



ISRA UNIVERSITY

Islamabad Campus

Department of Electrical Engineering

Program: B.E. (Electrical)

Semester – Spring 2016

EL-322 Digital Signal Processing

Assignment – 3 **Solution**

Marks: 20

Due Date: 24/05/2016

Handout Date: 18/05/2016

Question # 1:

A linear shift invariant system has a unit sample response given by:

$$h(0) = -0.01$$

$$h(1) = 0.02$$

$$h(2) = -0.10$$

$$h(3) = 0.40$$

$$h(4) = -0.10$$

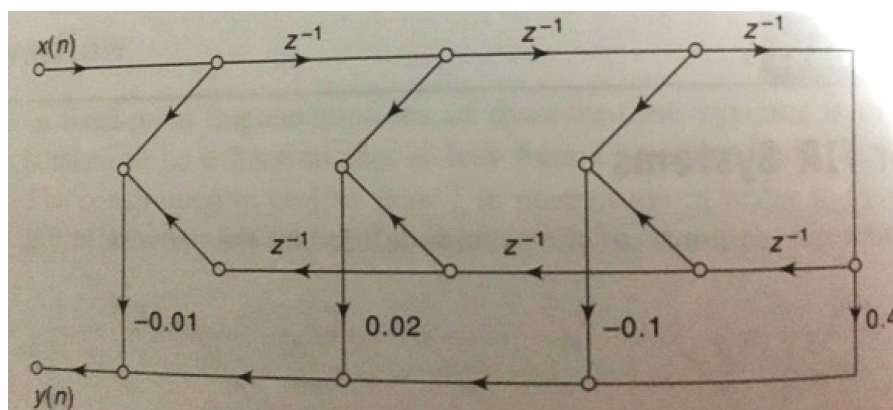
$$h(5) = 0.21$$

$$h(6) = -0.01$$

Draw a signal flow graph for this system that requires the minimum number of multiplications.

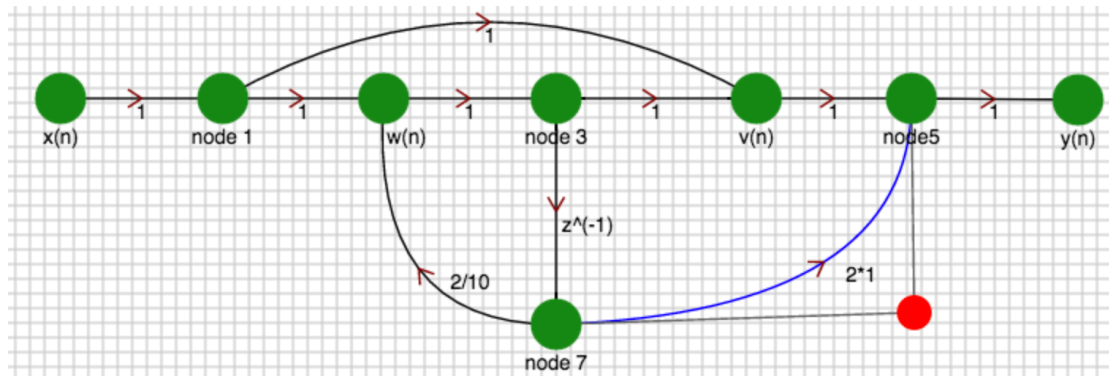
Solution:

This system is a linear phase filter; it may be implemented with a network that has only four multiplies and six delays as shown bellow:



Question # 2:

Consider the filter structure shown below and find the system function and the unit sample response of this system:



Solution:

We have the following node equations:

$$\begin{aligned} w(n) &= x(n) + 0.2w(n - 1) \\ v(n) &= x(n) + w(n) \\ y(n) &= v(n) + 2w(n - 1) \end{aligned}$$

Using z-transforms, the first equation becomes:

$$W(z) = \frac{1}{1 - 0.2z^{-1}} X(z)$$

Taking the z-transform of the second equation and substituting the expression above for W(z) we have:

$$V(z) = X(z) + W(z) = X(z) + \frac{1}{1 - 0.2z^{-1}} X(z) = \frac{2 - 0.2z^{-1}}{1 - 0.2z^{-1}} X(z)$$

Finally taking the z-transform of the last equation we get:

$$\begin{aligned} Y(z) &= V(z) + 2z^{-1}W(z) = \left[\frac{2 - 0.2z^{-1}}{1 - 0.2z^{-1}} + 2z^{-1} \frac{1}{1 - 0.2z^{-1}} \right] X(z) \\ &= \frac{2 + 1.8z^{-1}}{1 - 0.2z^{-1}} X(z) \end{aligned}$$

Therefore the system function is:

$$H(z) = \frac{2 + 1.8z^{-1}}{1 - 0.2z^{-1}}$$

The unit sample response is:

$$h(n) = 2(0.2)^n u(n) + 1.8(0.2)^{n-1} u(n - 1)$$

Good Luck