4.3 Continuing with this example, next assume that node C receives the following routing update message from node B. In the table below update node C's forwarding table (including any changes from part (4.2)).

$C \to B = 9$ Column from part 1.2

Routing update message from node B		+9	
Destination	Cost to destination		
A	9	18	
B	0	9	
C	5	14	
D	2	11	5
E	14	23	~~15~~ B
F	3	12	11
G	3	12	13

Forwarding table for C		
Destination	Next node	Cost to destination
A	A	9
B	B	9
C	C	0
D	D	5
E	B	23
F	A	11
G	B	12

4.4 For the remainder of this problem ignore the changes given in parts (4.2) and (4.3), and instead use the "beginning forwarding table for C" as given in the beginning of this problem. Now assume that there have been some changes in the network (but no changes to the links from C to its neighbors). Node A has updated its forwarding table and should send a routing update message to node C, however this message is lost so that node C does not receive this message. Also, node A does not know that the message was lost and so does not retransmit the message. Next node C sends a routing update message based on its forwarding table, and this message is correctly received at node A. Clearly mark in the table below changes (if any are necessary) that node A should make to its forwarding table.

from C $A \text{ to } C \to 5$

	+5	
A 9		–
B 7		12 x
D 5		10 x
E 13		18 x
F 11		16
G 13		18

Forwarding table for A		
Destination	Next node	Cost to destination
A	A	0
B	B	2
C	C	5
D	C	10
E	B	3
F	~~F~~ C	~~18~~ 16
G	~~F~~ C	~~20~~ 18

After node A has changed its forwarding table according to part (4.4), and node C still has its "beginning forwarding table for C". What problem is there in this network?

A loop to destination F for a packet at A or C. A forwards to C and C forwards to A

Name: Solutions

ECE 4380/6380: Computer Communications **Spring 2017**

Exam 2 (Each of the 4 problems is worth 25 points) **Friday, April 7**

Graduate students (638): For problem 1, you only need to answer any 8 of the short answer questions.
Undergraduate students (438): For problem 1, you only need to answer any 6 of the short answer questions. Extra credit earned on any extra answers will be added to your total homework score.

1 Short Answer. Your answer to each question should be twenty words or less.

1.1 How are forwarding tables built for learning bridges?

Each bridge monitors the source address for all frames it receives. The port the frame is received on is added to the table for this address

1.2 Assume router R8 receives a broadcast ARP query that is requesting host H25's MAC address. The other fields in R8's ARP table include H25's IP address and the IP and MAC addresses for the source of the ARP packet, which is host H19. If R8 finds that H25's IP address is in its ARP table but H19's IP address is not in its ARP table, how does R8 update its ARP table and what ARP reply packet does R8 send?

R8 ignores the ARP query and makes no reply.
H19 is unknown so not added to table
H25 is not the source of the query, so do not update the timer
(H25 is responsible for responding to the query)

1.3 Describe the actions performed by IP routers to catch packets that are going around in loops.

A router decrements the TTL (hop count) field in an IP packet. If the hop count is zero, the packet is discarded
An ICMP message can be sent to the source

1.4 A network that employs virtual-circuit forwarding must have a protocol to setup the virtual circuit before it can be utilized. One of the tasks during the setup phase is to assign the local virtual-circuit identifier (VCI) at each switch. Once the virtual circuit is setup, the packets are forwarded based on the VCI. How is the setup packet forwarded given that the local VCI's have not yet been established?

Setup packets are routed like datagrams using destination-based routing

1.5 An organization has a large number of LAN's and one DHCP server. How does a newly booted host contact the DHCP server when the server is not located on the host's LAN?

The host broadcasts a DHCP discovery message on the LAN. A DHCP relay sends a unicast message to the DHCP server

1.6 A host attached to an Ethernet LAN is configured with a single default route in its forwarding table. Assume two routers are connected to this LAN, R1 and R2, and that R1 is the default router for the host. If a destination host is reachable through R2, the first time a packet from the host is forwarded it travels to R1, and R1 forwards the packet to R2 (the packet travels on the LAN twice). What mechanism is available with IP to update the host to forward packets for this destination directly to R2?

ICMP redirect message to have the host install a host-specific entry in its forwarding table

1.7 Name an advantage of a level-3 switch compared to a level-2 switch.

Support for different types of LANs.

(lots of other reasons: improved routing, scalability, reduced collision domains, etc...)

1.8 The traceroute function allows a network engineer to discover the IP addresses for the routers in the path to some destination. What features of IP and ICMP make this capability easy to implement? Set the TTL field in an IP packet to 1. At first router, it is dropped and an ICMP error message is returned to source. Repeat for successively larger hop counts

1.9 A host that receives an IP packet that has been fragmented must wait until it collects all of the fragments associated with this packet. What actions does that host take if, after a suitably long period of time, there are still one or more fragments missing?

