



## IP Address Classes

Class A	1 – 127	(Network 127 is reserved for loopback and internal testing)	
	Leading bit pattern	0	00000000.00000000.00000000.00000000 Network . Host . Host . Host
Class B	128 – 191	Leading bit pattern	10
			10000000.00000000.00000000.00000000 Network . Network . Host . Host
Class C	192 – 223	Leading bit pattern	110
			11000000.00000000.00000000.00000000 Network . Network . Network . Host
Class D	224 – 239	(Reserved for multicast)	
Class E	240 – 255	(Reserved for experimental, used for research)	

## Private Address Space

Class A	10.0.0.0 to 10.255.255.255
Class B	172.16.0.0 to 172.31.255.255
Class C	192.168.0.0 to 192.168.255.255

## Default Subnet Masks

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

Produced by: Robb Jones  
jonesr@careertech.net  
Frederick County Career & Technology Center  
Cisco Networking Academy  
Frederick County Public Schools  
Frederick, Maryland, USA

Special Thanks to Melvin Baker and Jim Dorsch  
for taking the time to check this workbook for errors.

# Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers	Scratch Area
1	0	0	1	0	0	1	0	<u>146</u>	128 16 32
0	1	1	1	0	1	1	1	<u>119</u>	2 146 16 4
1	1	1	1	1	1	1	1	<u>255</u>	2 1
1	1	0	0	0	1	0	1	<u>197</u>	119
1	1	1	1	0	1	1	0	<u>246</u>	
0	0	0	1	0	0	1	1	<u>19</u>	
1	0	0	0	0	0	0	1	<u>129</u>	
0	0	1	1	0	0	0	1	<u>49</u>	
0	1	1	1	1	0	0	0	<u>120</u>	
1	1	1	1	0	0	0	0	<u>240</u>	
0	0	1	1	1	0	1	1	<u>59</u>	
0	0	0	0	0	1	1	1	<u>7</u>	
							00011011	<u>27</u>	
							10101010	<u>170</u>	
							01101111	<u>111</u>	
							11111000	<u>248</u>	
							00100000	<u>32</u>	
							01010101	<u>85</u>	
							00111110	<u>62</u>	
							00000011	<u>3</u>	
							11101101	<u>237</u>	
							11000000	<u>192</u>	

# Decimal To Binary Conversion

Use all 8 bits for each problem

128	64	32	16	8	4	2	1 = 255		Scratch Area
1	1	1	0	1	1	1	0	238	238
0	0	1	0	0	0	1	0	34	-128
0	1	1	1	1	0	1	1	123	110
0	0	1	1	0	0	1	0	50	-64
1	1	1	1	1	1	1	1	255	46
1	1	0	0	1	0	0	0	200	-32
0	0	0	0	1	0	1	0	10	14
1	0	0	0	1	0	1	0	138	-8
0	0	0	0	0	0	0	1	1	6
0	0	0	0	1	1	0	1	13	-4
1	1	1	1	1	0	1	0	250	2
0	1	1	0	1	0	1	1	107	-2
1	1	1	0	0	0	0	0	224	0
0	1	1	1	0	0	1	0	114	
1	1	0	0	0	0	0	0	192	
1	0	1	0	1	1	0	0	172	
0	1	1	0	0	1	0	0	100	
0	1	1	1	0	1	1	1	119	
0	0	1	1	1	0	0	1	57	
0	1	1	0	0	0	1	0	98	
1	0	1	1	0	0	1	1	179	
0	0	0	0	0	0	1	0	2	

## Address Class Identification

Address	Class
10.250.1.1	<u>A</u>
150.10.15.0	<u>B</u>
192.14.2.0	<u>C</u>
148.17.9.1	<u>B</u>
193.42.1.1	<u>C</u>
126.8.156.0	<u>A</u>
220.200.23.1	<u>C</u>
230.230.45.58	<u>D</u>
177.100.18.4	<u>B</u>
119.18.45.0	<u>A</u>
249.240.80.78	<u>E</u>
199.155.77.56	<u>C</u>
117.89.56.45	<u>A</u>
215.45.45.0	<u>C</u>
199.200.15.0	<u>C</u>
95.0.21.90	<u>A</u>
33.0.0.0	<u>A</u>
158.98.80.0	<u>B</u>
219.21.56.0	<u>C</u>

## Network & Host Identification

Circle the network portion of these addresses:

177.100.18.4

119.18.45.0

209.240.80.78

199.155.77.56

117.89.56.45

215.45.45.0

192.200.15.0

95.0.21.90

33.0.0.0

158.98.80.0

217.21.56.0

10.250.1.1

150.10.15.0

192.14.2.0

148.17.9.1

193.42.1.1

126.8.156.0

220.200.23.1

Circle the host portion of these addresses:

