Q1) A modem uses Quadrature Phase-Shift Keying (QPSK) on an 5000Hz Public Switched Telephone Network (PSTN).

1) Describe what is meant by QPSK.

Answer:

Modulation is a technique used in telecommunications to encode digital information onto a carrier signal for transmission. QPSK (Quadrature Phase-Shift Keying) is a modulation scheme used in digital communication to transmit data by changing the phase of the carrier wave. In QPSK, two bits are modulated at once, each represented by a specific phase of the carrier signal. Instead of having two possible phase shifts as in binary phase-shift keying (BPSK), QPSK has four possible phase shifts, each representing two bits of data. When a modem utilizes QPSK on a 5000Hz Public Switched Telephone Network (PSTN), it can efficiently transmit data over the PSTN channel with a bandwidth of 5000Hz, enabling higher data rates.

2) Deduce the Nyquist maximum data transfer rate.

Answer:

The Nyquist theorem states that,

$C=2*B*\log_2 M$

Where:

C is the maximum data transfer rate in bps.

B is the bandwidth in Hz.

M is number of signal level.

Given:

Bandwidth (B) = 5000 Hz

Number of signal levels (M) = 4 as per QPSK

And now, using the Nyquist formula:

$C = 2*B*\log_2 M$

$= 2*5000*\log_2 4$

$= 10000*\log_2 2^2$

$= 10000*2*\log_2 2$

$= 10000*2*1$

$= 20000$ bps

$= 20$ kbps

So, the Nyquist maximum data transfer rate for this modem using QPSK modulation on a 5000Hz PSTN is 20 kbps.

3) Assume the channel has a 10dB signal-to-noise-ratio. Calculate the Shannon-Hartley maximum data transfer rate for this channel.

Answer:

The Shannon-Hartley theorem states that,

$C = B*\log_2(1 + S/N)$

Where:

C is the maximum data transfer rate in bps.

B is the bandwidth in Hz.

S/N is the signal-to-noise ratio.

Given,

$C = B*\log_2(1 + S/N)$

First, we need to convert 10 dB into a S/N ratio.

We can use:

$S/N = 10^{(dB)/10} = 10^{(10/10)} = 10^1 = 10$

So,

$C = 5000*\log_2(1+10)$

$= 5000*\log_2 11$

$\approx 5000*\log_2 16$

$= 5000*\log_2 2^4$

$= 5000*4*\log_2 2$

$= 5000*4*1$

$= 20000$ bps

$= 20$ kbps

So, the Shannon-Hartley maximum data transfer for this modem using QPSK modulation on a 5000Hz PSTN with a 10dB signal-to-noise ratio is 20 kbps.

4) Would it be better to increase the number of phase shifts or to improve the signal-to-noise ratio of the line to increase the data transfer rate of this channel?

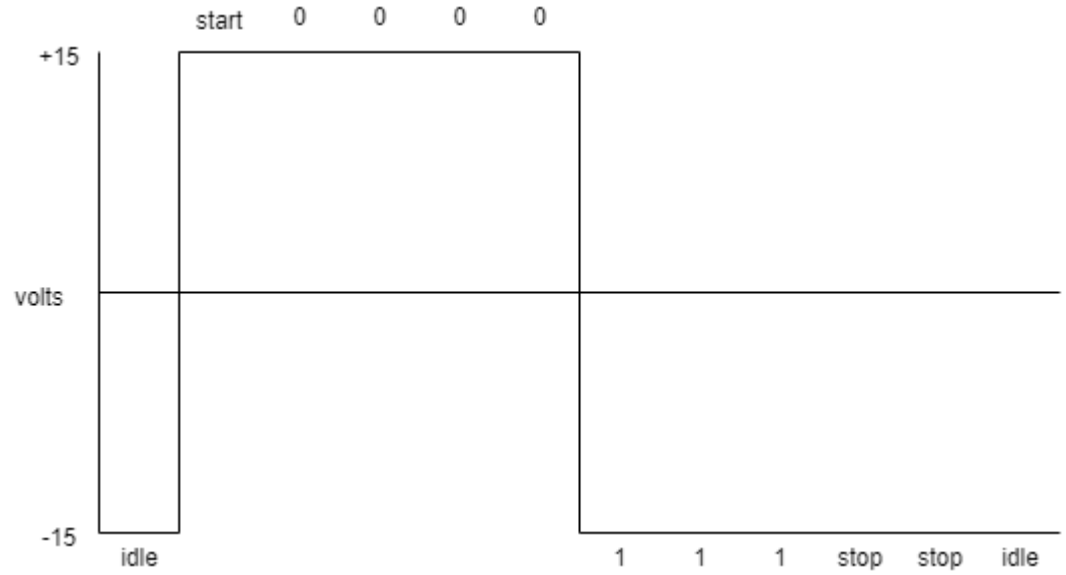
Answer:

