

IP Addressing and Subnetting

Workbook
Version 1.1

Instructor's Edition

111111110

10010101

00011011

10000110

11010011

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

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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 <u>146</u> 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>	<u>119</u>
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	34
									-128	-32
									110	2
0	0	1	0	0	0	1	0	34	-64	-2
									46	0
									-32	
0	1	1	1	1	0	1	1	123	14	
									-8	
0	0	1	1	0	0	1	0	50	6	
									-4	
1	1	1	1	1	1	1	1	255	2	
									-2	
1	1	0	0	1	0	0	0	200	0	
0	0	0	0	1	0	1	0	10		
1	0	0	0	1	0	1	0	138		
0	0	0	0	0	0	0	1	1		
0	0	0	0	1	1	0	1	13		
1	1	1	1	1	0	1	0	250		
0	1	1	0	1	0	1	1	107		
1	1	1	0	0	0	0	0	224		
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: **192 . 100 . 10 . 33**
 Host Portion: 192 . 100 . 10 . **33**

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)

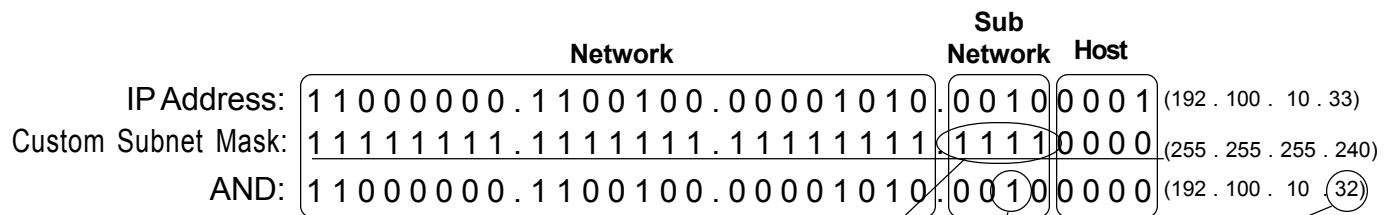
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

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)



Four bits borrowed from the host portion of the address for the custom subnet mask.

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>
192 . 10 . 10 . 0	0	0	0	0	0	0	0	0	0	0	

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	
14	Subtract 2 for the number of usable hosts.

16	Subtract 2 for the total number of subnets to get the usable number of subnets.
-2	
14	

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

128
 64
 32
 16
 8
 4
 2
 +1

 255

1024
 -2

 1,022

64 Observe the total number of hosts.
 -2

 62 Subtract 2 for the number of usable hosts.

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

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

Custom Subnet Masks

Problem 3

/26 indicates the total number of bits used for the network and subnetwork portion of the address. All bits remaining belong to the host portion of the address.

Network Address **148.75.0.0 /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

Show your work for Problem 3 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
		148	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 16 \\
 8 \\
 4 \\
 2 \\
 +1 \\
 \hline
 255
 \end{array}$$

$$\begin{array}{r}
 1024 \\
 -2 \\
 \hline
 1,022
 \end{array}$$

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

64 Observe the total number of hosts.
 $\frac{-2}{62}$ Subtract 2 for the number of usable hosts.

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>									
210	.	100	.	56	.	0	0	0	0
128		64	8	32		8	32	32	
+32		-2	-2	-2		6	30	30	
224		6	6	30		30	30	30	

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

128		
64		
32		
16		
8	64	4
+4	-2	-2
<u>252</u>	<u>60</u>	<u>2</u>

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

128
 64
 32
 16
 8
 4
 2
 +1

 255

2,048
 -2

 2,046

32
 -2

 30

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

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 9

Number of needed usable subnets **60**
 Number of needed usable hosts **1,000**
 Network Address **128.77.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 252 . 0

Total number of subnets 64

Number of usable subnets 62

Total number of host addresses 1,024

Number of usable addresses 1,022

Number of bits borrowed 6

Show your work for Problem 9 in the space below.

