1. As a communication systems engineer, what are the metrics you would use in system design?

   Throughput, delay, packet loss at the network layer, Bit error rate at the physical layer, Security at the application layer.

2. Describe the layers and corresponding functions of the OSI reference model. What layers comprise the TCP/IP stack?

   See the notes for the OSI and TCP/IP stack definitions and descriptions.

3. What are the pros and cons of cross layer design?

   Communication system design is basically a tradeoff of performance versus complexity. Cross layer design leads to performance gains at the cost of complexity. This complexity can be at run-time or at the design stage. Since cross layer design violates the layered architecture, it could also lead to stifling of innovation and difficult maintenance.

4. I characterized Packet Switching and the End-to-End principle as the two key design choices for the Internet. Describe them.

   Packet switching exploits the idea of statistical multiplexing. The end-to-end principle is the design principle that communication network functions should be implemented at the end hosts of the communication session. For example, TCP provides reliability by requiring the receiver to acknowledge packet receptions to the transmitter.

5. At what layer does ARQ exist? At what layer does TCP exist? Compare them in terms of how they provide reliability.

   ARQ provides link layer reliability at the hop-by-hop level. TCP is at the transport layer and provides end-to-end reliability.

6. Describe the hierarchical structure and addressing of the Internet.

   The internet a hierarchical network of networks with the Internet Protocol (IP) used for routing. IP addresses are assigned in a hierarchical fashion so that routers do not have to maintain entries for all possible addresses (for example, IPv4 has a 32 bit IP address allowing for over 4 billion addresses). If we assign addresses in a hierarchical fashion (so that addresses physically close together share a common address prefix), one entry in a routing table can match multiple addresses. IP addresses use a binary hierarchy (see CIDR in the notes) and routers use longest prefix matching to make forwarding decisions. In other words, hierarchical addressing facilitates routing by allowing blocks of addresses to be grouped together into single routing table entries.

7. Why do we have both MAC & IP Addresses?

   MAC addresses are used by the link layer within a LAN and IP addresses are used by the network layer within an Internet. We have both because LANs are designed to work with arbitrary network layer protocols. Additionally, we do not want the adapter ID of a node to change every time the node is moved. Finally, if the network layer were to read link-layer packets and do filtering, it would slow down processing. In summary, MAC & IP addressing allows for layers to be independent.

8. In setting up a network, should you use a switch or a router? Describe the pros and cons.

   A switch is appropriate for a LAN while a router is needed for connecting two networks. A switch is simpler than a router in that it can learn the forwarding table while the router must be configured. For example, in a home network, a router is needed to share the internet connection between multiple PCs. If you only use a switch, then one of the computers must have two network cards and be configured to do Internet Connection Sharing (which is essentially the router functions).

9. Think about security in a layer 2 switch. Lookup the broadcast storm and ARP/switch poisoning.

   Broadcast storm: http://bit.ly/PKXzzx
   ARP Poisoning: http://en.wikipedia.org/wiki/ARP_spoofing

10. Explain the tradeoff between Packet Switching and Circuit Switching?

    Packet switching exploits statistical multiplexing to increase overall system efficiency since resources are used opportunistically. The main problem is that individual users will not have performance guarantees such as bounded delay or minimum bandwidth. Circuit switching provides guarantees by allocating resources in a static fashion.