

Lab 7 SAMPLING AND ALIASING

1) Consider the sinusoid

$$x(t) = \cos(10\pi t) .$$

Plot the waveform of $x(t)$ for $0 \leq t < 5$, i.e., for 25 cycles, using MATLAB. To achieve this, create the sampled version

$$x[n] = x(nT_s) = \cos(10T_s\pi n)$$

where T_s is the sampling period, and plot $x[n]$ for $0 \leq n < \frac{5}{T_s}$ using the following values of T_s :

- a) $T_s = 0.001$ sec.
- b) $T_s = 0.01$ sec.
- c) $T_s = 0.1$ sec.
- d) $T_s = 0.1923$ sec.
- e) $T_s = 0.2$ sec.

Can you see 25 cycles in (d) and (e)? What is wrong? Explain using what you know about sampling and aliasing.

2) This time we want to plot

$$x(t) = \cos\left(\frac{\pi t^2}{64}\right)$$

for $0 \leq t < 128$, by creating

$$x[n] = \cos\left(\frac{\pi T_s^2 n^2}{64}\right)$$

- a) Before attempting to plot anything, determine whether $x(t)$ is periodic.
 - b) Sketch what $x(t)$ looks like by solving for α_k such that $x(\alpha_k) = 1$ and β_k such that $x(\beta_k) = -1$. As a very crude approximation, connect the alternating $(\alpha_k, 1)$ and $(\beta_k, -1)$ with straight lines. You can accomplish this by interleaving the α_k and β_k sequences and using the “plot” command in MATLAB. What do you observe? Zoom in if necessary. What happens to the distance between consecutive crests of the waveform as time proceeds? What does this imply about the frequency behavior as a function of time?
 - c) Set $T_s = 1$ and plot $x[n]$ for $0 \leq n < \frac{128}{T_s}$. What do you observe? Is $x[n]$ periodic? Is there any discrepancy between $x[n]$ and $x(t)$ in terms of behavior? If there is, explain why it is there.
 - d) Now set $T_s = 0.1$ and repeat (c). Do you (more or less) see the same signal as sketched in part (b)? Is this a universal solution for this signal? That is, what if we were interested in a larger interval, say, $0 \leq t < 1024$? Plot $x[n]$ for $0 \leq n < \frac{1024}{T_s}$ to see. What do you observe around $t = 640$?
 - e) Can we ever set T_s to a proper value which would work in any interval of t ? Why or why not?
- Explain using everything you know about sampling and aliasing.