EECE 446 Practice Problems II

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Abbreviated Solutions

These problems are to help you master the material. They are not comprehensive and may not exactly represent exam questions. You are encouraged to also study other materials, including previous exam questions.

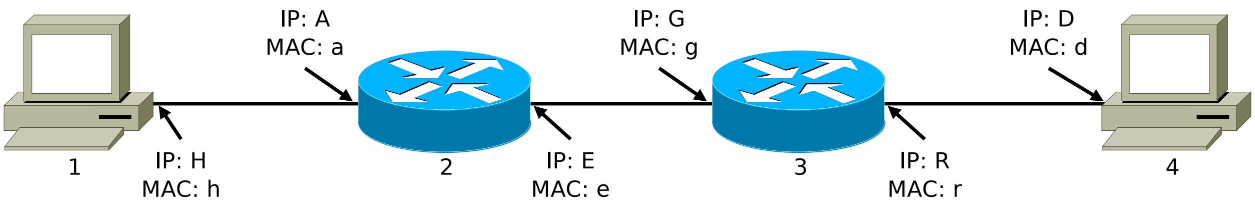
1. (a) As discussed in class, IPv6 has been delayed many times by protocol advancements and the use of additional protocols. In the list of topics below, circle the letter of those topics that helped delay the need to switch to IPv6.

   A. Multicast
   B. NAT
   C. OSPF Areas
   D. CIDR
   E. RIP version 2
   F. DHCP
   G. ARP
   H. DNS

   (b) Pick **two** of the topics you selected from the above list and describe how they helped delay the switch to IPv6.

   Solution: NAT: fewer public addresses used, CIDR: less wasted address space, DHCP: reuse IP addresses

2. The diagram below contains four devices, two hosts (1 and 4) and two routers (2 and 3). Host 1 wishes to send a unicast packet to Host 4. Fill in the Ethernet (MAC) and IP addresses for the sequence of packets below, which may appear during the communication. Do not worry about other transmissions that might occur. If needed, use `F` as the broadcast IP address and `f` as the broadcast MAC address.



(a) ARP Request from 1 to 2

Solution:

Dest MAC	Src MAC
f	h

(b) ARP Reply from 2 to 1

Solution:

Dest MAC	Src MAC
h	a

(c) Data Packet from 1 to 2

Solution:

Dest MAC	Src MAC	Dest IP	Src IP
a	h	D	H

(d) Data Packet from 2 to 3

Solution:

Dest MAC	Src MAC	Dest IP	Src IP
g	e	D	H

(e) ARP Request from 3 to 4

Solution:

Dest MAC	Src MAC
f	r

(f) ARP Reply from 4 to 3

Solution:

Dest MAC	Src MAC
r	d

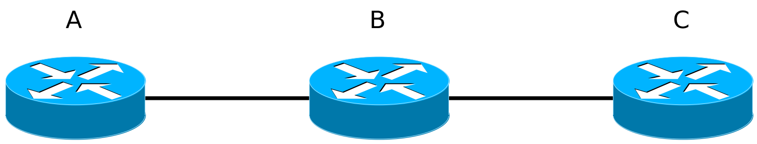
(g) Data Packet from 3 to 4

Solution:

Dest MAC	Src MAC	Dest IP	Src IP
d	r	D	H

3. Consider distance vector routing protocols for these questions.

   (a) In reference to the figure below, a basic distance vector routing protocol converges slowly for the route to node C when the link between between node B and node C fails. Name and briefly describe the problem that causes the slow convergence.

