Solutions to Chapter 3

1. Suppose the size of an uncompressed text file is 1 megabyte.

Solutions follow questions: **[4 marks – 1 mark each for a & b, 2 marks c]**

* 1. How long does it take to download the file over a 32 kilobit/second modem?

*T*32k = 8 (1024) (1024) / 32000 = 262.144 seconds

* 1. How long does it take to take to download the file over a 1 megabit/second modem?

*T*1M = 8 (1024) (1024) bits / 1x106 bits/sec = 8.38 seconds

* 1. Suppose data compression is applied to the text file. How much do the transmission times in parts (a) and (b) change?

If we assume a maximum compression ratio of 1:6, then we have the following times for the 32 kilobit and 1 megabit lines respectively:

*T*32k = 8 (1024) (1024) / (32000 x 6) = 43.69 sec

*T*1M = 8 (1024) (1024) / (1x106 x 6) = 1.4 sec

1. A scanner has a resolution of 600 x 600 pixels/square inch. How many bits are produced by an 8-inch x 10-inch image if scanning uses 8 bits/pixel? 24 bits/pixel? **[3 marks – 1 mark for pixels per picture, 1 marks each representation]**

# Solution:

The number of pixels is 600x600x8x10 = 28.8x106 pixels per picture.

With 8 bits/pixel representation, we have: 28.8x106 x 8 = 230.4 Mbits per picture. With 24 bits/pixel representation, we have: 28.8x106 x 24 = 691.2 Mbits per picture.

**6.** Suppose a storage device has a capacity of 1 gigabyte. How many 1-minute songs can the device hold using conventional CD format? using MP3 coding? **[4 marks – 2 marks each]**

# Solution:

A stereo CD signal has a bit rate of 1.4 megabits per second, or 84 megabits per minute, which is approximately 10 megabytes per minute. Therefore a 1 gigabyte storage will hold 1 gigabyte/10 megabyte = 100 songs.

An MP3 signal has a lower bit rate than a CD signal by about a factor of 14, so 1 gigabyte storage will hold about 1400 songs.

**8.** How many HDTV channels can be transmitted simultaneously over the optical fiber transmission systems in Table 3.3? **[2 marks]**

# Solution:

Suppose that an optical fiber carries 1600 x 109 bps, and an HDTV channel is about 38 Mbps, then the fiber can carry about 1600000/38 = 40,000 HDTV channels.

1. Let *g(x)=x3+x+*1. Consider the information sequence 1001.

# Solutions follow questions:

* 1. Find the codeword corresponding to the preceding information sequence. Using polynomial arithmetic we obtain: **[3 marks]**

|  |  |
| --- | --- |
|  | 1010 |
| 1011 | 1001000  1011 |
|  | 01000  1011 |
|  | 00110 |

Codeword = 1001110

* 1. Suppose that the codeword has a transmission error in the first bit. What does the receiver obtain when it does its error checking? **[2 marks]**

|  |  |
| --- | --- |
|  | 0001 |
| 1011 | 0001110  1011 |
|  | 101 |

CRC calculated by Rx = 101 € error

1. Suppose a header consists of four 16-bit words: (11111111 11111111, 11111111 00000000, 11110000 11110000, 11000000 11000000). Find the Internet checksum for this code. **[3 marks]**

# Solution:

*b*0 = 11111111 11111111 = 216 – 1 = 65535

*b*1 = 11111111 00000000 = 65280

*b*2 = 11110000 11110000 = 61680

*b*3 = 11000000 11000000 = 49344

*x* = *b*0 + *b*1 + *b*2 + *b*3 modulo 65535 = 241839 modulo 65535 = 45234

*b*4 = *x* modulo 65535 = 20301

So the Internet checksum = 01001111 01001101

1. Let *g1(x) = x* + 1 and let *g2(x) = x3 + x2* + 1. Consider the information bits (1,1,0,1,1,0).
   1. Find the codeword corresponding to these information bits if *g1(x)* is used as the generating polynomial. **[2 marks]**

|  |  |
| --- | --- |
|  | 100100 |
| 11 | 1101100  11 |
|  | 0011  11 |
|  | 0000 |