The host discards the fragments. It can send an ICMP reassembly failure message, but IP does not handle retransmissions

1.10 The following four IP packets have been received at a destination node. The packets are part of the same original IP packet, but the original packet was fragmented. Have all of the fragments been received? Justify your answer by describing how the fragments are reassembled or describing what portion (or portions) of the packet is missing.

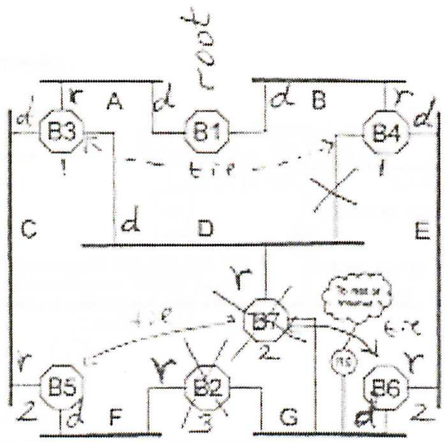
Packet no.	Source IP address	Fragment ID	M bit	Offset	Bytes of data
1	192.21.129.1	45	0	192	256
2	192.21.129.1	45	1	0	512
3	192.21.129.1	45	1	128	512
4	192.21.129.1	45	1	64	256

Offset	pkt#	Size	Words
0	2	512	64
64	4	256	32
96	—		32
128	3	512	64
192	1	256	—

No, missing fragment starting at offset 96. containing 256 bytes (or 32 words)

2 Spanning Tree Algorithm for Intelligent Bridges.

Consider the spanning tree algorithm for the network shown to the right. The seven bridges numbered 1 to 7 run the spanning tree algorithm. Router R0 is connected to LAN ~~A~~ G and provides a connection to the Internet.



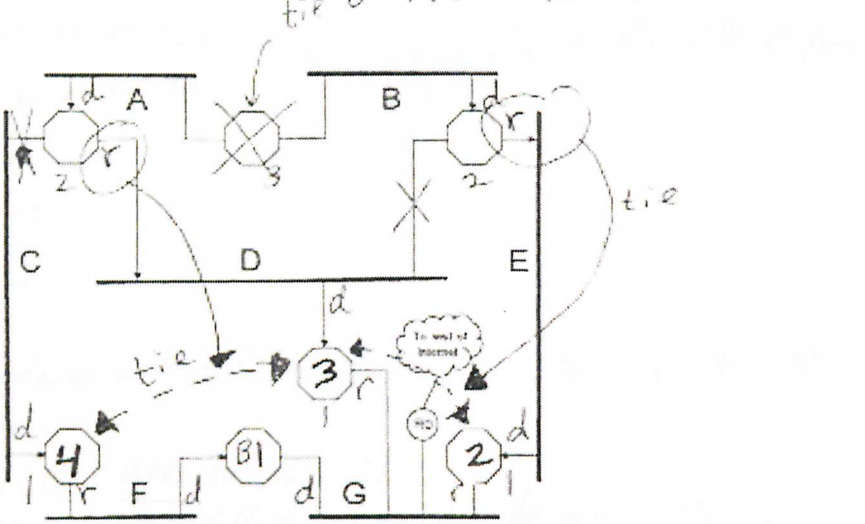
2.1 Indicate on the figure the spanning tree. Be sure to indicate the root port for each bridge (except the root bridge), the designated port for each LAN, and the links and bridges that do not participate in forwarding data frames.

2.2 Assume that hosts attached to LAN C generate traffic with destinations found through the router to the rest of the network, and the bridges have learned which port to use for forwarding traffic between LAN C and RO. Which bridges forward frames generated by hosts on LAN C to RO?

LAN C → B3 → LAN A → B1 → LAN B → B4 → LAN E → B6 → LAN G

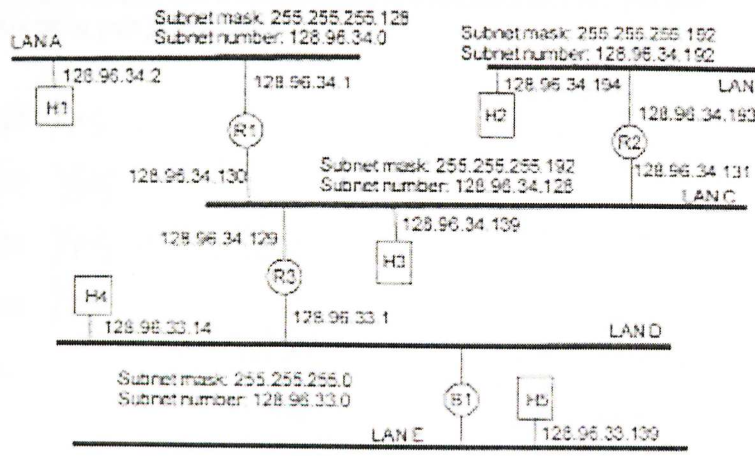
2.3 Assume that hosts attached to LAN's A, B, and C generate traffic with destinations found through the router to the rest of the network. Renumber the bridges so that the traffic from the hosts on LAN A traverses LAN D to LAN G, LAN B traverses LAN E to G, and LAN C traverses LAN F to G. Draw the resulting spanning tree in the figure below showing the new bridge numbers and root and designated ports. You can only change the numbers assigned to the bridges (e.g., links cannot be moved and no new links can be added).

