EE301A : Digital Signal Processing

Computer Assignment I

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Ans 1.(a) Observe that the final output is given by :

$$d_n = (b_n + jc_n)e^{-j\Theta_n}$$
$$\implies d_n = b_n e^{-j\Theta_n} + c_n e^{j(\frac{\pi}{2}-\Theta_n)}$$

Equating the real and imaginary parts of both sides and using the relation $d_n = a_n$ we get:

$$0 = -b_n \sin(\Theta_n) + c_n \cos(\Theta_n) \tag{1}$$
$$a_n = b_n \cos(\Theta_n) + c_n \sin(\Theta_n) \tag{2}$$

Multiplying with $\cos(\Theta_n)$ in (1) and $\sin(\Theta_n)$ in (2) and adding we get:

$$c_n = a_n \sin(\Theta_n) \tag{3}$$

Again multiplying with $\sin(\Theta_n)$ in (1) and with $\cos(\Theta_n)$ in (2) ,and subtracting (1) from (2) we get:

$$b_n = a_n \cos(\Theta_n) \tag{4}$$

But it is given that $b_n = a_n \cos(\frac{n\pi}{2})$. Thus from (4) we get

$$\boxed{\Theta_n = \frac{n\pi}{2}}$$

Given $a_n = p((n - n_o)T_s)$, we observe that a_n is symmetric about n =50 where $n \in \{1, 2, .., 100\}$.
From (2) , both sides should be symmetric about n=50.
Since b_n and $\cos(\Theta_n)$ is already symmetric about n =50 , we have $b_n \cos(\Theta_n)$ symmetric about n=50. Thus $c_n \sin(\Theta_n)$ should also be symmetric about n=50.

We have $c_n = \hat{b_{n+n_1}}$ which is just a n_1 point left shifted version of $\hat{b_n}$.
$\hat{b_n} = b_n \star h_n$.
From the plot of c_n(unshifted), we observe that it is symmetric about n=150 where $n \in \{1, 2, .., 300\}$.
$c_n \sin(\frac{n\pi}{2})$ is also symmetric about n=150.
Since in order to make $d_n = a_n$, we must have $c_n \sin(\Theta_n)$ symmetric about n=50, we need to left the shift c_n by n=100 so that finally it is symmetric about n=50. Thus , n_1 should be 100.

