**CIS 350 – INFRASTRUCTURE TECHNOLOGIES**

**HOMEWORK #6 – 70 points**

**Topics**: Networks and Data Communications (Chapter 12), Ethernet and TCP/IP Networking (Chapter 13), Communication Channel Technology (Chapter 14)

Name of Students: \_Elise Timmons\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Logistics**: Get in a group of 3 students maximum and work this homework in class on Mon, Nov 25. E-mail one solution per group one solution per group to [jozef.zurada@louisville.edu](mailto:jozef.zurada@louisville.edu). If you miss class, you need to work this homework individually or in a group and submit to me via e-mail by midnight, Mon, Nov 25.

**Show your calculations**!

**Problem 1** (2 points)

A mask representing some IP address is 255.255.224.0. Write the mask in

the binary form: **11111111.11111111.11100000.00000000**

the prefix notation: **/19**

**Problem 2** (3 points)

What is the class of the following IP addresses?

01000110.10000111.11001100.00000011 **Class A**

100.8.32.0 (the decimal form) **Class A**

11000011.10000111.11001100.00000011 **Class C**

**Problem 3** (5 points)

Your start-up company has been assigned the following IP address by IANA: 135.120.0.0. You are to design 600 subnetworks within this network, with each subnetwork supporting up to 500 hosts. Can these subnetworks and hosts be designed? If not, which address class A, B, or C would allow for this particular design? Show your calculations.

**This would fall under Class B. Default mask is 255.255.0.0 or 11111111.11111111.00000000.00000000 or /16.**

**32-16 = 16 bits.**

**There will be 16 bits left to design the required subnets and hosts.**

**Subnets:**

**2^n – 2 >= 600**

**2^n >= 602**

**n = 10**

**There will be 10 bits needed to design 600 subnetworks.**

**16 – 10 = 6 bits left for nodes within each network.**

**Hosts:**

**2^n -2 >= 500**

**2^n >= 502**

**n = 9**

**There will be 9 bits needed for 500 hosts. However, with only 6 bits left, the design cannot be performed. For the design a Class A address will be needed.**

**Problem 4**

Your company has been assigned the following IP address by IANA: 135.120.0.0. Design a network that consists of 1000 subnetworks with each subnetwork having up to 60 hosts.

1. What address class is it? (2 points) **This address class is Class B. (falls under [128,191])**

Express this IP address in the binary form: **10000111.11110000.00000000.00000000**

1. What is the network mask associated with this IP address? Write the mask in the decimal, binary and prefix form. (3 points)

Mask in decimal **255.255.0.0**

Mask in binary **11111111.11111111.00000000.00000000**

Mask in prefix form **/16**

1. Perform calculations below to check if this network can be designed. Show your calculations. (5 points)

**32 – 16 = 16 bits**

**16 bits left to design the required subnets and hosts.**

**Subnets:**

**2^n -2 >= 1000**

**2^n >= 1002**

**n = 10**

**There are 10 bits needed to design 1000 subnetworks.**

**16 - 10 = 6 bits left for the hosts within each subnetwork.**

**Host:**

**2^n -2 >= 60**

**2^n >= 62**

**n = 6**

**6 bits are needed for 60 hosts within each subnetwork.**

**This design can be performed.**

1. What is the subnetwork mask? Write the subnetwork mask in the decimal, binary and prefix form. (3 points)

Mask in decimal **255.255.252.0**

Mask in binary **11111111.11111111.11111100.00000000**

Mask in prefix form **/22**

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.

1. Write the address for the 1st subnetwork as well as the 1 host, 2nd host, the 60th host, and the broadcast address for the 1st subnetwork. Present the addresses in the binary and decimal forms. (10 points)

**1st subnet: 10000111.1111000.00000000.10000000 135.120.0.128**

**1st host: 10000111.1111000.00000000.10000001 135.120.0.129**

**2nd host: 10000111.1111000.00000000.10000010 135.120.0.130**

**60th host: 10000111.1111000.00000000.11111110 135.120.0.254**

**Broadcast Address for the 1st subnet: 10000111.1111000.00000000.11111111 135.120.0.255**

**Any 60 IP Addresses within the range [135.120.0.129 – 135.120.0.254].**

1. Write the address for the 2nd subnetwork as well as the 1 host, 2nd host, the 60th host, and the broadcast address for the 2nd subnetwork. Present the addresses in the binary and decimal forms. (10 points)

**2nd Subnetwork: 10000111.1111000.00000001.00000000 135.120.1.0**

**1st host: 10000111.1111000.00000001.00000001 135.120.1.1**

**2nd host: 10000111.1111000.00000001.00000010 135.120.1.2**

**60th host: 10000111.1111000.00000001.11111110 135.120.1.126**

**Broadcast address for the 2nd subnetwork: 10000111.1111000.00000001.11111111 135.120.1.127**

**Any 60 IP Addresses within the range [135.120.1.1 – 135.120.1.126].**

1. Write the address for the 1000th subnetwork as well as the 1 host, 2nd host, the 60th host, and the broadcast address for the 1000th subnetwork. Present the addresses in the binary and decimal forms. (10 points)

**1000th Subnetwork: 10000111.1111000.11111111.00000000 135.120.255.0**

**1st Host: 10000111.1111000.11111111.00000001 135.120.255.1**

**2nd host: 10000111.1111000.11111111.00000010 135.120.255.2**

**60th host: 10000111.1111000.11111111.01111110 135.120.255.126**

**Broadcast address for the 1000th subnetwork: 10000111.1111000.11111111.011111111 135.120.255.127**

**Any 60 IP Addresses within the range [135.120.255.1 – 135.120.255.126].**

1. Use the masking operation (the AND logical operator) to show explicitly that the 60th host residing on the 2nd subnetwork indeed belongs to this subnetwork. Align bits when you perform the AND bit-by-bit operation on the subnetwork mask and the 60th on the 2nd subnetwork. Show your calculations. (5 points).

**Subnetwork mask in binary: 11111111.11111111.11111100.00000000**

**60th host on the 2nd subnetwork: 10000111.1111000.00000001.11111110**

**The AND operation: 10000111.1111000.00000001.11111110**

**The AND operation and the address for the 2nd subnetwork are the same.**

**Problem 5** (6 points)

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? Show your calculations. (For help, see slide 24 in chapter 14 posted on BB.)

**Gain dB = 10 log10(PB/PA) = 10 log10(100/10000) = 10 (2) = 20 dB**

**The signal was amplified.**

**Problem 6** (6 points)

You should know from the slides on chapter 14 covered in the classroom that the speed of data transmission over a communication channel depends on the bandwidth of the channel [expressed in Hz] as well as the power of the signal and noise of the channel [both expressed in Watts]. Shannon proposed a formula that allows one to calculate the maximum data rate [expressed in bps (bits/second)] for an analog signal with noise send over a channel. (For help, see slide 25 in chapter 14 posted on BB.)

S = f × log2 (1+W/N)

where:

* S – data transfer rate in bps
* f – signal bandwidth [expressed in Hz]
* 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, 1000 watts of power, and 0.2 watts of noise? Show your calculations.

(Note that the log function uses base 2.)

The bandwidth is expressed in KHz so remember to convert it to Hz. You may use Excel function =LOG(x, 2) to calculate log2(x), where x is an argument and 2 is the base; or you may use your calculator with the LOG10(x) function knowing that log10(x)/log10(2) = log2(x).

**S = f \* log2 (1 + W/N) = 4000 \* log2 (1 + 1000/0.2) = 4000 \* log2(1 + 5000) = 4000 \* log2(5001) = 4000 \* 12.288 = 61,452.288 bps**