8.2-1) The spectrum of the sampled signal is
\[
X(\omega) = \frac{5\pi}{2} \sum_{k=-\infty}^{\infty} P(k\omega_0) X(\omega-k\omega_0)
\]
where \( P(\omega) \) is the Fourier transform of the pulse centered at \( t = 0 \) in the pulse train.

\( x(t) \) can be recovered by lowpass filtering. If the LPF has a BW of 100 Hz then the output of the filter will be equal to
\[
\tilde{x}(t) = 500\pi P(0) \text{sinc}(200\pi t)
\]
The output will be the same as long as the filter BW is less than 150 Hz. If the BW is greater than 150 Hz, the output of the filter will be a distorted version of the original \( x(t) \).

8.2-4) The spectrum of the sampled signal is
\[
\tilde{X}(\omega) = \sum_{k=-\infty}^{\infty} \frac{\omega_0}{a+jk\omega_0} X(\omega-k\omega_0)
\]
The signal can be recovered using a low pass filter with bandwidth \( B \) as long as the sampling time is small enough to satisfy the requirement \( T \leq 1/(2B) \).

8.2-6) a) 8 Hz  b) 8 Hz  c) 0 Hz  d) 2 Hz  e) 8 Hz

8.3-2) a) \( f_s = 10.8 \text{ MHz} \)  b) \( N = 10 \text{ bits} \)  c) \( r_b = 108 \text{ Mbps} \)

8.3-4) \( r_b = 109 \text{ kbps} \)

8.5-1) \( f_s = 20 \text{ kHz}, N_0 = 512, f_o = 39.1 \text{ Hz}, T_0 = 25.6 \text{ ms} \).
You must zero-pad from 10 ms to 25.6 ms.

8.5-3)

\[ B_1 = 15.91 \text{ Hz}, \quad N_0 = 256, \quad T = 25 \text{ ms}, \quad T_0 = 6.4 \text{ s} \]
\[ B_2 = 10.13 \text{ Hz}, \quad N_0 = 128, \quad T = 40 \text{ ms}, \quad T_0 = 5.12 \text{ s} \]

The magnitude and phase of the Fourier transform are shown in the Figures below as a solid line. The magnitude and phase of the DFT using \( T = 25 \text{ ms} \) and \( N_0 = 256 \) are shown as stem plots for comparison. Only the first 32 sample values are shown.

8.5-4)

\[ B_1 = 0.7329 \text{ Hz}, \quad N_0 = 32, \quad T = 0.5 \text{ s}, \quad T_0 = 16 \text{ s} \]
\[ B_2 = 0.3664 \text{ Hz}, \quad N_0 = 16, \quad T = 1 \text{ s}, \quad T_0 = 16 \text{ s} \]

The magnitude and phase of the Fourier transform are shown in the Figures below as a solid line. The magnitude and phase of the DFT using \( T = 0.5 \text{ s} \) and \( N_0 = 32 \) are shown as stem plots for comparison.
Use $N_0 = 32$ and $T_0 = 4$ s. The sample sequences and their corresponding convolution (computed using the FFT) are shown below.

$\mathbf{x}(t)$ and $x_n/T$

$\mathbf{g}(t)$ and $g_n/T$

$\mathbf{x}(t) \ast \mathbf{g}(t)$ and $(x_n \ast g_n)/T$
9.1-3)

\[ D[0-4] = [0, 0, e^{-j0.4\pi}, e^{j0.4\pi}, 0] \]

Amplitude Spectrum

Phase Spectrum

9.1-5)

\[ D[0-11] = [0, -j0.872, -j0.433, +j0.333, +j0.144, -j0.295, 0, +j0.295, -j0.144, -j0.333, +j0.433, +j0.872] \]

Amplitude Spectrum

Phase Spectrum