

# Discrete-Time Signals and Systems

Lecture 25

Which kind of filter is this system ?

$$y[n] = x[n] - x[n-1]$$

1) Low pass filter

2) High pass filter

3) All pass filter

4) Band pass filter

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Which kind of filter is this ?

$$y[n] = x[n] - x[n - 1]$$

$$h[n] = \delta[n] - \delta[n - 1]$$

$$H(e^{j\Omega}) = \sum_{k=-\infty}^{\infty} (\delta[k] - \delta[k - 1])e^{-j\Omega k}$$

Which kind of filter is this ?

$$H(e^{j\Omega}) = \sum_{k=-\infty}^{\infty} (\delta[k] - \delta[k-1])e^{-j\Omega k}$$

$$H(e^{j\Omega}) = 1 - e^{-j\Omega}$$

$$H(e^{j\Omega}) = e^{-j\Omega/2} (e^{j\Omega/2} - e^{-j\Omega/2})$$

$$H(e^{j\Omega}) = 2je^{-j\Omega/2} \sin(\Omega/2)$$

$$|H(e^{j\Omega})| = 2|\sin(\Omega/2)|$$

Which kind of filter is this system ?

$$y[n] = \frac{1}{2} (x[n] + x[n-1])$$

1) Low pass filter

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Which kind of filter is this ?

$$H(e^{j\Omega}) = \frac{1}{2} \sum_{k=-\infty}^{\infty} (\delta[k] + \delta[k-1])e^{-j\Omega k}$$

$$H(e^{j\Omega}) = \frac{1}{2} (1 + e^{-j\Omega})$$

$$H(e^{j\Omega}) = e^{-j\Omega/2} \cos(\Omega/2)$$

Which kind of filter is this system ?

$$y[n] - ay[n-1] = x[n]$$

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Which kind of filter is this ?

$$y[n] - ay[n-1] = x[n]$$

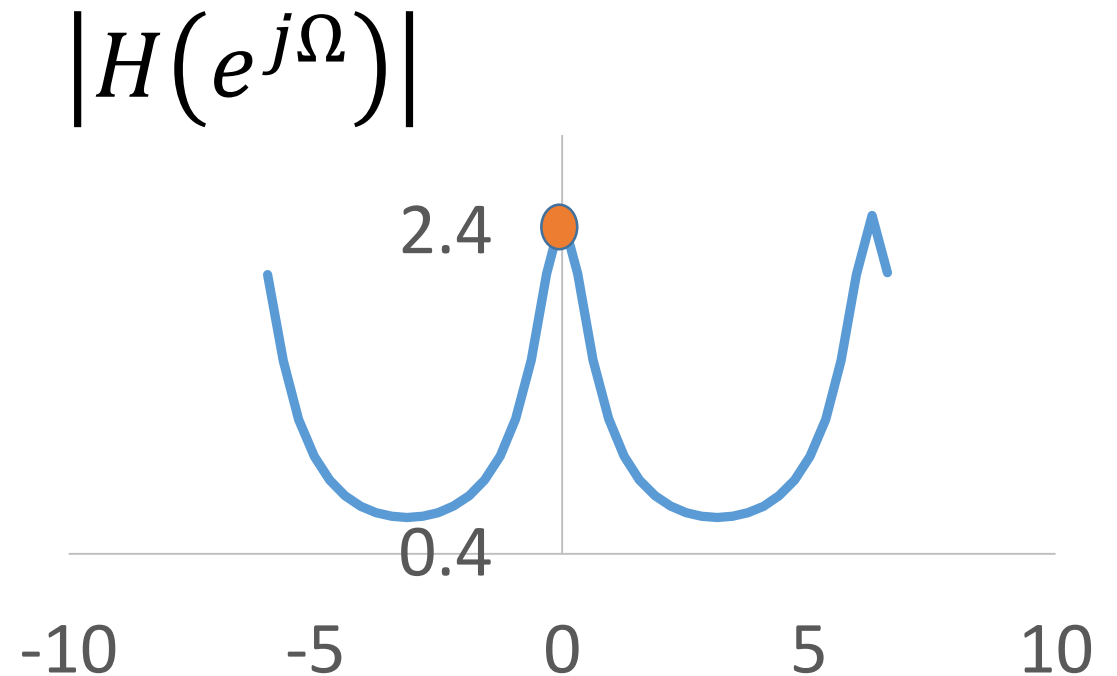
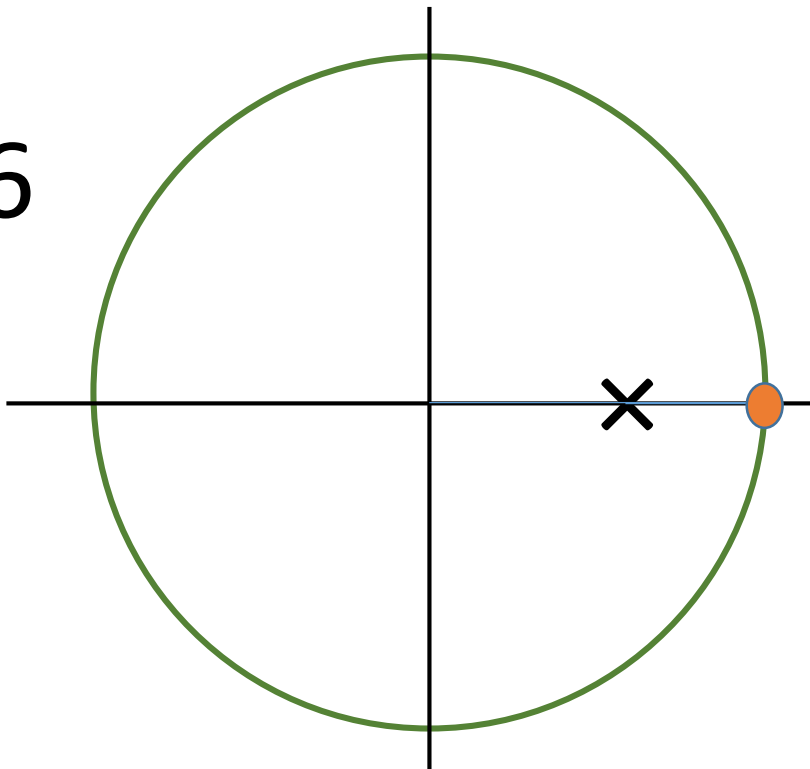
$$H(e^{j\Omega})e^{j\Omega n} - aH(e^{j\Omega})e^{j\Omega(n-1)} = e^{j\Omega n}$$