		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 Hosts	-	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
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
		128	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0

128		
64		
32		
16		
8	64	1,024
+4	-2	-2
<hr/>	<hr/>	<hr/>
252	62	1,022

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
198 . 100 . 10 .	0	0	0	0	0	0	0	0	0	

128	64	4
+64	-2	-2
<hr style="width: 50%; margin: 0 auto;"/>	<hr style="width: 50%; margin: 0 auto;"/>	<hr style="width: 50%; margin: 0 auto;"/>
192	62	2

Custom Subnet Masks

Problem 11

Number of needed usable subnets **250**
 Network Address **101.0.0.0**

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

Show your work for Problem 11 in the space below.

	4,194,304	2097,152	1048,576	524,288	262,144	131,072		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 Hosts -																								
Number of Subnets -	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304		
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1

101.00000000.00000000.00000000

128		
64		
32		
16		
8		
4		
2	256	65,536
+1	-2	-2
<u>255</u>	<u>254</u>	<u>65,534</u>

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

128		
64	64	4
+32	-2	-2
<u>224</u>	<u>62</u>	<u>2</u>

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
218 . 35 . 50 . 0	0	0	0	0	0	0	0	0	0	

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

Custom Subnet Masks

Problem 15

Number of needed usable hosts **50**

Network Address **172.59.0.0**

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 15 in the space below.

		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 Hosts	-																
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
		172	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		128															
		64															
		32															
		16															
		8															
		4															
		2				128		64		1,024							
		+1				+64		-2		-2							
		<u>255</u>				<u>192</u>		<u>62</u>		<u>1,022</u>							

Custom Subnet Masks

Problem 16

Number of needed usable hosts **29**
 Network Address **23.0.0.0**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 524,288

Number of usable subnets 524,286

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 19

Show your work for Problem 16 in the space below.

Number of Hosts	2	4	8	16	32	64	128	256	32	16	8	4	2
4,194,304									1048576	2097152	4194304		
2097,152									524,288	262,144	131,072		
1048,576									262,144	131,072	65,536		
524,288									131,072	65,536	32,768		
262,144									65,536	32,768	16,384		
131,072									32,768	16,384	8,192		
65,536									16,384	8,192	4,096		
32,768									8,192	4,096	2,048		
16,384									4,096	2,048	1,024		
8,192									2,048	1,024	512		
4,096									1,024	512	256		
2,048									512	256	128		
1,024									256	128	64		
512									128	64	32		
256									64	32	16		
128									32	16	8		
64									16	8	4		
32									8	4	2		
16									4	2	1		
8									2	1			
4									1				
2									0				
1									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				
0									0				

128		
64	32	524,288
+32	-2	-2
224	30	524,286

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.

	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
192.10.10.0	0	0	0	0	0	0	0	0	0	

(Invalid range)	0	192.10.10.0	to	192.10.10.15
	1	192.10.10.16	to	192.10.10.31
	1 0	192.10.10.32	to	192.10.10.47
	1 1	192.10.10.48	to	192.10.10.63
	1 0 0	192.10.10.64	to	192.10.10.79
	1 0 1	192.10.10.80	to	192.10.10.95
	1 1 0	192.10.10.96	to	192.10.10.111
	1 1 1	192.10.10.112	to	192.10.10.127
	1 0 0 0	192.10.10.128	to	192.10.10.143
	1 0 0 1	192.10.10.144	to	192.10.10.159
	1 0 1 0	192.10.10.160	to	192.10.10.175
	1 0 1 1	192.10.10.176	to	192.10.10.191
	1 1 0 0	192.10.10.192	to	192.10.10.207
	1 1 0 1	192.10.10.208	to	192.10.10.223
	1 1 1 0	192.10.10.224	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*

Show your work for Problem 2 in the space below.

