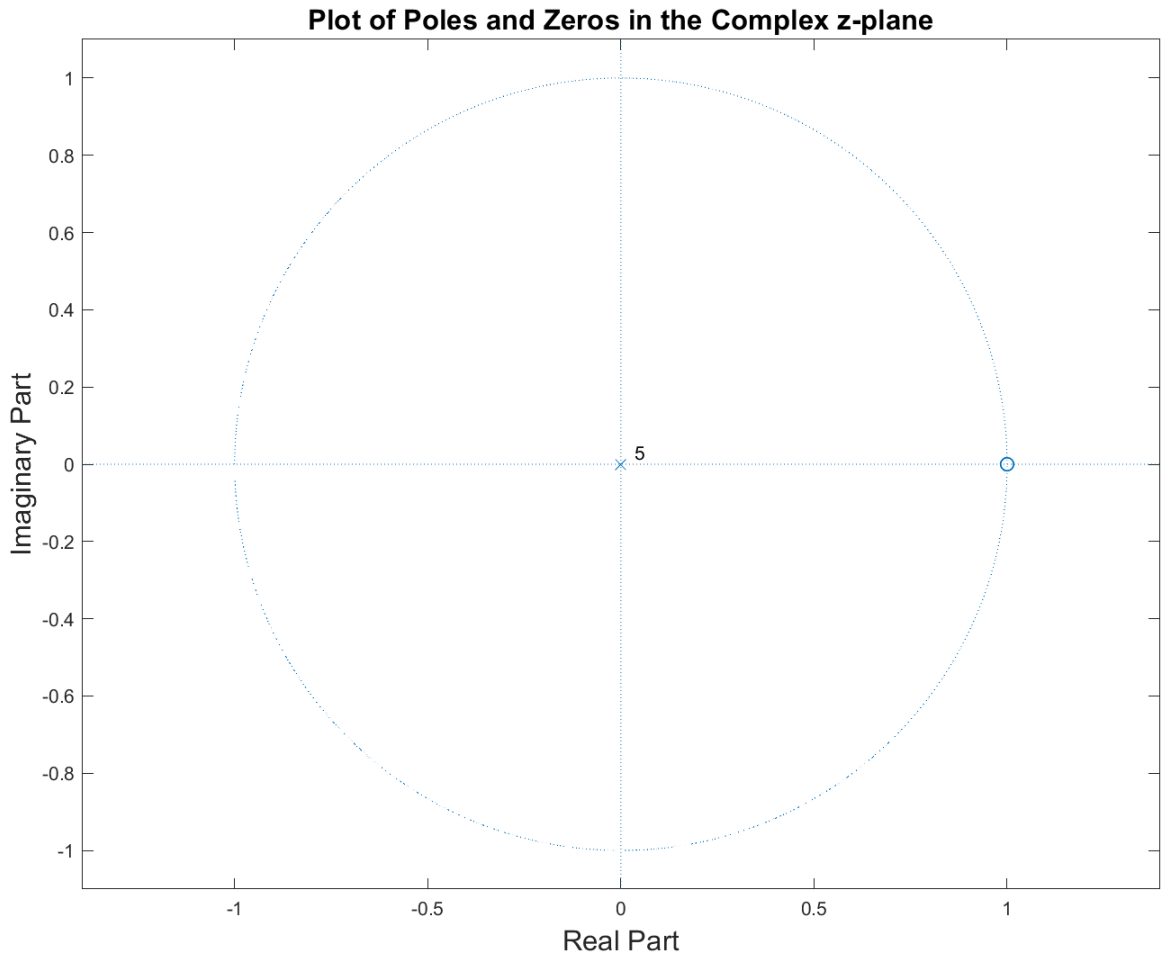
Problem 9.9

Given, $H(z)$ is the cascade of five first-difference filters.

(a) Then, the system function $H(z)$ of the overall system is: $H(z) = (1 - z^{-1})^5$

(b) Plot of poles and zeros in z-plane:



(c) Frequency response of the system : $H(e^{j\hat{\omega}}) = (1 - e^{-j\hat{\omega}})^5$

(d) $H(z) = (1 - z^{-1})^5$. This can be expanded using the binomial expansion formula: $(x + y)^n = \sum_{k=0}^{n} \binom{n}{k} x^k y^{n-k}$,

where $x = 1, y = -z^{-1}, n = 5$.

After expansion,

$H(z) = (1 - z^{-1})^5 = 1 - 5z^{-1} + 10z^{-2} - 10\delta[n-3] + 5z^{-4} - z^{-5}$

Thus, $h[n] = \delta[n] - 5\delta[n-1] + 10\delta[n-2] - 10\delta[n-3] + 5\delta[n-4] - \delta[n-5]$.