Report

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Question 1:

`(b)`

Here the input ‘x[n]’ is taken from n=-200 to n=200 as it covers all the different subparts of this question

`(c)`

As b is changed, firstly the input waveform (stem plot) changes, and also on increasing b, the graph converges for greater values of n.

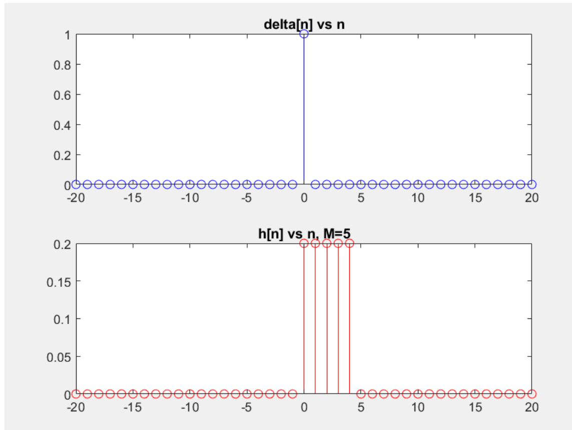
The DTFT changes as follows, the peaks on the graph of DTFT become more steeper / more spiky.

Question 2:

$$y[n] = \frac{1}{M} \sum_{m=0}^{M-1} x[n-m]$$

`(a)`

When we take $x[n] = \delta[n]$ we shall observe that the impulse response $h[n]$ looks like:



`(e)`

As the value of M is increased we observe that the filter reduces the amount of noise that is present in the signal as the moving average considers a more wider range of values to produce an output.

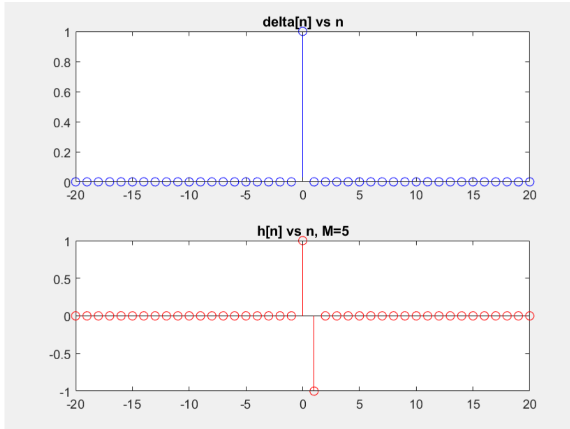
We can observe that as the value of M is increased from 5 to 21 to 51, the curve gets more smoothed out due to the filter range being increased.

One trade off that can be observed from the plots is that on increasing the value of M, the curve smoothens out closer to the original wave but it seems that the waveform is shifted by some margin.

`(g)`

$$y[n] = x[n] - x[n-1]$$

When we take $x[n] = \delta[n]$ we shall observe that the output, impulse response $h[n]$ looks like:



`(h)`

In terms of frequency selectivity in part (f) we can say that (by observing the DTFT's) that on increasing the value of M, the filters become more selective in terms of the frequencies observed in the output. As the peaks get sharper on the filter with greater value of M.

Also, about the differenetiator, this filter does not really act beneficial to the system as it distorts the signal more from the ideal signal than restore/rectify it. In terms of the frequency selectivity, it allows a large set of frequencies to be observed in the output.

Question 3:

$$x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{jw})e^{jwn}dw$$

`(a)`

when we define $X(e^{jw})$ from $-w_c \; to \; w_c$

$$x[n] = \frac{1}{2\pi}\int_{-w_c}^{w_c} e^{jwn}dw$$

$$x[n] = \frac{1}{2\pi}[\frac{e^{jwn}}{jn}]_{-w_c}^{w_c} \quad \rightarrow \quad x[n] = [\frac{1}{2\pi jn}e^{jwn}]_{-w_c}^{w_c}$$

$$x[n] = [\frac{-j}{2\pi n}(cos(wn) + j\ sin(wn))]_{-w_c}^{w_c}$$

$$x[n] = \frac{1}{2\pi n}(-j\ cos(w_c n) + sin(w_c n)) - \frac{1}{2\pi n}(-j\ cos(-w_c n) + sin(-w_c n))$$

$$x[n] = \frac{1}{2\pi n}(2sin(w_c n))\ =\ \frac{sin(w_c n)}{\pi n}$$

We can see that, by this, only real part of function will exist. The complex part of function will reduce down to zero.

In one plot we can see that we are getting some values in the complex plot however they are very less (in order of 10^{-74}) and hence can be considered equal to zero

So, it is expected that the output (x[n]) will be real valued only.

Also, when $w_c = \pi$, $sin(w_c n)$ will give value 0 for all values of n except n=0. So we just get a value at n=0, which is:

$$x[0] = \lim_{n \to \infty} \frac{sin(\pi n)}{\pi n} = \frac{1}{\pi} \lim_{n \to \infty} \frac{sin(\pi n)}{n} = \frac{1}{\pi} * \pi = 1$$
