1. List the components of a computer network and describe their functions.

- **Terminals or hosts** are the communication endpoints and are typically the devices users use to connect to the network.
- **Nodes or network elements** are intermediary devices in the network that enable communication between endpoints.
- **Links or edges** connect terminals and nodes of a computer network.

ii. Look up examples of other types of networks that have analogous components and functions. Explain/justify your answer.

   - Telephone network: consists of telephone lines and cables which are the links. The telephones are the terminals, and the telephone switches in the switching centers are the nodes.

2. i. What are the advantages of using a layered system design approach? What is the main disadvantage? Explain.

   Advantages include making the system easier to understand, easier to maintain and/or update.

   The main disadvantage is that layering impacts performance due to increased communication and processing overhead as well as duplication of functionality among layers.

   ii. Provide an example (other than the ones we saw in class) of a layered system. Identify the layers of the system and the source(s) of overhead.

   Answers will vary.

3. i. Explain what statistical multiplexing is.

   Statistical multiplexing is the concept of providing resources based on demand, as opposed to pre-allocating resources to users. By sharing network resources across multiple sources, statistical multiplexing allows the network to be used more efficiently.

   ii. If you were to re-design the Internet today, would you use circuit switching or packet switching? Explain.

   I would use packet switching because circuit switching is not scalable. While circuit switching provides excellent quality to services, it requires the reservation of a channel. Many users on the Internet are not continuously exchanging information and so using circuit switching would result in wasted reserved resources. Packet switching is better because it is scalable, more efficient in allocating resources and therefore can handle the dynamic nature of the Internet.

4. i. The statement "The Internet uses hierarchical addresses" is true or false? Explain.

   True. An IP address is made up of a network portion and a host portion. Most often, the network portion corresponds to a certain area and the host portion is unique within that network.
ii. Can you think of a disadvantage of hierarchical addressing? Explain. Hierarchical addressing is not very flexible because it requires external mechanisms to manage the addressing. In the case of the Internet, a hosts’ address depends on the network it is attached to. So if a host moves to a different area, extra mechanisms will have to be used in order to update the address of the moved host.

5. The network connection between hosts A and B has the following characteristics: it takes 120 milliseconds for information to travel from A to B; between the 2 hosts, there is one router whose queuing delay is 2.5 milliseconds and processing delay 1 millisecond. The link connecting A to B is 1Mbps.

i. What is the total latency or delay to send 1MByte of information between A and B?
\[
d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}\]
\[
= 1ms + 2.5ms + 8000ms +120ms\]
\[
= 8123.5 \text{ milliseconds}
\]

ii. What is the dominating factor causing latency in this scenario?
Transmission delay (dtrans)

6. In so-called "Big Data" applications, very large amounts of data are generated and will be transmitted over the network. Suppose you have 40 terabytes of data to transfer between a hospital in Houston, Texas and another one in San Francisco, California. You have a 100 Mbps dedicated link available for transferring the data. Is it more efficient to do the data transfer over the link or use an overnight postal delivery service?

1 TB = 1024 * 1024 MB
1 byte = 8 bits

Duration of Data transfer = 40 TB / 100 Mbps = (40 * 1024 * 1024 MB / 100) seconds
\[
= 3,355,443.2 \text{ seconds} \times (1 \text{ day} / 86400 \text{ seconds}) = \sim 39 \text{ days}
\]

Therefore, it is more efficient to use an overnight postal delivery service than to do the data transfer over the link.