CIS 350 – INFRASTRUCTURE TECHNOLOGIES
SOLUTION TO HOMEWORK #6 – 70 points

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

Show your calculations!

Problem 1 (2 points)

A mask representing some IP address is 255.255.128.0. Write the mask in

the binary form: 11111111.11111111.10000000.00000000
the prefix notation: **/17**

Problem 2 (3 points)

What is the class of the following IP addresses?

01000011.10000111.11001100.00000011	___**A**__________
135.80.42.0	___**B**__________
240.135.204.3	___**E**__________

Problem 3 (5 points)

The following IP address has been assigned to the University of Louisville by IANA: 136.165.0.0. Octets 1 and 2 of the address represent the network part. You are to design 300 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? You must show your calculations.

136.165.0.0 is a class B address.
nnnnnnnn.nnnnnnnn.hhhhhhhh.hhhhhhhh **Maks is /16**
network part host part

There are 16 bits left for the 300 subnetworks and 500 host.

$2^n - 2 >= 300$
$2^n >= 302$
N >= 9 needs at least 9 bits to hold 300 subnetworks

There are 7 bits left for 500 hosts
$2^n -2 >= 500$
$2^n >= 502$
N >= 9 needs at least 9 bits for 500 hosts, so the 7 bits are not enough for the host.

Class A address should be enough for this design.

nnnnnnnn.hhhhhhhh.hhhhhhhh.hhhhhhhh mask is /8
host part

The network part is 8 bits and 24 bits left for subnetworks and host, 300 subnetwork needs 9 bits and 500 host also needs 9 bits, which is 18 bits in total, so class A would allow this particular design.

Problem 4

The following IP address has been assigned to the University of Louisville by IANA: 136.165.0.0. Octets 1 and 2 of the address represent the network part. Design a network that consists of 50 subnetworks with each subnetwork having up to 1000 hosts.

(a) What address class is it? (2 points) ____**B**________

Express this IP address in the binary form: 10001000.10100101.00000000.00000000

(b) 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 255.255.000.000
Mask in binary 11111111.11111111.00000000.00000000
Mask in prefix form **_/16_______**

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

There are 16 bits for 50 subnetworks and 1000 hosts.

2^n -2 >= 50
2^n >= 52
N >= 6 needs 6 bits for 50 subnetworks, so there are 10 bits left for 1000 hosts,

2^n -2 >= 1000
2^n >= 1002
n >= 10 needs 10 bits for 1000 hosts.

So, this address would allow this design.

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

Subnet mask in binary 11111111.11111111.11111100.00000000
Subnet mask in decimal 255.255.252.000
Subnet 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**.

(e) Write the addresses in the binary and decimal forms for … (10 points). The network address (octets 1 & 2) does not change.

10001000.10100101.000001||00.00000000 136.165.4.0 the 1st subnet

10001000.10100101.000001||00.00000001 136.165.4.1 the 1st host on the 1st subnet

10001000.10100101.000001||00.00000010	136.165.4.2	the 2^{nd} host on the 1^{st} subnet
10001000.10100101.000001||11.11101000	136.165.4.232	the 1000^{th} host on the 1^{st} subnet
10001000.10100101.000001||11.11111111	136.165.4.255	the broadcast address for the 1^{st} subnet

(f) Write the addresses in the binary and decimal forms for … (10 points). The network address (octets 1 & 2) does not change.

10001000.10100101.000010||00.00000000	136.165.8.0	the 2^{nd} subnet
10001000.10100101.000010||00.00000001	136.165.8.1	the 1^{st} host on the 2^{nd} subnet
10001000.10100101.000010||00.00000010	136.165.8.2	the 2^{nd} host on the 2^{nd} subnet
10001000.10100101.000010||11.11101000	136.165.11.232	the 1000^{th} host on the 2^{nd} subnet
10001000.10100101.000010||11.11111111	136.165.11.255	the broadcast address for the 2^{nd} subnet

(g) Write the addresses in the binary and decimal forms for … (10 points). The network address (octets 1 & 2) does not change.

10001000.10100101.110010||00.00000000	136.165.200.0	the 50^{th} subnet
10001000.10100101.110010||00.00000001	136.165.200.1	the 1^{st} host on the 50^{th} subnet
10001000.10100101.110010||00.00000010	136.165.200.2	the 2^{nd} host on the 50^{th} subnet
10001000.10100101.110010||11.11101000	136.165.203.232	the 1000^{th} host on the 50^{th} subnet
10001000.10100101.110010||11.11111111	136.165.203.255	the broadcast address for the 50^{th} subnet

(h) Use the masking operation (the AND logical operator) to show explicitly that the 1000^{th} host residing on the 2^{nd} subnetwork indeed belongs to this subnetwork. **Align bits** when you perform the AND bit-by-bit operation on the subnetwork mask and the 1000^{th} host on the 2^{nd} subnetwork. Show your calculations. (5 points).

The subnet mask:	11111111.11111111.11111100.00000000	255.255.0.0
The 1000th host on the 2nd subnet:	10001000.10100101.00001011.11101000	136.165.11.232
The result of the AND operation	10001000.10100101.00001000.00000000	**136.165.8.0**

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 1,000 and 10,000 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.)

P2: 10000 watts
P1: 1000 watts
Gain[dB] = 10 * $\log_{10}$(10000/1000) = 10 dB
It was a signal amplified.

Problem 6 (6 points)

You should know from the slides of chapter 14 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.)

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

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 signal of the 20KHz bandwidth, 500 watts of power and 20 watts of noise? Show your calculations.

(Note that the log function uses base 2.)

The bandwidth above is expressed in KHz so remember to convert it to Hz. You may use Excel function =LOG(x, 2) to calculate $\log_2(x)$, where x is an argument and 2 is the base; or you may use your calculator with the $LOG_{10}(x)$ function knowing that $\log_2(x) = \log_{10}(x)/\log_{10}(2)$.

f: 20KHz = 20000 Hz
W: 500 watts
N: 20 watts

$S = f \times \log_2 (1+W/N) = 20000 * \log_2 (1 + 500/20) = 94000$ bps