$$H(e^{j\Omega}) = \frac{1}{1 - ae^{-j\Omega}} = \frac{e^{j\Omega}}{e^{j\Omega} - a}$$

Which kind of filter is this ?

$$H(e^{j\Omega}) = \frac{e^{j\Omega}}{e^{j\Omega} - a} \quad |H(e^{j\Omega})| = \frac{\text{Mag}(\text{Num})}{\text{Mag}(\text{Denom})}$$

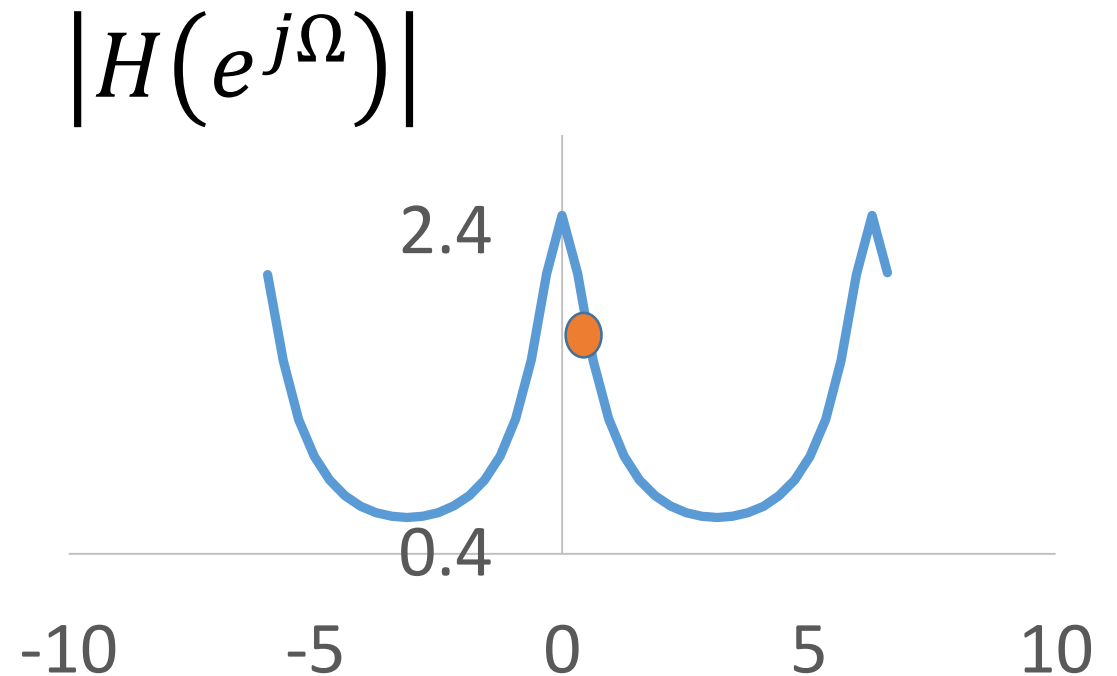
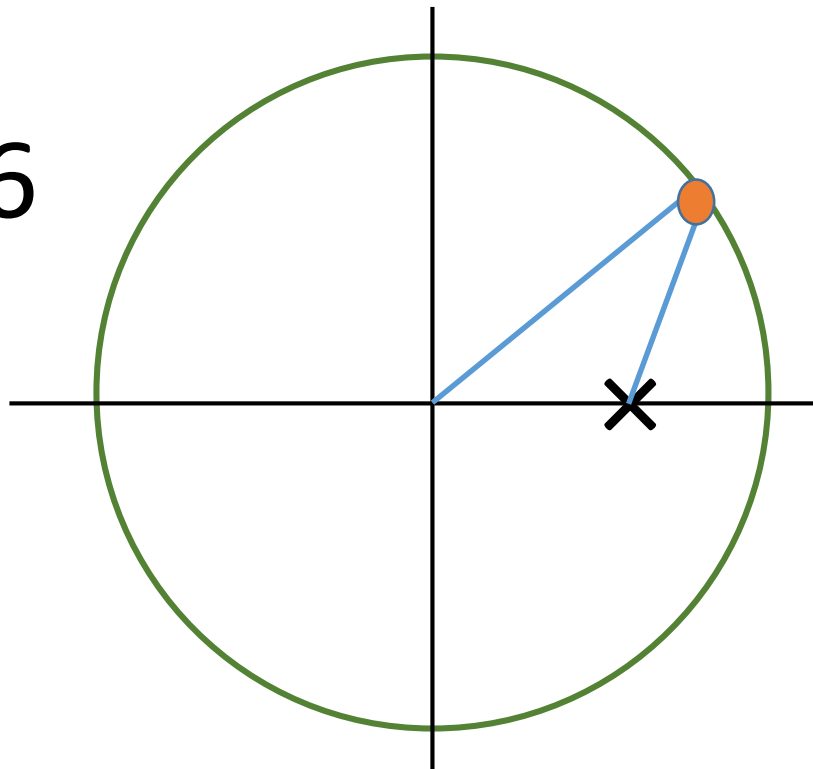
$a = 0.6$



Which kind of filter is this ?