Number of Hosts -	64	32	16	8	4	2
	2048	4,096	8,192	16,384	32,768	65,536
Number of Subnets -	2	4	8	16	32	64
Binary values -	128	64	32	16	8	4
165.100.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0

Usable hosts	64	128	64	32	16	8
Usable subnets	2	4	8	16	32	64
Custom subnet mask	128	64	32	16	8	4
	+64	+64	+64	+64	+64	+64
	192	192	192	192	192	192
						+1
						255

165.100.0.0	to	165.100.0.63
165.100.0.64	to	165.100.0.127
165.100.0.128	to	165.100.0.191
165.100.0.192	to	165.100.0.255
165.100.1.0	to	165.100.1.63
165.100.1.64	to	165.100.1.127
165.100.1.128	to	165.100.1.191
165.100.1.192	to	165.100.1.255
165.100.2.0	to	165.100.2.63
165.100.2.64	to	165.100.2.127
165.100.2.128	to	165.100.2.191
165.100.2.192	to	165.100.2.255
165.100.3.0	to	165.100.3.63
165.100.3.64	to	165.100.3.127
165.100.3.128	to	165.100.3.191
165.100.3.192	to	165.100.3.255

The binary value of the last bit borrowed is the range. In this problem the range is 64.

The first and last range of addresses are not usable.

The first usable range of addresses is: 165.100.0.64 to 165.100.0.127

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

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

Down to

165.100.255.128 to 165.100.255.191
 165.100.255.192 to 165.100.255.255

(Invalid range)

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.

	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					
195.223.50.0 0												
(Invalid range)	0	195.223.50.0 to 195.223.50.63										
	1	195.223.50.64 to 195.223.50.127										
	1 0	195.223.50.128 to 195.223.50.191										
(Invalid range)	1 1	195.223.50.192 to 195.223.50.255										
		128		4		64						
		<u>+64</u>		<u>-2</u>		<u>-2</u>						
		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*

Show your work for Problem 4 in the space below.

<p>Number of Hosts -</p> <p>65,536</p> <p>32,768</p> <p>16,384</p> <p>8,192</p> <p>4,096</p> <p>2,048</p> <p>1,024</p> <p>512</p> <p>256</p> <p>128</p>	<p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>	<p>1</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>
<p>Number of Subnets -</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p>	<p>1</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>	<p>1</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>
<p>Binary values -</p> <p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>1</p>	<p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>1</p>	<p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>1</p>
<p>190.35.0.0</p>	<p>0.0</p>	<p>0.0</p>
<p>190.35.0.64</p>	<p>0.64</p>	<p>0.64</p>
<p>190.35.0.128</p>	<p>0.128</p>	<p>0.128</p>
<p>190.35.0.192</p>	<p>0.192</p>	<p>0.192</p>
<p>190.35.1.0</p>	<p>1.0</p>	<p>1.0</p>
<p>190.35.1.64</p>	<p>1.64</p>	<p>1.64</p>
<p>190.35.1.128</p>	<p>1.128</p>	<p>1.128</p>
<p>190.35.1.192</p>	<p>1.192</p>	<p>1.192</p>
<p>190.35.2.0</p>	<p>2.0</p>	<p>2.0</p>
<p>190.35.2.64</p>	<p>2.64</p>	<p>2.64</p>
<p>190.35.2.128</p>	<p>2.128</p>	<p>2.128</p>
<p>190.35.2.192</p>	<p>2.192</p>	<p>2.192</p>
<p>190.35.3.0</p>	<p>3.0</p>	<p>3.0</p>
<p>190.35.3.64</p>	<p>3.64</p>	<p>3.64</p>
<p>190.35.3.128</p>	<p>3.128</p>	<p>3.128</p>
<p>190.35.3.192</p>	<p>3.192</p>	<p>3.192</p>

(Invalid range)

	128								
	64								
	32								
	16								
	8								
	4								
	2								
	+1								
	1,024								
	-2								
	1,022								

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

Show your work for Problem 5 in the space below.

