1 Short answers: (20 points)

a. What is fragmentation? Why is it needed? 4pt

Fragmentation is when a datagram has to be broken up into smaller datagrams to fit the frame size of a certain network. Different networks have different MTUs (maximum transfer unit), when a datagram enters a network with a smaller MTU the gateway/router needs to fragment this packet into smaller packets that fit the new MTU.

b. Why did the Internet need the IP protocol? 4pt

The Internet needed the IP protocol because it was made of many different networks. All these networks used specific protocols that didn't interoperate. In order for these heterogeneous networks with different characteristics to talk, IP was created. It assumed only the basic functions of a network, in this case, an unreliable best-effort datagram service.

c. Is the Internet a datagram or virtual circuit network? Explain what that means in terms of the services the Internet's network layer provides to the transport layer. 4pt

The Internet is a datagram network. This means that the network layer only provides a datagram service, in the case of the internet, best-effort. The network layer doesn't provide reliability or connection services to the transport layer. (Many people answered by saying that the "Internet is a datagram", that is *not* the case though I gave full marks, a datagram is a packet, the internet is not a packet).

d. List 3 funtions performed by TCP. Explain what each function tries to accomplish. 4pt
I accepted many answers for this. The most important are:

- Reliability: TCP delives data reliably.
- Ordered delivery: TCP delives data in order.
- Flow-Control: TCP makes sure the sender doesn't overflow the receiver.
- Congestion-Control: TCP sends less data when it detects congestion.
- Connection oriented: TCP is connection oriented

TCP is not in charge of fragmentation or routing.

e. In delivering TCP data from a sender to a receiver, do intermediate routes have to interpret TCP's segments? Explain. 4pt

NO, intermediate routers look only at the network layer headers. The TCP segments are only interpreted at either end of the connection. It is the first end to end layer.

2 Fill in the blanks: (10 points) 2pt each

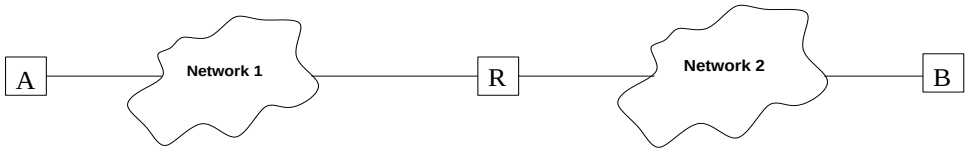
a. *TCP* and *UDP* are the Internet's transport protocols.

b. *Sliding window* is the mechanism TCP uses to perform flow control.

c. While the frame is the data link layer transmission unit, the *datagram/packet* is the network layer transmission unit and the *TPDU* is the transport layer transmission unit.

3 Problems: (25 points)

a. In the internetwork below, user A in network 1 is sending data to user B in network 2. The user produces a message that is 16KBytes long (i.e., 16,384 bytes). Suppose that the network 1's MTU is 4,096 bytes and network 2's MTU is 1,024 bytes. Describe how the message will be transferred to user B over the different networks. 10 pts



In this question we will ignore header overhead and/or assume that it's included in the initial 16KB. We will assume no packet loss.

A will send 4 packets of size 4KB to B over Network 1. These datagrams are not fragments, they are normal packets. When router R receives a packet, it will have to divide it into 4 fragments of size 1KB. When B receives the 4 fragments of an original packet it will reassemble the packet and hand it to the higher layer. 16 (1KB) fragments will be received by B, who will reassemble the 4 original packets who will be again reassembled to the 16KB message sent by the user.

b. One example IP address here at UCSC is 128.114.48.62. 15pts

i. What class of IP address does UCSC uses? Explain. 5pts

UCSC uses Class B addresses. We know this because it starts with 128 which is in the range for class B (128-191). These are the numbers that start with a 10 in binary.

ii. Which part of the IP address above is the network number and which part is the host address? Explain. 5pts

In a Class B network the netmask is 255.255.0.0, hence the network number is 128.114.0.0. The host number is 48.62. (Other forms of this answer were accepted).

iii. How many hosts can be connected on the UCSC campus? Explain. 5pts

A Class B address has 2^{16} possible hosts, that is, 64K.

4 Longer answers: (45 points)

a. Suppose you are administering your own network at home and even if you connect all possible computing devices you anticipate buying, you will not go beyond 50. 10pts

i. What class of IP address you should request for your home network? Explain. 5pts

You would request a Class C. This will give you 256 addresses which is more than enough for your requirement of 50.

ii. Now, assume that you were hired to administer the network of the new UC Merced campus. What class of IP address will you need? Explain. 5pts

You would require a Class B. An institution of that size would have more that 255 computers so a class C would be too small. Class A would be too big since it has 2^{24} addresses, that is, 16M.

b. Suppose that you need to go visit a friend at UC Santa Barbara but you have to finish working on your project 2 for CMPE 80N. Your friend suggests that you bring your laptop with you and tells you that "you can just plug yourself to the UCSB campus network and DHCP will automatically assign you a valid IP address". 15pts

i. What is DHCP and what does it do? 5pts

DHCP is the Dynamic Host Configuration Protocol. It gives addresses and network configuration to hosts as they plug in the network, hence, dynamic.

ii. Will you use your UCSC IP address while you are on the UCSB network? Explain. 5pts
No. UCSB is a different network and has different IP addresses.

iii. If DHCP was not available, what would you need to do to be able to be connected while visiting UCSB? 5pts
You would need to configure your computer manually with a UCSB address and network configuration.

c. Using TCP, 20pts

i. How does the sender know that its packets made it to the destination? 5pts
The destination will send back ACKs that will tell the source that it received the data.

ii. How does the sender detect when a packet gets lost? 5pts
When a packet is not acked TCP assumes that the packet was lost.

iii. What does the sender do to recover from packet losses? 5pts
The sender resends the packet until the receiver ACKs the packet.

iv. Is it possible for a receiver to receive more than one copy of the same packet? Explain. 5pts
Yes. A sender might think a packet is lost and send it again. This can happen if the ack hasn't reached the sender yet and it times out or if the ack is lost.