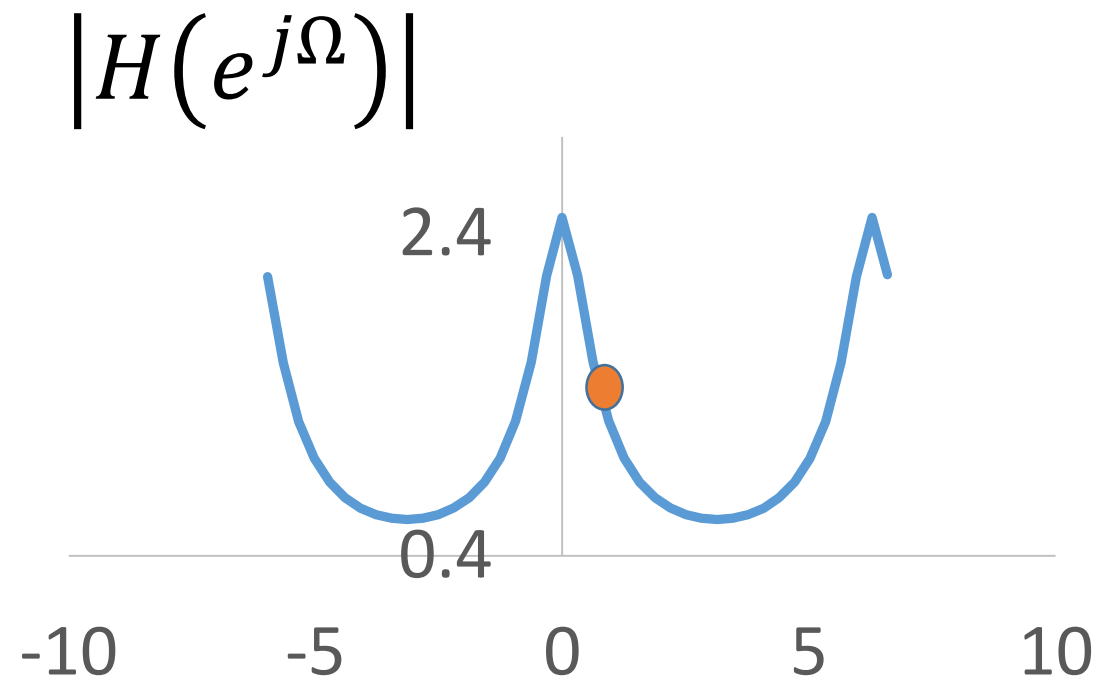
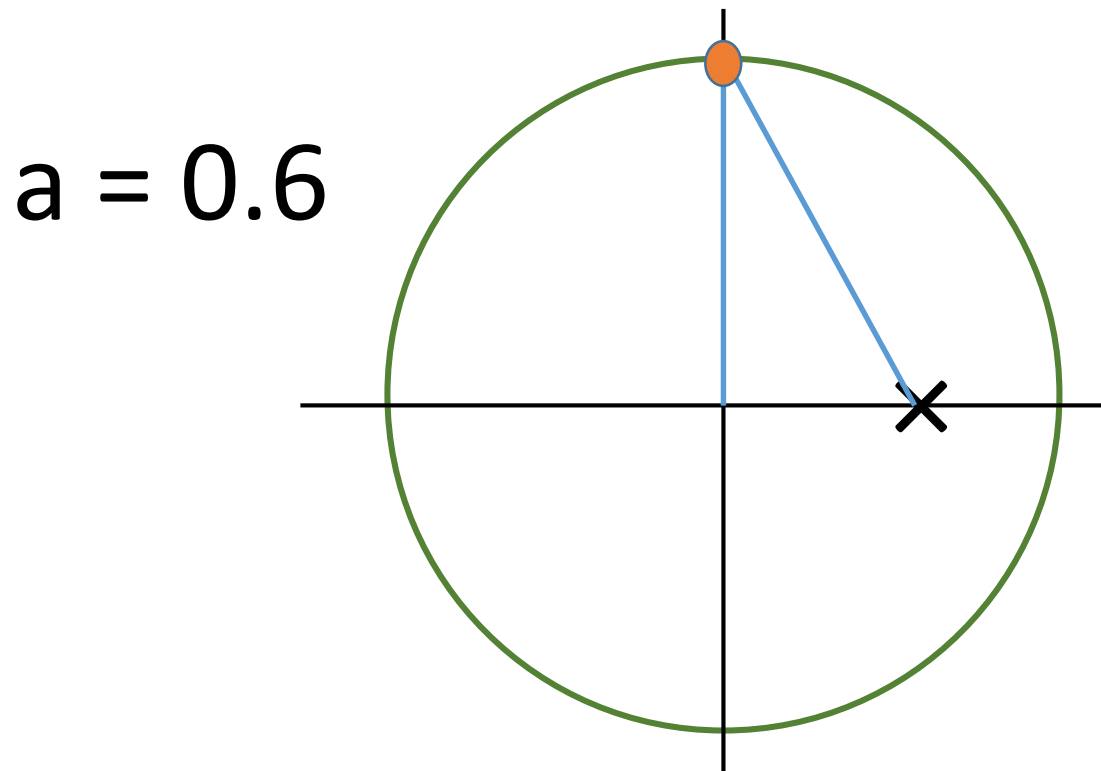
$$H(e^{j\Omega}) = \frac{e^{j\Omega}}{e^{j\Omega} - a} \quad |H(e^{j\Omega})| = \frac{\text{Mag}(\text{Num})}{\text{Mag}(\text{Denom})}$$