Number of Hosts	Number of Subnets	Binary values	126.0.0.0	to	126.0.0.7
4,194,304	2	128	126.0.0.0	to	126.0.0.15
2,097,152	4	64	126.0.0.16	to	126.0.0.23
1,048,576	8	32	126.0.0.24	to	126.0.0.31
524,288	16	16	126.0.0.32	to	126.0.0.39
262,144	32	8	126.0.0.40	to	126.0.0.47
131,072	64	4	126.0.0.48	to	126.0.0.55
65,536	128	2	126.0.0.56	to	126.0.0.63
32,768	256	+1	126.0.0.64	to	126.0.0.71
16,384	512	255	126.0.0.72	to	126.0.0.79
8,192	1,024	8	126.0.0.80	to	126.0.0.87
4,096	2,048	-2	126.0.0.88	to	126.0.0.95
2,048	4,096	6	126.0.0.96	to	126.0.0.103
1,024	8,192		126.0.0.104	to	126.0.0.111
512	16,384		126.0.0.112	to	126.0.0.119
256	32,768		126.0.0.120	to	126.0.0.127
128	65,536				
64	131,072				
32	262,144				
16	524,288				
8	1,048,576				
4	2,097,152				
2	4,194,304				

128	128	(Invalid range) 0
64	64	1
32	32	1 0
16	16	1 0 0
8	8	1 0 0 1
4	4	1 1 0
2	2	1 1 1
+1	+8	1 0 0 0
<u>255</u>	<u>248</u>	1 0 0 1
		1 0 1 0
		1 0 1 1
		1 1 0 0
		1 1 0 1
		1 1 1 0
		1 1 1 1

2,097,152	
-2	
<u>2,097,150</u>	

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.

				Number of Hosts											
Number of Subnets				256	128	64	32	16	8	4	2	1			
				-	2	4	8	16	32	64	128	256			
				Number of Subnets				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

Show your work for Problem 7 in the space below.