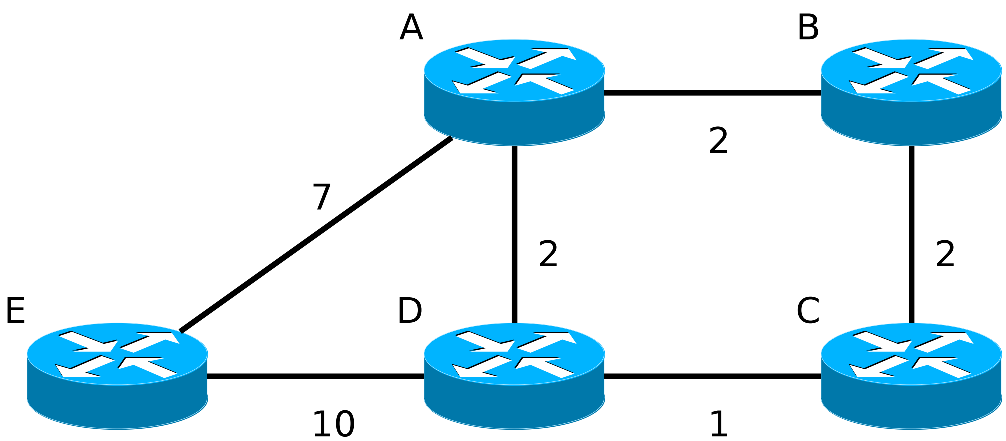


   > **Solution:** Count to infinity problem. B initially uses A as next hop to C.

   (b) What solution helps mitigate this problem in distance vector routing protocols? How does it mitigate the problem?

   > **Solution:** Split horizon, with or without poison reverse.

4. Answer the following questions about running routing protocols on the network below.



   (a) Incorrect route information has negative consequences on network operation. What happens when router B erroneously announces a route to router E with cost 1? Assume router B uses router A as the next hop to router E and that all devices use split horizon with poison reverse.

   > **Solution:** A routing loop is formed among A, B, C, and D. Because of the error, C forward to B, B forwards to A, A forwards to D, and D forwards to C.

   (b) Would a BGP router be able to detect the problem identified in part (a) if each device were an autonomous system? If so, how? If not, why not?

   > **Solution:** Yes, routing loops are easily detected with BGP's path vector method.

5. IPv6 introduces many improvements over IPv4, as discussed in class and your text.

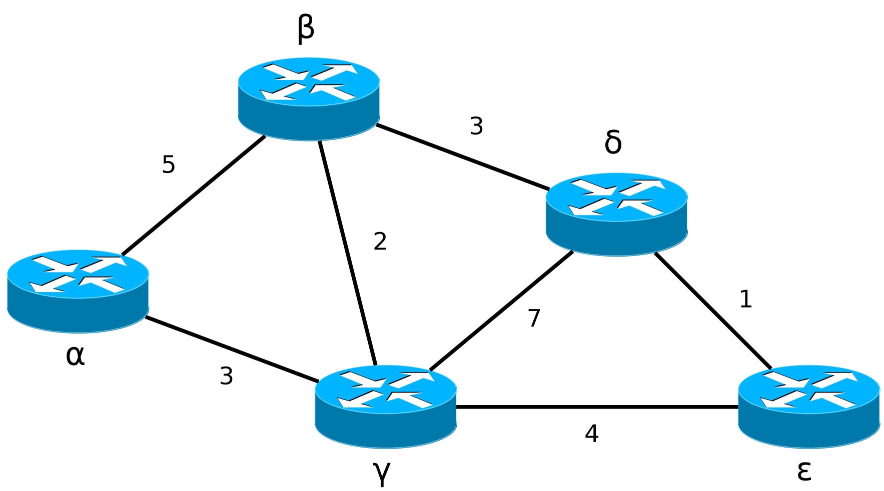
   (a) Briefly describe two improvements provided by IPv6 *beyond a larger address space*.

   > **Solution:** Several examples in simpler header processing, stateless configuration, and consolidated protocols.

   (b) Assume an Ethernet packet can contain a maximum of 1500 B, including all headers and data. If an Ethernet header is 14 B, an IPv4 header is 20 B, and an IPv6 header is 40 B, what reduction in throughput do you get switching from IPv4 to IPv6? Define any variables you use.

   > **Solution:** Let the old throughput equal T_{IPv4}.
   > IPv6 throughput would equal $T_{IPv4}\frac{1500-14-40}{1500-14-20}$.

