ITS 323 –INTERNETWORKING PRACTICE (ANSWERS)

1 IP Addresses

1.1 Classful Addressing

For the following questions, assume classful addressing is used.

1. Complete the table for the each IP address (an example is shown for 140.16.32.21 – do the same for the other 4 addresses):

	140.16.32.21	32.199.201.1	200.254.254.254	128.0.0.1	192.168.1.3
Class	B				
Network	140.16.0.0				
Broadcast	140.16.255.255				
No. Hosts	65534				
No. Networks	16384				

2. For the following scenarios, select an appropriate Class, Network address and IP address for one computer on the network:

   a. A medium sized business with 200 PCs, 60 laptops and 1 router

      Class: _____

      Network: _____

      IP Address: _____

   b. Your home network of a PC, laptop, PDA and router

      Class: _____

      Network: _____

      IP Address: _____

   c. An Internet Service Provider which has about 100,000 customers

      Class: _____

      Network: _____

      IP Address: _____

Note that this question ignores any details about using private addresses – you will cover these next semester.

3. Which of the following are valid IP addresses that can be assigned to computers?

   a. 68.0.0.1   Valid? _____ If no, why not? _____

   b. 68.0.0.0   Valid? _____ If no, why not? _____

   c. 68.1.1.1   Valid? _____ If no, why not? _____

   d. 68.255.1.1   Valid? _____ If no, why not? _____

   e. 68.1.1.255   Valid? _____ If no, why not? _____

   f. 68.254.254.254 Valid? _____ If no, why not? _____

   g. 68.255.255.1   Valid? _____ If no, why not? _____

   h. 68.255.255.255 Valid? _____ If no, why not? _____

   i. 127.0.0.1   Valid? _____ If no, why not? _____

Answers

Question 1

	140.16.32.21	32.199.201.1	200.254.254.254	128.0.0.1	192.168.1.3
Class	B	A	C	B	C
Network	140.16.0.0	32.0.0.0	200.254.254.0	128.0.0.0	192.168.1.0
Broadcast	140.16.255.255	32.255.255.255	200.254.254.255	128.0.255.255	192.168.1.255
No. Hosts	65534	16777214	254	65534	254
No. Networks	16384	126	2097152	16384	2097152

Question 2

a. Class B is needed (more than 254 hosts). Therefore you can choose any Class B network and corresponding host on that network

b. Class C is suitable

c. Class A is needed.

Question 3

All except b, h and i are valid. 68.x.x.x represents a Class A address (the first bit is a 0). Hence all addresses are valid except:

Network address: b – 68.0.0.0 (all host bits are 0)

Broadcast address: h – 68.255.255.255 (all host bits are 1)

Own address: i – 127.0.0.1 (first 8 bits are 01111111)

1.2 Classless Addressing

For the following questions assume classless addressing is used.

4. Complete the two tables for the each IP address:

	140.16.32.21	32.199.201.1	200.254.254.254	128.0.0.1	192.168.1.3
Subnet mask	/12	/22	/11		
Subnet mask	255.240.0.0			255.255.0.0	255.255.254.0
Network	140.16.0.0				
Broadcast	140.31.255.255				
No. Hosts	1048574				

	140.16.32.21	32.199.201.1	200.254.254.254	128.0.0.1	192.168.1.3
Subnet mask			/7		
Subnet mask	255.248.0.0				
Network					192.168.1.0
Broadcast					192.168.1.127
No. Hosts		30		32766	

5. For the following scenarios, select an appropriate Subnet mask, Network address and IP address for one computer on the network:

   a. A medium sized business with 200 PCs, 60 laptops and 1 router

   Subnet mask: _____

   Network: _____

   IP Address: _____

   b. Your home network of a PC, laptop, PDA and router

   Subnet mask: _____

   Network: _____

   IP Address: _____

   c. An Internet Service Provider which has about 100,000 customers

   Subnet mask: _____

   Network: _____

   IP Address: _____

Answers

Question 4

	140.16.32.21	32.199.201.1	200.254.254.254	128.0.0.1	192.168.1.3
Subnet mask	/12	/22	/11	/16	/23
Subnet mask	255.240.0.0	255.255.252.0	255.224.0.0	255.255.0.0	255.255.254.0
Network	140.16.0.0	32.199.200.0	200.224.0.0	128.0.0.0	192.168.0.0
Broadcast	140.31.255.255	32.199.203.255	200.255.255.255	128.0.255.255	192.168.1.255
No. Hosts	1048574	1022	2097150	65534	510

