CE-MATH Machine Exam Problem Set 1
Due: March 12, 2020 09:15 AM

Generate signal using matrix operation

Sinusoids are described by the following equation:

$$y(t) = A\sin(2\pi f_0 t)$$

A is the signal amplitude, f_0 is the fundamental frequency in Hz, t is the time in second. In MATLAB/Octave, this is generated by the following commands (in a script):

```
%%%%%%%%%%%%%%%%%%%%
A = 2;                   % Choose amplitude A depending on the specification
f0 = 10;                 % Frequency is f0  in Hz. This means that there are 10 cycles per second. You
                         % may choose any f0 depending on the specification.

                         % Generate a time interval t. The following commands will generate a time
                         % interval from 0 to 1 with exactly N samples (resolution) in the interval.
N = 10000;               % num of samples in 1 second – it is impossible to have continuous time in a
                         % computer
t = (0:1/N:1-1/N);       % Start with 0, interval is 1/N and ends at 1-1/N (because it starts at 0)

                         % Generate the signal y(t)
y = A*sin(2*pi*f0*t);    % Use the above equation

figure;                  % Create window for the figure
plot(t*N/1000,y);        % Plot the signal y(t). The plot should contain 10 cycles in one second.
                         % The first parameter is the x-axis which is time t in millisecond.
                         % millisecond because I divided it by 1000 for a more neat plot.
                         % y-axis is the dependent variable signal y(t).
xlabel(‘time in ms’);    % complete all the plots with labels
ylabel(‘y(t)’);
```

PROBLEM 1: A square wave signal with amplitude equal to 1 is defined as

$$y(t) = \frac{4}{\pi}\sum_{k=1}^{\infty}\frac{\sin(2\pi(2k-1)f_0 t)}{2k-1}$$

for $k = 1$, the frequency is $(2k\text{-}1)f_0 = f_0$. This is called the fundamental frequency.
for $k = 2$, the frequency is $(2k\text{-}1)f_0 = 3f_0$. This is called the third harmonic.
for $k = 3$, the frequency is $(2k\text{-}1)f_0 = 5f_0$. This is called the fifth harmonic.
And so on... In general, the square wave signal is generated by adding the sinusoids whose frequencies are odd-integer multiple of the fundamental frequency.

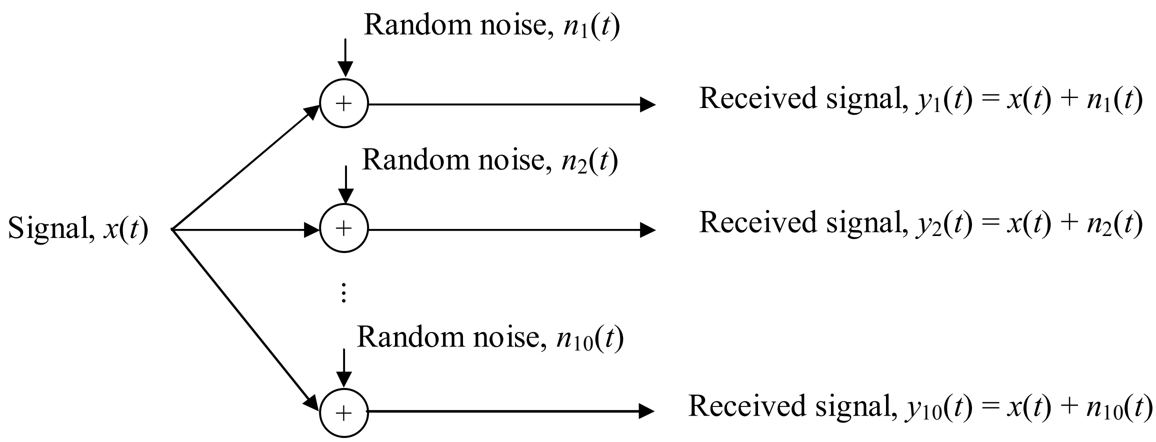
Using matrix addition, generate the square wave for

(a) $k = 1$ to 5

(b) $k = 1$ to 10

Required output: Plots and the generated signals for (a) and (b). Plots should be in jpg format and signals should be in matfile format.

Signal cleaning using matrix operation



One of the persistent problems in signal transmission is noise. It is typically modelled as an additive, white (i.e. present in all frequency bands), Gaussian, random signal. To combat this, one of the approaches is to use multiple receiver antennas, knowing that the average of noise “signal” is 0.

PROBLEM 2: Load the received signals y_1.wav, y_2.wav, ... y_10.wav and use matrix operations to come up with a better quality of signal.

```
%%%%%%%%%%%%%%%%%%%%%%%%

(y1,fs) = audioread(‘y_1.wav’);      % load the received signal y_1
(y2,fs) = audioread(‘y_2.wav’);      % load the received signal y_2
(y3,fs) = audioread(‘y_3.wav’);      % load the received signal y_3
(y4,fs) = audioread(‘y_4.wav’);      % load the received signal y_4
(y5,fs) = audioread(‘y_5.wav’);      % load the received signal y_5
(y6,fs) = audioread(‘y_6.wav’);      % load the received signal y_6
(y7,fs) = audioread(‘y_7.wav’);      % load the received signal y_7
(y8,fs) = audioread(‘y_8.wav’);      % load the received signal y_8
(y9,fs) = audioread(‘y_9.wav’);      % load the received signal y_9
(y10,fs) = audioread(‘y_10.wav’);    % load the received signal y_10

y_clean = <write your operation here>;
```

Required output: The code (m-file) and the clean signal y_clean saved as ‘y_clean.wav’.

Place all the required outputs in PROBLEM 1 and PROBLEM 2 in a zip file named <surname_x>.zip where surname is your surname and x is the first letter of your name. Upload the zip file to canvas before the deadline.