Codeword = 1101100

* 1. Find the codeword corresponding to these information bits if *g2(x)* is used as the generating polynomial. **[2 marks]**

|  |  |
| --- | --- |
|  | 100011 |
| 1101 | 110110000  1101 |
|  | 01000  1101 |
|  | 1010  1101 |
|  | 111 |

Codeword = 110110111

* 1. Can *g2(x)* detect single errors? double errors? triple errors? If not, give an example of an error pattern that cannot be detected. **[2 marks – 0.5 each]**

Single errors can be detected since *g2(x)* has more than one term. Double errors *cannot* be detected even though *g2(x)* is primitive because the codeword length exceeds 2n-k-1=7. An example of such undetectable error is 1000000010. Triple errors cannot be detected since *g2(x)* has only three terms.

* 1. Find the codeword corresponding to these information bits if *g(x) = g1(x) g2(x)* is used as the generating polynomial. Comment on the error-detecting capabilities of *g(x)*. **[4 marks – 2 marks for the codeword and 2 for the comment]**

|  |  |  |
| --- | --- | --- |
|  |  | 111101 |
| 10111 |  | 1101100000  10111 |
|  |  | 11000  10111 |
|  |  | 11110  10111 |
|  |  | 10010  10111 |
|  |  | 010100  10111 |
|  |  | 0011 |

Codeword = 1101100011

The new code can detect all single and all odd errors. It cannot detect double errors. It can also detect all bursts of length *n* – *k* = 4 or less. All bursts of length 5 are detected except for the burst that equals *g(x)*. The fraction 1/2*n-k* = 1/16 of all bursts of length greater than 5 are detectable.

1. Consider the *m* = 4 Hamming code.
   1. What is *n*, and what is *k* for this code? **[2 marks]**

*n* = 2*m*  1 = 15; *k* = *n*  *m* = 11 (15,11) Hamming code

* 1. Find parity check matrix for this code. **[2 marks – 0.5 for each]**

[ 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 ]

**H** = [ 1 1 1 0 0 0 0 1 1 1 1 0 1 0 0 ]

[ 0 1 1 1 0 1 1 0 0 1 1 0 0 1 0 ]

[ 1 0 1 1 1 0 1 0 1 0 1 0 0 0 1 ]

* 1. Give the set of linear equations for computing the check bits in terms of the information bits. **[2 marks – 0.5 for each]**

b12 = b5 + b6 + b7 + b8 + b9 + b10 + b11 b13 = b1 + b2 + b3 + b8 + b9 + b10 + b11 b14 = b2 + b3 + b4 + b6 + b7 + b10 + b11 b15 = b1 + b3 + b4 + b5 + b7 + b9 + b11

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**Q.1 (2 marks)** Consider a packet of length 1,000 bytes that propagates over a link of distance 2,500 km with propagation speed of 2,5 · 108 m/s, and transmission rate 2 Mbps?

a. How long does the packet propagation take?

b. Does this propagation delay depend on the packet length?

c. Does this propagation delay depend on the transmission rate?

***Note: Explain your answer in details***

**Answer:**

a. Transmission delay = L/R

= 8 bits/byte \* 1,000 bytes / 2,000,000 bps

= 4 ms

Propagation delay = d/s

= 2,500\*103/ 2,5×108

= 10 ms

Therefore, the total time = 4ms + 10 ms = 14 ms

b. No, the delay depend on packet lenght is not true.

c. No, the delay depend on transmission rate is not true.

**Q2. (2 marks)** Suppose a header consists of four 16-bit words: (11111111 11111111, 11111111 00000000, 11110000 11110000, 11000000 11000000). Find the Internet checksum for this code

***Note: Explain your answer in details***

**Answer:**

**b0 = 11111111 11111111 = 216 – 1 = 65535**

**b1 = 11111111 00000000 = 65280**

**b2 = 11110000 11110000 = 61680**

**b3 = 11000000 11000000 = 49344**

**x = b0 + b1 + b2 + b3 modulo 65535 = 241839 modulo 65535 = 45234 b4 = −x modulo 65535 = 20301**

**So the Internet checksum = 01001111 01001101**

**Note: SV có thể làm cách khác nhưng kết quả đúng vẫn được tính điểm Link: https://youtu.be/AtVWnyDDaDI**

**Q3. (2 marks)**

Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps.