$a = 0.6$



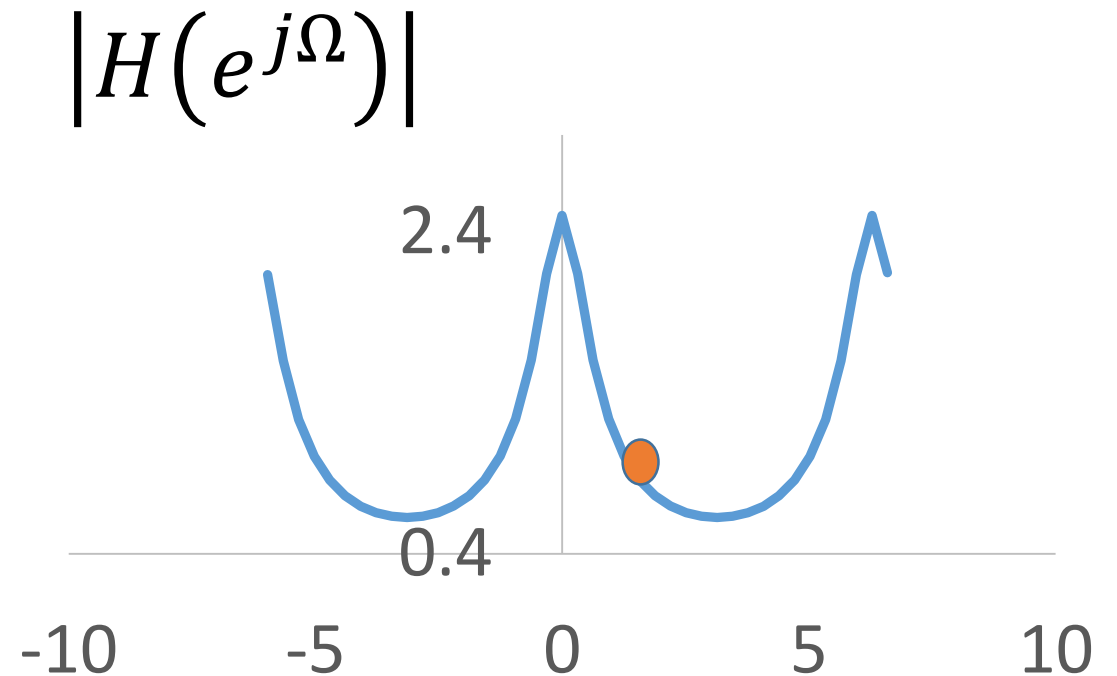
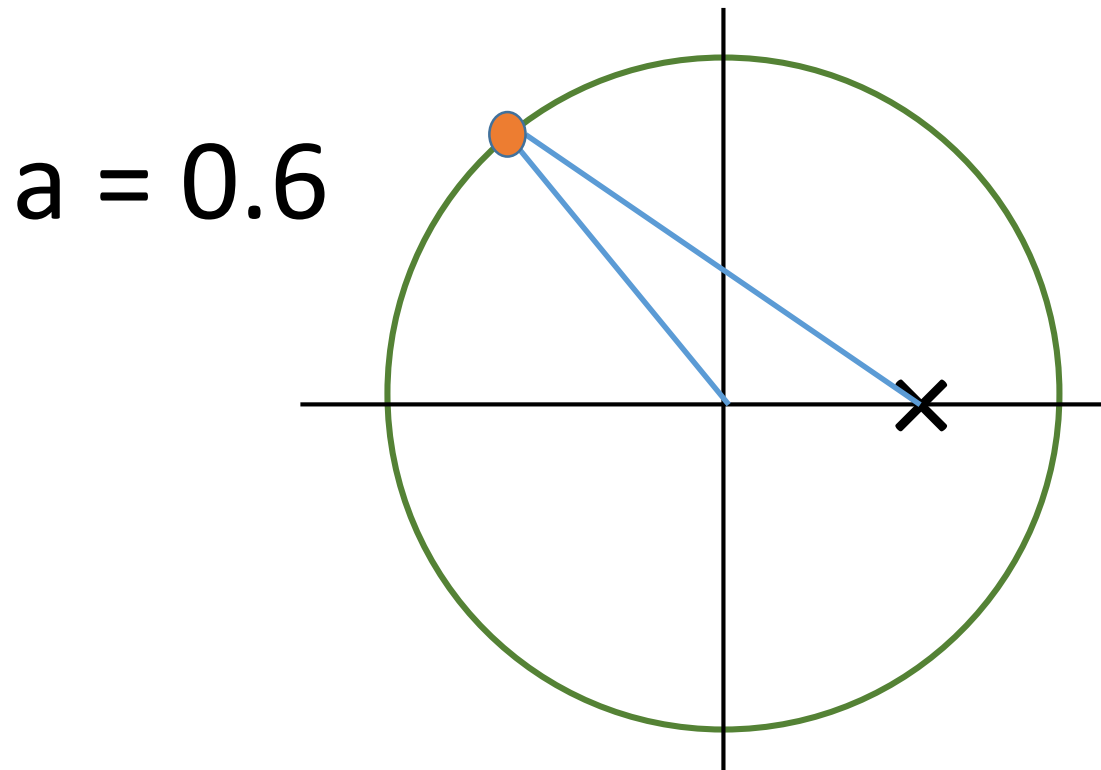