To increase the data transfer rate of the channel, it's better to focus on improving the signal-to-noise ratio (S/N) rather than increasing the number of phase shifts. This is because increasing the S/N directly increases the Shannon-Hartley maximum data transfer rate, as shown in the formula above in Q3. On the other hand, increasing the number of phase shifts might increase the data rate, but it could also make the modulation scheme more susceptible to errors, especially in a noisy environment like a PSTN. Therefore, it would be better to improve the signal-to-noise ratio rather than to increase the number of phase shifts of the line to increase the data transfer rate of this channel.

Q2) Draw the waveform that would be used to send the following bits over RS-232-C with 1 start bit, 7 data bits, 2 stop bits, and no parity bits:

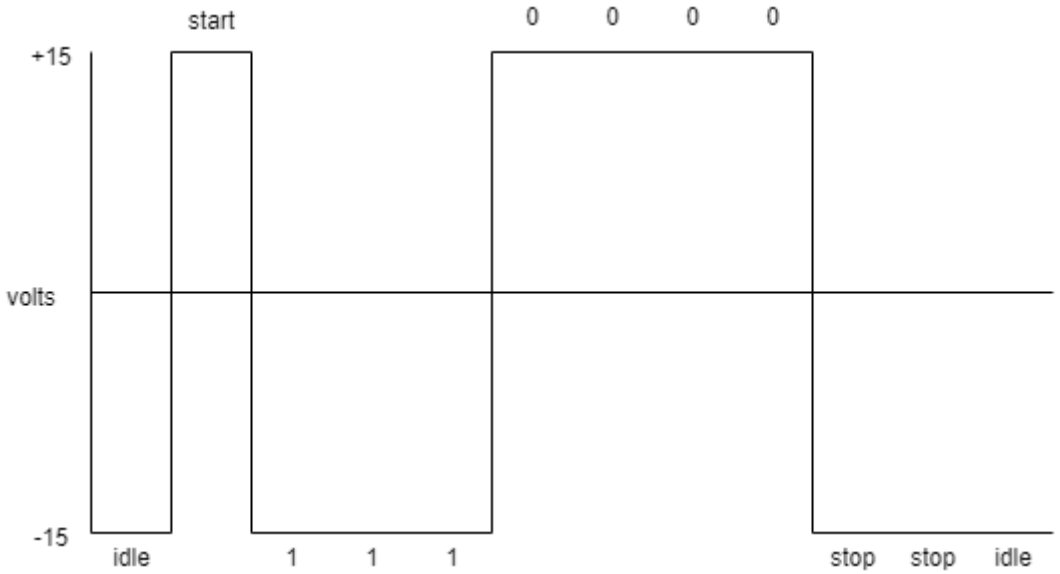
1) 0000111

Answer:



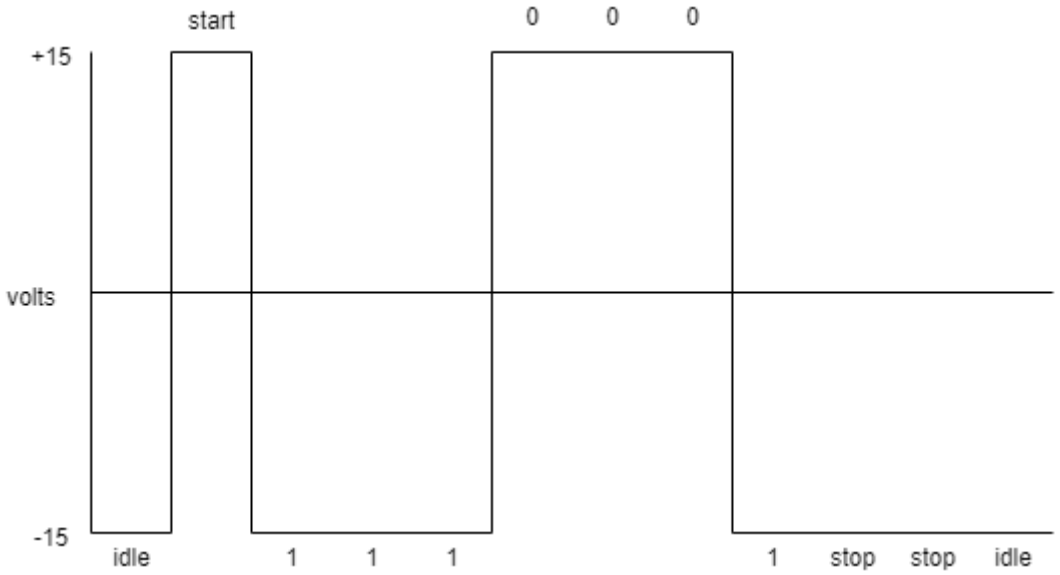
2) 1110000

Answer:



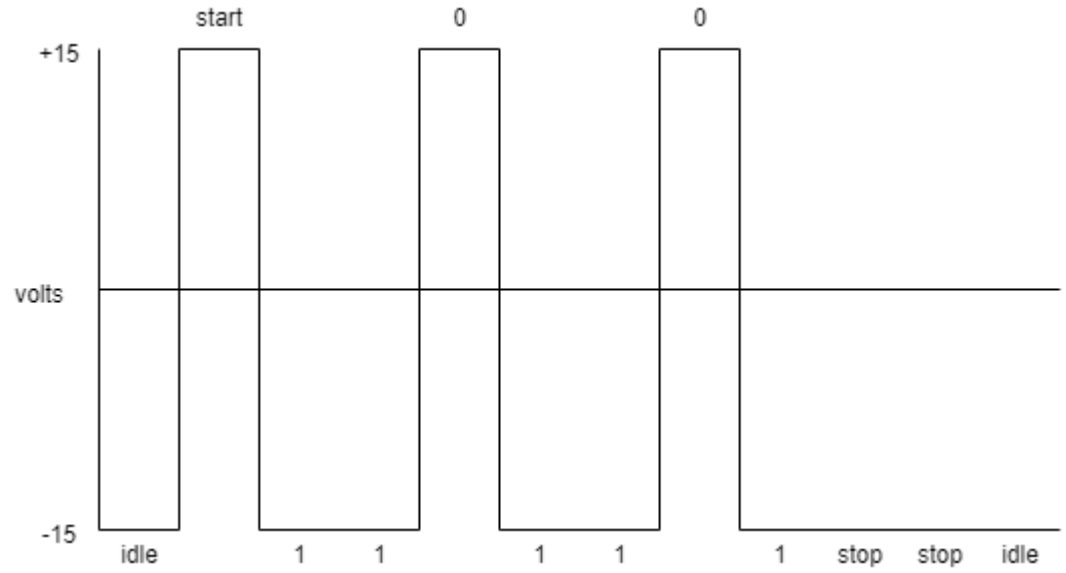
3) 1110001

Answer:



4) 1101101

Answer:



Q3) A bit stream 10101001 is transmitted using a standard CRC calculated using the generator polynomial $x^3 + x + 1$.

1) Find the actual transmitted bitstream.

Answer:

Here,

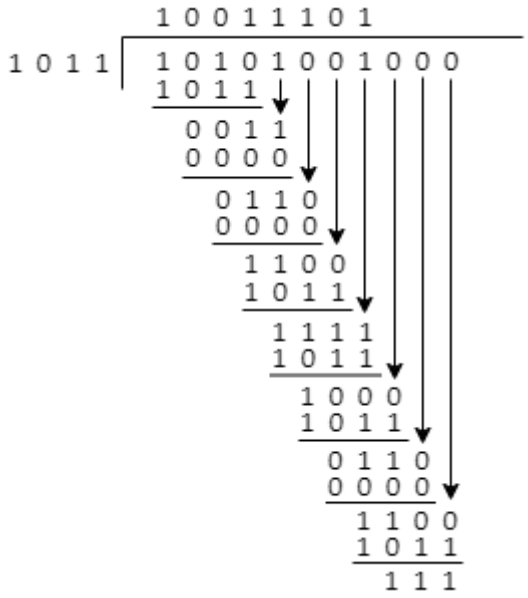
The original bitstream is 10101001 and the generator polynomial x^3+x+1 indicates that three bits should be appended to the original bitstream for error detection using CRC. So, it becomes 10101001000.

The generator polynomial is x^3+x+1.

Now, to simplify we get, $1x^3+0x^2+1x^1+1x^0$.

Taking the co-efficient we get, 1011.

Now,



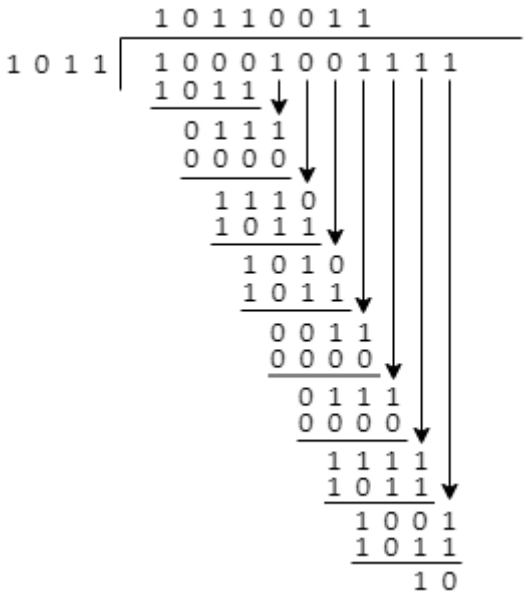
So, the actual transmitted bitstream is 10101001111.

2) Assume your answer for part 1) is received with the third bit from the left inverted (i.e. 0 is received as 1 or 1 is received as 0). Show how the receiver would detect this error.

Answer:

Assuming as per the question, the bitstream will be 10001001111.

