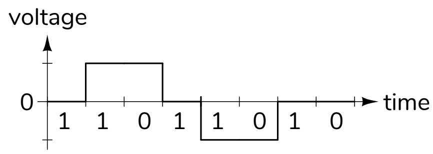
Solutions to Midterm 2

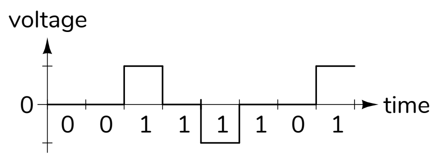
Question 1

The following waveform show 8 bits being transmitted using an MLT-3 line code. As shown, the first bit was a 1. What 8 bits were transmitted?

Solution

With MLT-3 a 1 is encoded as a change in level and a 0 as no change. There were two versions of this question; the decoded values are written on the waveforms below.





Question 2

The following bytes, shown in hexadecimal, were transmitted using PPP framing. What are the values of the bytes within in the frame? Give your answer in hexadecimal and assume the conventions described in the lecture notes were followed, including that escaped bytes are xor'ed with 0x20.

The bytes in the first version of the question were:

```
7E   88   7D   1D   7D   5D   23   7D   7D   7E
```

while the bytes in the second version of the question were:

```
7E   7D   7D   73   7D   5D   23   7D   1D   7E
```

Solution

PPP framing adds a flag character **`7E`** before and after each frame and puts an escape character **`7D`** before any "special" byte. This byte is then exclusive-or'ed with 0x20. The second line below marks the flag bytes to be removed with ff, escapes to be removed with ee, and the bytes to be xor'ed with 20. The resulting data bytes – the "payload" – are shown on the third line.

```
         7E   88   7D   1D   7D   5D   23   7D   7D   7E
remove:  ff        ee   20   ee   20        ee   20   ff
result:       88        3D        7D   23        5D
```

and:

```
         7E   7D   7D   73   7D   5D   23   7D   1D   7E
remove:  ff   ee   20        ee   20        ee   20   ff
result:            5D   73        7D   23        3D
```

Question 3

You would like to generate a PRBS that does not repeat for at least one day (24 hours) (or two days (48 hours)) when generating bits at 1 Mb/s. What is the minimum value of m (number of bits of generator state) required?

Solution

24 hours is $24 \times 60 \times 60 = 86,400$ s. At 1 Mb/s 86.4×10^9 bits would be transmitted. The period of a m-sequence is $2^m - 1$. Setting these equal and solving for m:

$$m = \log_2(86.4 \times 10^9 - 1)) = 36.33 \text{ bits}$$

We need to round this up to an integer number of bits so we would need at least $\boxed{37 \text{ bits}}$.

48 hours is $48 \times 60 \times 60 = 172,800$ s. So

$$m = \log_2(172.8 \times 10^3 \times 10^6 - 1)) = 37.33 \text{ bits}$$

so we would need at least $\boxed{38 \text{ bits}}$.

Question 4

You wish to protect the message 11011 (or 10000) using a CRC whose generator polynomial is $1x^2 + 0x^1 + 1x^0$.

- What is the length of the CRC in bits?
- What are n, k and $n-k$?
- Compute the CRC using the simplified algorithm described in the lectures.

Solution

- The length of the CRC $(n-k)$ in bits is one less than the number of terms in the generator polynomial, $G(x)$. Since there are three terms in $G(x)$, there are $\boxed{\text{two bits}}$ in the CRC.
- The number of bits in the payload plus CRC is $n = 5 + 2 = \boxed{7}$. k is the number of bits in the payload, $\boxed{5}$. $n - k = 7 - 5 = \boxed{2}$.
- The computations of the CRC using the simplified algorithm described in the lectures are shown below and give the results $\boxed{00}$ and $\boxed{01}$.

```
     -------
101 |1101100
     101
     ---
      111
      101
      ---
       101
       101
       ---
        000
        ---
         000
         ---
          00
```

and

```
     -------
101 |1000000
     101
     ---
      010
      ---
       100
       101
       ---
        010
        ---
         100
         101
         ---
          01
```