<p style="margin-left: 20px;">Number of Hosts -</p> <p style="margin-left: 20px;">Number of Subnets -</p> <p style="margin-left: 20px;">Binary values -</p> <p style="margin-left: 20px;">128 64 32 16 8 4 2 1</p>	<p style="margin-left: 20px;">131,072 ---</p> <p style="margin-left: 20px;">262,144 ---</p> <p style="margin-left: 20px;">524,288 ---</p> <p style="margin-left: 20px;">1,048,576 ---</p> <p style="margin-left: 20px;">2,097,152 ---</p> <p style="margin-left: 20px;">4,194,304 ---</p>	<p style="margin-left: 20px;">256 128 64 32 16 8 4 2</p> <p style="margin-left: 20px;">4,194,304</p> <p style="margin-left: 20px;">2,097,152</p> <p style="margin-left: 20px;">1,048,576</p> <p style="margin-left: 20px;">524,288</p> <p style="margin-left: 20px;">262,144</p> <p style="margin-left: 20px;">131,072</p>
<p style="margin-left: 20px;">10.0.0.0</p> <p style="margin-left: 20px;">10.1.0.0</p> <p style="margin-left: 20px;">10.2.0.0</p> <p style="margin-left: 20px;">10.3.0.0</p> <p style="margin-left: 20px;">10.4.0.0</p> <p style="margin-left: 20px;">10.5.0.0</p> <p style="margin-left: 20px;">10.6.0.0</p> <p style="margin-left: 20px;">10.7.0.0</p> <p style="margin-left: 20px;">10.8.0.0</p> <p style="margin-left: 20px;">10.9.0.0</p> <p style="margin-left: 20px;">10.10.0.0</p> <p style="margin-left: 20px;">10.11.0.0</p> <p style="margin-left: 20px;">10.12.0.0</p> <p style="margin-left: 20px;">10.13.0.0</p> <p style="margin-left: 20px;">10.14.0.0</p> <p style="margin-left: 20px;">10.15.0.0</p>	<p style="margin-left: 20px;">0</p> <p style="margin-left: 20px;">1</p> <p style="margin-left: 20px;">1 0</p> <p style="margin-left: 20px;">1 1</p> <p style="margin-left: 20px;">1 0 0</p> <p style="margin-left: 20px;">1 0 1</p> <p style="margin-left: 20px;">1 1 0</p> <p style="margin-left: 20px;">1 1 1</p> <p style="margin-left: 20px;">1 0 0 0</p> <p style="margin-left: 20px;">1 0 0 1</p> <p style="margin-left: 20px;">1 0 1 0</p> <p style="margin-left: 20px;">1 0 1 1</p> <p style="margin-left: 20px;">1 1 0 0</p> <p style="margin-left: 20px;">1 1 0 1</p> <p style="margin-left: 20px;">1 1 1 0</p> <p style="margin-left: 20px;">1 1 1 1</p>	<p style="margin-left: 20px;">10.0.255.255</p> <p style="margin-left: 20px;">10.1.255.255</p> <p style="margin-left: 20px;">10.2.255.255</p> <p style="margin-left: 20px;">10.3.255.255</p> <p style="margin-left: 20px;">10.4.255.255</p> <p style="margin-left: 20px;">10.5.255.255</p> <p style="margin-left: 20px;">10.6.255.255</p> <p style="margin-left: 20px;">10.7.255.255</p> <p style="margin-left: 20px;">10.8.255.255</p> <p style="margin-left: 20px;">10.9.255.255</p> <p style="margin-left: 20px;">10.10.255.255</p> <p style="margin-left: 20px;">10.11.255.255</p> <p style="margin-left: 20px;">10.12.255.255</p> <p style="margin-left: 20px;">10.13.255.255</p> <p style="margin-left: 20px;">10.14.255.255</p> <p style="margin-left: 20px;">10.15.255.255</p>
<p style="margin-left: 20px;">128</p> <p style="margin-left: 20px;">64</p> <p style="margin-left: 20px;">32</p> <p style="margin-left: 20px;">16</p> <p style="margin-left: 20px;">8</p> <p style="margin-left: 20px;">4</p> <p style="margin-left: 20px;">2</p> <p style="margin-left: 20px;">+1</p> <hr style="width: 50%; margin-left: 0;"/> <p style="margin-left: 20px;">255</p>	<p style="margin-left: 20px;">(Invalid range) 0</p>	<p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p> <p style="margin-left: 20px;">to</p>
<p style="margin-left: 20px;">256</p> <p style="margin-left: 20px;">-2</p> <hr style="width: 50%; margin-left: 0;"/> <p style="margin-left: 20px;">254</p>	<p style="margin-left: 20px;">65,536</p> <p style="margin-left: 20px;">-2</p> <hr style="width: 50%; margin-left: 0;"/> <p style="margin-left: 20px;">65,534</p>	<p style="margin-left: 20px;">10.0.0.0</p> <p style="margin-left: 20px;">10.1.0.0</p> <p style="margin-left: 20px;">10.2.0.0</p> <p style="margin-left: 20px;">10.3.0.0</p> <p style="margin-left: 20px;">10.4.0.0</p> <p style="margin-left: 20px;">10.5.0.0</p> <p style="margin-left: 20px;">10.6.0.0</p> <p style="margin-left: 20px;">10.7.0.0</p> <p style="margin-left: 20px;">10.8.0.0</p> <p style="margin-left: 20px;">10.9.0.0</p> <p style="margin-left: 20px;">10.10.0.0</p> <p style="margin-left: 20px;">10.11.0.0</p> <p style="margin-left: 20px;">10.12.0.0</p> <p style="margin-left: 20px;">10.13.0.0</p> <p style="margin-left: 20px;">10.14.0.0</p> <p style="margin-left: 20px;">10.15.0.0</p>

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**

Show your work for Problem 8 in the space below.

