1) $W_K = e^{j\omega_K n}$; $\omega_K = 2\pi \frac{K}{N}$

$W_K[n] = e^{j \cdot \frac{2\pi}{N} Kn}$

let $W = e^{j\frac{2\pi}{N}}$

$\therefore \ W_K[n] = W_n^{nK}$

$W^{(0)} = [1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1]$

$W^{(1)} = [1 \ W^1 \ W^2 \ W^3 \ W^4 \ W^5 \ W^6 \ W^7 \ W^8 \ W^9]$

$W^{(5)} = [1 \ W^5 \ 1 \ W^5 \ 1 \ W^5 \ 1 \ W^5 \ 1 \ W^5]$

$W^{(9)} = [1 \ W^9 \ W^8 \ W^7 \ W^6 \ W^5 \ W^4 \ W^3 \ W^2 \ W]$

plots are in (Question 1) folder

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2) A) white noise : It's a random signal, have equal intensity at different freqnencies, giving constant power.

1- tv when it has no screen. صوت الوِش الى فى التلفاز

2- radio, when you move from channal to another one

B) yes, if you gave randn ; sigma = power of the wgn

C, D) plots are in (Question 2) folder

3) $\because$ $w^k = [1 \quad w^k \quad w^{2k} \quad \cdots \quad w^{(N-1)k}]$,

$\because$ W is complex exponential $= e^{\frac{2\pi j}{N}}$

$\therefore$ $\langle w^m, w^n \rangle = \sum_{i=0}^{N-1} w_i^m \bar{w}_i^n$

$$= \sum_{i=0}^{N-1} W^{(m-n)i} = \begin{cases} N & n = m \\ \dfrac{1 - W^{(m-n)N}}{1 - W^{(m-n)}} & n \neq m \end{cases}$$

$\because$ $W^{(m-n)N} = e^{\frac{2\pi j}{N} \cdot N} = 1$

$\therefore$ $\dfrac{1 - W^{(m-n)N}}{1 - W^{(m-n)}} = \dfrac{1-1}{1-W^{(m-n)}} = 0$

$\therefore$ $\langle w^m, w^n \rangle = N\,\delta[n-m]$

$\because$ $\langle w^m, w^n \rangle = N\,\delta[n-m]$;

$\because$ $\| w^{(k)} \|^2 = \langle w^{(k)}, w^{(k)} \rangle$

$\therefore$ $\| w^{(k)} \|^2 = N\,\delta[k-k]$

$= N$

4) Plots are in question 4 folder