1. Traditional checksum calculation needs to be done in one's complement arithmetic. Computers and calculators today are designed to do calculations in two's complement arithmetic. One way to calculate the traditional checksum is to add the numbers in two's complement arithmetic, find the quotient and remainder of dividing the result by 2^{16}, and add the quotient and the remainder to get the sum in one's complement. The checksum can be found by subtracting the sum from $2^{16} - 1$. Use the above method to find the checksum of the following four numbers: 43,689, 64,463, 45,112, and 59,683.

2. Given the data word 101001111 and the divisor 10111, show the generation of the CRC codeword at the sender site (using binary division)

3. **Answer to the following subnetting questions:**

    - **Target IP address: 19.49.125.150/23**

    Network Address:

    First Host Address:

    Last Host Address:

    Broadcast Address:

    Next Subnet Address:

    Subnet Mask in Binary:

    Subnet Mask in Dotted Decimal:

    Total Number of Hosts:

- **Target IP address: 66.113.191.94/9**

Network Address:

First Host Address:

Last Host Address:

Broadcast Address:

Next Subnet Address:

Subnet Mask in Binary:

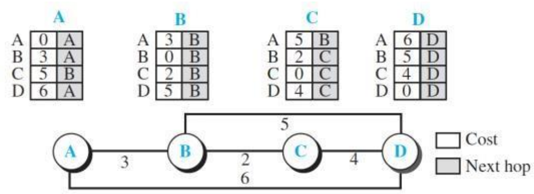
Subnet Mask in Dotted Decimal:

Total Number of Hosts:

4. In an IPv4 packet:
   a. the value of HLEN is $(1000)_2$. How many bytes of options are being carried by this packet?
   b. the value of HLEN is 5, and the value of the total length field is $(0028)_{16}$. How many bytes of data are being carried by this packet?
   c. A packet has arrived with an M bit value of 0. Is this the first fragment, the last fragment, or a middle fragment? Do we know if the packet was fragmented?
   d. A packet has arrived in which the offset value is 100. What is the number of the first byte? Do we know the number of the last byte?

5. Router A sends two RIP messages to two immediate neighboring routers, B and C. Do the two datagrams carrying the messages have the same source IP addresses? Do the two datagrams have the same destination IP addresses?

6. In distance-vector routing, good news (decrease in a link metric) will propagate fast. In other words, if a link distance decreases, all nodes quickly learn about it and update their vectors. In the figure below, we assume that a four-node internet is stable, but suddenly the distance between nodes A and D, which is currently 6, is decreased to 1 (probably due to some improvement in the link quality). Show how this good news is propagated and find the new distance vector for each node after stabilization.



7. Compare the range of 16-bit addresses, 0 to 65,535, with the range of 32-bit IP addresses, 0 to 4,294,967,295. Why do we need such a large range of IP addresses, but only a relatively small range of port numbers?