Midterm Exam

CSCI 4273/5273 and ECEN 5273, Network Systems

October 18, 2017

Name: _____

1. Enter your name above. Check that you have 8 pages & 4 problems.
2. Partial credit will be given, but you must show the details of your work and state assumptions that you make.
3. Feel free to use the back of sheets. Just indicate when you've done so.
4. The Honor Code applies to this exam. This exam is closed book. Calculators may be used, but no cheat sheets are allowed.

Problem 1 (51 points): Internet and Wireless

(a) (2 points) List two more ways to share the media in the link-layer. The first way is providing strict isolation: division over time or frequency.

"Taking turns" or token passing
Random access

(b) (2 points) What is the role of TTL (Time-to-Live) field in each IP packet?

It is used to identify packets stuck in forwarding loops and it let the network eventually discards those packets.

(c) (2 points) What is the name of protocol that provides the MAC address for the given IP address?

Address Resolution Protocol (ARP)

(d) (2 points) What is the name of protocol that provides the IP address for the given host name, and vice versa?

Domain Name Service (DNS)

(e) (2 points) When a DHCP client receives the DHCP offer message from the DHCP server, why it echoes selected parameters?

As there could be multiple DHCP servers may respond, a DHCP client informs the other servers that they were not chosen.

(f) (2 points) With IP anycast, why failover doesn't really work with TCP?

TCP is stateful: with failover, other server instances will just respond with RSTs (as they are in fact different instances).

(g) (2 points) Please list two multicast protocols

PIM Sparse Mode (PIM-SM)
PIM Dense Mode (PIM-DM)

(h) (2 Points) Name one method that WiFi employs to avoid collisions

Any of the following is correct:
CSMA/CA, RTS/CTS, exponential backoff, "listen before talk", etc.

(i) (2 points) What is the purpose of spanning trees in Ethernet?

Prevent loops

(j) (3 points) Briefly explain the main difference between Go-Back-N and Selective Repeat protocol.

Selective Repeat allows selective retransmit of previously missed packet, while Go-Back-N has to roll back to the missed packet and have all proceeding packet retransmitted.

(k) (2 points) If 2 computers are directly connected by Ethernet cable, what will affect the transmit time of packets?

Bandwidth

(l) (2 points) Given link layer retransmission, why do you need end-to-end retransmission?

For efficiency (packets still can be lost in upper layers – IP routers or end hosts can discard packets)

(m)(2 points) What is the difference between flow control and congestion control in TCP?

Flow control: control the rate between two end hosts
Congestion control: control the rate between the sender and the network

(n) (2 points) What MTU and MSS stand for?

MTU: Maximum Transmission Unit
MSS: Maximum Segment Size

(o) (2 points) When Fast Retransmission in TCP triggers?

Triple Duplicated ACKs

(p) (1 point) By returning IP addresses in "round robin" fashion, DNS operators can distribute load to multiple servers
(True)/False

(q) (1 point) Random access (e.g., CSMA/CD) is inefficient at low load
True/(False)

(r) (1 point) All hosts on subnet see all communication.
(a)Ethernet (wired), (b) 802.11 (wireless), (c) Both, (d) Neither

(s) (1 point) Simple application multicast has O(n) running time to send data to the group of users while advanced overlay multicast ("peer-to-peer") has O(nlogn) work on the sender. Here n is the number of users in the group.
True/False

(t) (1 point) Compared to hubs, Ethernet switches support.
(a)Larger geographic span, (b) Similar span, (c) Smaller span

(u) (1 point) Please choose the service not part of link layer services.
(a)Encoding, (b)Framing, (c)Flow control, (d)Error correction, (e)congestion control

(v) (1 point) DHCP servers require a special coordination protocol to maintain their address pool's consistency?
(a)True, (b)False

(w) *(6 points)* Suppose that, like the path traversed by the car, the link is 200 km long and the bandwidth is 800Kbits/sec. The speed of electricity in a copper cable is 200,000,000 meters/second. How big does the receive window need to be to avoid becoming the main constraint on the transfer rate? (Ignore the effects of header sizes, TCP congestion control, and packet loss, and assume that the receiver immediately sends an ACK packet after receiving each data packet and that there is no congestion.)