tie but does not matter how broken



3 IP forwarding, LAN forwarding, ARP, and subnet masks.

An organization with five Ethernet LAN's utilizes a Class B address with network number 128.96. Using subnet masks, the organization has created four subnets pictured in the figure. Routers R1, R2, and R3 connect the subnets. Notice that the learning bridge B1 connects LANs D and E into an extended LAN. The organization assigned subnet numbers and masks shown in the figure. For example, the IP address for host H1 on LAN A is 128.96.34.2 and its mask is 255.255.255.128.



Part A. For part A only, assume a network manager has configured the mask for host H3 incorrectly. The IP address 128.96.34.139 is correct, but the manager set the subnet mask to 255.255.255.0 instead of 255.255.255.192. The default router for host H3 is 128.96.34.130 (R1).

For each of the following four questions determine if H3 can send an IP packet to the given destination. If it can, describe the Ethernet frames that each host transmits. If not, describe the problem. The incorrect subnet mask causes problems. Be sure to explain what the problem is.

3.1 Can H3 send an IP packet to H1? No } H3 broadcasts ARP query on LAN C

3.2 Can H3 send an IP packet to H2? No } but gets no reply

3.3 Can H3 send an IP packet to H4? Yes } H3 forwards to R1 (its default

3.4 Can H3 send an IP packet to H5? Yes } router)

H3: 128.96.34.139

Mask · 255.255.255.0

subnet 128.96.34.0

⇒ H3 decides an IP address with subnet number 128.96.34.0 to ..34.255 is on its local network.

⇒ H3 believes H1 and H2 are on its LAN but H4 and H5 are on a different LAN (due to subnet 33.0)

For H4 and H5, H3 broadcasts ARP query for R1's MAC on LAN C. R1 replies with its MAC address. H3 forwards IP packet to R1

R1 repeats 3 steps to forward to R3. R3 repeats 3 steps to forward to hosts. (If MAC address found in cache, can skip ARP query/reply steps)

Part B. For this part, assume the network manager corrects the subnet mask for H3. However, after this change the manager thinks that host H5 should also use a subnet mask of 255.255.255.192. For the following questions, repeat the analysis from part A but for H5.

3.5 Can H5 send an IP packet to H1? Yes

3.6 Can H5 send an IP packet to H2? Yes

3.7 Can H5 send an IP packet to H3? Yes

3.8 Can H5 send an IP packet to H4? Yes

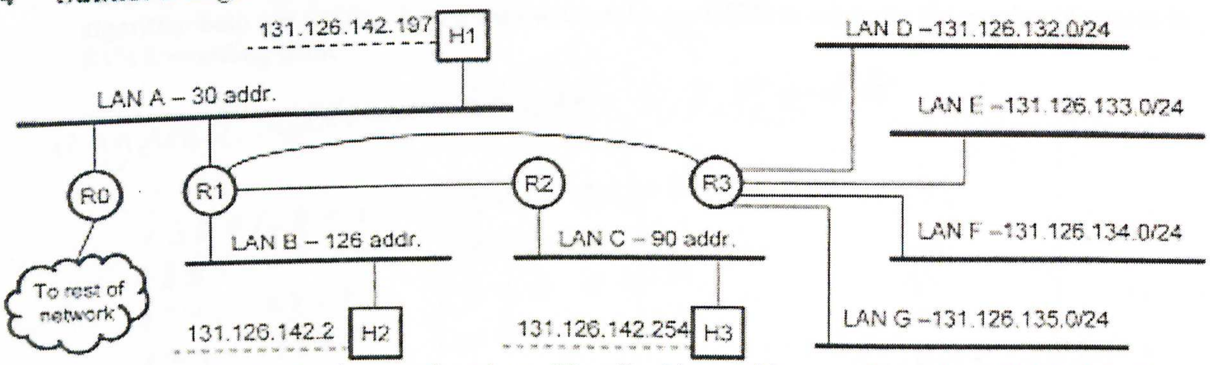
H5: 128.96.33.139
mask 255.255.255.192
128.96.33.128

Since none of H1, H2, H3, or H4 has an IP address in the 33.128 range (from 33.128 to 33.191) H5 believes all hosts are not in its local LAN

H5 forwards these IP packets to its default router (R3) using the normal method (ARP query / reply if MAC not in cache, followed by sending IP to R3).
Note R3 can forward the packet to H4.

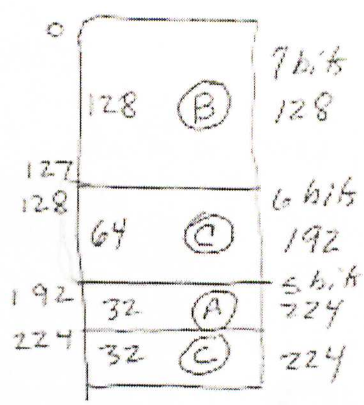
R3 can send an ICMP redirect message to H5 for H4 (as could be done in previous part of the problem for H3 to H4 and H5).

4 Subnet Design and CIDR.



Suppose an organization has been assigned one Class B address with network number 131.126.0.0. The organization must utilize the block of addresses from 131.126.142.0 to 131.126.142.255 for LAN's A, B, and C. The addresses must be organized so that 30 IP addresses are available for LAN A, 126 IP addresses for LAN B, and 90 IP addresses for LAN C. Furthermore, the three hosts, H1, H2, and H3 must have the IP addresses shown in the figure. (Notice LAN's D, E, F, and G have a subnet mask indicated by /24, which is equivalent to 255.255.255.0)

142 subnet



4.1 List subnet numbers and mask assignments for LAN's A, B, and C.

LAN A ⇒ block size 32 in range 192 to 223
LAN B ⇒ 128 0 to 127
LAN C ⇒ two blocks of 64 and 32
64 in range 128 to 191
32 in range 224 to 255

LAN A 131.126.142.192
255.255.255.224

111[---

LAN B 131.126.142.0
255.255.255.128

1000 0000

LAN C 131.126.142.128
255.255.255.192

1000 0000
1110 0000

131.126.142.224
255.255.255.224

4.2 Simplify the IP forwarding table for router R1, assuming the routing protocol and IP forwarding algorithm both use CIDR. You must use the rules for CIDR to minimize the number of entries in R1's forwarding table.

1) aggreate addresses for LANs D, E, F, and G

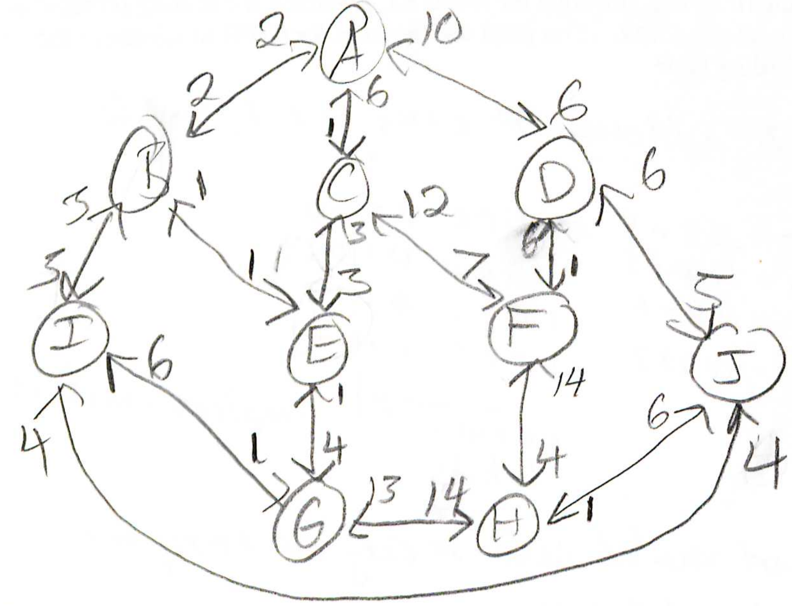
132 = 128 + 4	1000 01|00
133 = 128 + 5	1000 01|01
134 = 128 + 6	1000 01|10
135 = 128 + 7	1000 01|11

common 6 bits → implies mask is /22

2) use longest match rule so only one entry for LAN A and C (R2)

R1's forwarding table

subnet / mask	next hop	
131.128.132.0/22	R3	
131.126.142.0/25	LAN B	
131.126.142.128/25	R2	
131.126.142.192/27	LAN A	(longest match rule)
default	R0	



C	B	E	I	G	D	F	J	H
1	2	3	5	6	6	7	9	10

A → B → I → J → H   3.2 ✓

3.3)

G	E	B	A	C	$\boxed{H}$	J	D	F
1	2	3	5	5	$\boxed{6}$	6	11	12

A → B → I → G → H

3.4

E	B	A	C	I	J	D	F
1	2	4	4	6	9	10	11

A → B → I → G → E → B, loop