<p>Number of Hosts -</p> <table style="margin-left: 20px;"> <tr><td>65,536</td><td>-----</td><td>2</td></tr> <tr><td>32,768</td><td>-----</td><td>4</td></tr> <tr><td>16,384</td><td>-----</td><td>8</td></tr> </table> <p>Number of Subnets -</p> <table style="margin-left: 20px;"> <tr><td>2</td><td>-----</td><td>4</td></tr> <tr><td>4</td><td>-----</td><td>8</td></tr> <tr><td>8</td><td>-----</td><td>16</td></tr> <tr><td>16</td><td>-----</td><td>32</td></tr> <tr><td>32</td><td>-----</td><td>64</td></tr> <tr><td>64</td><td>-----</td><td>128</td></tr> <tr><td>128</td><td>-----</td><td>256</td></tr> </table> <p>Binary values -</p> <table style="margin-left: 20px;"> <tr><td>128</td><td>-----</td><td>1</td></tr> <tr><td>64</td><td>-----</td><td>2</td></tr> <tr><td>32</td><td>-----</td><td>4</td></tr> <tr><td>16</td><td>-----</td><td>8</td></tr> <tr><td>8</td><td>-----</td><td>16</td></tr> <tr><td>4</td><td>-----</td><td>32</td></tr> <tr><td>2</td><td>-----</td><td>64</td></tr> <tr><td>1</td><td>-----</td><td>128</td></tr> </table> <p>172.50.000</p>	65,536	-----	2	32,768	-----	4	16,384	-----	8	2	-----	4	4	-----	8	8	-----	16	16	-----	32	32	-----	64	64	-----	128	128	-----	256	128	-----	1	64	-----	2	32	-----	4	16	-----	8	8	-----	16	4	-----	32	2	-----	64	1	-----	128	<table style="width: 100%;"> <tr><td>512</td><td>-----</td><td>256</td></tr> <tr><td>1,024</td><td>-----</td><td>512</td></tr> <tr><td>2,048</td><td>-----</td><td>1,024</td></tr> <tr><td>4,096</td><td>-----</td><td>2,048</td></tr> <tr><td>8,192</td><td>-----</td><td>4,096</td></tr> <tr><td>16,384</td><td>-----</td><td>8,192</td></tr> <tr><td>32,768</td><td>-----</td><td>16,384</td></tr> <tr><td>65,536</td><td>-----</td><td>32,768</td></tr> </table>	512	-----	256	1,024	-----	512	2,048	-----	1,024	4,096	-----	2,048	8,192	-----	4,096	16,384	-----	8,192	32,768	-----	16,384	65,536	-----	32,768
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<table style="width: 100%;"> <tr><td>128</td><td></td><td>172.50.0.0</td><td>to</td><td>172.50.31.255</td></tr> <tr><td>64</td><td>1</td><td>172.50.32.0</td><td>to</td><td>172.50.63.255</td></tr> <tr><td>32</td><td>1 0</td><td>172.50.64.0</td><td>to</td><td>172.50.95.255</td></tr> <tr><td>16</td><td>1 1</td><td>172.50.96.0</td><td>to</td><td>172.50.127.255</td></tr> <tr><td>8</td><td>1 0 0</td><td>172.50.128.0</td><td>to</td><td>172.50.159.255</td></tr> <tr><td>4</td><td>1 0 1</td><td>172.50.160.0</td><td>to</td><td>172.50.191.255</td></tr> <tr><td>2</td><td>1 1 0</td><td>172.50.192.0</td><td>to</td><td>172.50.223.255</td></tr> <tr><td>1</td><td>1 1 1</td><td>172.50.224.0</td><td>to</td><td>172.50.255.255</td></tr> </table> <p>(Invalid range) 1 1 1</p>	128		172.50.0.0	to	172.50.31.255	64	1	172.50.32.0	to	172.50.63.255	32	1 0	172.50.64.0	to	172.50.95.255	16	1 1	172.50.96.0	to	172.50.127.255	8	1 0 0	172.50.128.0	to	172.50.159.255	4	1 0 1	172.50.160.0	to	172.50.191.255	2	1 1 0	172.50.192.0	to	172.50.223.255	1	1 1 1	172.50.224.0	to	172.50.255.255	<table style="width: 100%;"> <tr><td>172.50.0.0</td><td>to</td><td>172.50.31.255</td></tr> <tr><td>172.50.32.0</td><td>to</td><td>172.50.63.255</td></tr> <tr><td>172.50.64.0</td><td>to</td><td>172.50.95.255</td></tr> <tr><td>172.50.96.0</td><td>to</td><td>172.50.127.255</td></tr> <tr><td>172.50.128.0</td><td>to</td><td>172.50.159.255</td></tr> <tr><td>172.50.160.0</td><td>to</td><td>172.50.191.255</td></tr> <tr><td>172.50.192.0</td><td>to</td><td>172.50.223.255</td></tr> <tr><td>172.50.224.0</td><td>to</td><td>172.50.255.255</td></tr> </table>	172.50.0.0	to	172.50.31.255	172.50.32.0	to	172.50.63.255	172.50.64.0	to	172.50.95.255	172.50.96.0	to	172.50.127.255	172.50.128.0	to	172.50.159.255	172.50.160.0	to	172.50.191.255	172.50.192.0	to	172.50.223.255	172.50.224.0	to	172.50.255.255														
128		172.50.0.0	to	172.50.31.255																																																																											
64	1	172.50.32.0	to	172.50.63.255																																																																											
32	1 0	172.50.64.0	to	172.50.95.255																																																																											
16	1 1	172.50.96.0	to	172.50.127.255																																																																											
8	1 0 0	172.50.128.0	to	172.50.159.255																																																																											
4	1 0 1	172.50.160.0	to	172.50.191.255																																																																											
2	1 1 0	172.50.192.0	to	172.50.223.255																																																																											
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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*

Show your work for Problem 9 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256
Number of Subnets -	2	4	8	16	32	64	128	256	512
Binary values -	128	64	32	16	8	4	2	1	0
172.50.0.0	0	0	0	0	0	0	0	0	0
128	1	0	0	0	0	0	0	0	0
64	0	1	0	0	0	0	0	0	0
32	0	0	1	0	0	0	0	0	0
16	0	0	0	1	0	0	0	0	0
8	0	0	0	0	1	0	0	0	0
4	0	0	0	0	0	1	0	0	0
2	0	0	0	0	0	0	1	0	0
+1	0	0	0	0	0	0	0	1	0
252	0	0	0	0	0	0	0	1	0
1,024	1	0	0	0	0	0	0	0	0
-2	0	0	0	0	0	0	0	0	0
1,022	0	0	0	0	0	0	0	0	0
64	1	0	0	0	0	0	0	0	0
-2	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0
(Invalid range)	0	0	0	0	0	0	0	0	0
172.50.0.0	172.50.0.0	172.50.0.32	172.50.0.64	172.50.0.96	172.50.0.128	172.50.0.160	172.50.0.192	172.50.0.224	172.50.0.255
to	to	to	to	to	to	to	to	to	to
172.50.0.31	172.50.0.63	172.50.0.95	172.50.0.127	172.50.0.159	172.50.0.191	172.50.0.223	172.50.0.255	172.50.1.31	172.50.1.63
172.50.1.63	172.50.1.95	172.50.1.127	172.50.1.159	172.50.1.191	172.50.1.223	172.50.1.255	172.50.1.255	172.50.1.31	172.50.1.63
172.50.1.63	172.50.1.95	172.50.1.127	172.50.1.159	172.50.1.191	172.50.1.223	172.50.1.255	172.50.1.255	172.50.1.31	172.50.1.63

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

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

Show your work for Problem 11 in the space below.

