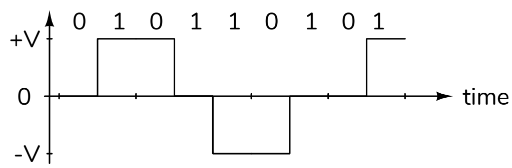
Solutions to Midterm 2

Question 1



The diagram above shows a waveform that has been encoded using only MLT-3 (not 4B5B). The waveform shows nine bit periods and a portion of the previous bit. What nine bit values were transmitted?

Answer

MLT-3 encodes ones as a transition and zeros as no transition. The diagram above has been marked with a '1' at each bit position where the level is different from the previous bit and a '0' at each bit position where the level is the same as the previous bit. The transmitted data was thus:

0 1 0 1 1 0 1 0 1

Question 2

A differential transmitter has two outputs labelled D^+ and D^-. The differential voltage is 100 mV and D^+ is more positive than D^-. The common-mode voltage is 3 V. What are the voltages on D^+ and D^-?

Answer

The differential voltage, defined as $D^+ - D^-$, is 0.1 V and the common-mode voltage, defined as $\frac{D^+ + D^-}{2}$, is 3 V.

These two equations with two unknowns can be solved by substituting $D^+ = 0.1 + D^-$ to get $\frac{0.1+2D^-}{2} = 3$ from which $D^- = 2.95$ and $D^+ = 3.05$.

Question 3

In general, a receiver should have an input impedance that is:

(a) as low as possible
(b) as high as possible
(c) something else

Answer

The correct answer is "something else" because a matched load (input impedance) will maximize power transfer and minimize reflections.

Question 4

Slew rate limiting has the following effect on the maximum data rate that can be achieved:

(a) decreases it
(b) increases it
(c) has no effect

Answer

The correct answer is that it reduces the achievable data rate because slew rate limiting increases rise and fall times which in turn reduces the time that the signal can be held at the desired level.

Question 5

The sequence of eight bits: 0111 1110 is to be framed using HDLC. What bits are transmitted? Show the all bits including the flag bits and any bit stuffing.

Answer

We start and end the frame with a flag sequence[1] and insert a zero bit after the five consecutive ones within the frame. Thus the sequence of bits transmitted is:

[1] This sequence of bits is actually a flag sequence.

```
0111 1110 0111 11 0 10 0111 1110
```

Question 6

A communication system uses a simple CRC computed as described in the lecture notes. The generator polynomial is $G(x) = x^2 + x + 1$. The message to be protected with a CRC is: 1010.

(a) How long is the CRC (in bits)?
(a) What is the value of the CRC?
(a) What is the complete message, including the CRC, that is transmitted?

Answer

- The length of the CRC is $n - k$ which is also the order of the highest-order term of the generator polynomial. In this case $n - k = 2$ so there are two bits in the CRC.
- The CRC is computed by finding the remainder of dividing the message with $n-k$ bits appended by the generator polynomial. Using 0's and 1's instead of polynomials, the division is:

```
       ------------
111 | 101000
      111
      ---
       100
       111
       ---
        110
        111
        ---
         010
         ---
          10
```

  The remainder is 10 so the CRC is 10.
- The complete message is the k (4) bits of the message plus $n-k$ (2) bits of the CRC for a total block length of n (6) bits:

```
1010 10
```