The receive window needs to be large enough to accommodate a round-trip time of data. The one-way delay is 1sec/200,000km * 200km, or 0.001 seconds (or 1 msec). So, the round-trip time is 0.002 seconds (or 2 msec). Since the link bandwidth is 800,000 bits/sec, the total number of bytes transmitted during a round-trip time is:
0.002 sec * 800,000bits/sec = 1600 bits
OR
0.002 sec * 800,000bits/sec * 1byte/8bits, or a grand total of 200 bytes.

(x) (3 points) With Go-Back-N and N=4, what is the performance for the following case? The bandwidth is 1.5Mbps, the round trip time between two end hosts is 45ms, and the frame size is 1KB.

BDP: 1.5 Mbps x 0.045 /(1 x 1024 x 8) = 8.64 packets.(In case a student did not follow instructions given and takes 1K =1024.)

OR
(1K = 1000, 1M = 1000*1000 and 1B= 8bits)
BDP: 1.5*1000*1000 x 0.045 /(1 x 1000 x 8) = 8.43 packets.
The network can hold around 8 packets and 4 packets are sent in burst with the Go-Back-N protocol with N = 4, indicating that it will achieve around 50% performance.

(y) (4 points) Assume that HDLC denotes beginning and end of a packet/frame with "01111110" flag. The sender wants to send the message "01101111111001111011111" with bit stuffing to the receiver. Describe how the sender can deliver this message using bit stuffing? How the receiver can decode the stuffed message?

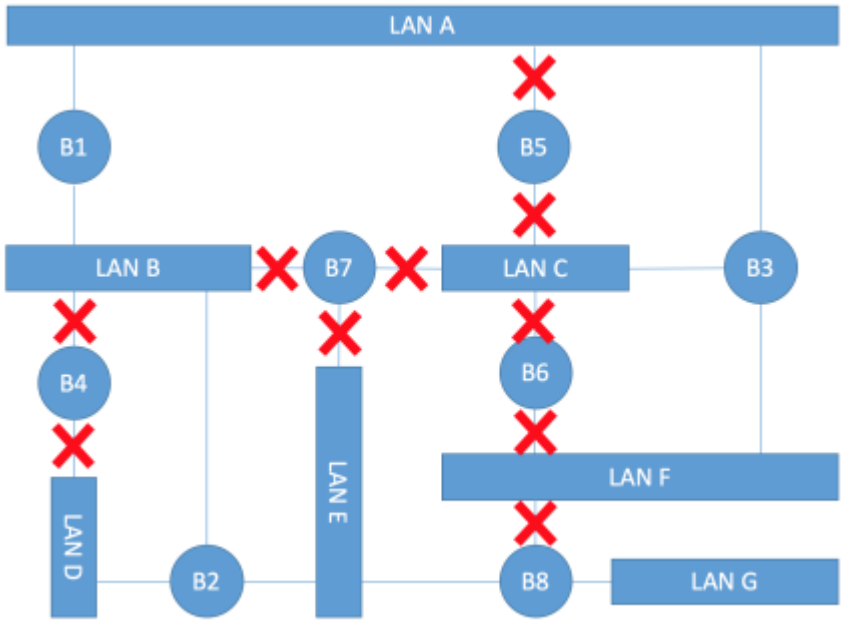
<flag> 011011111011001111100111110 <flag>