a. Assuming no other traffic in the network, what is the throughput for the file transfer?

b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

***Note: Explain your answer in details***

**Answer:**

a)

Consider givend data:R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps The throughput for the file transfer=min{R1,R2,R3}

=min{500 kbps, 2 Mbps, 1 Mbps}

**=500 kbps**

**So, the throughput for the file transfer=500 kbps**

**b)**

**Consider given data:**

The file size= 4 million bytes

Convert million bytes to bits

=32,000,000 bits.

From (a), Throughput for the file transfer=500 Kbps

=500,000 bps

Dividing the file size by the throughput,roughly how long will it take to transfer the file to Host B:

=file size/hroughput for the file transfer

=32,000,000 bits/500,000 bps

= **64 seconds**

**Q.4 (2 marks)**

Consider the 7-bit generator, G=10011, and suppose that D has the value 1010101010. What is the value of R? Show your all steps to have result.

***Note: Explain your answer in details*** Table

Description automatically generated

**Answer:**

**So, the 7-bit generator, G=10011, and D has the value 1010101010. then the value of R is 0100.**

**Q.5 (2 marks) A router has the following CIDR entries in its routing table:** *Address/mask Next hop*

135.46.56.0/22 Interface 0

135.46.60.0/22 Interface 1

192.53.40.0/23 Router 1

default Router 2

(a) What does the router do if a packet with an IP address 135.46.63.10 arrives?

Taking the first 22 bits of the above IP address as network address, we have 135.46.60.0.

It matches the network address of 135.46.60.0/22. So, the router will forward the packet to Interface 1.

(b) What does the router do if a packet with an IP address 135.46.57.14 arrives? Taking the first 22 bits of the above IP address as network address, we have 135.46.56.0.

It matches the network address of 135.46.56.0/22. The packet will be forwarded to Interface 0.

**Note:**

- **Students have to follow the steps and complete the tasks in details in order to have the results. If the students only write the result, that is, that result is not marked or recorded.**

- **Students do examination on paper and answer by English**

**RETAKE PE NWC203c SUMMER 2021**

**Q.1. (2 marks)** Let g(x)=x3+x+1. Consider the information sequence 1001. Find the codeword corresponding to the preceding information sequence. Using polynomial arithmetic we obtain:

**Answer:**

Step 1: Add 000 to data bits string. It will be 1001000

Step 2: Devide 1001000 to 1011 in modulo – 2 method.

1001000 1011

1011

01000

1011

00110

Codeword = 1001110

**Q2. (2 marks)**

Consider the 7-bit generator, G=10011, , and suppose that D has the value 1001010101. What is the value of R? Show your all steps to have result.

***Note: Explain your answer in details***

**Answer:**

The value of *D+r* is 10010101010000 is taken by previous problem.

Consider the value, *D*=1001010101

Now dividing *D+r* with *G* the value of *R* is:

Table

Description automatically generated

**So, R value is 0000**

**Q.3. (2 marks)**

Suppose two hosts, A and B, are separated by 20,000 kilometers and are connected by a direct link of R = 2 Mbps. Suppose the propagation speed over the link is 2.5 x 108 meters/sec.

a. Calculate the bandwidth-delay product, R \_ dprop.

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

***Note: Explain your answer in details***

**Answer:**

a)

The distance (Distance) between two hosts A and B = 20,000 km



Trasmission rate(R) of the direct link between A and B =2Mbps



Propagation Speed(S) of the link between A and B Calculate the propagation delay:



Calculate the band-width delay product:



Therefore, band-with delay product is 160000bits

b)

Size of the file =800000 bits 

Trasmission rate(R) of the direct link between A and B =2Mbps



The band-width delay product:



Therefore, the maximum number of bits at a given time will be 160000bits. **Q.4. (2 marks)**

A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, one other packet is halfway done being transmitted on this outbound link and four other packets are waiting to be transmitted. Packets are transmitted in order of arrival.

