ECE 461 – Internetworking

Problem Sheet 1

Instructions (read carefully):
- Try to solve the problems on your own.
- Solutions will be discussed in tutorials.

Problem 1. Consider an Ethernet network with three hosts, Host A, Host B, and Host C as shown in Figure 1. No machine is configured as an IP router, and there is no IP router on this network. Assume that the IP addresses and subnet masks are as shown in the figure.

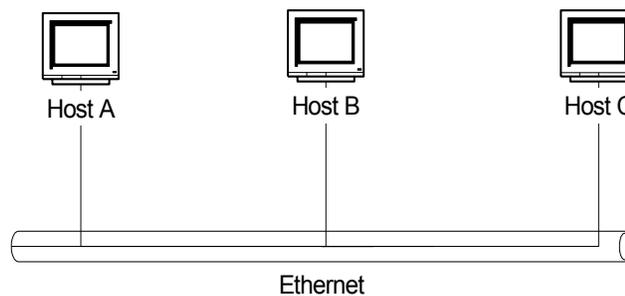|			
IP Adress:	192.0.3.88	192.0.3.94	192.0.3.200
Subnet Mask:	255.255.255.0	255.255.255.240	255.255.255.240

Figure 1: Network Topology

For each of the following IP datagram transmissions, describe if the transmissions will be successful. If a transmission will not work, provide an explanation:

    (a) Host C sends an IP datagram to Host A   **does not work**
    (b) Host A sends an IP datagram to Host B   **works**
    (c) Host A sends an IP datagram to Host C   **works**
    (d) Host B sends an IP datagram to Host A   **works**
    (e) Host B sends an IP datagram to Host C   **does not work**

Problem 2. Consider the 128.100.112.0/21 block of IP addresses. This block of addresses must be divided into four subnetworks that have each at least 500 IP addresses.

    a) Give the subnet mask of the four new subnetworks.
    b) Specify the network address and the network prefix for each subnetwork.
    c) Specify the broadcast IP address for each subnetwork.

    (a) 11111111.11111111.11111110 → 255.255.254.0

(b) 128.100.112.0/23
128.100.114.0/23
128.100.116.0/23
128.100.118.0/23

(c) 128.100.113.255
128.100.115.255
128.100.117.255
128.100.119.255

Problem 3. Select a subnet mask for 10.0.0.0/8 so that there will be at least 16,000 subnets with at least 700 host addressed on each subnet.

To find the number of subnets, one needs to select a number "n" such that $2^n \geq 16,000$. There must be enough host bits h remaining so that $2^h - 2 \geq 700$. A subnet mask of 255.255.252.0 provides 16,382 subnets of the class A address and 1022 host addresses on each subnet. (Note this is the only subnetmask which will work).

Problem 4. Assume that you have been assigned the 200.35.1.0/24 network block.
   a) Define an extended-network-prefix that allows the creation of 20 hosts on each subnet.

A minimum of five bits are required to define 20 hosts so the extended-network- prefix is a /27 (27 = 32-5).

   b) What is the maximum number of hosts that can be assigned to each subnet?
       The maximum number of hosts on each subnet is $2^5 - 2$, or 30.
   c) What is the maximum number of subnets that can be defined?
       The maximum number of subnets is 2^3, or 8.
   d) 4. Specify the subnets of 200.35.1.0/24 in binary format and dotted decimal notation.
       Subnet #0: *11001000.00100011.00000001.* **000** 00000 = 200.35.1.0/27
       Subnet #1: *11001000.00100011.00000001.* **001** 00000 = 200.35.1.32/27
       Subnet #2: *11001000.00100011.00000001.* **010** 00000 = 200.35.1.64/27
       Subnet #3: *11001000.00100011.00000001.* **011** 00000 = 200.35.1.96/27
       Subnet #4: *11001000.00100011.00000001.* **100** 00000 = 200.35.1.128/27
       Subnet #5: *11001000.00100011.00000001.* **101** 00000 = 200.35.1.160/27
       Subnet #6: *11001000.00100011.00000001.* **110** 00000 = 200.35.1.192/27
       Subnet #7: *11001000.00100011.00000001.* **111** 00000 = 200.35.1.224/27
   e) List range of host addresses that can be assigned to Subnet #6 (200.35.1.192/27)
       Subnet #6: *11001000.00100011.00000001.* **110** 00000 = 200.35.1.192/27
       Host #1: 11001000.00100011.00000001.110 **00001** = 200.35.1.193/27
       Host #2: *11001000.00100011.00000001.110* **00010** = 200.35.1.194/27
       Host #3: *11001000.00100011.00000001.110* **00011** = 200.35.1.195/27
       :
       Host #29: *11001000.00100011.00000001.110* **11101** = 200.35.1.221/27
       Host #30: *11001000.00100011.00000001.110* **11110** = 200.35.1.222/27

f) What is the broadcast address for subnet 200.35.1.192/27?
   11001000.00100011.00000001.110 **11111** = 200.35.1.223

Problem 5. For my research lab in the Bahen Center, I have requested a block of IP addresses from the University of Toronto. In reply to my request (on Sept. 19, 2007) I received the following response:

```
Information for new network:

Base address: 142.150.235.0
Network mask: 255.255.255.224
Broadcast address: 142.150.235.31
Reserved Router address: 142.150.235.1

This network should go on:
 bcit-ece-tier3-if.gw switch and our bcit router.
```

a) What is the address of the assigned subnetwork and what is the extended network prefix?
b) Which IP addresses can I use to configure the computers in my lab?
c) How do I configure the IP address, default gateway, and subnet mask on my computers?
d) Does the assigned address block use subnetting? Do I need to care?
e) What is the meaning and relevance of the last two lines in the above message (about the switch and the bcit router)?
f) If subnetting is used, how many bits of the host number are used to designate the subnet, and what is the IP address of the network that is divided into subnets (without subnetting)?
g) What is the role of the "reserved router address"? Why is this information important?
h) Do I need to set up a router in my lab?
i) Suppose I wanted to do subdivide the assigned address block into 4 smaller subnetworks of equal size. How large are these networks, and how many IP addresses can I assign in each subnetwork? What other equipment and configurations are necessary?