6. Consider the network below with five routers (α, β, γ, δ, and ε) and networks identified with the cost to cross that network. Answer the following questions about a distance-vector routing protocol.



   (a) After stabilizing, what distance vector does β announce to δ if split horizon, but not poison reverse, were used?

   > **Solution:** α at 5, β at 0, and γ at 2.

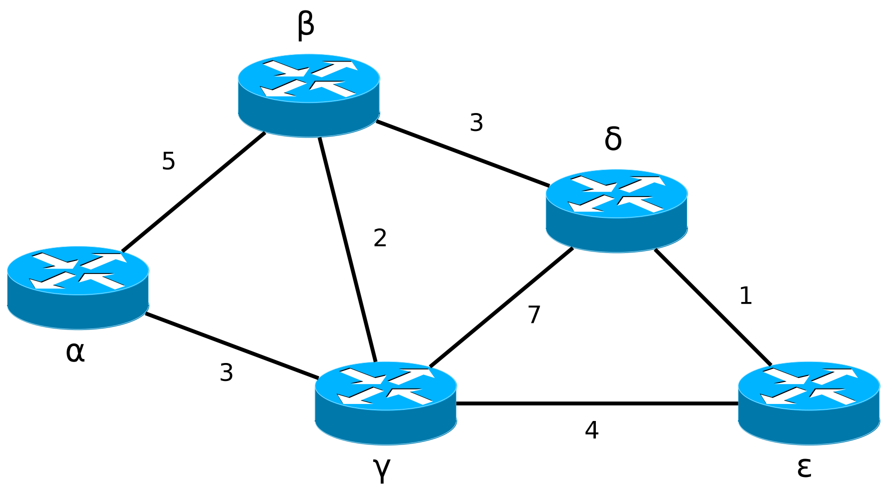
   (b) After stabilizing, what distance vector does β announce to δ if split horizon with poison reverse were used?

   > **Solution:** α at 5, β at 0, γ at 2, and δ and ε at ∞.

   (c) How does split horizon with poison reverse improve performance with distance vector routing protocols?

   > **Solution:** In some instances, eliminates the count to infinity problem and decreases convergence time.

7. Consider the network below with five routers (α, β, γ, δ, and ε) and networks identified with the cost to cross that network. Show how router δ would find the minimum cost path to each other router using Dijkstra's algorithm. Be sure to show your work and track cost and next hop for each destination.



> **Solution:** Many ways to show work. Final result is δ at 0, α at 8 via β or ε, β at 3 via β, γ at 5 via β or ε, and ε at 1 via ε.

8. Under normal circumstances, addresses uniquely identify devices or entities and communication fails when the same address is used by multiple devices. Consider a network with three devices in the same IP network: A, B, and C. A and B have the same address due to misconfiguration or error and C wishes to communicate with A. All devices are active in the network. For the following scenarios, explain when and how communication fails between A and C. Your answer should include what protocol packets are sent and when communication fails.

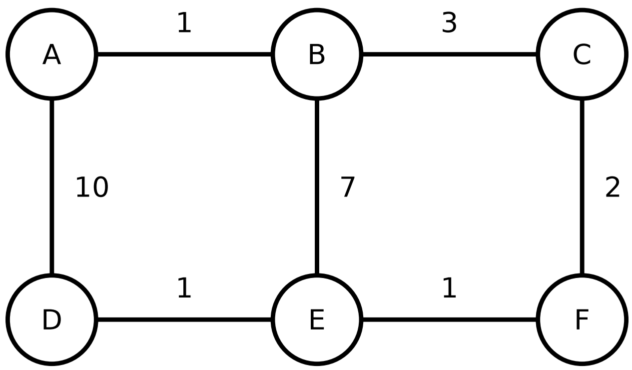
   (a) A and B have unique Ethernet addresses, but share the same IP address. Explain what happens as C tries to communicate with A *for the first time.*

   > **Solution:** ARP fails due to multiple ARP replies. Unclear who gets packets with A as the IP destination.