10.15.123.50

171.2.199.31

198.125.87.177

223.250.200.222

17.45.222.45

126.201.54.231

191.41.35.112

155.25.169.227

192.15.155.2

123.102.45.254

148.17.9.155

100.25.1.1

195.0.21.98

25.250.135.46

171.102.77.77

55.250.5.5

218.155.230.14

10.250.1.1

## Default Subnet Masks

Write the correct default subnet mask for each of the following addresses:

177.100.18.4	<u>255 . 255 . 0 . 0</u>
119.18.45.0	<u>255 . 0 . 0 . 0</u>
191.249.234.191	<u>255 . 255 . 0 . 0</u>
223.23.223.109	<u>255 . 255 . 255 . 0</u>
10.10.250.1	<u>255 . 0 . 0 . 0</u>
126.123.23.1	<u>255 . 255 . 0 . 0</u>
223.69.230.250	<u>255 . 255 . 255 . 0</u>
192.12.35.105	<u>255 . 255 . 255 . 0</u>
77.251.200.51	<u>255 . 0 . 0 . 0</u>
189.210.50.1	<u>255 . 255 . 0 . 0</u>
88.45.65.35	<u>255 . 0 . 0 . 0</u>
128.212.250.254	<u>255 . 255 . 0 . 0</u>
193.100.77.83	<u>255 . 255 . 255 . 0</u>
125.125.250.1	<u>255 . 0 . 0 . 0</u>
1.1.10.50	<u>255 . 0 . 0 . 0</u>
220.90.130.45	<u>255 . 255 . 255 . 0</u>
134.125.34.9	<u>255 . 255 . 0 . 0</u>
95.250.91.99	<u>255 . 0 . 0 . 0</u>

## ANDING With Default subnet masks

Every IP address must be accompanied by a subnet mask. By now you should be able to look at an IP address and tell what class it is. Unfortunately your computer doesn't think that way. For your computer to determine the network and subnet portion of an IP address it must "AND" the IP address with the subnet mask.

### Default Subnet Masks:

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

### ANDING Equations:

1 AND 1 = 1  
 1 AND 0 = 0  
 0 AND 1 = 0  
 0 AND 0 = 0

### Sample:

What you see...

IP Address:                    192 . 100 . 10 . 33

What you can figure out in your head...

Address Class:	C
Network Portion:	<u>192 . 100 . 10</u> . 33
Host Portion:	192 . 100 . 10 . <u>33</u>

In order for your computer to get the same information it must AND the IP address with the subnet mask in binary.

	Network	Host
IP Address:	1 1 0 0 0 0 0 0 . 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	0 0 1 0 0 0 0 1 (192 . 100 . 10 . 33)
Default Subnet Mask:	1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 (255 . 255 . 255 . 0)
AND:	1 1 0 0 0 0 0 0 . 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	0 0 0 0 0 0 0 0 (192 . 100 . 10 . 0)

ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

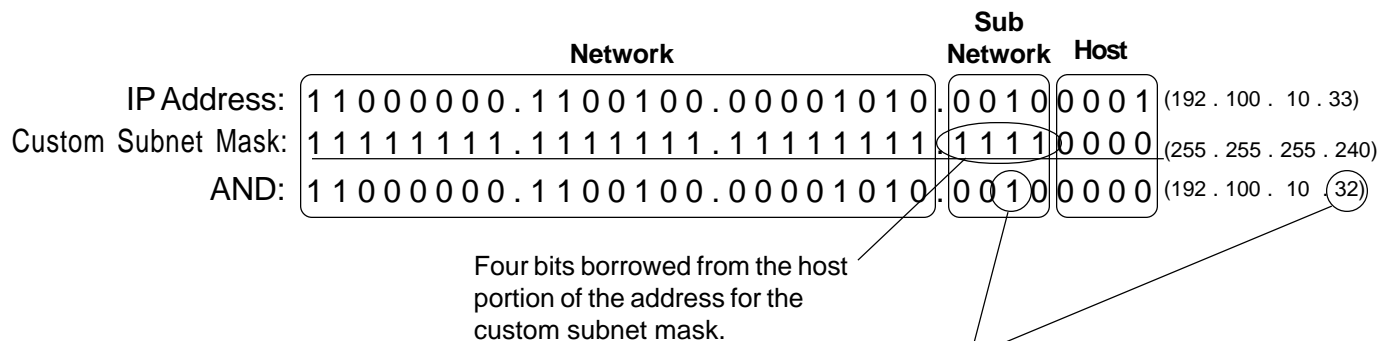


## ANDING With Custom subnet masks

When you take a single network such as 192.100.10.0 and divide it into five smaller networks (192.100.10.16, 192.100.10.32, 192.100.10.48, 192.100.10.64, 192.100.10.80) the outside world still sees the network as 192.100.10.0, but the internal computers and routers see five smaller subnetworks. Each independent of the other. This can only be accomplished by using a custom subnet mask. A custom subnet mask borrows bits from the host portion of the address to create a subnetwork address between the network and host portions of an IP address. In this example each range has 14 usable addresses in it. The computer must still AND the IP address against the custom subnet mask to see what the network portion is and which subnetwork it belongs to.