	140.16.32.21	32.199.201.1	200.254.254.254	128.0.0.1	192.168.1.3
Subnet mask	/13	/27	/7	/17	/25
Subnet mask	255.248.0.0	255.255.255.224	254.0.0.0	255.255.128.0	255.255.255.128
Network	140.16.0.0	32.199.201.0	200.0.0.0	128.0.0.0	192.168.1.0
Broadcast	140.23.255.255	32.199.201.31	201.255.255.255	128.0.127.255	192.168.1.127
No. Hosts	524286	30	33554430	32766	126

Question 5

You determine the subnet mask by considering the number of hosts needed. You can choose any IP address, and then apply the subnet mask to determine the appropriate network address.

a. 261 hosts are needed. Hence there must be at least 9 host bits (510 possible hosts), since with 8 host bits there are only 254 possible hosts. Hence the subnet mask should be /23 or 255.255.254.0. If we chose the IP address 123.45.67.8, the network address would be 123.45.66.0.

b. 4 hosts needed. 3 host bits allows for 6 possible hosts, so a subnet mask of /29 is possible.

c. 100,000 hosts needed. Subnet mask of /17.

2 Internetworking with IP

Consider the example network shown below. There are 6 Hosts, 6 routers and 2 Switches. Each router has multiple IP interfaces (labelled, for example, A1, A2, A3 and A4 are the four interfaces of router A), and each Host has one IP interface.
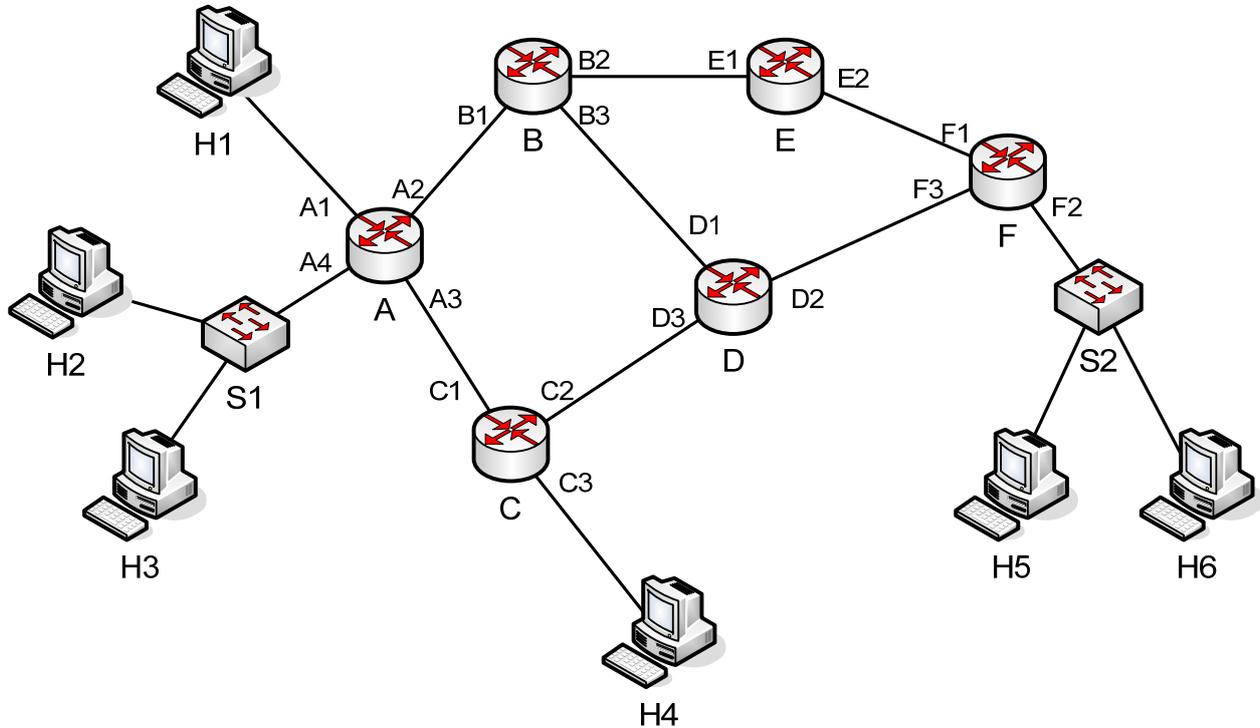
2.1 IP Addressing