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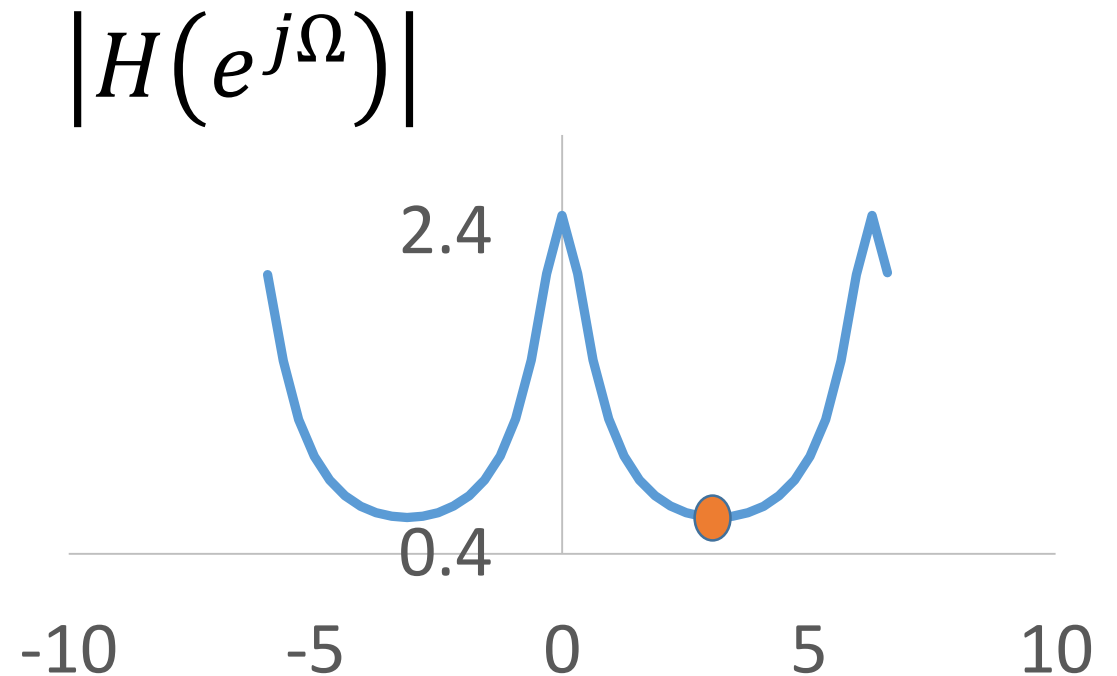
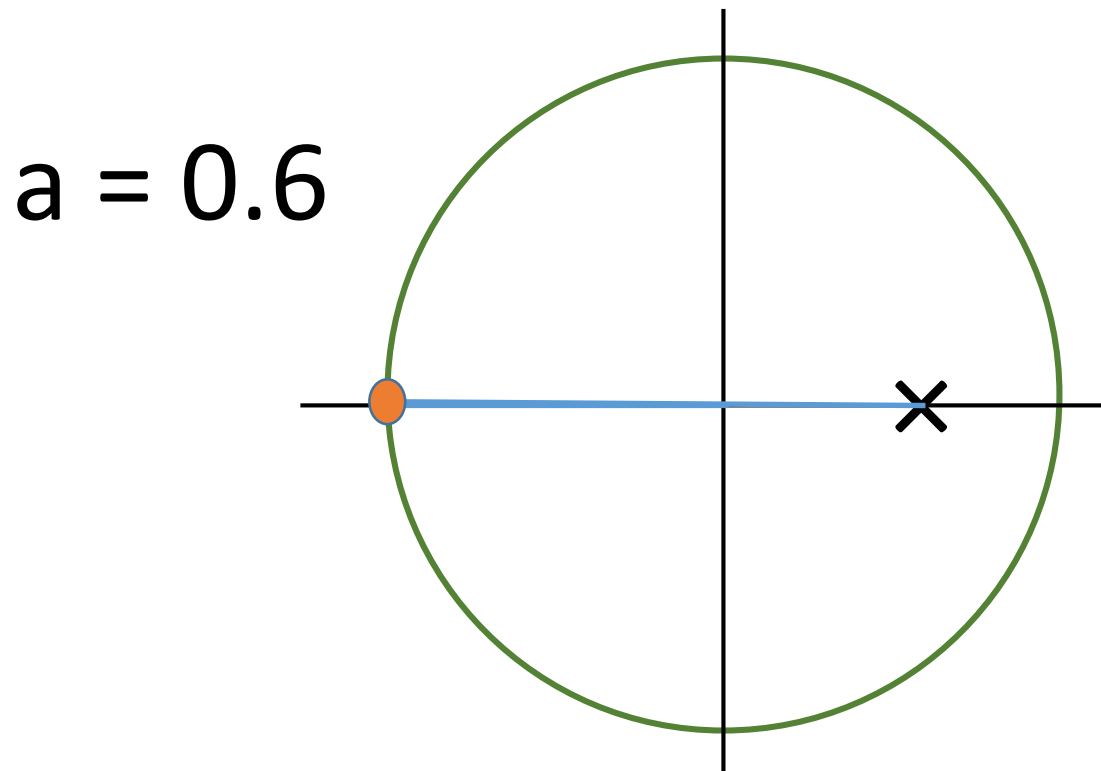
