Experiment No: 2 – Time-domain sampling and alias

1. Plot the following waveforms in one single plot for $0 \leq t \leq 1$
   - (a) $x_{a1}(t) = 2\cos(10\pi t)$.
   - (b) $x_{a2}(t) = \cos(20\pi t)$.
   - (c) $x_{a3}(t) = 0.5\cos(60\pi t)$.

   i. Plot $x_a(t) = x_{a1}(t) + x_{a2}(t) + x_{a3}(t)$ in another figure.

   ii. Sample $x_a(t)$ with the following sampling frequency and plot the discrete-time waveforms (using stem) in another figure (as subplots).
   - (a) $F_s = 50$ samples/second (i.e., $t1 = 0{:}\,1/50{:}\,1$)
   - (b) At the Nyquist rate of $x_a(t)$.
   - (c) 5 times the Nyquist rate

   iii. Perform a linear interpolation (you can use plot command which performs this) on the sampled responses for the different sampling rates. Do you observe any difference between the reconstructed waves for the three different sampling rates? Comment on the same.

   iv. Draw the energy density spectrum for ii(a), ii(b) and ii(c) using FFT. [Plot the square of the absolute value of FFT scaled by N { ((abs(X)).^2)/N} with respect to $F_k = (0{:}\,N-1) * \frac{Fs}{N}$.]

2. Use the program for generating the “sa-re-ga-ma…” notes in Experiment No 0 and try using different sampling rates (example: 1000 Hz, 1600 Hz, 2200 Hz etc.) and write them in to different wav files and listen to see the difference.
3. Load “Track001.wav” and generate different wav files with several values of the sampling rate (for example, half the original sampling rate, $1/3^{rd}$ of the original sampling rate etc.) and see the effect of this different sampling rate on the audio. Remember: you need to do x1=x(1:K:end) to get every K^{th} sample for a 1/K rate. Use wavwrite(x1,Fs/K,’FileName.wav”) to write it.