1. Consider the network defined by an IP address 203.182.128.0 and the subnet mask 255.255.224.0. Which of the following addresses do not belong to the network (choose all that apply)?
    (a) 203.182.158.210
    (b) 203.182.161.7
    (c) 203.182.160.210
    (d) 203.182.162.3

2. Suppose that an organization gets the IP network 144.16.192.0/23. It wants to break it up into 1 subnet of size 256 addresses, 1 subnet of size 128 addresses, and 2 subnets of size 64 addresses. Call the subnets Subnet 1 to Subnet 4 respectively. For each subnet, show the subnet address using / notation.

3. Consider a router with 4 network interfaces (all Ethernet) named eth0, eth1, eth2, and eth3. The routing table of the router has the following entries:

Destination	Next Hop	Cost	Interface
144.16.203.0/24	144.16.203.2	10	eth0
144.16.203.64/26	144.16.203.69	20	eth1
144.16.203.176/27	144.16.203.170	5	eth2
0.0.0.0/0	144.16.230.7	10	eth3

    Suppose that an IP packet comes with destination IP 144.16.203.88. Clearly explain step by step how is the packet forwarded to its next hop, starting from how the next hop is found from the routing table till how the packet reaches the IP layer of that next hop.

4. Suppose that an ISP has a network 155.20.30.0/24. It allocates the networks 155.20.30.0/26, 155.20.30.64/26, and 155.20.30.192/26 to one organization abc.com, and 155.20.30.128/26 to another organization xyz.com. The IP address of the router for abc.com is 155.20.30.2 and that of xyz.com is 155.20.30.130. First show the routing entries in the ISP's router in the form <destination, next hop, cost> to route incoming packets correctly to abc.com and xyz.com. Assume that hop count is the metric used. You should try to minimize the number of entries in the ISP's router. Then explain (1 sentence each) how a packet will be routed if it is destined for (i) a host in any one network in abc.com (you choose), and (ii) a host in xyz.com.

5. Suppose that data is to be transmitted in an IP based network from the node A (IP address 150.100.10.20) to the node C (IP address 198.40.50.60). There is only one router B (with two network interfaces, one with IP address 150.100.10.2 on A's subnet

and the other with IP address 198.40.50.2 on C's subnet) on the route between A and C. The link from A to B has an MTU of 1000 bytes, and the link from B to C has an MTU of 600 bytes. Each node knows only the MTU of the next link. The IP layer in A wants to send 1700 bytes of data (not including header) to C. Clearly show all header fields (**except** Version, Checksum, Type of Service, and Protocol) of all IP packets **received at C** for this transfer.

6. Suppose that an IP datagram is broken into 6 fragments, numbered from 0 to 5. Fragments 0, 1, 3, 4, 5 arrive at the destination but fragment 2 is delayed. The reassembly timer expires at the destination. Then fragment 2 arrives. What will happen to fragment 2?

7. In reactive routing techniques (not done in class), a node x tries to find a path to another node y only when x receives a packet with a destination address y. Can you propose a scheme using flooding to find a path from one node x to y when x has to send a packet to y? Is this a good approach to find a path every time a packet is to be sent? If yes, justify why. If no, suggest how your basic scheme can be improved on.

8. List the actions taken when a TCP segment is received.

9. How can you determine the no. of bytes of data contained in a TCP segment received?

10. Suppose that an user makes send() calls with 200 bytes of data each every 50 milliseconds for 1 second. The round trip time is 100 millseconds, and MSS is 600 bytes. The initial sequence no. is 1500. The receiver side has a buffer of 4200 bytes and the receiver side does not make any recv() call. Identify all TCP segments that will be sent and received by the TCP code on the user side, along with their time of send and receive. For each segment, show the header fields for Seq No., Acknowledgeent no., relevant flag fields, and window size. Assume that no other data is being sent in the system, no cumulative acks are there, and no timeout or out-of-order packet arrival happens. Ignore the effect of congestion window.

    How will this change if you assume that the TCP ack sending rule taught is applicable, with the ack timer at 200 milliseconds?

11. Consider a path with bandwidth 10 Mbps and round-trip delay 200 milliseconds. MSS is 1000 bytes. Is slow start/congestion avoidance (ignore fast retransmit and fast recovery) a good scheme for congestion control on such a link? Justify your answer briefly.