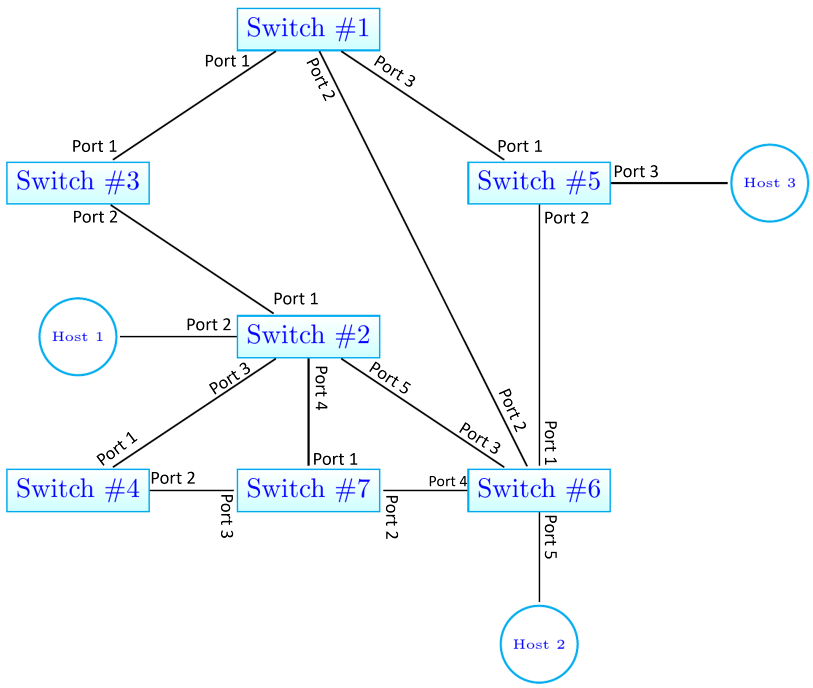

Figure 2: Network of switches

(a) **[1 points]**. Provide the format of the messages that switches exchange.

Answer. See Worksheet 5 Solution – Q2.

(b) **[1.75 points]**. **Initialization:** For each node, indicate the initial state of the node, *i.e.*, the first message the node exchanges with its neighbors.

Node	Message
1	
2	
3	
4	
5	
6	
7	

Answer. See Worksheet 5 Solution – Q2.

(c) **[3.5 points]**. **Step 1:** Assume that all nodes received the messages from their neighbor during the initialization step given in (b). For each node, indicate the next messages that it exchanges with its neighbors.

Node	Message
1	
2	
3	
4	
5	
6	
7	

Answer. See Worksheet 5 Solution – Q2.

(d) **[1.75 points]**. **Step 2:** Assume that all nodes received the messages from their neighbor during Step 1 in (c). For each node, indicate the next messages that it exchanges with its neighbors.

Node	Message
1	
2	
3	
4	
5	
6	
7	

Answer. See Worksheet 5 Solution – Q2.

(e) **[8 points]**. Assume the spanning tree algorithm has converged. The following events occur sequentially. After each event (i)-(iii) occurs, draw the MAC address tables for Switch #1 and Switch #7. Write your answer in the tables provided on the next page.

(i) H1 sends a packet to H2

(ii) H3 sends a packet to H2

(iii) H2 sends a packet to H3

Answer. See Worksheet 5 Solution – Q2.

Your Answer to Question 6:

Switch #1's table after step (i)	
MAC address	Port

Switch #7's table after step (i)	
MAC address	Port

Switch #1's table after step (ii)	
MAC address	Port

Switch #7's table after step (ii)	
MAC address	Port

Switch #1's table after step (iii)	
MAC address	Port

Switch #7's table after step (iii)	
MAC address	Port

Question 6. [10 points]

(a) [**4 points**] A packet of size 1000 bits is transmitted over a link with an independent and identically distributed (i.i.d.) error model. Given a bit error rate of 0.001, **what is the probability that the packet is transmitted without any errors?** You can use the following estimation: $(1-\epsilon)^k \approx e^{-k\epsilon}$.

Answer. See Worksheet 3 Solution – Q1.

(b) [**6 points**] Referring to the scenario in part (a), suppose Stop-and-Wait ARQ is employed for reliable packet transmission. In Stop-and-Wait ARQ, the sender transmits a single packet and waits for an acknowledgment (ACK) from the receiver before sending the next packet. If no ACK is received due to a timeout, the sender retransmits the same packet. Calculate the average number of transmissions required to successfully deliver one packet. Assume the acknowledgments to be error-free for simplicity. [**HINT:** The expectation of a geometric random variable with success probability of ρ is $\frac{1}{\rho}$.]

Answer. See Worksheet 3 Solution – Q1.