Solutions
a) 142.150.235.0/27

b) 142.150.235.2 – 142.150.235.30

c) IP address: from (b)
   default gateway: 142.150.235.1
   Subnet mask: 255.255.255.224

d) Yes, 142.150.0.0/16 is assigned to UofT (see ARIN records). So, subnetting is used.
   I don't need to know if subnetting is used when managing my own network.

e) The information is used for correct "wiring" of Ethernet switches to the IP router, and for configuring the IP router.

f) From ARIN records, the original network address is 142.150.0.0/16.
   So, 11 bits are used to designate the subnet.

g) This is the address of an IP router on the 142.150.235.0/27 subnet. All systems on this subnet should use the address 142.150.235.1 as default gateway.

h) No, I assume that the router is provided (at address 142.150.235.1).

i) I can assign 4 networks with a 29-bit prefix, with network addresses:

142.150.235.0/29
142.150.235.8/29
142.150.235.16/29
142.150.235.24/29

There can be 6 IP addresses on each subnet (3 bits = 8 addresses. But cannot use `000' (network address) and `111' (broadcast address))

Problem 6. *(Not discussed in the tutorial)* The "American Registry for Internet Numbers (ARIN)" is a non-profit organization that has the authority for IP address allocation in North America. Use the website of ARIN at www.arin.net to find answers to the following questions:

a) What are the IP address blocks allocated to the University of Toronto? Roughly, how many IP addresses does UofT have?

b) What is the "autonomous system (AS)" number allocation to the university of Toronto?

c) Suppose you start a large company (or found a large university) and want to allocate a block of 10,000 IP addresses from ARIN. Describe the process and try to estimate the costs.

d) ARIN can allocate both IPv4 and IPv6 addresses? Which type should you request?

e) Can you re-sell portions of the IP address space to others? Describe the constraints, both legal and engineering constraints.

f) In addition to allocating IP addresses, what else do you need to obtain from ARIN.

The following IP address blocks are assigned to the University of Toronto as of 2013. How many IPv4 and IPv6 addresses are these?
http://whois.arin.net/rest/org/UNIVER-36/nets

OISENET (NET-192-75-177-0-1)	192.75.177.0 - 192.75.177.255
USGTEST (NET-192-139-244-0-1)	192.139.244.0 - 192.139.244.255
CA-NET (NET-138-51-0-0-1)	138.51.0.0 - 138.51.255.255
CANET-NET3 (NET-142-253-0-0-1)	142.253.0.0 - 142.253.255.255
HOSER-NET (NET-199-212-42-0-1)	199.212.42.0 - 199.212.43.255
UTORONTO (NET-142-1-0-0-1)	142.1.0.0 - 142.1.255.255
OISENET2 (NET-205-211-129-0-1)	205.211.129.0 - 205.211.129.255

USG-BLK2 ([NET-207-34-12-0-1](#))   207.34.12.0 - 207.34.23.255
TORONTO-NETS ([NET-192-12-174-0-1](#)) 192.12.174.0 - 192.12.183.255
SCARB-NET ([NET-142-151-0-0-1](#))   142.151.0.0 - 142.151.255.255
ADMIN-NET ([NET-198-96-61-0-1](#))   198.96.61.0 - 198.96.61.255
ERINDALE-NET ([NET-142-150-0-0-1](#))   142.150.0.0 - 142.150.255.255
TORONTO ([NET-128-100-0-0-1](#))   128.100.0.0 - 128.100.255.255
ESC-CQUEST ([NET-192-139-206-0-1](#))   192.139.206.0 - 192.139.206.255
ESC-CQUEST-P ([NET-192-139-207-0-1](#)) 192.139.207.0 - 192.139.207.255
ATRC-UTOR-CA ([NET-199-212-31-0-1](#)) 199.212.31.0 - 199.212.31.255
GENERIC-CLSC ([NET-192-139-73-0-1](#)) 192.139.73.0 - 192.139.73.255
TRINITY-NET ([NET-192-75-254-0-1](#))   192.75.254.0 - 192.75.254.255
UOFT-XNET ([NET-192-55-194-0-1](#))   192.55.194.0 - 192.55.194.255
TORONTO2 ([NET-192-82-128-0-1](#))   192.82.128.0 - 192.82.128.255
TORONTO5 ([NET-192-82-131-0-1](#))   192.82.131.0 - 192.82.131.255
TORONTO4 ([NET-192-82-130-0-1](#))   192.82.130.0 - 192.82.130.255
TORONTO3 ([NET-192-82-129-0-1](#))   192.82.129.0 - 192.82.129.255
UOFT-IPV6 ([NET6-2606-FA00-1](#))   2606:FA00:: - 2606:FA00:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF