2.1) 3 ms at $f_s = 3$ kHz yields 9 samples. The sample values are:

$$s = [0.8660, -0.8660, 0, 0.8660, -0.8660, 0, 0.8660, -0.8660, 0]$$

The corresponding binary values are:

$$b = [0101, 1101, 0000, 0101, 1101, 0000, 0101, 1101, 0000]$$

The waveforms for the first 12 bits (first millisecond) are shown below. These waveforms would repeat during the second and third milliseconds.

Here is the Octave code to produce the plots above: `pr_02_01.m`.

2.6) I decoded the values from the waveform as:

$$[00, 11, 11, 01, 10, 00, 01]$$

The corresponding stairstep approximation and a possible waveform are shown below.
2.7) \( R_b = 60 \text{ kpps} \)

2.13) 

a) I chose \( \Delta = 2 \text{ V} \). The original analog signal and the approximation are shown below.

Octave code: pr_02_13a.m.

b) I chose \( \Delta_{\text{min}} = 1 \text{ V} \). The original analog signal and the approximation are shown below.

Octave code: pr_02_13b.m.

2.21) The corresponding waveforms are shown in the Figure below.
Many designs are possible. I used a 3 channel main mux with $f_s = 20$ kHz. One channel was used for a marker and another one was used for the 10 kHz signal. The two 10 kHz signal were input into a 2 channel sub-mux with $f_s = 10$ kHz. The output of the sub-mux was fed into the remaining input of the main mux.

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2.18) $R_b = 56$ Mbps

2.19) The total power in NRZ-L with amplitude $+V$ and $-V$ is $P_T = V^2$. The normalized power spectrum is

$$G_n(f) = |G(f)| P_T = T_b \text{sinc}^2(f T_b)$$

The normalized power between $-R_b$ and $+R_b$ is (where $R_b = 1 / T_b$)

$$P = \int_{-R_b}^{R_b} T_b \text{sinc}^2(f T_b) df$$

substituting $\lambda = f T_b$ gives
\[ P = \int_{-1}^{1} \text{sinc}^2(\lambda) \, d\lambda. \]

This can be evaluated numerically using Octave:

```octave
> P = quad( @(f) sinc(f).^2, -1, 1)

P = 0.90282
```

2.22)

The corresponding NRZ-S and bi-phase-M waveforms are shown below: