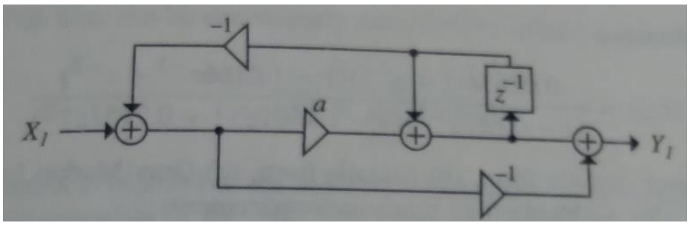
Signal Processing **Assignment- 7** Monsoon 2023

1. Given a *lowpass* FIR filter H(z) determine what happens if
    a. z is replaced by -z
    b. z is replaced by z^{-1}
    c. z is replaced by z^2

2. An FIR filter is described by the difference equation below.
   $y[n] = \sum_{k=0}^{10} (\frac{1}{2})^{|5-k|}\, x[n-k]$
   a. Draw the block diagram for a *direct* implementation of this filter.
   b. Draw the block diagram for a *linear phase* implementation of this filter.
   c. Derive H(Ω) for part b and prove that the implementation is linear phase.

3. An FIR filter is antisymmetric, i.e. $h[n]$ – $h[M\text{-}1\text{-}n]$, $0 \le n \le M\text{-}1$, where M is <u>even</u>.
   a. Show that the amplitude response of this filter is given as
      $H(\Omega) = \sum_{n=1}^{M/2} d[n] \sin\,[\,(n - \frac{1}{2})\Omega]$ where d[n] is related to h[n].
   b. Find $H\left(e^{j\frac{\pi}{2}}\right)$ and $H(0)$. Give an application for this filter.

4. A digital filter is shown below.



   a. Derive the filter transfer function H(z). Plot the poles and zeros, assuming a = 0.5
   b. What kind of filter is this?

5. The ideal magnitude response of a lowpass filter is given below.

$$\left|H\left(e^{j\Omega}\right)\right| = 2 \quad 0 \le \Omega < \frac{\pi}{6}$$
$$= 1 \quad \frac{\pi}{6} \le \Omega < \frac{\pi}{3}$$

   a. Find the impulse response of this filter.
   b. Design a practical filter of order M = 10 using a Hann window. Plot the magnitude response and compare against the ideal response.