<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p> <p>135.70.0.0</p>	<p>16,384</p> <p>32,768</p> <p>65,536</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1,024</p> <p>2,048</p> <p>4,096</p> <p>8,192</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>1</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1,024</p> <p>2,048</p> <p>4,096</p> <p>8,192</p> <p>16,384</p> <p>32,768</p> <p>65,536</p>
<p>(Invalid range) 0</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>(Invalid range) 1</p>	<p>135.70.0.0</p> <p>135.70.32.0</p> <p>135.70.64.0</p> <p>135.70.96.0</p> <p>135.70.128.0</p> <p>135.70.160.0</p> <p>135.70.192.0</p> <p>135.70.224.0</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>135.70.0.0</p> <p>135.70.31.255</p> <p>135.70.63.255</p> <p>135.70.95.255</p> <p>135.70.127.255</p> <p>135.70.159.255</p> <p>135.70.191.255</p> <p>135.70.223.255</p> <p>135.70.255.255</p>
<p>8</p> <p>-2</p> <p>6</p> <p>8,192</p> <p>-2</p> <p>8,190</p>	<p>128</p> <p>64</p> <p>+32</p> <p>224</p>

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	-	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		
(Invalid range)		0		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			
(Invalid range)		1	1		198.125.50.192	to	198.125.50.255			

128	4	64
+64	-2	-2
<u>192</u>	<u>2</u>	<u>62</u>

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
200 . 10 . 10 . 0 0 0				0	0	0	0	0	0	
(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

Show your work for Problem 15 in the space below.

<p>Number of Hosts -</p> <p>Number of Subnets - 2 4 8 16 32 64 128 256</p> <p>Binary values - 128 64 32 16 8 4 2 1</p> <p>93.00000000.0000</p>	<p>(Invalid range) 0</p> <p>1 0</p> <p>1 0</p> <p>1 0 0</p> <p>1 0 1</p> <p>1 1 0</p> <p>1 1 1</p> <p>1 0 0 0</p> <p>1 0 0 1</p> <p>1 0 1 0</p> <p>1 0 1 1</p> <p>1 1 0 0</p> <p>1 1 0 1</p> <p>1 1 1 0</p>	<p>93.0.0.0 to 93.0.31.255</p> <p>93.0.32.0 to 93.0.63.255</p> <p>93.0.64.0 to 93.0.95.255</p> <p>93.0.96.0 to 93.0.127.255</p> <p>93.0.128.0 to 93.0.159.255</p> <p>93.0.160.0 to 93.0.191.255</p> <p>93.0.192.0 to 93.0.223.255</p> <p>93.0.224.0 to 93.0.255.255</p> <p>93.1.0.0 to 93.1.31.255</p> <p>93.1.32.0 to 93.1.63.255</p> <p>93.1.64.0 to 93.1.95.255</p> <p>93.1.96.0 to 93.1.127.255</p> <p>93.1.128.0 to 93.1.159.255</p> <p>93.1.160.0 to 93.1.191.255</p> <p>93.1.192.0 to 93.1.223.255</p>
<p>4,194,304 -</p> <p>2,097,152 -</p> <p>1,048,576 -</p> <p>524,288 -</p> <p>262,144 -</p> <p>131,072 -</p> <p>65,536 -</p> <p>32,768 -</p> <p>16,384 -</p> <p>8,192 -</p> <p>4,096 -</p> <p>2,048 -</p> <p>1,024 -</p> <p>512 -</p>	<p>4,194,304</p> <p>2,097,152</p> <p>1,048,576</p> <p>524,288</p> <p>262,144</p> <p>131,072</p> <p>65,536</p> <p>32,768</p> <p>16,384</p> <p>8,192</p> <p>4,096</p> <p>2,048</p> <p>1,024</p> <p>512</p>	<p>256 128 64 32 16 8 4 2</p> <p>16,384 - 2,048</p> <p>32,768 - 1,024</p> <p>65,536 - 512</p> <p>131,072 -</p> <p>262,144 -</p> <p>524,288 -</p> <p>1,048,576 -</p> <p>2,097,152 -</p> <p>4,194,304 -</p>
<p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>+1</p> <hr/> <p>255</p>	<p>128</p> <p>64</p> <p>+32</p> <hr/> <p>224</p>	<p>2,048</p> <p>-2</p> <hr/> <p>2,046</p>
<p>8,192</p> <p>-2</p> <hr/> <p>8,190</p>		

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