   (b) A and B share the same Ethernet address, but have unique IP addresses. Explain what happens as C tries to communicate with A *for the first time.*

   > **Solution:** Fails when packets arrive at the switches. Depending on who communicated last the forwarding tables might point to the wrong device.

9. For the network below, fill in the forwarding tables for the appropriate devices to enable router A to ping router F assuming the network has stabilized using a routing protocol that determines minimum cost paths. The number next to each link is the cost of that link. Only create the entries necessary to enable A to ping F. You may use router letters to indicate both the destination and the next hop in the forwarding tables.



Solution:

Router A Forwarding Table

Destination	Next Hop
F	B

Router B Forwarding Table

Destination	Next Hop
F	C
A	A

Router C Forwarding Table

Destination	Next Hop
F	F
A	B

Router D Forwarding Table

Destination	Next Hop

Router E Forwarding Table

Destination	Next Hop

Router F Forwarding Table

Destination	Next Hop
A	C

10. (a) Your friend suggests that ARP Replies should be broadcast to the entire network (the Ethernet destination address is the broadcast address). Describe one advantage and one disadvantage of this proposal. For this question, do not consider security aspects.

> **Solution:** Devices could cache the ARP Replies they overhear and potentially eliminate the need for a future ARP Request. This would generate increased processing and storage requirements on devices. Total traffic may increase or decrease.

(b) What security implications or problems would arise if this proposal was implemented?

> **Solution:** Much easier to perform ARP cache poisoning since devices are accepting unsolicited broadcast replies.

11. Use the following forwarding table and network information for a router to answer the next questions. The networks directly connected to the router are 192.168.55.0/24 and 192.168.100.0/24 and the default route for the router is to 192.168.55.7.

Network	**Next Hop**
101.78.9.0/24	192.168.100.3
101.78.0.0/16	192.168.55.9
101.0.0.0/8	192.168.100.70
66.22.177.0/24	192.168.55.30

(a) Where would the router send a packet with the destination IP address 101.81.9.101?

A. A local network
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

(b) Where would the router send a packet with the destination IP address 101.78.4.37?

A. A local network
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

(c) Where would the router send a packet with the destination IP address 192.168.100.13?

A. A local network
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

(d) Where would the router send a packet with the destination IP address 192.168.88.64?

A. A local network
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

(e) Where would the router send a packet with the destination IP address 101.78.9.88?

A. A local network
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

(f) What address would the router attempt to resolve using an ARP Request for a packet with the destination IP address 101.78.9.88?

A. 101.78.9.88
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

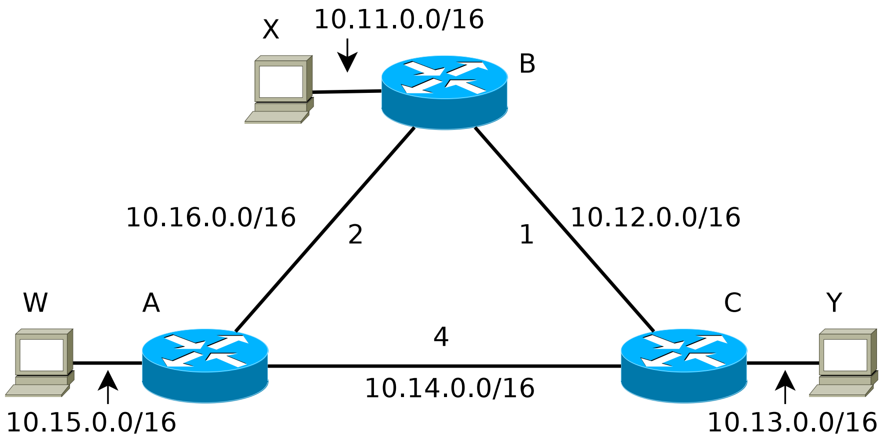
(g) What address would the router attempt to resolve using an ARP Request for a packet with the destination IP address 192.168.88.64?

