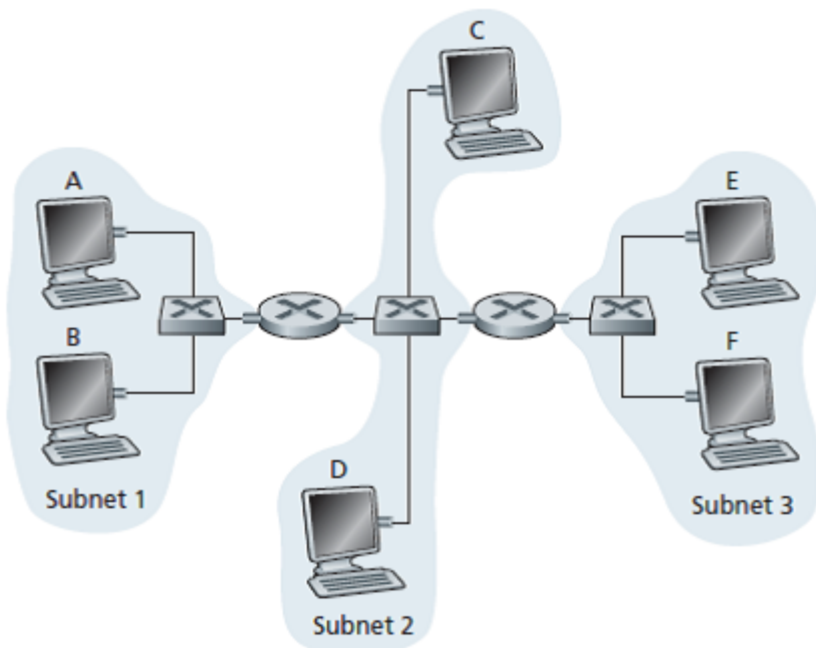
CSC358 - Problem Set 1 (PS1)
Due Date: Friday, Feb 2 at 11:59PM

Submit a **PDF** document on MarkUs (https://mcsmark.utm.utoronto.ca/csc358s18). The filename should be ps1.pdf. Ensure you have your name and student number on your PS1. No submission 48 hours after the due date is accepted. Show your work if you want part marks.

1. Show (give an example) that two-dimensional parity checks can correct and detect a single bit error. Show and give an example of a double-bit error that can be detected but not corrected.

2. Consider the diagram below. If we replace the router between subnets 1 and 2 with a switch S1, and label the router between subnets 2 and 3 as R1.



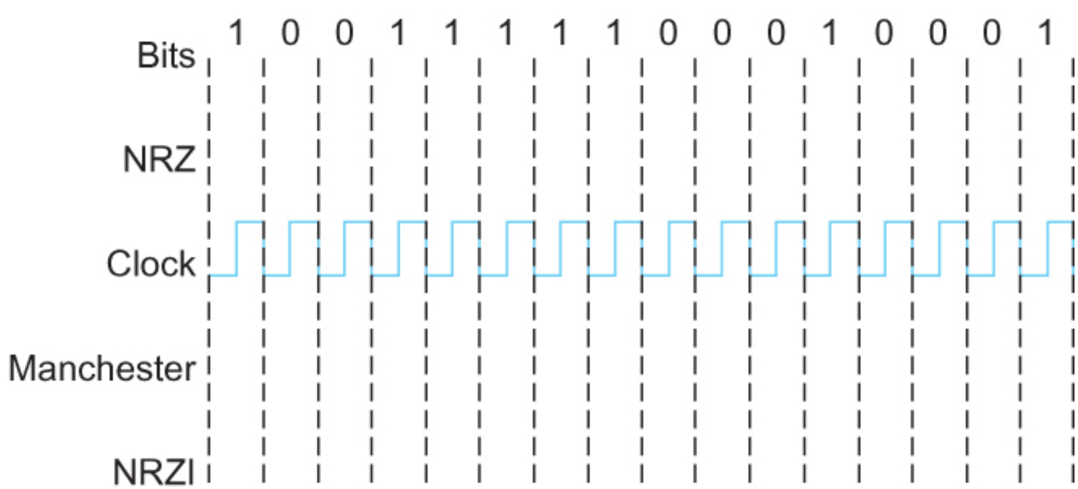
a) Suppose E would like to send and IP datagram to B, and assume that E's ARP cache does not contain B's MAC address. Will E perform an ARP query to find B's MAC address? Why? In the Ethernet frame (containing the IP datagram destined to B) that is delivered to router R1, what are the source and destination IP and MAC addresses?

b) Suppose Host A would like to send an IP datagram to Host B, and neither A's ARP cache contains B's MAC address nor does B's ARP cache contain A's MAC address. Further suppose that the switch S1's forwarding table contains entries for Host B and router R1 only. Thus, A will broadcast an ARP request message. What actions will switch S1 perform once it receives the ARP request message? Will router R1 also receive this ARP request message? If so, will R1 forward the message to Subnet 3? Once Host B receives this ARP request message, it will send back to Host A an ARP response message. But will it send an ARP query message to ask for A's MAC address? Why? What will switch S1 do once it receives an ARP response message from Host B?

3. Suppose a 1-Gbps point-to-point link is being set up between the Earth and a new lunar colony. The distance from the moon to the Earth is approximately 385,000 km, and data travels over the link at the speed of light—3×10^8 m/s.
   a) Calculate the minimum RTT for the link.
   b) Using the RTT as the delay, calculate the delay × bandwidth product for the link.
   c) What is the significance of the delay × bandwidth product computed in (b)?
   d) A camera on the lunar base takes pictures of the Earth and saves them in digital format to disk. Suppose Mission Control on Earth wishes to download the most current image, which is 25 MB. What is the minimum amount of time that will elapse between when the request for the data goes out and the transfer is finished?

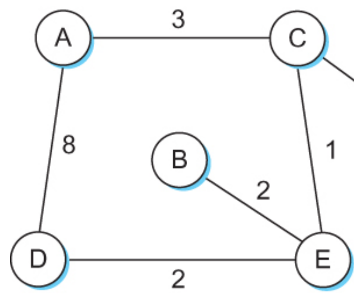
4. Calculate the latency (from first bit sent to last bit received) for the following:
   a) 100-Mbps Ethernet with a single store-and-forward switch in the path and a packet size of 12,000 bits. Assume that each link introduces a propagation delay of 10 μs and that the switch begins retransmitting immediately after it has finished receiving the packet.
   b) Same as (a) but with three switches.
   c) Same as (a), but assume the switch implements "cut-through" switching; it is able to begin retransmitting the packet after the first 200 bits have been received.

5. Show the NRZ, Manchester, and NRZI encodings for the bit pattern shown below. Assume that the NRZI signal starts out low.

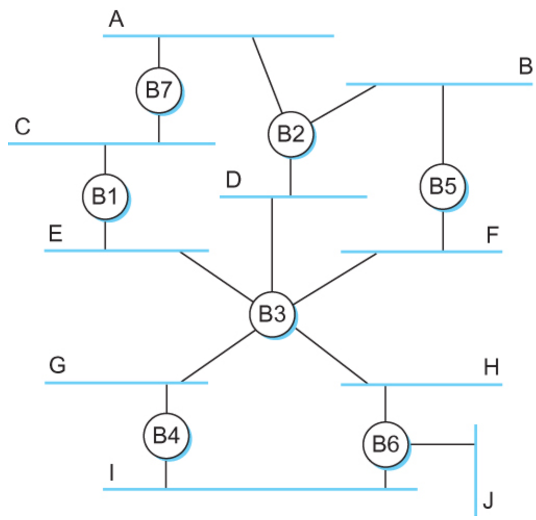


6. Suppose we want to transmit the message 11100011 and protect it from errors using the CRC polynomial $x^3 + 1$.
   a) Use polynomial long division to determine the message that should be transmitted.
   b) Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What is the result of the receiver's CRC calculation? How does the receiver know that an error has occurred?

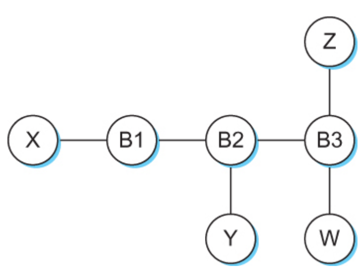
7. For the network given below, give the datagram forwarding table for each node. The links are labeled with relative costs; your tables should forward each packet via the lowest-cost path to its destination.



8. Given the extended LAN shown below, indicate which ports are not selected by the spanning tree algorithm.



9. Consider hosts X, Y, Z, W and learning bridges B1, B2, B3, with initially empty forwarding tables, as in the figure below.
   a) Suppose X sends toW. Which bridges learn where X is? Does Y's network interface see this packet?
   b) Suppose Z now sends to X. Which bridges learn where Z is? Does Y's network interface see this packet?
   c) Suppose Y now sends to X. Which bridges learn where Y is? Does Z's network interface see this packet?
   d) Finally, suppose W sends to Y. Which bridges learn where W is? Does Z's network interface see this packet?



10. An organization has been assigned the prefix 212.1.1/24 (class C) and wants to form subnets for four departments, with hosts as follows:

A	75 hosts
B	35 hosts
C	20 hosts
D	18 hosts

There are 148 hosts in all.

a) Give a possible arrangement of subnet masks to make this possible.
b) Suggest what the organization might do if department D grows to 32 hosts.

11. Suppose a router has built up the routing table shown in Table 3.19. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Assume the router does the longest prefix match. Describe what the router does with a packet addressed to each of the following destinations:

a) 128.96.171.92
b) 128.96.167.151
c) 128.96.163.151
d) 128.96.169.192
e) 128.96.165.121

Subnet Number	Subnet Mask	Next Hop
128.96.170.0	255.255.254.0	Interface 0
128.96.168.0	255.255.254.0	Interface 1
128.96.166.0	255.255.254.0	R2
128.96.164.0	255.255.252.0	R3
(default)		R4

12. What kind of problems can arise when two hosts on the same Ethernet share the same hardware address? Describe what happens and why that behavior is a problem.