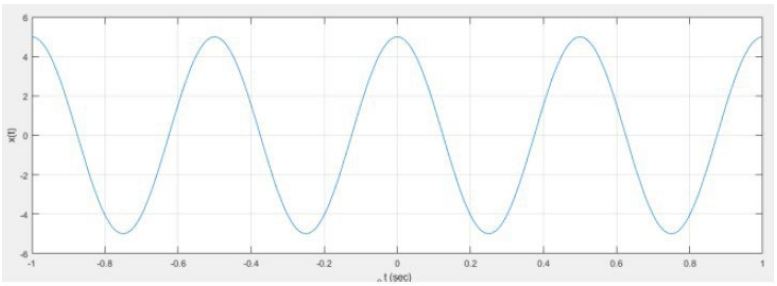
Coverage: Sampling, Aliasing, and DT Line Spectra

Problems

(1) Complete the following with the continuous-time (CT) signal $x(t) = 5\cos(4\pi t)$.

(a) Use MATLAB to plot $x(t)$ over the time range $-1 \le t \le 1$. Include a copy of this plot in line with your work and include the MATLAB code that generates this plot. Reshape the window to obtain a plot that looks like the following aspect ratio.



(b) Draw circles on the plot of $x(t)$ to indicate the sample locations in both directions beginning at $t = 0$ for a sample rate $f_s = 20$ S/s (samples per second).

(c) Write the equation for the discrete-time (DT) signal $x[n]$ obtained by sampling $x(t)$ in the form $x[n] = A\cos(\hat{\omega}_0 n + \varphi)$, where $\hat{\omega}_0$ is expressed as a positive-only value in the range $0 \le \hat{\omega}_0 \le \pi$. *Hint: Remember that the process you use to express $\hat{\omega}_0$ in the proper range may also affect the sign of the phase angle φ.*

(d) State whether the CT signal is oversampled, undersampled, or Nyquist-sampled.

(e) Use MATLAB to plot $x[n]$ as a stem plot, using the `stem` function in the same fashion as the `plot` function over the range $-10 \le n \le 10$; include the MATLAB code that generates this plot.

(f) Repeat (a) through (e) for $f_s = 10$ S/s.

(g) Repeat (a) through (e) for $f_s = 5$ S/s.

(h) Repeat (a) through (e) for $f_s = 4$ S/s.

(i) Repeat (a) through (e) for $f_s = 3\frac{1}{3}$ S/s.

(j) Repeat (a) through (e) for $f_s = 1\frac{2}{3}$ S/s.

(k) One or more pairs of stem plots should look identical (except for a possible time shift). Which pair(s) of sampling rates are these? For each pair, which sampling rate was "guilty" of aliasing to make the two plots look identical?

(2) Repeat problem (1) with the CT signal $x(t) = 5 \cos(4\pi t + \pi/4)$.

(3) P-4.3

(4) P-4.13