IP Address:                    192 . 100 . 10 . 0  
 Custom Subnet Mask:        255.255.255.240

Address Ranges:    192.10.10.0 to 192.100.10.15    (Invalid Range)  
                           192.100.10.16 to 192.100.10.31    (1st Usable Range)  
                           192.100.10.32 to 192.100.10.47    (Range in the sample below)  
                           192.100.10.48 to 192.100.10.63  
                           192.100.10.64 to 192.100.10.79  
                           192.100.10.80 to 192.100.10.95  
                           192.100.10.96 to 192.100.10.111  
                           192.100.10.112 to 192.100.10.127  
                           192.100.10.128 to 192.100.10.143  
                           192.100.10.144 to 192.100.10.159  
                           192.100.10.160 to 192.100.10.175  
                           192.100.10.176 to 192.100.10.191  
                           192.100.10.192 to 192.100.10.207  
                           192.100.10.208 to 192.100.10.223  
                           192.100.10.224 to 192.100.10.239  
                           192.100.10.240 to 192.100.10.255 (Invalid Range)



The ANDING process of the four borrowed bits shows which range of IP addresses this particular address will fall into.

In the next set of problems you will determine the necessary information to determine the correct subnet mask for a variety of IP addresses.

# Custom Subnet Masks

## Problem 1

Number of needed usable subnets **14**  
 Number of needed usable hosts **14**  
 Network Address **192.10.10.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 240    

Total number of subnets           16          

Number of usable subnets           14          

Total number of host addresses           16          

Number of usable addresses           14          

Number of bits borrowed           4          

**Show your work for Problem 1 in the space below.**

	256	128	64	32	16	8	4	2	1	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>	
<b>192 . 10 . 10 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>		

Add the binary value numbers to the left of the line to create the custom subnet mask.

128
64
32
+16
240

16	Observe the total number of hosts.
-2	Subtract 2 for the number of usable hosts.
14	

16
-2
14

Subtract 2 for the total number of subnets to get the usable number of subnets.

# Custom Subnet Masks

## Problem 2

Number of needed usable subnets **1000**

Number of needed usable hosts **60**

Network Address **165.100.0.0**

Address class   **B**  

Default subnet mask   **255 . 255 . 0 . 0**  

Custom subnet mask   **255 . 255 . 255 . 192**  

Total number of subnets   **1,024**  

Number of usable subnets   **1,022**  

Total number of host addresses   **64**  

Number of usable addresses   **62**  

Number of bits borrowed   **10**  

Show your work for **Problem 2** in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
165 . 100 . 0 0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

128  
64  
32  
16  
8  
4  
2  
+1  
-----  
255

Add the binary value numbers to the left of the line to create the custom subnet mask.

64    Observe the total number of hosts.  
-2  
-----  
62    Subtract 2 for the number of usable hosts.

1024  
-2  
-----  
1,022

Subtract 2 for the total number of subnets to get the usable number of subnets.



# Custom Subnet Masks

## Problem 4

Number of needed usable subnets **6**  
 Number of needed usable hosts **30**  
 Network Address **210.100.56.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 224    

Total number of subnets             8            

Number of usable subnets             6            

Total number of host addresses             32            

Number of usable addresses             30            

Number of bits borrowed             3            

**Show your work for Problem 4 in the space below.**

	256	128	64	32	16	8	4	2	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>
<b>210 . 100 . 56 . 0 0 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

<b>128</b>		
<b>64</b>	<b>8</b>	<b>32</b>
<b>+32</b>	<b>-2</b>	<b>-2</b>
<b>224</b>	<b>6</b>	<b>30</b>

## Custom Subnet Masks

### Problem 5

Number of needed usable subnets **6**  
 Number of needed usable hosts **30**  
 Network Address **195.85.8.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 252    