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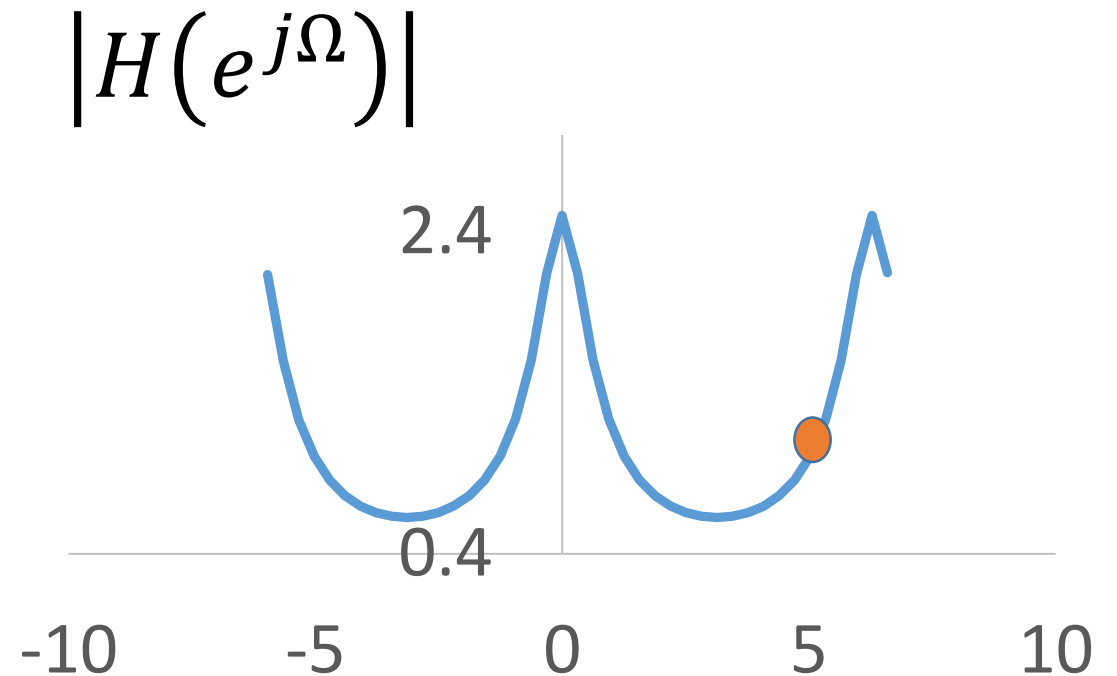
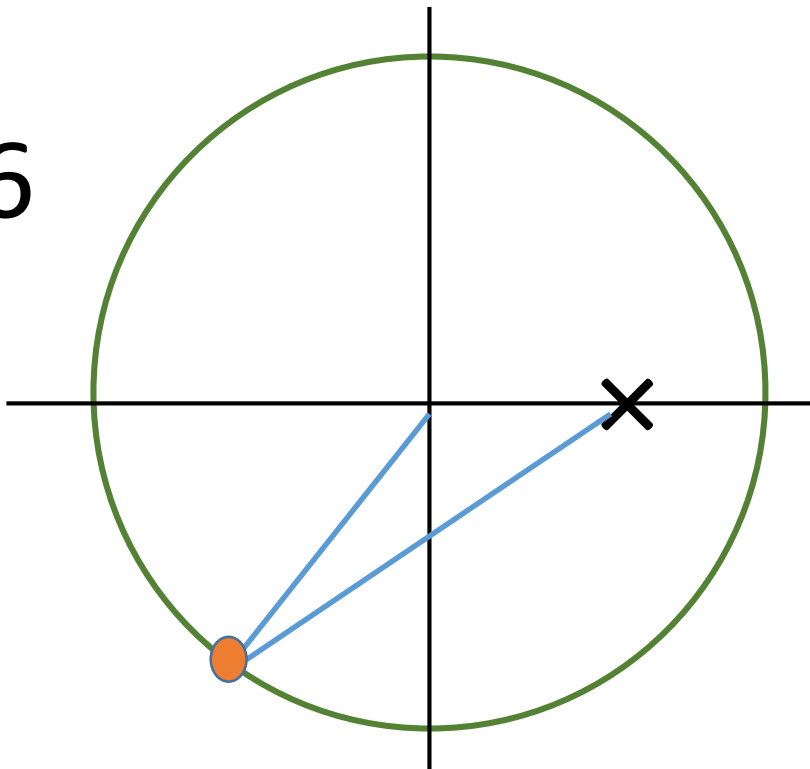
