1 Labwork

1.1 Sampling

- Obtain the signals $x_1[n] = cos[2\pi f_1 n]$ and $x_2[n] = sin[2\pi f_2 n]$ according to the sampling frequency $F_s = 80$kHz, $f_1 = 2.5$kHz and $f_2 = 6$kHz
- Downsample the signal $x[n] = x_1[n] + x_2[n]$ with the factors 4 and 12.
- You may not use the MATLAB built-in function **downsample(.)**
- Plot the time domain original signal and the downsampled signals using **stem(.)** function in a 3×1 figure using **subplot(.)**
- Plot the magnitude frequency responses of the original signal and downsampled signals in a 3×1 subplot figure.
- **Report**: Comment on the effect of the downsampling in frequency domain and time domain.
- Reconstruct the original signal with cubic and linear interpolation using **interp1(.)**.
- Plot the original signal and reconstructed signals on the same figure using 2×1 subplot figure using **hold on**

1.2 Quantization

- Obtain the continuous time signal $x(t) = 3cos(2\pi f_1 t) + sin(2\pi f_2 t)$ with $F_s = 80$kHz, $f_1 = 2$kHz and $f_2 = 400$Hz
- Obtain quantized signal X_Q with $N = 4$ and $N = 6$ by, where N is the number of bits for quantization and b is the

$$X_Q = \left\lfloor \frac{x-a}{b-a} * (2^N - 1) \right\rfloor * \frac{b-a}{2^N - 1} + a \tag{1}$$

  maximum value of the original signal and a is the minimum value of the original signal.
- Plot the quantized signals and original signal on the same figure by using 2×1 subplot and **hold on**.
- Calculate Signal-to-Quantization-Noise Ratio (SQNR) γ in dB for $N = 4$ and $N = 6$ by

$$\gamma = \frac{\sigma_x^2}{\sigma_e^2} \tag{2}$$

  where e is the error signal between the original signal and the quantized signal. Note that γ is in linear scale you must convert it in dB.
- e is defined as:

$$e = x(t) - X_Q \tag{3}$$

- You can use **var(.)** function to take the variances of the signals.
- Display the SQNRs in the command window
- **Report**: Which SQNR is greater and why? Comment on it.

In your figures, to get full credit, legend, title and labels must be added

1.3 Remaining Questions for the Report

Include figures, comments and answers to questions in your reports

- What is the Nyquist frequency explain and give the formula.
- Explain the sampling theorem, in which case(s) the perfect reconstruction of the signal from its sampled one is not possible.