EHB 315E Digital Signal Processing
Fall 2020
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MATLAB HOMEWORK 1

Starting Date: 02.01.2021
Due Date: 20.01.2021

1 [20 pts] Generate and plot each of the following sequences over the indicated interval. Label carefully x and y-axes. For complex sequences, plot real and imaginary part of them seperately. Use Matlab functions `impseq`, `stepseq`, `subplot`, `real`, and `imag`. To learn how to create unit impulse sequence and unit step sequence, see the section "Functions to Use" in this document for the functions `impseq` and `stepseq`

(a) $x(n) = 2\delta(n+4) - \delta(n-2) + u(n-3), -6 \leq n \leq 10$

(b) $x(n) = \sum_{k=0}^{\infty} 4\delta(n-3k-1), -6 \leq n \leq 10$

(c) $x(n) = \cos(\pi n)\, u(n-2) + \sin(\pi n/2)\, [u(n) - u(n-5)], -16 \leq n \leq 16$

(d) $x(n) = ne^{-j2\pi/5n}, -6 \leq n \leq 10$

2 [20 pts] Determine analytically the convolution $y(n) = x(n) * h(n)$ of the following sequences, and verify your answers using the `conv_m` function. Choose $-10 \leq n \leq 10$ as an graphics interval (See the section "Functions to Use" in this document for the function `conv_m`)

(a) $x(n) = u(n)$

$h(n) = 2\delta(n) - \delta(n-4)$

(b) $x(n) = 2\delta(n) + 3\delta(n-1) + \delta(n-2)$

$h(n) = \delta(n) + 3\delta(n-1) + 2\delta(n-2)$

3 [20 pts] For each of the linear, shift-invariant systems described by the impulse response, determine the frequency response function $H(e^{j\omega})$. Plot the magnitude response $|H(e^{j\omega})|$ and the phase response $\angle H(e^{j\omega})$ over the interval $-\pi \leq \omega \leq \pi$. Use `abs`, and `angle` for magnitude response and phase response, respectively.

(a) $h(n) = (0.9))^{|n|}$

(b) $h(n) = (0.5))^{|n|} \cos(0.1\pi n)$

4 [20 pts] Using the matrix-vector multiplication approach (e.g. vectorization), write a MATLAB function to compute the DTFT of a finite-duration sequence. The format of the function should be

```
function [X]= dtft(x, n, w)
% Computes Discrete-time Fourier Transform
```

```
% [X] = dtft(x, n, w)
%  X = DTFT values computed at w frequencies
%  x = finite duration sequence over n
%  n = sample position vector
%  w = frequency location vector
```

Use this function to compute the DTFT $X\left(e^{j\omega}\right)$ of the following finite-duration sequences over $-\pi \le \omega \le \pi$. Plot DTFT magnitude and angle graphs in one figure window. Use `abs` and `angle` for magnitude and phase responses. Examine vectorization in Matlab

(a) $x(n) = n(0.9)^n[u(n) - u(n-21)]$

(b) $x(n) = [\cos(0.5\pi n) + j\sin(0.5\pi n)][u(n) - u(n-51)]$. Comment on the magnitude plot.

5 [20 pts] Using Matlab's `freqz` command, determine $H\left(e^{j\omega}\right)$, and plot its magnitude and phase for each of the following systems:

(a) $y(n) = \frac{1}{5}\sum_{m=0}^{4} x(n-m)$

(b) $y(n) = x(n) - x(n-2) + 0.95y(n-1) - 0.9025y(n-2)$

FUNCTIONS TO USE

1. `impseq` Function

```
function [x,n] = impseq(n0,n1,n2)
% Generates x(n) = delta(n-n0); n1 <= n,n0 <= n2
% ----------------------------------------------
% [x,n] = impseq(n0,n1,n2)
%

if ((n0 < n1) || (n0 > n2) || (n1 > n2))
error('arguments must satisfy n1 <= n0 <= n2')
end

n = [n1:n2];
%x = [zeros(1,(n0-n1)), 1, zeros(1,(n2-n0))];
x = [(n-n0) == 0];
```

2. `stepseq` Function

```
function [x,n] = stepseq(n0,n1,n2)
% Generates x(n) = u(n-n0); n1 <= n,n0 <= n2
% ------------------------------------------
% [x,n] = stepseq(n0,n1,n2)
%
if ((n0 < n1) | (n0 > n2) | (n1 > n2))
error('arguments must satisfy n1 <= n0 <= n2')
end

n = [n1:n2];
%x = [zeros(1,(n0-n1)), ones(1,(n2-n0+1))];
x = [(n-n0) >= 0];
```

3. `conv_m` Function

```
function [y,ny] = conv_m(x,nx,h,nh)
% Modified convolution routine for signal processing
% --------------------------------------------------
% [y,ny] = conv_m(x,nx,h,nh)
%  y = convolution result
% ny = support of y
%  x = first signal on support nx
% nx = support of x
%  h = second signal on support nh
% nh = support of h
%
```

```
nyb = nx(1)+nh(1); nye = nx(length(x)) + nh(length(h));
ny = [nyb:nye];
y = conv(x,h);
```