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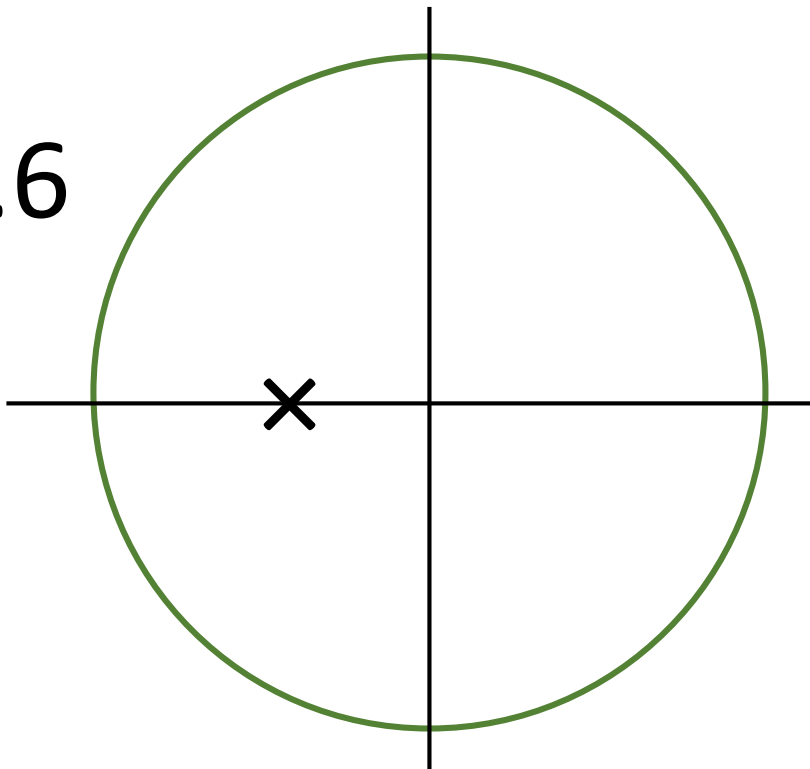
$a = 0.6$