Problem 2 (5 points): Link Layer

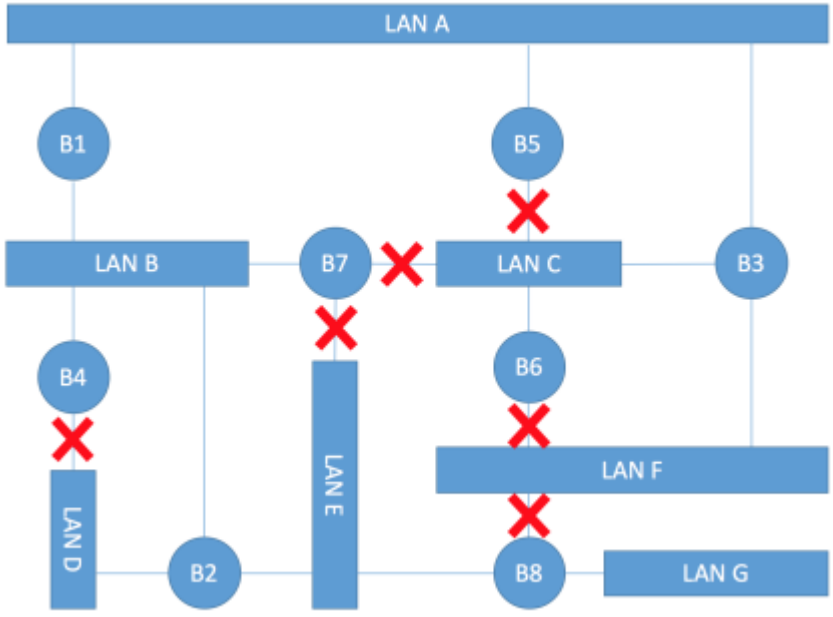
For the figure below, indicate all ports not selected by the spanning tree algorithm by crossing out deselected ports using "X" marks. (Note: When tie happens, path will be chosen via smallest id number.)

Official answer:

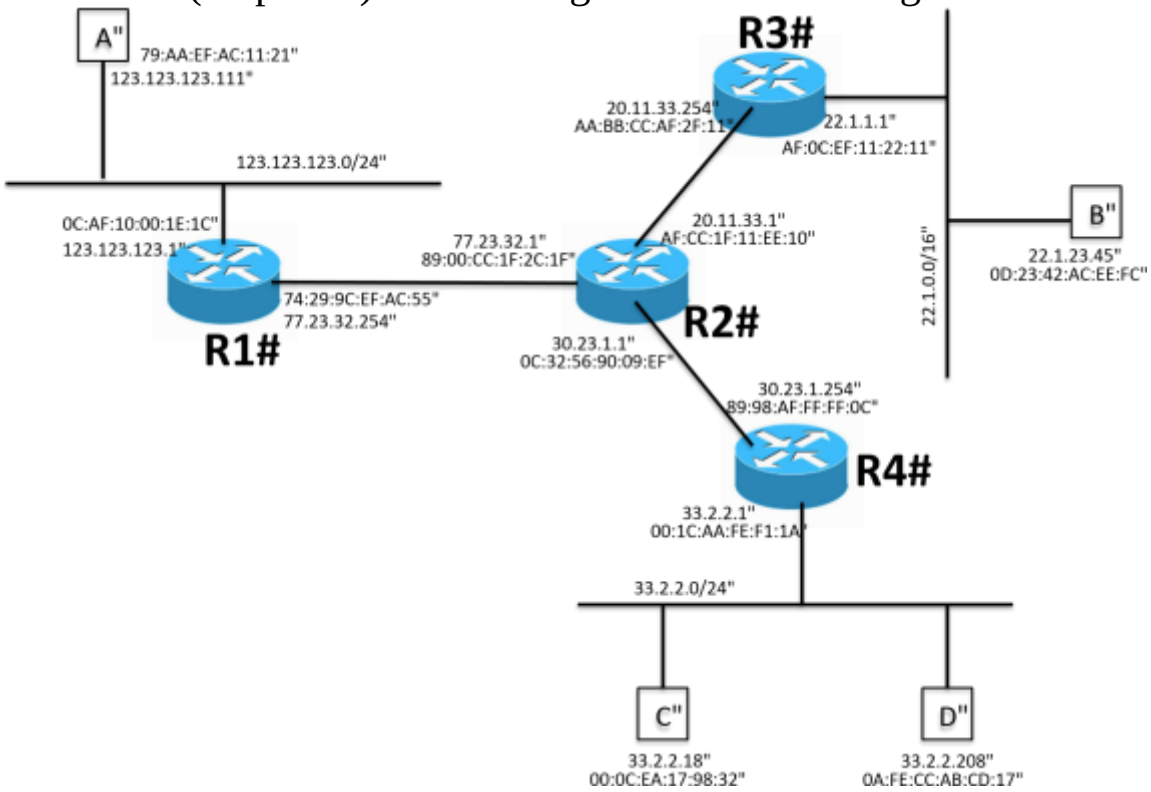
"The main idea of the spanning tree is for the bridges to select the ports over which they will forward frames."(pp196.Computer Networks 5th ed).