Total number of subnets     64    

Number of usable subnets     62    

Total number of host addresses     4    

Number of usable addresses     2    

Number of bits borrowed     6    

**Show your work for Problem 5 in the space below.**

	256	128	64	32	16	8	4	2	-	<i>Number of</i>
<i>Number of</i>										<i>Hosts</i>
<i>Subnets</i>	-	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	<i>- Binary values</i>
<b>195 . 85 . 8 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>		

128		
64		
32		
16		
8	64	4
+4	-2	-2
252	60	2



# Custom Subnet Masks

## Problem 7

Number of needed usable subnets **2000**

Number of needed usable hosts **15**

Network Address **178.100.0.0**

Address class     **B**    

Default subnet mask     **255 . 255 . 0 . 0**    

Custom subnet mask     **255 . 255 . 255 . 224**    

Total number of subnets     **2,048**    

Number of usable subnets     **2,046**    

Total number of host addresses     **32**    

Number of usable addresses     **30**    

Number of bits borrowed     **11**    

Show your work for Problem 7 in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4,096	8,192	16,384	32,768	65,536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
178 . 100 . 0 0 0 0 0 0 0 0 . 0 0 0												0	0	0	0	0

**128**  
**64**  
**32**  
**16**  
**8**  
**4**     **2,048**     **32**  
**2**             **-2**             **-2**  
**+1**             **2,046**             **30**  


---

**255**



# Custom Subnet Masks

## Problem 8

Number of needed usable subnets **1**  
 Number of needed usable hosts **45**  
 Network Address **200.175.14.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Number of usable subnets 2

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

**Show your work for Problem 8 in the space below.**

	256	128	64	32	16	8	4	2	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>
<b>200 . 175 . 14 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

128	4	64
+64	-2	-2
<hr style="width: 100%;"/>	<hr style="width: 100%;"/>	<hr style="width: 100%;"/>
240	2	62



# Custom Subnet Masks

## Problem 10

Number of needed usable hosts **60**

Network Address **198.100.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Number of usable subnets 2

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

**Show your work for Problem 10 in the space below.**

	256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	Binary values
<b>198 . 100 . 10 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

128	64	4
+64	-2	-2
<hr style="width: 100%; border: 0; border-top: 1px solid black; margin: 0;"/>	<hr style="width: 100%; border: 0; border-top: 1px solid black; margin: 0;"/>	<hr style="width: 100%; border: 0; border-top: 1px solid black; margin: 0;"/>
192	62	2



# Custom Subnet Masks

## Problem 12

Number of needed usable subnets **5**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Number of usable subnets 6

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

**Show your work for Problem 12 in the space below.**

	256	128	64	32	16	8	4	2	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>
<b>218 . 35 . 50 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

128		
64	64	4
+32	-2	-2
224	62	2

## Custom Subnet Masks

### Problem 13

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 224    

Total number of subnets             8            

Number of usable subnets             6            

Total number of host addresses           32          

Number of usable addresses           30          

Number of bits borrowed             3            

**Show your work for Problem 13 in the space below.**

	256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	- Binary values
<b>218 . 35 . 50 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

128		
64	8	32
<u>+32</u>	<u>-2</u>	<u>-2</u>
224	6	30

# Custom Subnet Masks

## Problem 14

Number of needed usable subnets **10**

Network Address **172.59.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 240 . 0

Total number of subnets 16

Number of usable subnets 14

Total number of host addresses 4,096

Number of usable addresses 4,094

Number of bits borrowed 4

Show your work for Problem 14 in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8,192	16,384	32,768	65,536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	172	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0

128		
64		
32	16	4,096
+16	-2	-2
240	14	4,094







# Subnetting

## Problem 1

Number of needed usable subnets **14**

Number of needed usable hosts **14**

Network Address **192.10.10.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 240    

Total number of subnets           16          

Number of usable subnets           14          

Total number of host addresses           16          

Number of usable addresses           14          

Number of bits borrowed           4          

What is the 3rd usable subnet range?     192.10.10.48 to 192.10.10.63    

What is the subnet number for the 7th usable subnet?     192 . 10 . 10 . 112    

What is the subnet broadcast address for the 12th usable subnet?     192 . 10 . 10 . 207    

What are the assignable addresses for the 8th usable subnet?     192.10.10.129 to 192.10.10.142

Show your work for Problem 1 in the space below.

				16	8	4	2	-	Number of Hosts	
Number of Subnets	256	128	64	32	16	8	4	2	-	Number of Hosts
	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	Binary values
192.10.10.0	0	0	0	0	0	0	0	0		
(Invalid range)	0									192.10.10.0 to 192.10.10.15
										1 to 192.10.10.31
										1 0 to 192.10.10.47
										1 1 to 192.10.10.63
										1 0 0 to 192.10.10.79
										1 0 1 to 192.10.10.95
										1 1 0 to 192.10.10.111
										1 1 1 to 192.10.10.127
										1 0 0 0 to 192.10.10.143
										1 0 0 1 to 192.10.10.159
										1 0 1 0 to 192.10.10.175
										1 0 1 1 to 192.10.10.191
										1 1 0 0 to 192.10.10.207
										1 1 0 1 to 192.10.10.223
										1 1 1 0 to 192.10.10.239
(Invalid range)	1	1	1	1						192.10.10.240 to 192.10.10.255

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 +16 \\
 \hline
 \text{Custom subnet mask } 240
 \end{array}$$

$$\begin{array}{r}
 16 \\
 -2 \\
 \hline
 \text{Usable subnets } 14
 \end{array}$$

$$\begin{array}{r}
 16 \\
 -2 \\
 \hline
 \text{Usable hosts } 14
 \end{array}$$

The binary value of the last bit borrowed is the range. In this problem the range is 16.

The first and last range of addresses are not usable.

The first usable range of addresses is: 192.10.10.16 to 192.10.10.31.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

# Subnetting

## Problem 2

Number of needed usable subnets **1000**

Number of needed usable hosts **60**

Network Address **165.100.0.0**

Address class     *B*    

Default subnet mask     *255 . 255 . 0 . 0*    

Custom subnet mask     *255 . 255 . 255 . 192*    

Total number of subnets     *1,024*    

Number of usable subnets     *1,022*    

Total number of host addresses     *64*    

Number of usable addresses     *62*    

Number of bits borrowed     *10*    

What is the 14th usable subnet range?     *165.100.3.128 to 165.100.3.191*    

What is the subnet number for the 5th usable subnet?     *165 . 100 . 1 . 64*    

What is the subnet broadcast address for the 5th usable subnet?     *165 . 100 . 1 . 127*    

What are the assignable addresses for the 8th usable subnet?     *165.100.2.1 to 165.100.0.62*



# Subnetting

## Problem 3

Number of needed usable subnets **1**

Network Address **195.223.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Number of usable subnets 2

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

What is the 2nd usable subnet range? 195.223.50.128 - 195.223.50.191

What is the subnet number for the 1st usable subnet? 195.223.50.64

What is the subnet broadcast address for the 1st usable subnet? 195.223.50.127

What are the assignable addresses for the 2nd usable subnet? 195.223.50.129 - 195.223.50.190

Show your work for Problem 3 in the space below.

Number of Subnets	256	128	64	32	16	8	4	2	-	Number of Hosts
	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	Binary values
<b>195.223.50.0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>		
<i>(Invalid range)</i>	0	1								
	1									
<i>(Invalid range)</i>	1	0								
<i>(Invalid range)</i>	1	1								

128	4	64
+64	-2	-2
192	2	62

# Subnetting

## Problem 4

Number of needed usable subnets **750**

Network Address **190.35.0.0**

Address class     *B*    

Default subnet mask     *255 . 255 . 0 . 0*    

Custom subnet mask     *255 . 255 . 255 . 192*    

Total number of subnets     *1,024*    

Number of usable subnets     *1,022*    

Total number of host addresses     *64*    

Number of usable addresses     *62*    

Number of bits borrowed     *10*    

What is the 14th usable subnet range?     *190.35.3.128 to 190.35.3.191*    

What is the subnet number for the 12th usable subnet?     *190.35.3.0*    

What is the subnet broadcast address for the 9th usable subnet?     *190.35.2.127*    

What are the assignable addresses for the 5th usable subnet?     *190.35.1.65 to 190.35.1.126*





# Subnetting

## Problem 5

Number of needed usable hosts **6**

Network Address **126.0.0.0**

Address class     *A*    

Default subnet mask     *255 . 0 . 0 . 0*    

Custom subnet mask     *255 . 255 . 255 . 248*    

Total number of subnets     *2,097,152*    

Number of usable subnets     *2,097,150*    

Total number of host addresses     *8*    

Number of usable addresses     *6*    

Number of bits borrowed     *21*    

What is the 1st usable subnet range?     *126.0.0.8 to 126.0.0.15*    

What is the subnet number for the 4th usable subnet?     *126.0.0.32*    

What is the subnet broadcast address for the 6th usable subnet?     *126.0.0.55*    

What are the assignable addresses for the 9th usable subnet?     *126.0.0.73 to 126.0.0.78*



# Subnetting

## Problem 6

Number of needed usable subnets **10**

Network Address **192.70.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Number of usable subnets 14

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 8th usable subnet range? 192.70.10.128 to 192.70.10.143

What is the subnet number for the 3rd usable subnet? 192.70.10.48

What is the subnet broadcast address for the 11th usable subnet? 192.70.10.191

What are the assignable addresses for the 9th usable subnet? 192.70.10.145 to 192.70.10.158

Show your work for **Problem 6** in the space below.