A. 192.168.88.64
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

(h) What address would the router attempt to resolve using an ARP Request for a packet with the destination IP address 192.168.100.13?

A. 192.168.100.13
B. 192.168.100.3
C. 192.168.55.9
D. 192.168.100.70
E. 192.168.55.30
F. 192.168.55.7

12. Use the network below to answer the following questions. A, B, and C are routers and W, X, and Y are hosts. The single digit next to the central links are the cost of the link for the routing protocol.



(a) Fill in the forwarding tables for B and C with the *minimum* number of entries to route packets between X and Y. You only need to specify the device to use as a next hop, not an IP address. Leave any unused entries blank.

Solution:

Router B	
Destination	**Next Hop**
10.13.0.0/16	C

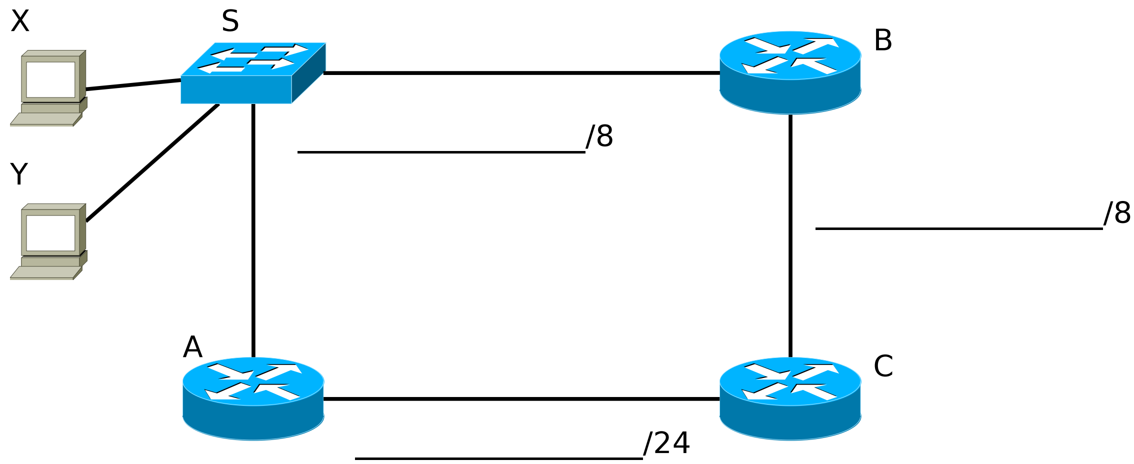
Router C	
Destination	**Next Hop**
10.11.0.0/16	B

(b) Fill in the forwarding table for A with the entries required to reach *all* IP networks in the figure. You only need to specify the device to use as a next hop, not an IP address. Leave any unused entries blank.

Solution:

Destination	Next Hop
10.11.0.0/16	B
10.12.0.0/16	B
10.13.0.0/16	B

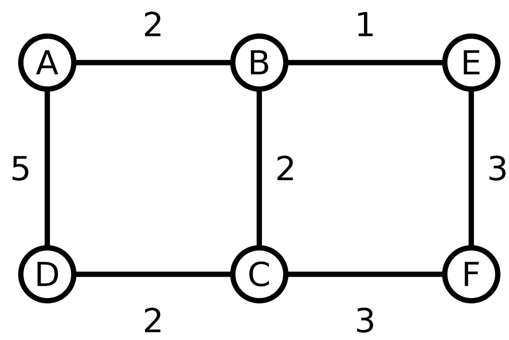
13. You need to mange the network in the figure below by assigning valid *public* IP ranges to each subnetwork and assigning valid IP addresses to all appropriate entities. The figure contains routers A, B, and C, switch S, and hosts X and Y. Put the network address for each subnetwork in the blanks provided in the figure. Use the table below to list a description and an IP address for *all* appropriate entities. Leave any unused table entries blank. You may annotate the figure to clarify your answer.



Entity	**IP Address**

Solution: Many possible solutions. Items to watch: each router has two IP addresses, the switch has no IP address, and ensure IP networks do not overlap.

