**Problem 1**

*What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?*

From top-to-bottom: application, transport, network, link, and physical.

Responsibilities:

* Application Layer: Where network applications and their application-layer protocols reside.
* Transport Layer: Transports application-layer messages between application endpoints.
* Network Layer: Responsible for moving network-layer packets known as datagrams from one host to another.
* Link Layer: Responsible for moving a packet from one node (host or router) to the next node in the route.
* Physical Layer: Responsible for moving the individual bits within the frame from one node to the next.

**Problem 2**

*List six access technologies. Classify each one as residential access, company access, or mobile access.*

1. Dial-up modem over telephone line: residential
2. DSL over telephone line: residential
3. Cable to HFC: residential
4. 100 Mbps switched Ethernet: company
5. Wireless LAN: mobile
6. Cellular mobile access: mobile

**Problem 3**

*Compare the delay in sending an x-bit message over a k-hop path in a circuit-switched network and a (lightly loaded) packet-switched network. The circuit setup time is s seconds, the propagation delay is d seconds per hop, the packet size is p bits, and the data rate is b bps. Under what conditions does the circuit-switched network have a shorter delay? [NOTE: you need to explain the reasoning process on how you come out the final answer.]*

Circuit-switched: Total Delay = s + kd + x/b

Packet-switched: Total Delay = kd + x/b + (k-1)p/b

Here we see that both total delays have the (kd + x/b) terms, so the determining factor in which is faster is the difference between s and (k-1)p/b, or more explicitly: The circuit setup time vs. The time to send a packet of **p** bits at **b** bps over **k**-1 hops.

\*When s > (k-1)p/b, the packet-switched network has a lower total delay.

**Problem 4**

*List the four broad classes of services that a transport protocol can provide. For each of the serivce classes, indicate if either UDP or TCP (or both) provides such a service.*

1. Reliable Data Transfer
   1. TCP provides a reliable byte-stream between client and server but UDP does not
2. Guarantee that a certain value for throughput is maintained
   1. Neither can provide this
3. Guarantee that data will be delivered in specific amount of time
   1. Neither can provide this
4. Security
   1. Neither can provide this