	256	128	64	32	16	8	4	2	1	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1		Binary values
192 . 70 . 10 .	0	0	0	0	0	0	0	0	0	
(Invalid range)	0									192.70.10.0 to 192.70.10.15
	1									192.70.10.16 to 192.70.10.31
		1	0							192.70.10.32 to 192.70.10.47
		1	1							192.70.10.48 to 192.70.10.63
		1	0	0						192.70.10.64 to 192.70.10.79
		1	0	1						192.70.10.80 to 192.70.10.95
		1	1	0						192.70.10.96 to 192.70.10.111
		1	1	1						192.70.10.112 to 192.70.10.127
	1	0	0	0						192.70.10.128 to 192.70.10.143
	1	0	0	1						192.70.10.144 to 192.70.10.159
	1	0	1	0						192.70.10.160 to 192.70.10.175
	1	0	1	1						192.70.10.176 to 192.70.10.191
	1	1	0	0						192.70.10.192 to 192.70.10.207
	1	1	0	1						192.70.10.208 to 192.70.10.223
	1	1	1	0						192.70.10.224 to 192.70.10.239
(Invalid range)	1	1	1	1						192.70.10.240 to 192.70.10.255

128	16	16
+64	-2	-2
-----	-----	-----
240	14	14

# Subnetting

## Problem 7

Network Address **10.0.0.0 /16**

Address class   A  

Default subnet mask   255 . 0 . 0 . 0  

Custom subnet mask   255 . 255 . 0 . 0  

Total number of subnets   256  

Number of usable subnets   254  

Total number of host addresses   65,536  

Number of usable addresses   65,534  

Number of bits borrowed   8  

What is the 10th usable subnet range?   10.10.0.0 to 10.10.255.255  

What is the subnet number for the 5th usable subnet?   10.5.0.0  

What is the subnet broadcast address for the 1st usable subnet?   10.1.255.255  

What are the assignable addresses for the 8th usable subnet?   10.8.0.1 to 10.8.255.254



# Subnetting

## Problem 8

Number of needed usable subnets **4**

Network Address **172.50.0.0**

Address class     **B**    

Default subnet mask     **255 . 255 . 0 . 0**    

Custom subnet mask     **255 . 255 . 224 . 0**    

Total number of subnets     **8**    

Number of usable subnets     **6**    

Total number of host addresses     **8,192**    

Number of usable addresses     **8,190**    

Number of bits borrowed     **3**    

What is the 3rd usable subnet range?     **172.50.96.0 to 172.50.127.255**    

What is the subnet number for the 4th usable subnet?     **172.50.128.0**    

What is the subnet broadcast address for the 5th usable subnet?     **172.50.191.255**    

What are the assignable addresses for the 2nd usable subnet?     **172.50.64.1 to 172.50.95.254**





# Subnetting

## Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class     *B*    

Default subnet mask     *255 . 255 . 0 . 0*    

Custom subnet mask     *255 . 255 . 255 . 224*    

Total number of subnets     *2,048*    

Number of usable subnets     *2,046*    

Total number of host addresses     *32*    

Number of usable addresses     *30*    

Number of bits borrowed     *11*    

What is the 1st usable subnet range?     *172.50.0.32 to 172.50.0.63*    

What is the subnet number for the 9th usable subnet?     *172.50.1.32*    

What is the subnet broadcast address for the 3rd usable subnet?     *172.50.0.127*    

What are the assignable addresses for the 5th usable subnet?     *172.50.0.161 to 172.50.0.190*



# Subnetting

## Problem 10

Number of needed usable subnets **45**

Network Address **220.100.100.0**

Address class     *C*    

Default subnet mask     *255 . 255 . 255 . 0*    

Custom subnet mask     *255 . 255 . 255 . 252*    

Total number of subnets     *64*    

Number of usable subnets     *62*    

Total number of host addresses     *4*    

Number of usable addresses     *2*    

Number of bits borrowed     *6*    

What is the 4th usable subnet range?     *220.100.100.16 to 220.100.100.19*    

What is the subnet number for the 3rd usable subnet?     *220.100.100.12*    

What is the subnet broadcast address for the 12th usable subnet?     *220.100.100.51*    

What are the assignable addresses for the 11th usable subnet?     *220.100.100.45 to 220.100.100.46*

Show your work for Problem 10 in the space below.