14. (P&D 5*th* Edition, Chapter 3 Problem 47) For the network given below, give the distance vector at each node (router) when



(a) each node knows only the distances to its immediate neighbors.

(b) each node has reported the information it had in the preceding step to its immediate neighbors.

(c) step (b) happens a second time.

Solution: (a)

	Distance to Node					
Node	**A**	**B**	**C**	**D**	**E**	**F**
A	0	2	∞	5	∞	∞
B	2	0	2	∞	1	∞
C	∞	2	0	2	∞	3
D	5	∞	2	0	∞	∞
E	∞	1	∞	∞	0	3
F	∞	∞	3	∞	3	0

(b)

	Distance to Node					
Node	**A**	**B**	**C**	**D**	**E**	**F**
A	0	2	4	5	3	∞
B	2	0	2	4	1	4
C	4	2	0	2	3	3
D	5	4	2	0	∞	5
E	3	1	3	∞	0	3
F	∞	4	3	5	3	0

(c)

	Distance to Node					
Node	**A**	**B**	**C**	**D**	**E**	**F**
A	0	2	4	5	3	6
B	2	0	2	4	1	4
C	4	2	0	2	3	3
D	5	4	2	0	5	5
E	3	1	3	5	0	3
F	6	4	3	5	3	0

15. (P&D 5*th* Edition, Chapter 3 Problem 53) Suppose we have the forwarding tables shown below for nodes A and F, in a network where all links have cost 1. Give a diagram of the smallest network consistent with these tables.

Node A

Node	**Cost**	**Next Hop**
B	1	B
C	1	C
D	2	B
E	3	C
F	2	C

Node F

Node	**Cost**	**Next Hop**
A	2	C
B	3	C
C	1	C
D	2	C
E	1	E

Solution: One possible solution is:

1. A adjacent to B and C.
2. B adjacent to A and D.
3. C adjacent to A, D, and F.
4. D adjacent to B and C.
5. E adjacent to F.
6. F adjacent to C and E.

16. (P&D 5*th* Edition, Chapter 3 Problem 43) IPv4 uses 32-bit addresses. If we could redesign IPv4 to use the 6-byte MAC address instead of the 32-bit address, would we be able to eliminate the need for ARP? Explain why or why not.

Solution: Likely not due to MAC addresses using a flat address space.

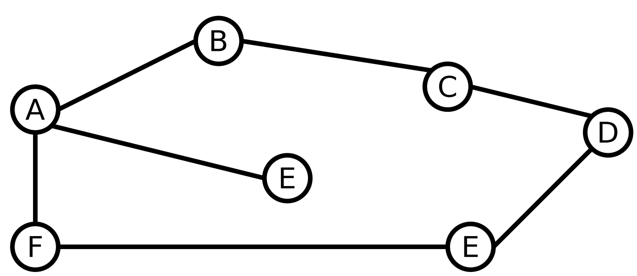
17. (P&D 5*th* Edition, Chapter 3 Problem 56) Suppose a router has built up the routing table shown below. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Assume the router does the longest prefix match. Describe what the router does with a packet addressed to each of the following destinations:

Network	**Mask**	**Next Hop**
128.96.170.0	255.255.254.0 (/23)	Interface 0
128.96.168.0	255.255.254.0 (/23)	Interface 1
128.96.166.0	255.255.254.0 (/23)	R2
128.96.164.0	255.255.252.0 (/22)	R3
0.0.0.0	0.0.0.0 (/0)	R4

(a) 128.96.171.92
(b) 128.96.167.151
(c) 128.96.163.151
(d) 128.96.169.192
(e) 128.96.165.121

