Lab-5

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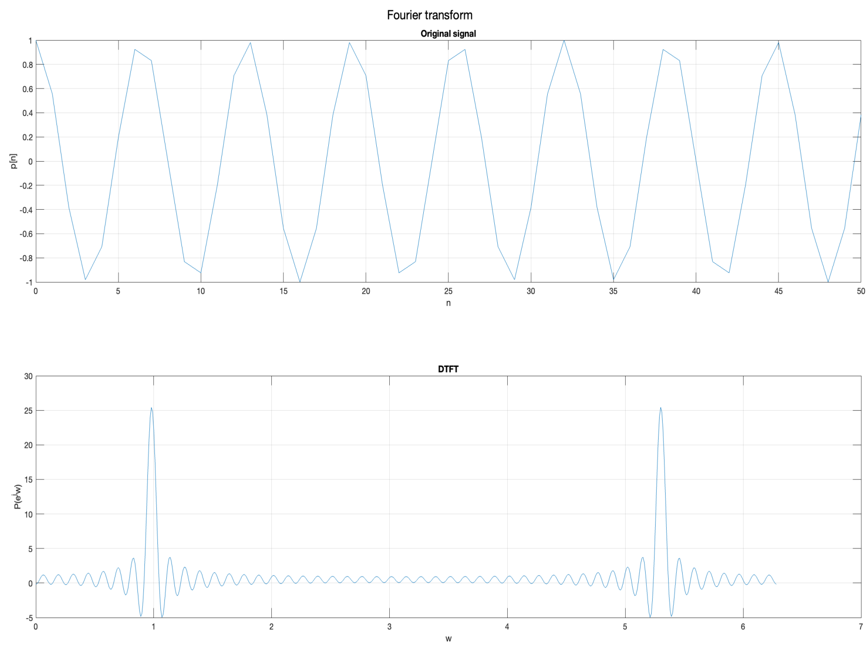
Question 1:

(a) DTFT of p[n]



Calculation:

Given, p[n]= cos($2\pi f_0 n/f_s$)

$$=\frac{e^{\frac{j*2\pi f0n}{fs}} + e^{-\frac{j*2\pi f0n}{fs}}}{2}$$

$$P(e^{jw})=\sum_{n=-\propto}^{n=\propto} p[n]\, e^{-jwn}$$

On solving, we get

$$\mathbf{P(e^{jw})=\frac{1}{2}* [2\pi b(2\pi\frac{f0}{fs} - w) + 2\pi b(2\pi\frac{f0}{fs} + w)]}$$

(b).

The location of impulses follow x1= -x2

(c).

x[n]= p[n] . w[n]

Using **multiplication property** where multiplication in time domain is equivalent to convolution in frequency domain

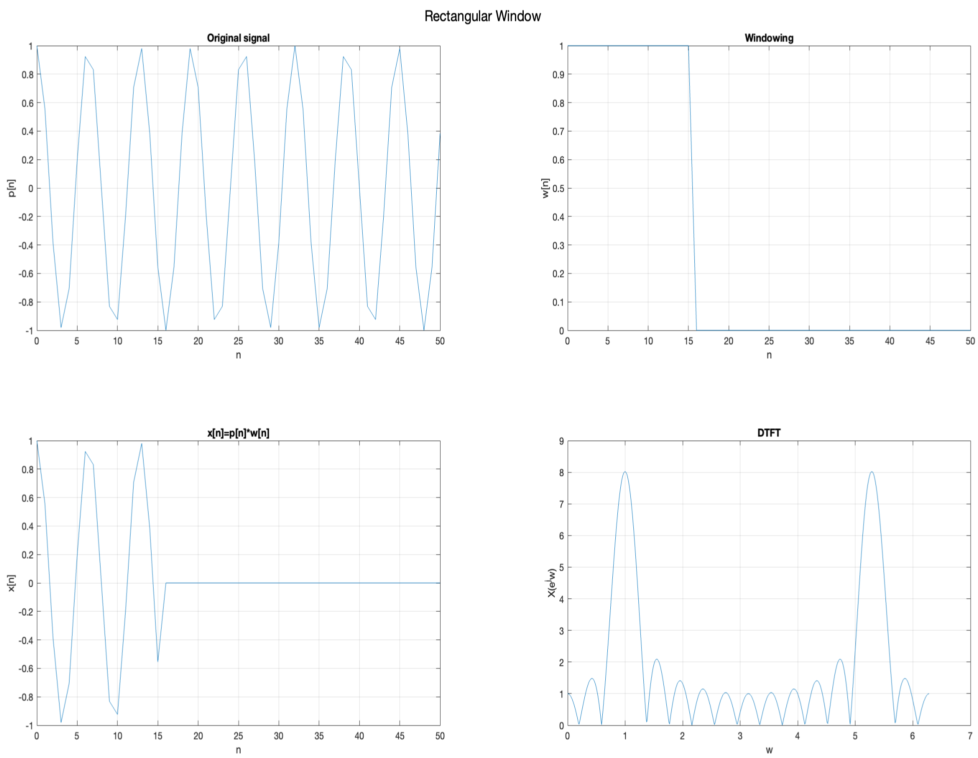
$$\mathbf{X(e^{jw}) = P(e^{jw}) * W(e^{jw})}$$

Now, W(e^{jw})= $\sum_{n=0}^{n=L-1} e^{-jwn}$

On plugging the values,

X(e^{jw})= P(e^{jw}) * $\sum_{n=0}^{n=L-1} e^{-jwn}$ where 0<w<2π

- Magnitude spectrum become less denser
- Significant peak decreases.



(d).

- **No**, our plot is **not consistent** with part c as there is discontinuity in signal
- This is due to **spectral leakage**
- Spectral leakage occurs when measured signal is **not periodic** in sampled interval.

(e). On increasing the value of L:

- Peaks become **sharper.**
- Magnitude spectrum becomes **denser**.
- **Frequency** resolution **decreases**.

(g).

- We observe that main lobe width almost gets **twice** to that of rectangular window.
- There is **decrease in spectral leakage** in case of Hanning window.

(i). The three **strongest** frequencies present in the audio signal:

- ± 18600
- ± 19160
- ± 16360

Question 2:

(b). The expected length for **linear convolution** of two signals **$x_1[n]$ -> N_1** and **$x_2[n]$ -> N_2** is **$N_1 + N_2 - 1$** while for **circular convolution** it is **$\max(N_1, N_2)$**

(d). From the plot, we observe that direct and DFT based method give **same result** for linear as well as circular convolution.

Question 3:

- Yes, we can identify the low and high frequencies
- We observe that the **maximum frequency** is at the **maxima of magnitude spectrum** and similarly, **minimum frequency** is at the **minima of magnitude spectrum.**

(a).
For N=4
Maximum frequency : 0 Hz
Minimum frequency : 1 Hz

For N=16
Maximum frequency : 0 Hz
Minimum frequency : 4 Hz

For N=64

Maximum frequency : 0 Hz

Minimum frequency : 16 Hz

(b).

For N=20

Maximum frequency : 4 Hz,18 Hz

Minimum frequency : 0-19 Hz except 3 Hz,17 Hz

(c).

For N=20

Maximum frequency : 4 Hz,18 Hz

Minimum frequency : 0-19 Hz except 4 Hz,18 Hz

(d).

For N=20

Maximum frequency : 3 Hz,17 Hz

Minimum frequency : 0-19 Hz except 3 Hz,17 Hz

(e).

For N=20

Maximum frequency : 0 Hz

Minimum frequency : 10 Hz

(f).

For N=20

Maximum frequency : 10 Hz

Minimum frequency : 0 Hz , 19 Hz