Suppose all packets are 1,500 bytes and the link rate is 2 Mbps. What is the queuing delay for the packet? More generally, what is the queuing delay when all packets have length *L*, the transmission rate is *R*, *x* bits of the currently-being-transmitted packet have been transmitted, and *n* packets are already in the queue?

***Note: Explain your answer in details.***

**Answer:**

**Text

Description automatically generated**

**Q.5. (2 marks) A router has the following CIDR entries in its routing table:** *Address/mask Next hop*

135.46.56.0/22 Interface 0

135.46.60.0/22 Interface 1

192.53.40.0/23 Router 1

default Router 2

(a) What does the router do if a packet with an IP address 135.46.63.10 arrives? **Answer:**

Taking the first 22 bits of the above IP address as network address, we have 135.46.60.0.

It matches the network address of 135.46.60.0/22. So, the router will forward the packet to Interface 1.

(b) What does the router do if a packet with an IP address 135.46.57.14 arrives? **Answer:**

Taking the first 22 bits of the above IP address as network address, we have 135.46.56.0.

It matches the network address of 135.46.56.0/22. The packet will be forwarded to Interface 0.

**Note:**

- **Students have to follow the steps and complete the tasks in details in order to have the results. If the students only write the result, that is, that result is not marked or recorded.**

- **Students do examination on paper and answer by English**

**CÂU HỎI ÔN TẬP ĐỀ PE NWC203c FALL 2021**

**SV PHẢI LÀM TỪNG BƯỚC ĐẾN KẾT QUẢ**

**1.** Suppose two hosts, A and B, are separated by 30,000 kilometers and are connected by a direct link of *R* = 3 Mbps. Suppose the propagation speed over the link is 2.5 x 108 meters/sec.

1. Calculate the bandwidth-delay product, *R* \_ *d*prop.

1. Consider sending a file of 900,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

🡪

a.  
We have:

So, the bandwidth-delay product is:

b. The file is 900000 bits higher than bandwidth-delay (360000 bits) so the maximum number of bits is 360000 bits.

1. Let g(x)=x3+x+1. Consider the information sequence 1011. Find the codeword corresponding to the preceding information sequence. Using polynomial arithmetic we obtain.

🡪

Information bits: 1011  
 Polynomial bits representation of is 1011.  
 We have to expand 3 0s more into the end of information bits before dividing.  
 We got: 1011000  
Calculate:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | 1 | 0 | 0 | 0 |
| 1 0 1 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| XOR | 1 | 0 | 1 | 1 |  |  |  |
|  |  |  |  |  | 0 | 0 | 0 |

The remaining: 000  
Codeword: 1011000

1. A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, one other packet is halfway done being transmitted on this outbound link and four other packets are waiting to be transmitted. Packets are transmitted in order of arrival.

Suppose all packets are 2,500 bytes and the link rate is 3 Mbps. What is the queuing delay for the packet? More generally, what is the queuing delay when all packets have length *L*, the transmission rate is *R*, *x* bits of the currently-being- transmitted packet have been transmitted, and *n* packets are already in the queue?

🡪

Packet length = L = 2, 500 bytes

Transmission rate = R = 3Mbps

Currently transmitted packet = x bit = 2500/2 = 1250

Waiting queue = n packets = 4

Formula for Queuing delay:  
Queuing delay

1. Suppose a header consists of four 16-bit words: (11111111 11111110,

11111111 00000000, 11110000 11110000, 11000000 11000001). Find the Internet checksum for this code

🡪

modulo   
 modulo   
So the Internet checksum

**5.** Consider a packet of length 2,000 bytes that propagates over a link of distance 3,500 km with propagation speed of 2,5 · 108 m/s, and transmission rate 2 Mbps?

1. How long does the packet propagation take?
2. Does this propagation delay depend on the packet length?
3. Does this propagation delay depend on the transmission rate?