Now,

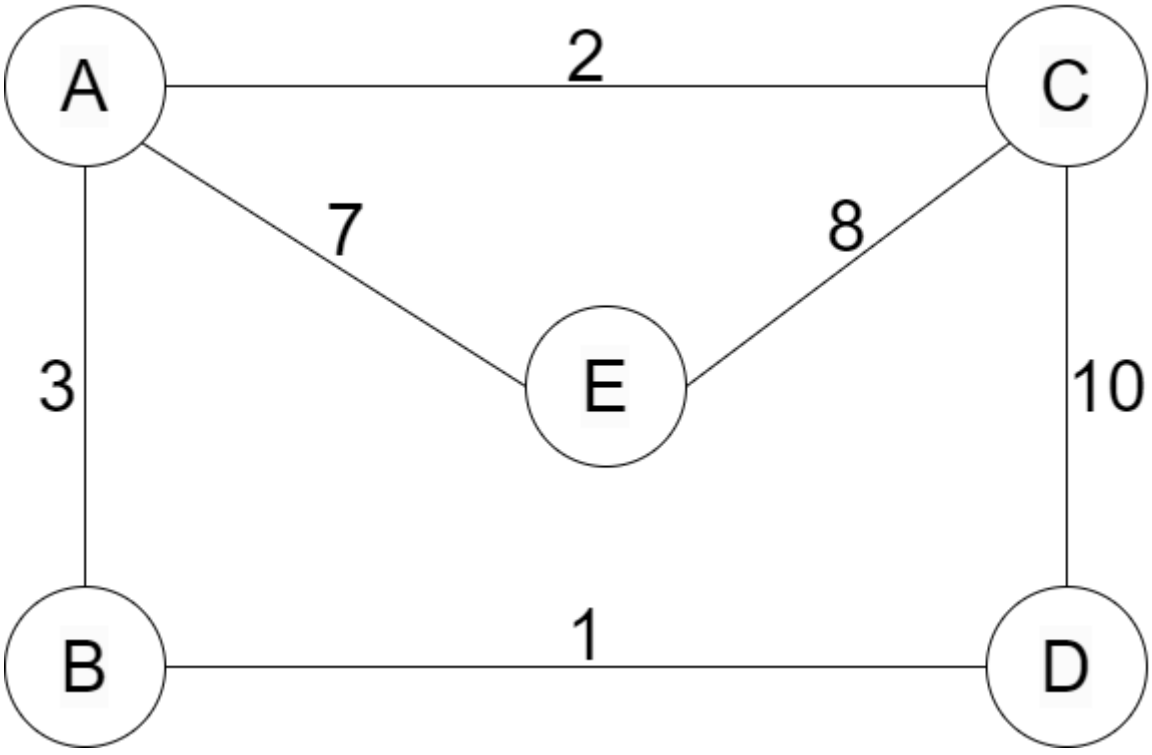


A non-zero remainder means an error is detected.

Q4) Consider the network consisting of 4 routers and link weights described by (A, B, 3), (A, C, 2), (A, E, 7), (B, D, 1), (C, D, 10), (C, E, 8).

1) Draw the network.

Answer:



2) Produce the routing table for each router.

Answer:

Routing Table for Router A	
Ultimate Destination	**Exit Link**
B	**B**
C	**C**
D	**B**
E	**E**

Routing Table for Router B	
Ultimate Destination	**Exit Link**
A	**A**
C	**A**
D	**D**
E	**A**

Routing Table for Router C	
Ultimate Destination	**Exit Link**
A	**A**
B	**A**
D	**A**
E	**E**

Routing Table for Router D	
Ultimate Destination	**Exit Link**
A	**B**
B	**B**
C	**B**
E	**B**

Routing Table for Router E	
Ultimate Destination	**Exit Link**
A	**A**
B	**A**
C	**C**
D	**A**

Q5) Security Planner is an easy-to-use guide designed to help users increase their online security.

1) Go through the Security Planner questions and list your top priority (i.e. the top suggestion that the guide gives you).

Answer:

The top priority listed in security planner is:

- Regain Control of Hacked or Compromised Accounts

2) Describe how to implement this suggestion.

Answer:

To implement this suggestion, we need to follow the steps outlined by each company and platform to regain the access. And, after we have regained, we need to change our password and make it as strong and unique as we can. Then after, we need to complete self-guided security checkups and put maximum security measures in place. We should not provide our accounts information to any other apps or websites which are not reliable.

3) Describe how implementing this suggestion improves your security.

Answer:

After implementing all the above suggestions, we can securely access our accounts and avoid the risk for future account takeovers. After we put maximum security measures in place, it's hard for hackers as they need more information rather than just a password to gain access to our accounts. The more security measures we apply, the more secure is our accounts. Many times, we use password manager applications to store our passwords. So, we should only use reliable and trusted password manager applications which store our passwords in encrypted form.