Lets assume classless addressing is used. I have assigned IP addresses to most interfaces (including hosts). The addresses are given in the following tables. Complete the tables – that is, fill in the IP addresses for the remaining interfaces.

Host IP Addresses

Host	IP Address				Subnet Mask
H1	.	.	.	2	
H2	.	.	13	. 1	
H3	.	.	14	. 1	
H4	.	.	.	2	
H5	200 .	10 .	5 .	6	/24
H6	.	.	.	31	

Router IP Addresses

Router	IP Address	Subnet Mask
	Router A	
A1	60 . 45 . 12 . 3	/28
A2	130 . 10 . 0 . 1	/16
A3	130 . 20 . 0 . 1	/16
A4	. . 12 . 1	/22
	Router B	
B1	130 . 10 . 0 . 2	/16
B2	. . 1 . 1	/16
B3	. . 2 . 3	
	Router C	
C1	. . 0 . 2	
C2	. . 0 . 1	
C3	190 . 5 . 5 . 1	/24
	Router D	
D1	140 . 30 . 3 . 1	/16
D2	150 . 20 . 10 . 6	/16
D3	150 . 10 . 0 . 2	/16
	Router E	
E1	140 . 10 . 2 . 1	
E2	140 . 20 . 7 . 3	/16
	Router F	
F1	. . 5 . 3	
F2	. . . 1	
F3	. . 10 . 13	

Answers

Host IP Addresses

Host	IP Address	Subnet Mask
H1	60 . 45 . 12 . 2	/28
H2	70 . 2 . 13 . 1	/22
H3	70 . 2 . 14 . 1	/22
H4	190 . 5 . 5 . 2	/24
H5	200 . 10 . 5 . 6	/24
H6	200 . 10 . 5 . 31	/24

Router IP Addresses

Router	IP Address	Subnet Mask
	Router A	
A1	60 . 45 . 12 . 3	/28
A2	130 . 10 . 0 . 1	/16
A3	130 . 20 . 0 . 1	/16
A4	70 . 2 . 12 . 1	/22
	Router B	
B1	130 . 10 . 0 . 2	/16
B2	140 . 10 . 1 . 1	/16
B3	140 . 30 . 2 . 3	/16
	Router C	
C1	130 . 20 . 0 . 2	/16
C2	150 . 10 . 0 . 1	/16
C3	190 . 5 . 5 . 1	/24
	Router D	
D1	140 . 30 . 3 . 1	/16
D2	150 . 20 . 10 . 6	/16
D3	150 . 10 . 0 . 2	/16
	Router E	
E1	140 . 10 . 2 . 1	/16
E2	140 . 20 . 7 . 3	/16
	Router F	
F1	140 . 20 . 5 . 3	/16
F2	200 . 10 . 5 . 1	/24
F3	150 . 20 . 10 . 13	/16

2.2 Route Discovery

Normally a routing protocol is continuously running for routers to discovery routes to other networks. Lets assume a least-cost path routing protocol is being used, where the costs of the links between routers are shown in the figure below. Assume the links are bi-directional and the same cost in each direction.
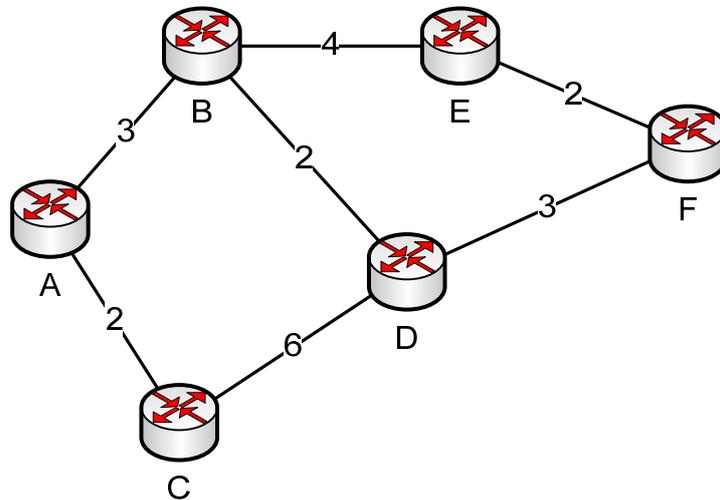
Lets ignore the hosts for now (we will discuss this later). Find the least-cost paths between every pair of routers and write them in the following table.