Number of Subnets		256	128	64	32	16	8	4	2	-	Number of Hosts
-		2	4	8	16	32	64	128	256		
220 . 100 . 100 .		0	0	0	0	0	0	0	0		Binary values
<hr/>											
(Invalid range)											
128							0	220.100.100.0	to	220.100.100.3	
64					1	0	1	220.100.100.4	to	220.100.100.7	
32				1	1	0	1	220.100.100.8	to	220.100.100.11	
16			1	0	0	1	0	220.100.100.12	to	220.100.100.15	
8			1	0	1	0	1	220.100.100.16	to	220.100.100.19	
+4			1	1	0	1	0	220.100.100.20	to	220.100.100.23	
<u>252</u>			1	1	1	0	1	220.100.100.24	to	220.100.100.27	
			1	1	1	1	0	220.100.100.28	to	220.100.100.31	
	1	0	0	0	0	0	0	220.100.100.32	to	220.100.100.35	
	1	0	0	1	0	0	1	220.100.100.36	to	220.100.100.39	
	1	0	1	0	1	0	0	220.100.100.40	to	220.100.100.43	
	1	0	1	1	0	1	1	220.100.100.44	to	220.100.100.47	
	1	1	0	0	1	0	0	220.100.100.48	to	220.100.100.51	
	1	1	1	0	1	0	1	220.100.100.52	to	220.100.100.55	
	1	1	1	1	1	0	0	220.100.100.56	to	220.100.100.59	
	1	1	1	1	1	1	1	220.100.100.60	to	220.100.100.63	
64											
-2											
<u>62</u>											
4											
-2											
<u>2</u>											

# Subnetting

## Problem 11

Number of needed usable hosts **8,000**

Network Address **135.70.0.0**

Address class     *B*    

Default subnet mask     *255 . 255 . 0 . 0*    

Custom subnet mask     *255 . 255 . 224 . 0*    

Total number of subnets     *8*    

Number of usable subnets     *6*    

Total number of host addresses     *8,192*    

Number of usable addresses     *8,190*    

Number of bits borrowed     *3*    

What is the 5th usable subnet range?     *135.70.160.0 to 135.70.191.255*    

What is the subnet number for the 6th usable subnet?     *135.70.192.0*    

What is the subnet broadcast address for the 2nd usable subnet?     *135.70.95.255*    

What are the assignable addresses for the 4th usable subnet?     *135.70.128.1 to 135.70.159.254*



# Subnetting

## Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 192    

Total number of subnets           4          

Number of usable subnets           2          

Total number of host addresses          64          

Number of usable addresses          62          

Number of bits borrowed           2          

What is the 1st usable subnet range?     198.125.50.64 to 198.125.50.127    

What is the subnet number for the 1st usable subnet?           198.125.50.64          

What is the subnet broadcast address for the 2nd usable subnet?           198.125.50.191          

What are the assignable addresses for the 2nd usable subnet?     198.125.50.129 to 198.125.50.190



Show your work for Problem 12 in the space below.

Number of Subnets	256	128	64	32	16	8	4	2	1	Number of Hosts	
	- 2	4	8	16	32	64	128	256			
		128	64	32	16	8	4	2	1	Binary values	
198 . 125 . 50 .	0	0	0	0	0	0	0	0	0		
(Invalid range)	0	1	198.125.50.0 to 198.125.50.63					1	198.125.50.64 to 198.125.50.127		
	1	0	198.125.50.128 to 198.125.50.191					1	198.125.50.192 to 198.125.50.255		
(Invalid range)	1	1									

128	4	64
+64	-2	-2
192	2	62

# Subnetting

## Problem 13

Network Address **165.200.0.0 /26**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Number of usable subnets 1,022

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 9th usable subnet range? 165.200.2.64 to 165.200.2.127

What is the subnet number for the 10th usable subnet? 165.200.2.128

What is the subnet broadcast address for the 1022nd usable subnet? 165.200.255.191

What are the assignable addresses for the 1021st usable subnet? 165.200.255.65 to 165.200.255.126



# Subnetting

## Problem 14

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Number of usable subnets 6

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

What is the 6th usable subnet range? 200.10.10.192 to 200.10.10.223

What is the subnet number for the 4th usable subnet? 200.10.10.128

What is the subnet broadcast address for the 3rd usable subnet? 200.10.10.127

What are the assignable addresses for the 5th usable subnet? 200.10.10.161 to 200.10.10.190

Show your work for Problem 14 in the space below.

