Tune-Up Tuesday for October 16, 2018

In the time domain, the output (response) of a linear time-invariant (LTI) system is the convolution of the input signal and the impulse response of the LTI system.

(a) Define an impulse response *h*[*n*] of an averaging filter of 10 coefficients.

h = (1/10)\*ones(1, 10);

(b) Define *x*[*n*] to be a causal rectangular pulse of 5 samples each with value of 1/5.

x = (1/5)\*ones(1, 5);

(c) Define *y*[*n*] to be the output of the average filter given the input *x*[*n*] in (b):

y = conv(h, x);

(d) Plot *y*[*n*]. What is the shape of *y*[*n*]?

n = 0 : length(y)-1;

figure;

stem(n, y);

% Trapezoid

(e) How many samples are in *y*[*n*]?

length(y) % 14 samples

(f) Let Nh and Nx be the numbers of samples in *h*[*n*] and *x*[*n*], respectively. How does the answer relate to the answer to (e)?

% Nh + Nx – 1

% This can be computed

(g) *Homogeneity*. Scale *x*[*n*] in (b) by -1. How does the filter response change?

yscaled = conv(h, -x);

n = 0 : length(yscaled)-1;

figure;

stem(n, yscaled);

% Filter response is negated

(h) *Time Invariance*. Delay *x*[*n*] in (b) by 3 samples. How does the filter response change?

xshifted = [ 0 0 0 x ];

yshifted = conv(h, xshifted);

n = 0 : length(yshifted)-1;

figure;

stem(n, yshifted);

% Filter response is y[n] delayed by three samples

(i) *All-Zero Input*. Let *x*[*n*] be 0 for 5 samples. What is the response (output) of the filter?

xzeros = zeros(1, 5);

yzeros = conv(h, xzeros);

n = 0 : length(yzeros)-1;

figure;

stem(n, yzeros);

% Filter response is zero for all samples

Please submit your MATLAB code for parts (a)-(d) and (g)-(i) and your answers to the questions in (e)-(i) as comments in your MATLAB code. See next page for the code.

% Tune-Up Tuesday #6, Oct. 16, 2018

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%

% Parts (a) - (d)

h = (1/10)\*ones(1, 10);

x = (1/5)\*ones(1, 5);

y = conv(h, x);

n = 0 : length(y) - 1;

figure;

stem(n, y); % looks like a trapezoid

% (e)

length(y) % 14

% (f) Nh + Nx - 1

% (g)

yscaled = conv(h, -x);

n = 0 : length(yscaled)-1;

figure;

stem(n, yscaled);

% Filter response is negated

% (h)

xshifted = [ 0 0 0 x ];

yshifted = conv(h, xshifted);

n = 0 : length(yshifted)-1;

figure;

stem(n, yshifted);

% Filter response is y[n] delayed by three

% (i) All zero input

xzeros = zeros(1, 5);

yzeros = conv(h, xzeros);

n = 0 : length(yzeros) - 1;

figure;

stem(n, yzeros);

% Filter response is zero for all samples