$$\boxed{n_1 = 100}$$

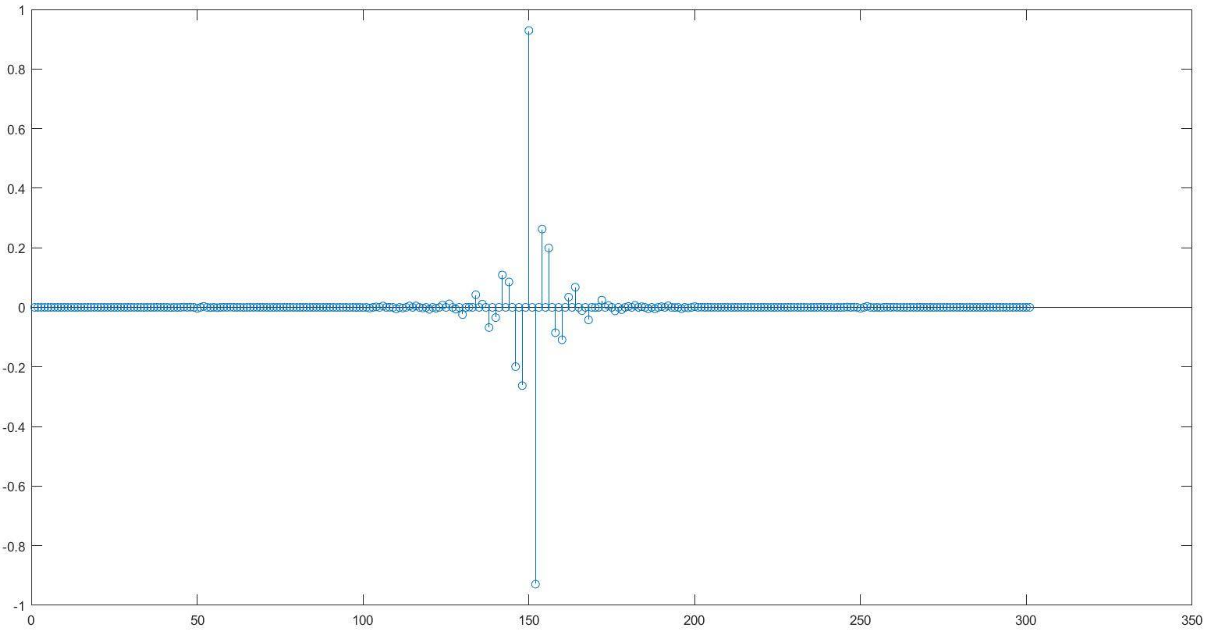

Figure 1: Plot of c_n unshifted : symmetric about n=150

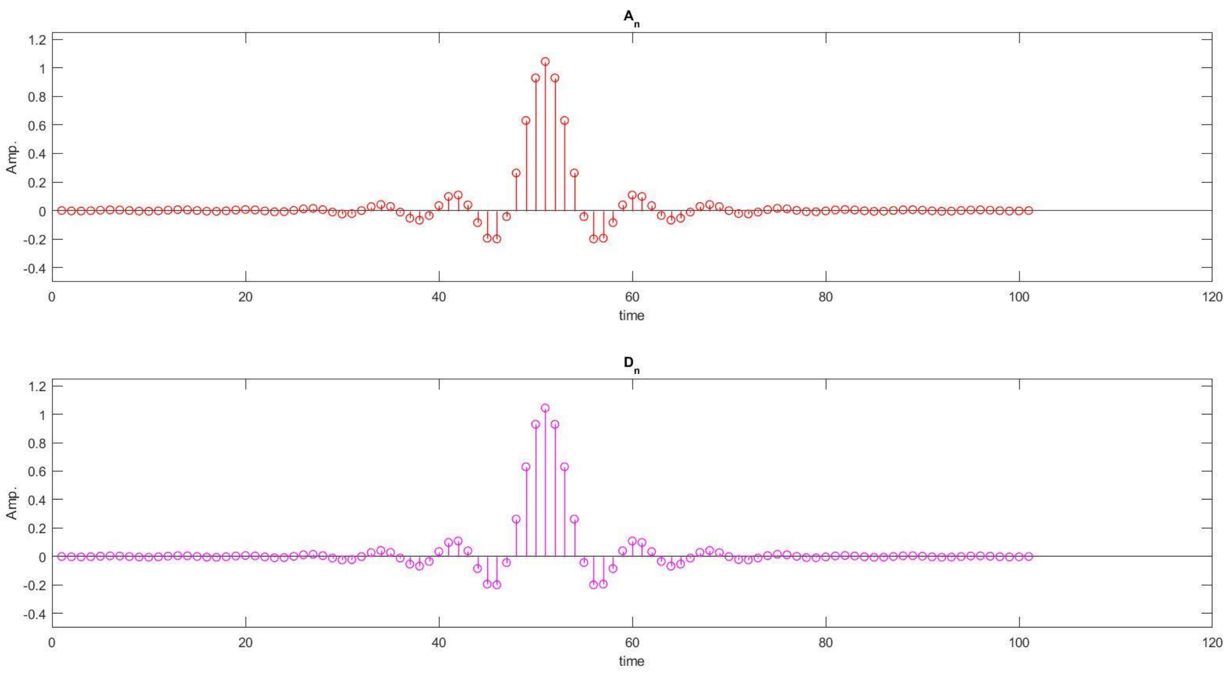

Figure 2: (b).Plot of A_n and D_n vs time in linear scale

