ECE113, Fall 2022 | **Homework #1**
Digital Signal Processing | Prof. A. Kadambi
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Due Friday, 27 Jan 2023, by 11:59pm to Gradescope.
50 points total.

1. (10 points) Consider the following sequences:

$$x[n] = \{2, \quad 0, \quad -1, \quad 6, \quad -3, \quad 2, \quad 0\}, -3 \leq n \leq 3,$$
$$y[n] = \{8, \quad 2, \quad -7, \quad -3, \quad 0, \quad 1, \quad 1\}, -5 \leq n \leq 1,$$
$$w[n] = \{3, \quad 6, \quad -1, \quad 2, \quad 6, \quad 6, \quad 1\}, -2 \leq n \leq 4.$$

   The sample values of each of the above sequences outside the ranges specified are all zeros. Generate the following sequences:

   (a) $c[n] = x[n+3]$,
   (b) $d[n] = y[n-2]$,
   (c) $e[n] = x[-n]$
   (d) $u[n] = x[n-3] + y[n+3]$
   (e) $v[n] = y[n-3] \cdot w[n+2]$,
   (f) $s[n] = y[n+4] - w[n-3]$, and
   (g) $r[n] = 3.9w[n]$

2. (10 points) Determine the fundamental period of the sinusoidal sequence $\tilde{x}[n] = A\sin(\omega_0 n)$ for the following values the angular frequency ω_0:

   (a) 0.3π,
   (b) 0.48π,
   (c) 0.45π,
   (d) 0.525π,
   (e) 0.7π,
   (f) 0.75π.

3. (10 points) Determine the fundamental period of the following periodic sequences:

   (a) $\tilde{x}_a[n] = e^{j0.25\pi n}$,
   (b) $\tilde{x}_b[n] = \cos(0.6\pi n + 0.3\pi)$
   (c) $\tilde{x}_c[n] = \mathrm{Re}\left(e^{j\pi n/8}\right) + \mathrm{Im}\left(e^{j\pi n/5}\right)$,
   (d) $\tilde{x}_d[n] = 6\sin(0.15\pi n) - \cos(0.12\pi n + 0.1\pi)$
   (e) $\tilde{x}_e[n] = \sin(0.1\pi n + 0.75\pi) - 3\cos(0.8\pi n + 0.2\pi) + \cos(1.3\pi n)$

4. (10 points) Assume $x(n)$ has period N. Are the following sequences periodic? Please provide your reasoning:

   (i) $x(1 - 2n)$

   (ii) $x(n) + (-1)^n x(0)$

5. (10 points) Write a **Python** or **MATLAB** program to plot a continuous-time signal $x(t) = \cos(2\pi f_0 t)$ and its sampled version with the following frequency f_0 and sampling frequency f_s:

   (i) $f_0 = 3$ Hz, $f_s = 10$ Hz

   (ii) $f_0 = 7$ Hz, $f_s = 10$ Hz

   (iii) $f_0 = 13$ Hz, $f_s = 10$ Hz

   Is it possible to perfectly reconstruct the original continuous-time function from the samples? Why? Please provide your code, plots, and answers in your report.