CIS 350 – INFRASTRUCTURE TECHNOLOGIES
SOLUTION TO HOMEWORK # 6

Problem 1

A mask representing some IP address is 255.255.252.0. Write the mask in

the binary form:	**11111111.11111111.11111100.00000000**
the prefix notation:	**/22**

Problem 2

What is the class of the following IP addresses?

10000011.10000111.11001100.00000011	**Class B**
11000110.10000111.11001100.00000011	**Class C**
01111110.10000111.11001100.00000011	**Class A**

Problem 3

Your start-up company has been assigned the following IP address by ICANN: 211.226.10.0. You are to design 30 subnetworks within this network, with each subnetwork supporting up to 10 hosts. Can these subnetworks and hosts be designed? If not, what address class A, B, or C would allow for this particular design?

As the 1st octet falls into the decimal range of [192,223] this is class C address. Class C addresses have the following mask 255.255.255.0 or 11111111.11111111.11111111.00000000 or /24.

32-24 = 8 bits

Thus we have 8 bits left to design the required subnets and hosts.

$2^n - 2 \geq 30$

$2^n \geq 32$

$n=5$

We need 5 bits to design 30 subnetworks.

8 – 5 = 3 bits are left for the hosts/nodes within each subnetwork.

$2^n - 2 \geq 10$

$2^n \geq 12$

$n=4$

I need 4 bits for the hosts/nodes. However, only 3 is left. This design <u>cannot</u> be performed.

For this particular design a class B address would be needed.

Problem 4

Your company has been assigned the following IP address by ICANN: 140.204.0.0. Design a network that consists of 500 subnetworks with each subnetwork having up to 60 hosts.

(a) What address class is it?

The class B address as the 1st octet of 140 falls into the [128,191] range.

Express this IP address in the binary form: **10001100.11001100.00000000.00000000**

(b) What is the mask associated with this IP address? Write the mask in the decimal, binary and prefix form.

Mask in decimal **255.255.0.0**
Mask in binary **11111111.11111111.00000000.00000000**
Mask in prefix form **/16**

(c) Perform calculations below to check if this network can be designed.

32-16 = 16 bits

Thus we have 16 bits left to design the required subnets and hosts/nodes.

$2^n - 2 \geq 500$

$2^n \geq 502$

n=9 bits

We need 9 bits to design 500 subnetworks. Actually, with 9 bits one can design 2^9-2=512-2=510 subnetworks.

16 – 9 = 7 bits are left for the hosts/nodes within each subnetwork.

$2^n - 2 \geq 60$

$2^n \geq 62$

n=6 bits is the minimum, but 7 bits will be used. Actually, with 7 bits one can design 2^7-2=128-2=126 hosts within each subnet.

This design can be performed.

(d) What is the subnetwork mask? Write the subnetwork mask in the decimal, binary and prefix form.

Mask in decimal **255.255.255.128**
Mask in binary **11111111.11111111.11111111.10000000**
This reflects 16 bits of the class B address mask + 9 additional bits which you borrowed from the host part to represent the subnetworks.
Mask in prefix form **/25**

For questions (e) through (h) do **not** follow the Cisco approach with AllZero and AllOnes addresses for subnetworks briefly discussed in class and described at this link http://www.cisco.com/en/US/tech/tk648/tk361/technologies_tech_note09186a0080093f18.shtml, but rather use the approach covered in the class examples.

(e) Write the address for the 1^{st} subnetwork as well as the 1 host, 2^{nd} host, 60^{th} host, the last 126^{th} host, and the broadcast address for the 1^{st} subnetwork. Present the addresses in the binary and decimal forms.

1^{st} subnet:	**10001100.11001100.00000000.1 0000000**	**140.204.0.128**
1^{st} host:	**10001100.11001100.00000000.1 0000001**	**140.204.0.129**
2^{nd} host:	**10001100.11001100.00000000.1 0000010**	**140.204.0.130**

60^{th} host:	**10001100.11001100.00000000.1 0111100**	**140.204.0.188**
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last 126^{th} host:	**10001100.11001100.00000000.1 1111110**	**140.204.0.254**
broadcast address for the 1^{st} subnet:	**10001100.11001100.00000000.1 1111111**	**140.204.0.255**

(f) Write the address for the 2^{nd} subnetwork as well as the 1 host, 2^{nd} host, 60^{th} host, and the last 126^{th} host, and the broadcast address for the 2^{nd} subnetwork. Present the addresses in the binary and decimal forms.

2^{nd} subnet:	**10001100.11001100.00000001.0 0000000**	**140.204.1.0**
1^{st} host:	**10001100.11001100.00000001.0 0000001**	**140.204.1.1**
2^{nd} host:	**10001100.11001100.00000001.0 0000010**	**140.204.1.2**

60^{th} host:	**10001100.11001100.00000001.0 0111100**	**140.204.1.60**
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last 126^{th} host:	**10001100.11001100.00000001.0 1111110**	**140.204.1.126**
broadcast address for the 2^{nd} subnet:	**10001100.11001100.00000001.0 1111111**	**140.204.1.127**

(g) Write the address for the 500^{th} subnetwork as well as the 1 host, 2^{nd} host, 60^{th} host, and the last 126^{th} host, and the broadcast address for the 500^{th} subnetwork. Present the addresses in the binary and decimal forms.