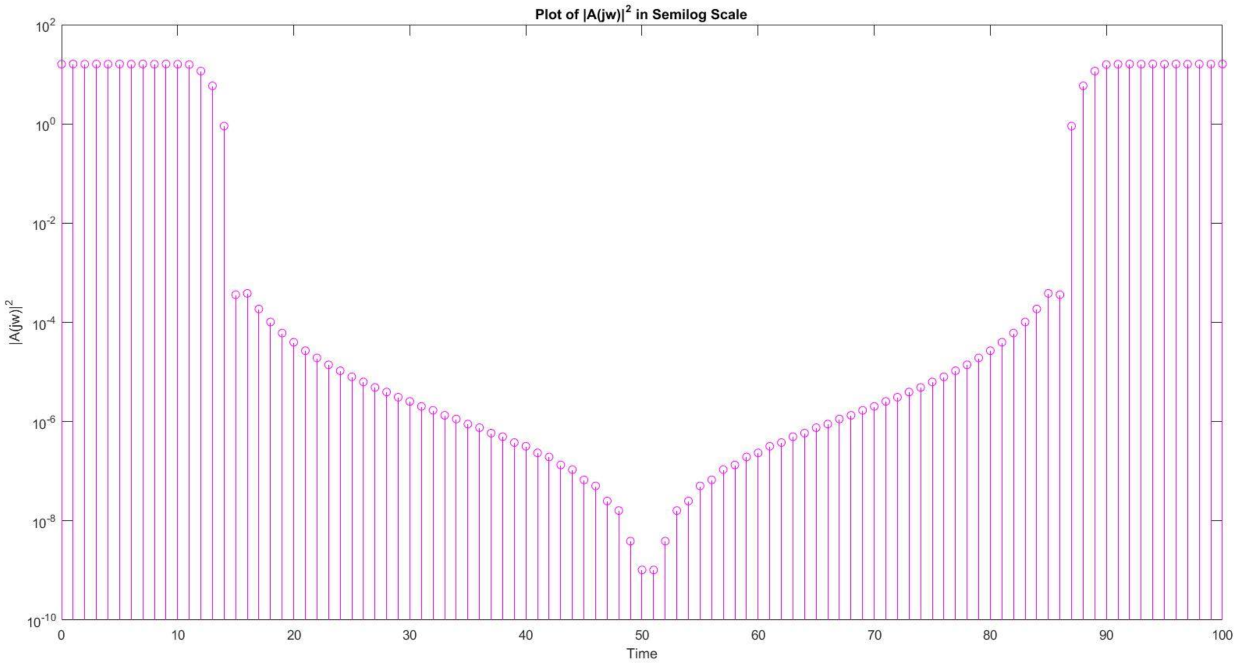

Figure 3: (c).101-point DFT of $|A(w)|^2$ in semilog scale

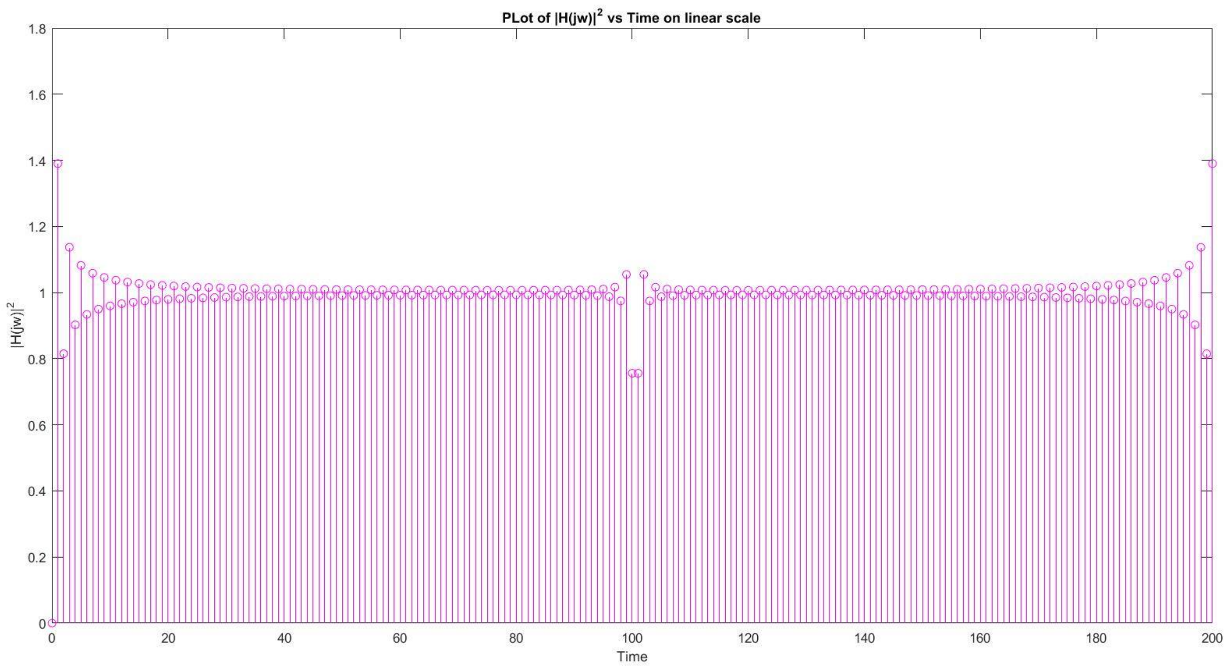

Figure 4: (d).201-point DFT of $|H(w)|^2$ in linear scale