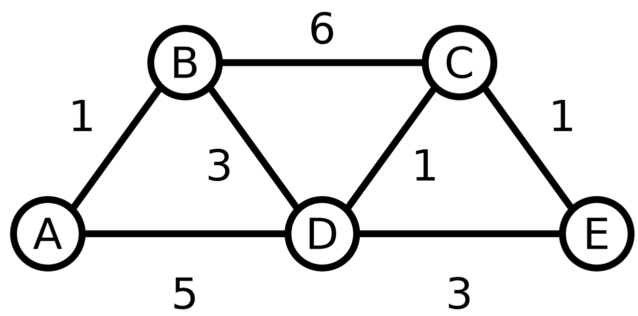
Solution: (a) Interface 0
(b) R2
(c) R4
(d) Interface 1
(e) R3

18. (P&D 5*th* Edition, Chapter 3 Problem 58) Consider the situation involving the creation of a routing loop in the network below when the A-E link goes down. List *all* sequences of table updates among A, B, and C, pertaining to destination E, that lead to the loop. Assume that table updates are done one at a time, that the split-horizon technique is observed by all participants, and that A sends its initial report of E's unreachability to B before C. You may ignore updates that don't result in changes.



Solution: (1) A tells B it can't reach E, (2) C tells B it can reach E, (3) B tells A it can reach E.

19. (P&D 5*th* Edition, Chapter 3 Problem 63) Use Dijkstra's Algorithm to find the minimum cost paths for A in the figure below.



> **Solution:** Any valid approach results in:
>
> - B at a cost of 1 via B
> - C at a cost of 5 via B
> - D at a cost of 4 via B
> - E at a cost of 6 via B

20. (P&D 5*th* Edition, Chapter 3 Problem 66) IP hosts that are not designated routers are *required* to drop packet misaddressed to them, even if they would otherwise be able to forward them correctly. In the absence of this requirement, what would happen if a packet addressed to IP address A were inadvertently broadcast at the link layer? What other justifications for this requirement can you think of?

> **Solution:** Duplicate packets

21. (P&D 5*th* Edition, Chapter 3 Problem 68) An organization has been assigned the address range 212.1.1.0/24 and wants to form subnets for four departments, with hosts as follows:

A 75 hosts
B 35 hosts
C 20 hosts
D 18 hosts

There are 148 hosts in all.

(a) Give a possible arrangement of subnet masks to make this possible.

> **Solution:** A uses /25, B uses /26, C and D use /27. You should find concrete network addresses for each department.

(b) Suggest what the organization might do if department D grows to 32 hosts.

> **Solution:** Multiple solutions of varying complexity and cost.

22. (P&D 5*th* Edition, Chapter 3 Problem 71) Suppose two subnets share the same physical LAN; hosts on each subnet will see the other subnet's broadcast packets.

    (a) How will DHCP fare if two servers, one for each subnet, coexist on the shared LAN? What problems will arise?

    Solution: Poorly. Many problems, including hosts getting an IP address arbitrarily from one subnet or the other.

    (b) Will ARP be affected by such sharing?

    Solution: No

23. (P&D 5*th* Edition, Chapter 3 Problem 72) The forwarding table below uses CIDR. Address bytes are in hexadecimal. State to what next hop packets with the given destination address will be delivered.

Network	Next Hop
C4.50.00.00/12	A
C4.5E.10.00/20	B
C4.60.00.00/12	C
C4.68.00.00/14	D
80.00.00.00/1	E
40.00.00.00/2	F
00.00.00.00/2	G

Solution:

Dst Address	Selected Next Hop
C4.5E.13.87	B
C4.5E.22.09	A
C3.41.80.02	E
5E.43.91.12	F
C4.6D.31.2E	C
C4.6B.31.2E	D

24. (P&D 5*th* Edition, Chapter 4 Problem 20) Determine whether or not the following IPv6 address notations are correct:

    1. ::0F53:6382:AB00:67DB:BB27:7332
    2. 7803:42F2:::88EC:D4BA:B75D:11CD
    3. ::4BA8:95CC::DB97:4EAB
    4. 74DC::02BA
    5. ::00FF:128.112.92.116

Solution: Top to bottom: Yes, No, No, Yes, Yes (it is one method to map IPv4 to IPv6).