LAB-3

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3.1 Moving average system:

(c).

For this sequence, we observe that there is increase in for all the values of N. This means that the signal is showing an upward trend.

(d). We observe that for N close to 50, we get smooth curve.
We want to find a value of N such that we can find a trend for the given signal.
If we get our moving average to be below the values of signal, then we determine the trend.

3.1.1. Implementing system using impulse response

If we find the impulse response of the system, our value of N gets fixed, otherwise we can change the value of N.

3.2.b Upsampling

We observe that time axis has been scaled by a factor of M. Again, there are some zeroes introduced between the transitions
This phenomenon is mostly used in image processing while zooming the image.

3.2 Amplitude Modulation (AM) system

(b).

$$cos(A) = \frac{e^{jA} + e^{-jA}}{2} \; and \; sin(A) = \frac{e^{jA} - e^{-jA}}{2j}$$

Let ω_m=ω_c= ω

$$x[n] = A_m sin(\omega n)$$

$$X(Z) = \sum_{0}^{\infty} A_m sin(\omega n)\, Z^{-n}$$

$$X(Z) = A_m \sum_{0}^{\infty} \frac{e^{j\omega n} - e^{-j\omega n}}{2j}\, Z^{-n}$$

$$X(Z) = \frac{A_m}{2j} \sum_{0}^{\infty} \left(e^{j\omega} z^{-1}\right)^n - \frac{A_m}{2j} \sum_{0}^{\infty} \left(e^{-j\omega} z^{-1}\right)^n$$

$$X(Z) = \frac{A_m}{2j} \left[\frac{1}{1 - e^{j\omega} z^{-1}} - \frac{1}{1 - e^{-j\omega} z^{-1}}\right]$$

$$X(Z) = \frac{A_m}{2j} \left[\frac{z\left(e^{j\omega} - e^{-j\omega}\right)}{z^2 - z(e^{j\omega} + e^{-j\omega}) + 1}\right]$$

$$X(Z) = \frac{zsin(\omega)}{z^2 - 2zcos\omega + 1}, \qquad ROC: |z| > 1$$

$$y[n] = A_m cos(\omega_c t) \times sin(\omega_m t)$$

$$y[n] = \frac{A_m}{2} [sin(\omega_c + \omega_m)n - sin(\omega_c - \omega_m)]$$

$$y[n] = \frac{A_m}{2} [sin(2\omega)n]$$

$$Y(Z) = \sum_{-\infty}^{\infty} y[n] z^{-n}$$

$$Y(Z) = \frac{A_m}{2} * \frac{zsin(2\omega)}{z^2 - 2zcos2\omega + 1}$$

$$H(Z) = \frac{Y(Z)}{X(Z)} = \frac{cos\omega * (z^2 - 2zcos\omega + 1)}{z^2 - 2zcos2\omega + 1}$$

(c). Pole zero plot

It has been plotted in the result.

d). ROC:

From the pole-zero plot,

|z|>1

3.3 (a) Effect of r and θ on $H(Z)$

- On changing r, it does affect the zeroes of the system but affects the poles of the system and it gets scaled according to r.
- On changing θ, it rotates the poles and zeroes of the system in clockwise or anticlockwise direction as per θ.

(b). Finding the impulse response

h[n] = 1 for n<=0;

$$= \frac{(r-1)(a^2-r)\left(\frac{r}{a}\right)^n + (a^2-r-1)(ar)^n}{(a^2-1)r^2}$$ otherwise

where $z=re^{i\theta}$