🡪

1. Transmission delay = L/R

= 8 bits/byte \* 2,000 bytes / 2,000,000 bps

= 8 ms

Propagation delay = d/s

= 3,500\*103/ 2,5×108

= 14 ms

Therefore, the total time = 8ms + 14 ms = 22 ms

1. No, the delay depend on packet length is not true.
2. No, the delay depend on transmission rate is not true.

**6.** A router has the following CIDR entries in its routing table:

*Address/mask Next hop*

135.46.56.0/22 Interface 0

135.46.60.0/22 Interface 1

192.53.40.0 /23 Router 1

default Router 2

* 1. What does the router do if a packet with an IP address 135.46.63.10 arrives?

🡪 Taking the first 22 bits of the above IP address as network address, we have 135.46.60.0.

It matches the network address of 135.46.60.0/22. So, the router will forward the packet to Interface 1.

* 1. What does the router do if a packet with an IP address 135.46.57.14 arrives?

🡪 Taking the first 22 bits of the above IP address as network address, we have 135.46.56.0.

It matches the network address of 135.46.56.0/22. The packet will be forwarded to Interface 0.

**7.**Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links of rates R1 = 250 kbps, R2 = 3 Mbps, and R3 = 2 Mbps.

1. Assuming no other traffic in the network, what is the throughput for the file transfer?

🡪 Given data: R1 = 250 kbps, R2 = 3 Mbps, and R3 = 2 Mbps

The throughput for the file transfer = min {R1, R2, R3} = 250kbps

So, the throughput for the file transfer = 250kbps

1. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

🡪 The file size = 4 million bytes   
Convert million bytes to bits

= 32,000,000 bits

From a. the throughput for the file transfer = 250kbps = 250,000 bps

Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B:

= file size/throughput for the file transfer

= 32,000,000 bits/250,000 bps

= 128 seconds

1. Suppose an application layer entity wants to send an *L*-byte message to its peer process, using an existing TCP connection. The TCP segment consists of the message plus 20 bytes of header. The segment is encapsulated into an IP packet that has an additional 20 bytes of header. The IP packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer. What percentage of the transmitted bits in the physical layer correspond to message information, if *L* = 200 bytes, 1000 bytes, 2000 bytes?

🡪

TCP/IP over Ethernet allows data frames with a payload size up to 1460 bytes.

Therefore, L = 200, 1000 and 2000 bytes are within this limit.

The message overhead includes:

TCP: 20 bytes of header

IP: 20 bytes of header

Ethernet: 18 bytes of header and trailer.

Therefore:

L = 200 bytes, 200/258 = 78% efficiency.

L = 1000 bytes, 1000/1058 = 95% efficiency.

L = 2000 bytes, 2000/2058 = 97% efficiency.

1. Suppose the size of an uncompressed text file is 1 megabyte

* 1. How long does it take to download the file over a 35 kilobit/second modem?

🡪T35k = 8\*220/35000 = 239.675 sec

* 1. How long does it take to take to download the file over a 1 megabit/second modem?

🡪 T1M = 8\*220/106 = 8.4 sec

* 1. Suppose data compression is applied to the text file. How much do the transmission times in parts (a) and (b) change?

If we assume a maximum compression ratio of 1:6, then we have the following times for the 35 kilobit and 1 megabit lines respectively:

🡪 T35k = 8\*220/ (35000\*6) = 39.95 sec

🡪 T1M = 8\*220/ (106 \*6) = 1.4 sec

Consider the three-way handshake in TCP connection setup.

1. Suppose that an old SYN segment from station A arrives at station B, requesting a TCP connection. Explain how the three-way handshake procedure ensures that the connection is rejected.

🡪 In a three-way handshake procedure, one must ensure the selection of the initial sequence number is always unique. If station B receives an old SYN segment from A, B will acknowledge the request based on the old sequence number. When A receives the acknowledge segment from B, A will find out that B received a wrong sequence number. A will discard the acknowledgement packet and reset the connection.

1. Now suppose that an old SYN segment from station A arrives at station B, followed a bit later by an old ACK segment from A to a SYN segment from B. Is this connection request also rejected?

🡪 If an old SYN segment from A arrives at B, followed by an old ACK segment from A to a SYN segment from B, the connection will also be rejected. Initially, when B receives an old SYN segment, B will send a SYN segment with its own distinct sequence number set by itself. If B receives the old ACK from A, B will notify A that the connection is invalid since the old ACK sequence number does not match the sequence number previously defined by B. Therefore, the connection is rejected.

