EE 473 HW 0 (Fall 2019)

1) This is a warm-up exercise to get you (re)acquainted with Matlab.
2) Homework is due **September 26, Thursday!** Printed homeworks should be brought to class, or handed to the TA.

1: *Discrete-Time Sinusoids.* (a) Consider the discrete-time signal

$$x_M[n] = \sin\left(\frac{2\pi Mn}{N}\right)$$

where $N = 12$. For $M = 4, 5, 7, 10$, plot $x_M[n]$ over the range $n = 0, 1, \ldots, 2N-1$. What is the fundamental period of each signal?

(b) Now consider

$$x_k[n] = \sin(\omega_k n)$$

where $\omega_k = 2\pi k/5$. Plot $x_k[n]$ for $k = 1, 2, 4, 6$, and $n = 0, 1, 2, \ldots, 8, 9$ in the same figure. How many unique signals have you plotted? If two signals with distinct k are identical, explain how different values of ω_k can produce the same signal.

(c) Determine whether or not the following signals are periodic.

$$y_1[n] = \cos\left(\frac{2\pi n}{6}\right) + 2\cos\left(\frac{3\pi n}{6}\right),$$
$$y_2[n] = 2\cos\left(\frac{2n}{6}\right) + \cos\left(\frac{3n}{6}\right),$$
$$y_3[n] = \cos\left(\frac{2\pi n}{6}\right) + 3\sin\left(\frac{5\pi n}{12}\right).$$

If a signal is periodic, then plot it for two periods starting at $n = 0$. If not, plot the signal for $n = 0, 1, \ldots, 24$, and explain why it is not periodic.

2: *Implementing a First-Order Difference Equation.* Two simple difference equations are the first-order moving average (MA)

$$y[n] = x[n] + bx[n-1],$$

and the first-order autoregression (AR)

$$y[n] = ay[n-1] + x[n]. \tag{1}$$

The first-order MA in (1) can be used to model a bank account where $y[n]$ is the balance and $x[n]$ is the deposit or withdrawal on day n while $a = 1 + r$ is the compounding due to interest rate r.

(a) Write a function `y = diffeqn(a,x,yn1)` which computes the output $y[n]$ of the causal system described by (1). The input vector `x` contains $x[n]$ for $n = 0, 1, 2, \ldots, N-1$ and `yn1` corresponds to the value of $y[-1]$, i.e., the initial condition. The output vector `y` contains $y[n]$ for $n = 0, 1, 2, \ldots, N-1$.

(b) Assume that $a = 1, y[-1] = 0$. Use your function in (a) to computes the response due to $x_1[n] = \delta[n]$ and $x_2[n] = u[n]$, the unit-impulse and unit-step, respectively, for $n = 0, 1, 2, \ldots, 30$. Plot each response.