Hint 1: The reverse paths are simply the opposite of the forward paths. For example, if the path from A to E is A-B-E then you immediately know that the path from E to A is E-B-A (since the link costs are the same in both directions).

Hint 2: You can manually calculate the paths by looking at the figure – you don't have to use Dijkstra or Bellman-Ford.

Least Cost Paths

From/To	A	B	C	D	E	F
A	-	A-B (3)	A-C (2)	A-B-D (5)	A-B-E (7)	A-B-D-F (9)
B	B-A (3)	-				
C			-			
D				-		
E					-	
F						-

Answers

Least Cost Paths

From/To	A	B	C	D	E	F
A	-	A-B (3)	A-C (2)	A-B-D (5)	A-B-E (7)	A-B-D-F (9)
B	B-A (3)	-	B-A-C (5)	B-D (2)	B-E (4)	B-D-F (5)
C	C-A (2)	C-A-B (5)	-	C-D (6)	C-A-B-E (9)	C-D-F (9)
D	D-B-A (5)	D-B (2)	D-C (6)	-	D-F-E (5)	D-F (3)
E	E-B-A (7)	E-B (4)	E-B-A-C (9)	E-F-D (5)	-	E-F (2)
F	F-D-B-A (7)	F-D-B (5)	F-D-C (9)	F-D (3)	F-E (2)	-

2.3 Routing Tables for Hosts

Each host is, at the IP level, directly connected to only one router. Therefore the routing table for each host is simple: send everything (no matter what the destination) to the directly connected router. In other words, H1 will send everything to A1; H2 will send everything to A4; and so on. Therefore the routing tables for each Host are simple. Note that for the Next Router I have shown the interface label (such as A1) as well as the IP address of that interface. In some cases you should complete the IP address for the Next Router, based on the IP Addresses in Section 2.1.

Routing Table for Host H1

Destination	Next Router
*	A1: 60.45.12.3/28

Routing Table for Host H2

Destination	Next Router
*	A4:

Routing Table for Host H3

Destination	Next Router
*	A4:

Routing Table for Host H4

Destination	Next Router
*	C3: 190.5.5.1/24

Routing Table for Host H5

Destination	Next Router
*	F2:

Routing Table for Host H6

Destination	Next Router
*	F2:

Answers

Routing Table for Host H1

Destination	Next Router
*	A1: 60.45.12.3/28

Routing Table for Host H2

Destination	Next Router
*	A4: 70.2.12.1/22

Routing Table for Host H3

Destination	Next Router
*	A4: 70.2.12.1/22

Routing Table for Host H4

Destination	Next Router
*	C3: 190.5.5.1/24

Routing Table for Host H5

Destination	Next Router
*	F2: 200.10.5.1/24

Routing Table for Host H6

Destination	Next Router
*	F2: 200.10.5.1/24

2.4 Routing Tables for Routers

Now we know the least-cost paths, we can use this information to create the routing table for each router. Lets simplify the routing tables by assuming the networks attached to routers B, D and E will never be destinations (they have no hosts). So there are 4 possible destination networks – write the Network Address for each of these networks:

1. Network with H1 (router A is directly connected)

    Network Address (Net1): _____

2. Network with H2 and H3 (router A is directly connected)

    Network Address (Net2): _____

3. Network with H4 (router C is directly connected)

    Network Address (Net3): _____

4. Network with H5 and H6 (router F is directly connected)

    Network Address (Net4): 200.10.5.0/24

Now, for each router, include a routing table entry (row) for each of the four destination networks. Using Router A as an example, the fourth row says: in order to reach Net4 which has network address 200.10.5.0/24, send to interface B1 with IP address 130.10.0.2/16. The first row says: in order to reach Net1 (you must give the network address), send direct to the host (since router A is directly connected to the host).