1. Sender A wants to send 100111010011110 to receiver B. This transmission uses CRC algorithm for error detection with generator polynomial bits string is 10110. What is bits string will be transmitted on the medium. Show your all steps to have result.

🡪 We have to expand 4 0s more into the end of information bits.

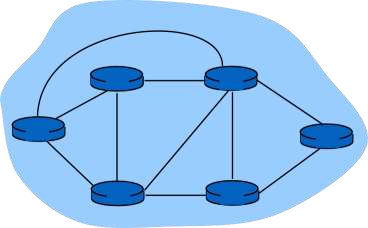
🡪 Information bits: 1001110100111100000

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | 1 | 0 | 1 | 1 | 0 | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  | |  |  | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  | 0 | 1 | 0 | 0 | 1 | 1 |  |  |  |  |  |  |  | |  |  |  |  |  |  |  | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  | 1 | 0 | 1 | 1 | 1 |  |  |  |  |  | |  |  |  |  |  |  |  |  |  | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 0 | 0 | 0 | 0 |  | |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 0 | 1 | 1 | 0 |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 1 | 0 | 0 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |

Remaining: 1100

Transmitted bits: 1001110100111100000

1. Consider the following network Figure 1. With the indicated link costs, use Dijkstra’s shortest-path algorithm to compute the shortest path from u to all network nodes. Show how the algorithm works by computing a table.



5



2



v



3



w



5



u



2



4



z



1



4



x



3



1



y

***Figure 1***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Where:  
S: subnet of nodes  
 : current path of node   
I(v): least cost path of node v  
So the following are shortest paths from U along with their costs:  
Z: UXYZ = 5

Let g1(x) = x + 1 and let g2(x) = x3 + x2 + 1. Consider the information bits (1,1,0,1,1,1).

* 1. Find the codeword corresponding to these information bits if g1(x) is used as the generating polynomial.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | 1 | 0 | 0 | 1 | 0 | 1 |  |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |  |
|  |  | 1 | 1 |  |  |  |  |  |  |
|  |  |  |  |  | 1 | 1 |  |  |  |
|  |  |  |  |  | 1 | 1 |  |  |  |
|  |  |  |  |  | 0 | 0 | 1 | 0 |  |
|  |  |  |  |  |  |  | 1 | 1 |  |
|  |  |  |  |  |  |  |  | 1 |  |

Codeword = 1101111

* 1. Find the codeword corresponding to these information bits if g2(x) is used as the generating polynomial.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  | 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
|  |  |  |  | 1 | 1 | 0 | 1 |  |  |  |  |  |
|  |  |  |  |  |  |  |  | 1 | 1 | 0 | 0 |  |
|  |  |  |  |  |  |  |  | 1 | 1 | 0 | 1 |  |
|  |  |  |  |  |  |  |  |  |  |  | 1 | 0 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

Codeword = 110111010

1. Consider the 7-bit generator, G=10111, and suppose that D has the value 1010100001. What is the value of R? Show your all steps to have result.

The polynomial expression of G =

The degree of the expression is 4. So, r = 4, we have to add 4 0s into the end of D

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | 1 | 0 | 1 | 1 | 1 | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 1 | 1 |  |  |  |  |  |  |  |  |  | |  |  |  | 1 | 0 | 0 | 0 | 0 |  |  |  |  |  |  | |  |  |  | 1 | 0 | 1 | 1 | 1 |  |  |  |  |  |  | |  |  |  |  |  | 1 | 1 | 1 | 0 | 1 |  |  |  |  | |  |  |  |  |  | 1 | 0 | 1 | 1 | 1 |  |  |  |  | |  |  |  |  |  |  |  |  | 1 | 1 | 0 | 0 | 0 |  | |  |  |  |  |  |  |  |  | 1 | 0 | 1 | 1 | 1 |  | |  |  |  |  |  |  |  |  |  |  | 1 | 1 | 1 | 1 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |

🡪 R = 1111