500^{th} subnet:	**10001100.11001100.11111010.0 0000000**	**140.204.250.0**
1^{st} host:	**10001100.11001100.11111010.0 0000001**	**140.204.250.1**
2^{nd} host:	**10001100.11001100.11111010.0 0000010**	**140.204.250.2**

60^{th} host:	**10001100.11001100.11111010.0 0111100**	**140.204.250.60**
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last 126th host: **10001100.11001100. <u>11111010.0</u> <u>1111110</u>** **140.204.250.126**

broadcast address for the 500th subnet: **10001100.11001100. <u>11111010.0</u> <u>1111111</u>** **140.204.250.127**

(h) Write the address for the <u>last 510th subnetwork</u> as well as the 1 host, 2nd host, 60th host, the last host, and the broadcast address for the last subnetwork. Present the addresses in the binary and decimal forms.

last 510th subnet: **10001100.11001100.<u>11111111.0</u> <u>0000000</u>** **140.204.255.0**

1st host: **10001100.11001100.<u>11111111.0</u> <u>0000001</u>** **140.204.255.1**

2nd host: **10001100.11001100.<u>11111111.0</u> <u>0000010</u>** **140.204.255.2**

60th host: **10001100.11001100.<u>11111111.0</u> <u>0111100</u>** **140.204.255.60**

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last 126th host: **10001100.11001100.<u>11111111.0</u> <u>1111110</u>** **140.204.255.126**

broadcast address for the last 510th subnet: **10001100.11001100.<u>11111111.0</u> <u>1111111</u>** **140.204.255.127**

To represent 500 subnetworks on the network you can select any 500 out of 510 available IP addresses for subnetworks. Also, to represent 60 hosts on each of the above subnetworks you can choose any 60 out of 126 available addresses for hosts. (The broadcast and network addresses are excluded.)

The last subnetwork cannot be represented by the address
10001100.11001100.<u>11111111.1</u> <u>0000000</u> **140.204.255.128**
as this the broadcast address for all subnetworks (or for the network). The broadcast address would actually be 10001100.11001100.<u>11111111.1</u> <u>1111111</u> **140.204.255.255**

(i) Using the masking operation find the subnetwork on which the host with this IP address 140.204.250.60 resides.

Subnetwork mask in binary: **11111111.11111111.11111111.10000000**

The IP address of the host in binary: **10001100.11001100.11111010.00111100**

The result from the AND operation: 10001100.11001100.11111010.00000000
is the binary address of the 500th subnetwork. The decimal address of the 500th subnetwork is 140.204.250.0. This IP address 140.204.250.60 is the address of the 60th host on this subnetwork. **See 4(g) on p. 3.**

Problem 5

A signal travels from point A to B in a communication channel. The signal power at points A and B are 10000 and 100 watts, respectively. Calculate the signal gain/loss in [decibels – dB] at point B. Was the signal attenuated or amplified? See slide 24 for chapter 14.

Loss [db] = $10 \log_{10}(P_B/P_A) = 10 \log_{10}(100/10000) = -20$ dB

The signal was attenuated.

(The minus sign).

Problem 6

A signal travels from point A to B in a communication channel. The signal power at points A and B are 100 and 10000 watts, respectively. Calculate the signal gain/loss in [decibels – dB] at point B. Was the signal attenuated or amplified? See slide 24 for chapter 14.

Gain [db] = $10 \log_{10}(P_B/P_A) = 10 \log_{10}(10000/100) = 20$ dB

The signal was amplified.

Problem 7

You should know from chapter 14 that the speed of data transmission over a communication channel depends on the bandwidth of the channel as well as the power of the signal and noise of the channel. Shannon proposed a formula that allows one to calculate the maximum data rate [bps – bits per second] for an analog signal with noise send over a channel. See slide 25 for chapter 14.

$S = f \times \log_2 (1+W/N)$

where:

- S – data transfer rate in bps
- f – signal bandwidth
- W – signal power in watts, and
- N – noise power in watts

Calculate the data rate (speed of transmission) of the telephone signal of 4 KHz bandwidth, 5 watts of power, and 0.02 watts of noise? (Note that the log function uses base 2.)

$S = f \times \log_2 (1+W/N) = 4000 \times \log_2 (1+5/0.02) = 4000 \times = 4000 \times \log_2 (1+250) =$
$4000 \times \log_2 (251) = 4000 \times 7.97 \approx 31886$ bps

Note that you must convert 4 KHz to 4000 Hz because bandwidth f has to be expressed in Hz. One has to do the appropriate conversion if bandwidth is expressed in MHz or GHz.

1 KHz = 1000 Hz
1 MHz = 1000000 Hz
1 GHz = 1000000000 Hz