P3.

|  |  |  |
| --- | --- | --- |
| Character | ASCII value in decimal | 8-bit binary number |
| N | 78 | 0100 1110 |
| e | 101 | 0110 0101 |
| t | 116 | 0111 0100 |
| w | 119 | 0111 0111 |
| o | 111 | 0110 1111 |
| r | 114 | 0111 0010 |
| k | 107 | 0110 1011 |
| i | 105 | 0110 1001 |
| n | 110 | 0110 1110 |
| g | 103 | 0110 0111 |

First sum: 0100 1110 0110 0101

+ 0111 0100 0111 0111

= 1100 0010 1101 1100

Second: + 0110 1111 0111 0010

= 0011 0010 0100 1110

Overflow sum + 1

= 0011 0010 0100 1111

Third: + 0110 1011 0110 1001

= 1001 1101 1011 1000

Fourth: + 0110 1110 0110 0111

= 0000 1100 0001 1111

Overflow sum + 1

= 0000 1100 0010 0000

1’s compliment

1111 0011 1101 1111

P5. 101101110

10011⟌1010101010

10011

1100

0000

11001

10011

10100

10011

1111

0000

11110

10011

11010

10010

10010

10011

010

000

0100

0000

0100

P7. A. CRC can detect any single bit error in data bits because any single bit change in the data while sending from sender to receiver will completely change the data bits at the receiver side.

B. Given G can detect any odd number of bit errors in the data. The CRC can detect any errors like odd bit errors, single bit errors and burst bit errors with the length equal to polynomial degree. Any number of bits change in the data while sending from sender to receiver can be easily detected. While sending data the sender will add the remainder bits at the end of the data and sends to the sender. The receiver must perform ex-or operation again to get the original data. As the data bits contains remainder bit it should produce 0 as remainder at receiver side, then we can come to know that there is no error in data. Likewise, it can detect any number of bit errors in the data.

P14. A & B. A: 192.168.1.001 & 00-00-00-00-00-00

B: 192.168.1.003 & 11-11-11-11-11-11

AB router: 192.168.1.002 & 22-22-22-22-22-22

C: 192.168.2.001 & 44-44-44-44-44-44

D: 192.168.2.004 & 66-66-66-66-66-66

CD router: 192.168.2.003 & 55-55-55-55-55-55

AB – CD router: 192.168.2.002 & 33-33-33-33-33-33

E: 192.168.3.001 & 77-77-77-77-77-77

F: 192.168.3.003 & 99-99-99-99-99-99

EF router: 192.168.3.002 & 88-88-88-88-88-88

C. Forwarding table of ‘E’ finds that the datagram should be routed to interface 192.168.3.001

Host E uses ARP to determine the LAN address for 192.168.3.002, namely 88-88-88-88-88-88.

The adapter in E frames an Ethernet packet with Ethernet destination address 88-88-88-88-88-88.

The first router after receiving the packet it extracts the datagram. The forwarding table of this router tells that the datagram must be routed to 192.168.2.002

The first router uses ARP and obtains the associated Ethernet address, namely 33-33-33-33-33-33.

The process continues util the packet reaches the Host B.

D. ARP in E must find the LAN address of 192.168.3.002. Host E starts sending an ARP query packet within a broadcast Ethernet frame. The first router gets the query packet and delivers Host E an ARP response packet. This packet response from ARP is carried out by an Ethernet frame with Ethernet destination address 192.168.3.001

P15. A. As Host E and Host F are in the same subnet 3, Host E does NOT ask Router R1 when sending an IP datagram to Host F. If Host E's ARP cache does NOT contain MAC address of Host F then Host E uses ARP broadcast to query MAC address of Host F. In the Ethernet frame containing the IP datagram.

|  |  |
| --- | --- |
| Field | Value |
| Source MAC address | MAC address of Host E |
| Destination MAC address | MAC address of Host F |
| Source IP address | IP address of Host E |
| Destination IP address | IP address of Host F |

B. Host B is in subnet 1. Host E is in subnet 3. Since Host E and Host B are in different subnets, ARP query to find Host B's MAC address is NOT performed by Host E. Instead, the packet is forwarded to the only / default router (for example R1) connected. In the Ethernet frame containing the IP datagram.

|  |  |
| --- | --- |
| Field | Value |
| Source MAC address | MAC address of Host E |
| Destination MAC address | MAC address of Router R1 |
| Source IP address | IP address of Host E |
| Destination IP address | IP address of Host B |

C. Host A and Host B are in same subnet 1. For Host A to send an IP datagram to Host B, Host A needs to know the MAC address of Host B. An ARP request is broadcast by Host A to find MAC address of Host B. Switch S1 sends the broadcast ARP request from Host A to other Hosts (for example Host B) in subnet 1. Router R1 does NOT receive the ARP request as it is in a different subnet. Host B does NOT send another ARP query message as sender (for example Host A) MAC address is present in the broadcast ARP request received. ARP response message (from Host B) is sent to Host A. Host A can now send an Ethernet frame containing the IP datagram to Host B.

P17. Given K = 100. Now waiting time for 1 Mbps is (100 x 512 bits) / 1 x 106 bps = 51.2 ms.

Now waiting time for 10 Mbps is (100 x 512 bits) / 10 x 106 bps = 5.12 ms.

P19. Since KB = 1, it must wait KB x 512 = 1 x 512 = 512 bit times. After 512 bit times, that is at t = 293 + 512 = 805 bit times. Before it transmits the frame, node B must sense channel for 96 bit times. So, node B retransmits at t = 805 + 96 = 901 bit times. Since KA = 0, it must wait KA x 512 = 0 x 512 = 0 bit times. But since node B already sent 245 bits, it must wait t = 245 + 48 + 245 = 538 bit times. At t = 538 bit times, node A senses the channel for 96 bit times and detects an idle channel at t = 538 + 96 = 634 bit times. Due to propagation delay being 245 bit times, node A’s signal reaches node B at t = 634 + 245 = 879 bit times.