Routing Table for Router A

Destination	Next Router
Net1:	Direct
Net2:	Direct
Net3:	C1:
Net4: 200.10.5.0/24	B1: 130.10.0.2/16

Routing Table for Router B

Destination	Next Router
Net1:	
Net2:	
Net3:	
Net4: 200.10.5.0/24	D1: 140.30.3.1/16

Routing Table for Router C

Destination	Next Router
Net1:	
Net2:	
Net3:	
Net4: 200.10.5.0/24	

Routing Table for Router D

Destination	Next Router
Net1:	
Net2:	
Net3:	
Net4: 200.10.5.0/24	

Routing Table for Router E

Destination	Next Router
Net1:	
Net2:	
Net3:	
Net4: 200.10.5.0/24	

Routing Table for Router F

Destination	Next Router
Net1:	
Net2:	
Net3:	
Net4: 200.10.5.0/24	

Answers

1. Network with H1 (router A is directly connected)

   Network Address (Net1): 60.45.12.0/28

2. Network with H2 and H3 (router A is directly connected)

   Network Address (Net2): 70.2.12.0/22

3. Network with H4 (router C is directly connected)

   Network Address (Net3): 190.5.5.0/24

4. Network with H5 and H6 (router F is directly connected)

   Network Address (Net4): 200.10.5.0/24

Routing Table for Router A

Destination	Next Router
Net1: 60.45.12.0/28	Direct
Net2: 70.2.12.0/22	Direct
Net3: 190.5.5.0/24	C1: 130.20.0.2/16
Net4: 200.10.5.0/24	B1: 130.10.0.2/16

Routing Table for Router B

Destination	Next Router
Net1: 60.45.12.0/28	A2: 130.10.0.1/16
Net2: 70.2.12.0/22	A2: 130.10.0.1/16
Net3: 190.5.5.0/24	A2: 130.10.0.1/16
Net4: 200.10.5.0/24	D1: 140.30.3.1/16

Routing Table for Router C

Destination	Next Router
Net1: 60.45.12.0/28	A3: 130.20.0.1/16
Net2: 70.2.12.0/22	A3: 130.20.0.1/16
Net3: 190.5.5.0/24	Direct
Net4: 200.10.5.0/24	D3: 150.10.0.2/16

Routing Table for Router D

Destination	Next Router
Net1: 60.45.12.0/28	B3: 140.30.2.3/16
Net2: 70.2.12.0/22	B3: 140.30.2.3/16
Net3: 190.5.5.0/24	C2: 150.10.0.1/16
Net4: 200.10.5.0/24	F3: 150.20.10.13/16

Routing Table for Router E

Destination	Next Router
Net1: 60.45.12.0/28	B2: 140.10.1.1/16
Net2: 70.2.12.0/22	B2: 140.10.1.1/16
Net3: 190.5.5.0/24	B2: 140.10.1.1/16
Net4: 200.10.5.0/24	F1: 140.20.5.3/16

Routing Table for Router F

Destination	Next Router
Net1: 60.45.12.0/28	D2: 150.20.10.6/16
Net2: 70.2.12.0/22	D2: 150.20.10.6/16
Net3: 190.5.5.0/24	D2: 150.20.10.6/16
Net4: 200.10.5.0/24	Direct

2.5 Forwarding in IP

Now that you have routing tables for every node in the network, data can be sent in the network. In the same way that we following the SIIT Network example in the lecture, you should study the steps taken for the following cases:

1. H4 sends a datagram to H1

2. H1 sends a datagram to H6

3. H1 sends a datagram to H2

4. H2 sends a datagram to H3

You should be able to describe what happens from the perspective of IP. For example:

"H4 creates an IP datagram, with destination address = …. . As the destination address is not H4 and is not on the same network as H4, the routing table of H4 is used to determine that the datagram must be sent to Router C (C3, IP address = ….).

C3 receives the IP datagram, and since the destination address is not Router C, and is not on a network directly attached to C, router C uses its routing table to determine that the datagram must be sent to Router A (A3, IP address = …)."

And so on …