Problem 1

'traceroute' is a computer network diagnostic tool for displaying the route (path) and measuring transit delays of packets across an Internet Protocol (IP) network. In this problem, you will use the 'traceroute' command to understand how packets route to a destination.

1. Run *traceroute* command to find a route to 'ucla.edu'. How many hops are there in between your local host to the destination? Copy and paste the result on your console in the answer box. (If you are using Windows Command Prompt, then use '*tracert*' command instead.)
2. Run *traceroute* command to find a route to 'columbia.edu'. Copy and paste the result into the answer box.
3. Compare two results in terms of the number of hops and the delays.

1. traceroute result to ucla.edu
2. traceroute result to columbia.edu
3. traceroute result to ucla.edu has less number of hops and less delays than traceroute result to columbia.edu since the destination node of columbia.edu is located far from here (LA).

Problem 2

Host A is sending real-time voice over a packet-switched network. Host A converts analog voice to a digital 128 kbps bit stream on the fly. Host A then groups 1,600 bytes into a packet. Assume that the 1,600 bytes packet already includes all headers. There is one link between Hosts A and B; its transmission rate is 3 Mbps and its propagation delay is 20 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packets bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)? In this problem, do not consider acknowledgement (response) from Host B.

Packet generation time: $\frac{1600 \times 8bits}{128kbps} = 100msec$
Transmission time: $\frac{1600 \times 8bits}{3Mbps} = 4.27msec$
Propagation delay: $20msec$
Therefore, $100msec + 4.27msec + 20msec = 124.27msec$ (or $124msec$)

Problem 3

Tow hosts, A and B are separated by 20,000 kilometers and are connected by a direct link of $R = 2Mbps$. Suppose the propagation speed over the link is $2.5 * 10^8 meters/sec$.

1. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?
2. How long does it take to send the file, assuming it is sent continuously?
3. Suppose now the file is broken up into 20 packets with each packet containing 40,000 bits. Suppose that each packet is acknowledged by the receiver and the transmission time of an acknowledgment packet is negligible. Finally, assume that the sender cannot send a packet until the preceding one is acknowledged. How long does it take to send the file?

1. Propagation delay $= \frac{20{,}000 \times 1{,}000}{2.5 \times 10^8} = 0.08sec$
   Transmission speed is given as $2Mbps$.
   Therefore, the maximum number of bits in the link is $2 \times 10^6 bps \times 0.08sec = 160,000bits$

2. Transmission delay $= \frac{800{,}000bits}{2 \times 10^6 bps} = 0.4sec$
   Propagation delay is $0.08sec$
   Therefore it takes $0.48sec$ (or $480msec$).

3. Each packet takes $\frac{40{,}000bits}{2 \times 10^6 bps} = 0.02sec$ transmission delay plus $0.08sec$ propagation delay, which is $0.1sec$.
   The propagation delay of an ACK is $0.08sec$.
   RTT for one data packet and ACK is $0.1 + 0.08 = 0.18sec$ There are 20 packets, so the total time is $3.6sec$.

Problem 4

Alice and Bob are working remotely on a course project and are using `git` as the version control software.

1. Is it true that one must have GitHub/GitLab account to use git?
2. What is(are) the command(s) to initialize a local git repository?
3. Do Alice and Bob both must initialize local git repository? If no, what are the alternative?
4. Let's consider that Alice modified the file `server.cpp`:
   (a) What git commands Alice needs to save modifications in the local git repository
   (b) What git commands Alice needs to upload saved modifications to GitHub
   (c) What git commands Bob needs to get Alice's changes and apply them to the local repository
5. Let's consider that both Alice and Bob modified the file `server.cpp` and Alice was first to successfully upload saved modifications (commit) to GitHub
   (a) Can Bob upload his changes without any additional actions? If no, why?
   (b) If actions needed, list git commands that Bob will need to use to share his modifications with Alice.

1. No, GitHub/GitLab provide just a hosting service. Git is a distributed source code management system and can be used without any central service: code (commits) can be directly shared between developers.
2. *git init*
3. No. Bob can "clone" repository from Alice (or vice versa).
4. (a) *git add server.cpp* (or *git add .*) and *git commit*
   (b) *git push* (or *git push origin*, or *git push origin master*)
   (c) *git pull* (or *git fetch* && git merge FETCH_HEAD)
5. (a) No. GitHub will refuse to accept Bob's changes as they don't cleanly "advance" the default branch (not a "fast-forward merge").
   (b) Bob needs to fetch changes from GitHub (pull or fetch and merge), resolve conflicts (e.g., by running git mergetool), and push again

Problem 5

You will learn some basic usages of `Vagrant` in your projects.

1. What is Vagrant mainly used for?
2. What is VirtualBox used for?
3. What is *Vagrantfile*?
4. List at least five commands you can use with Vagrant.

1. Vagrant is a tool for building and managing virtual machine environments in a single workflow.

2. VirtualBox is a cross-platform consumer virtualization product to create virtual machines.

3. Vagrantfile is to describe the type of machine required for a project, and how to configure and provision these machines.

4. It can be **vagrant** plus the following:
   up, **ssh**, **box**, **connect**, **provision**, **status**, **init**, **help**, **version**, etc.
   See vagrant -h for more options.