The following answer can also be considered correct if the student try to leave **root port open** on each switch/bridge. The concept of root port is not introduced in this course



Problem 3 (26 points): Addressing and IP Forwarding



Above is the picture of a network with 4 routers (R1, R2, R3, R4) and 4 hosts (A, B, C, D). Each interface is labeled with both an IP address and a MAC address. Routing is enabled so the any two hosts can communicate each other and also the default gateway of each host is set to its gateway router.

(a) [8 points] Suppose that A send an IP packet to B through R1, R2, and R3. How does the IP packet's content (src Mac, dst Mac, src IP, dst IP) change over each path (Path1: A->R1, path2: R1-> R2, Path 3: R2->R3, Path 4: R3->B)? Be specific.

Path1: A -> R1

Source IP	123.123.123.111
Destination IP	22.1.23.45
Source MAC	79: AA: EF: AC: 11: 21
Destination MAC	0C: AF: 10: 00: 1E: 1C

Path2: R1 -> R2

Source IP	123.123.123.111
Destination IP	22.1.23.45

Source MAC	74: 29: 9C: EF: AC: 55
Destination MAC	89: 00: CC: 1F: 2C: 1F

Path3: R2 -> R3

Source IP	123.123.123.111
Destination IP	22.1.23.45
Source MAC	AF: CC: 1F: 11: EE: 10
Destination MAC	AA: BB: CC: AF: 2F: 11

Path4: R3 -> B

Source IP	123.123.123.111
Destination IP	22.1.23.45
Source MAC	AF: 0C: EF: 11: 22: 11
Destination MAC	0D: 23: 42: AC: EE: FC

(b) [4 points] When B sends out an ARP query for its default gateway, what is the reply to that query?

MAC address of the default gateway which is AF: 0C: EF: 11: 22: 11

(c) [6 points] Suppose that all four hosts can communicate. What will be the R2's routing table entries?

Destination / Mask	NextHop	Interface/logical port identifier
77.23.32.0/24	Directly connected	*Interface 0*
20.11.33.0/24	Directly connected	*Interface 1*
30.23.1.0/24	Directly connected	*Interface2*
123.123.123.0/24	77.23.32.254	*Interface 0*
22.1.0.0/16	20.11.33.254	*Interface 1*
33.2.2.0/24	30.23.1.254	*Interface 2*

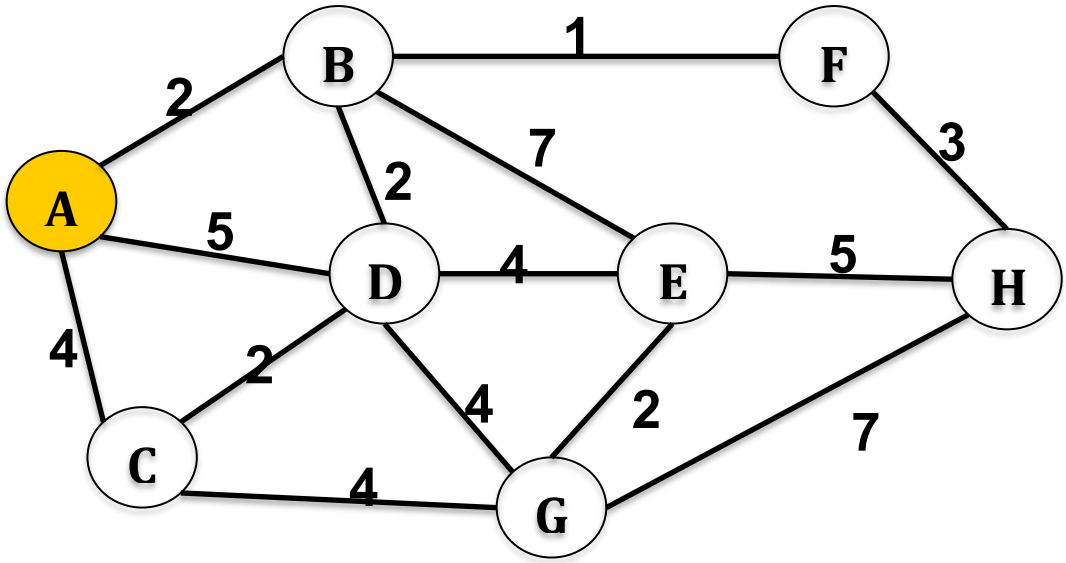
(d) (8 points) The network where host A is connected (123.123.123.0/24) wants to accompany 4 different subnets with the following number of hosts: 64, 32, 16 and 15. Please provide a plan of how to divide the subnets for the network admin.

Remember subnet such as 123.123.123.0/25 will have 128 IPs but can only assign to 126 hosts. So the solution will be as below:

123.123.123.0/25,
123.123.123.128/26,
123.123.123.192/27,
123.123.123.224/27

Problem 4 (18 points): Routing and Routing Stability

A shortest-path, link-state routing protocol (based on link weights not simply hops) running on the following network, where the numbers corresponds to link weights:



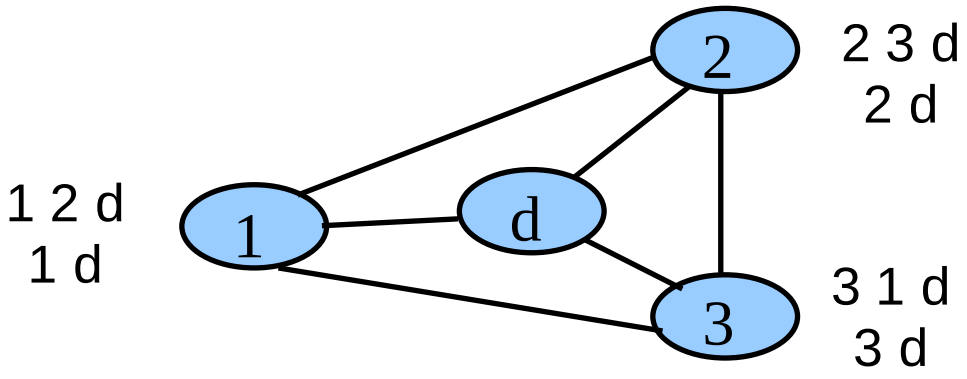
(a) Suppose the link between nodes D and E fails. Before the failure, what is the shortest path from node A to node E? (4 points) What is the new path after the failure, when routing-protocol convergence completes? (4 points)

Before failure: A->B->D->E
After failure: A->B->E

(b) Suppose the link between nodes A and B fails. Please draw the forwarding table at A (4 points).

Destination	Next Hop
B	D
C	C
D	D
E	D
F	D
G	C
H	D

(c) Consider a network with four ASes speaking BGP. ASes 1, 2, and 3 are trying to select routes to a destination in AS d. Each AS prefers a two-hop path through their clockwise neighbor over a direct path (i.e., AS 2 prefers "2 3 d" over "2 d"), and the ASes do not export any other routes (e.g., AS 3 does not export "3 d" to AS 1, and AS 2 would only export "2 d" to AS 1). What decisions will the ASes make? How will the system behave? *(*6 points*)*



Traffic going to d will end up in a circle among 1,2,3 they will never be delivered to d (loop!)

Problem 1: _____ / 51
Problem 2: _____/ 5
Problem 3: _____ / 26
Problem 4: _____ / 18
Overall Score: _____ / 100