B1. Networking (25 points) Answer all parts.

Consider the group of IPv4 network addresses: 200.20.16.0/21

Note: $200_{10} = 11001000_2$ $20_{10} = 00010100_2$ $16_{10} = 00010000_2$ $21_{10} = 00010101_2$

a) (2pts) How many host addresses are in this network?

b) (2pts) What is the last host address in this network?

c) (3pts) What would be the subnet mask for this group?

d) (3pts) From this network address group, sequentially allocate 4 subnets each with exactly 32 host addresses. Give your answers using "/n" notation.

e) (3pts) Divide the 2nd subnet in your part (d) answer into 3 subnets, one with 16 host addresses, and 2 each with 8 host addresses. Give your answers using "/n" notation.

f) (4pts) What is the general purpose of a subnet mask, i.e., how/when is it used?

g) (4pts) What is a broadcast address? Describe an application when one might be used.

h) (4pts) What is a multicast address? Describe an application when one might be used.

B2. Networking (25 points) Answer all parts.

Consider **Link State Routing (LSR)**. (Hint: flooding and Dijkstra's Algorithm).

a) (4pts) What information is contained in a LSR-Protocol Data Unit (LSR-PDU) update?

b) (5pts) Describe an approach that prevents LSR-PDU updates from being infinitely flooded.

c) (3pts) Under what circumstances will a router (say X) send its own new LSR-PDU update?

Consider **Distance Vector Routing (DV).** (Hint: Bellman-Ford Algorithm)

Assume Router A has three outgoing lines 1, 2, 3 with line costs 2, 5, 4, respectively. At one point in time, Router A has the following information:

Destination	Total cost using outgoing line including line costs 2, 5, 4, resp. 1	2	3	Use outgoing line
A	-	-	-	
B	12	14	16	
C	15	10	8	
D	13	9	11	
E	8	7	11	
F	6	9	4	

d) (2pts) Fill in the above column "Use outgoing line" indicating which line should be used to route an N-PDU containing data to each destination?

e) (5pts) Suppose a distance vector routing update (DV-PDU) arrives on line 2 with the following info. Neatly show all changes to the table above.

Destination	Cost to Destination (not including line 2's cost)
A	5
B	6
C	4
D	5
E	infinity
F	7
G	8

f) (3pts) After Router A updates its table, what would be the DV-PDU that A would advertise out its line 3? Important: Assume "poisoned reverse" is used.

g) (3pts) Under what circumstances will a router (say X) send its own new DV-PDU update?

B3. Networking (25 points) Answer all parts.

a) (6 points) In IEEE 802.3, an Ethernet segment is implemented on a coaxial cable of up to 500m. Multiple Ethernet segments can be joined together by repeaters as long as no more than 4 repeaters are positioned between any pair of hosts. Let the maximum round-trip propagation delay between any two hosts be T. Explain why all frames (i.e., Ethernet-PDUs) must take more than T to transmit. Let T be 51.2 microseconds, for a 10 Mbps Ethernet. Derive the minimum frame length in bytes.

b) (6 points) Both end-to-end propagation delay and bandwidth play a significant role in the channel efficiency of Ethernet. Explain.

c) (6 points) Computers today are often connected by Ethernet switches (sometimes called bridges). A "learning" Ethernet switch was proposed to help reduce traffic that Ethernet hubs produced. Succinctly explain how a learning switch works.

d) (7 points) Could we, (1) in theory and (2) in practice, connect all existing Internet hosts that have permanent IP addresses via LAN switches alone using their Ethernet address rather than using their IP address? Defend your answer.

B4. Networking (25 points) Answer all parts.

a) (7 points) Describe two basic ways in which TCP detects lost T-PDUs. Consider the perspective of both the data sender and data receiver.

b) (6 points) Describe an alternative way not used by TCP that could be used for detecting lost T-PDUs.

c) (6 points) Describe one protocol change to TCP that would improve performance, and explain how/why you believe performance would be improved.

d) (6 points) Consider a TCP-like transport protocol with a fixed T-PDU length of 1000 bytes. Consider a link with 100msec end-to-end propagation time (latency) and 1msec transmission time. What is the transmission rate of the link? What is the maximum number of unacknowledged data T-PDUs that can be in flight at any point in time? What is that maximum if the transmission time is reduced to .1msec? State any assumptions.