Number of Subnets	256	128	64	32	16	8	4	2	-	Number of Hosts
	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	Binary values
<b>200 . 10 . 10 . 0 0 0</b>				<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	
(Invalid range)	0									200.10.10.0 to 200.10.10.31
	1									200.10.10.32 to 200.10.10.63
		1	0							200.10.10.64 to 200.10.10.95
		1	1							200.10.10.96 to 200.10.10.127
	1	0	0							200.10.10.128 to 200.10.10.159
	1	0	1							200.10.10.160 to 200.10.10.191
	1	1	0							200.10.10.192 to 200.10.10.223
(Invalid range)	1	1	1							200.10.10.224 to 200.10.10.255

128		
64	8	32
+32	-2	-2
224	6	30

# Subnetting

## Problem 15

Network Address **93.0.0.0** \19

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 2,048

Number of usable subnets 2,046

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 11

What is the 14th usable subnet range? 93.1.192.0 to 93.1.223.255

What is the subnet number for the 8th usable subnet? 93.1.0.0

What is the subnet broadcast address for the 6th usable subnet? 93.0.223.255

What are the assignable addresses for the 11th usable subnet? 93.1.96.1 to 93.1.127.254



## Valid and Non-Valid IP Addresses

Using the material in this workbook identify which of the addresses below are correct and usable. If they are not usable addresses explain why.

IP Address: 0.230.190.192  
Subnet Mask: 255.0.0.0

*The network ID cannot be 0.*

IP Address: 192.10.10.1  
Subnet Mask: 255.255.255.0

*OK*

IP Address: 245.150.190.10  
Subnet Mask: 255.255.255.0

*245 is reserved for experimental use.*

IP Address: 135.70.191.255  
Subnet Mask: 255.255.254.0

*This is the broadcast address for this range.*

IP Address: 127.100.100.10  
Subnet Mask: 255.0.0.0

*127 is reserved for loopback testing.*

IP Address: 93.0.128.1  
Subnet Mask: 255.255.224.0

*OK*

IP Address: 200.10.10.128  
Subnet Mask: 255.255.255.224

*This is the subnet address for the 3rd usable range of 200.10.10.0*

IP Address: 165.100.255.189  
Subnet Mask: 255.255.255.192

*OK*

IP Address: 190.35.0.10  
Subnet Mask: 255.255.255.192

*This address is taken from the first range for this subnet which is invalid.*

IP Address: 218.35.50.195  
Subnet Mask: 255.255.0.0

*This has a class B subnet mask.*

IP Address: 200.10.10.175 /22

*A class C address must use a minimum of 24 bits.*

IP Address: 135.70.255.255  
Subnet Mask: 255.255.224.0

*This is a broadcast address.*



### Class A Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.192.0.0	4	2	4,194,304	4,194,302
3	255.224.0.0	8	6	2,097,152	2,097,150
4	255.240.0.0	16	14	1,048,576	1,048,574
5	255.248.0.0	32	30	524,288	524,286
6	255.252.0.0	64	62	262,144	262,142
7	255.254.0.0	128	126	131,072	131,070
8	255.255.0.0	256	254	65,536	65,534
9	255.255.128.0	512	510	32,768	32,766
10	255.255.192.0	1,024	1,022	16,384	16,382
11	255.255.224.0	2,048	2,046	8,192	8,190
12	255.255.240.0	4,096	4,094	4,096	4,094
13	255.255.248.0	8,192	8,190	2,048	2,046
14	255.255.252.0	16,384	16,382	1,024	1,022
15	255.255.254.0	32,768	32,766	512	510
16	255.255.255.0	65,536	65,534	256	254
17	255.255.255.128	131,072	131,070	128	126
18	255.255.255.192	262,144	262,142	64	62
19	255.255.255.224	524,288	524,286	32	30
20	255.255.255.240	1,048,576	1,048,574	16	14
21	255.255.255.248	2,097,152	2,097,150	8	6
22	255.255.255.252	4,194,304	4,194,302	4	2

### Class B Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.255.192.0	4	2	16,384	16,382
3	255.255.224.0	8	6	8,192	8,190
4	255.255.240.0	16	14	4,096	4,094
5	255.255.248.0	32	30	2,048	2,046
6	255.255.252.0	64	62	1,024	1,022
7	255.255.254.0	128	126	512	510
8	255.255.255.0	256	254	256	254
9	255.255.255.128	512	510	128	126
10	255.255.255.192	1,024	1,022	64	62
11	255.255.255.224	2,048	2,046	32	30
12	255.255.255.240	4,096	4,094	16	14
13	255.255.255.248	8,192	8,190	8	6
14	255.255.255.252	16,384	16,382	4	2

### Class C Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.255.255.192	4	2	64	62
3	255.255.255.224	8	6	32	30
4	255.255.255.240	16	14	16	14
5	255.255.255.248	32	30	8	6
6	255.255.255.252	64	62	4	2