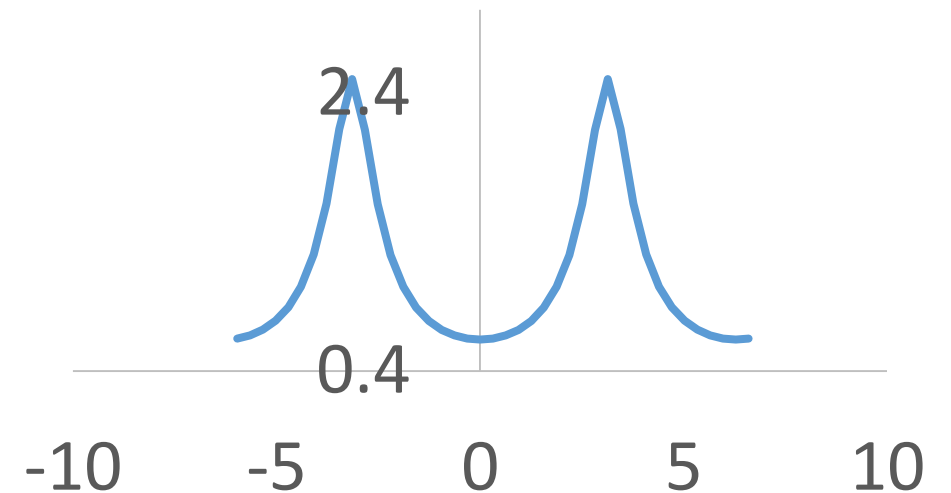
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$a = -0.6$

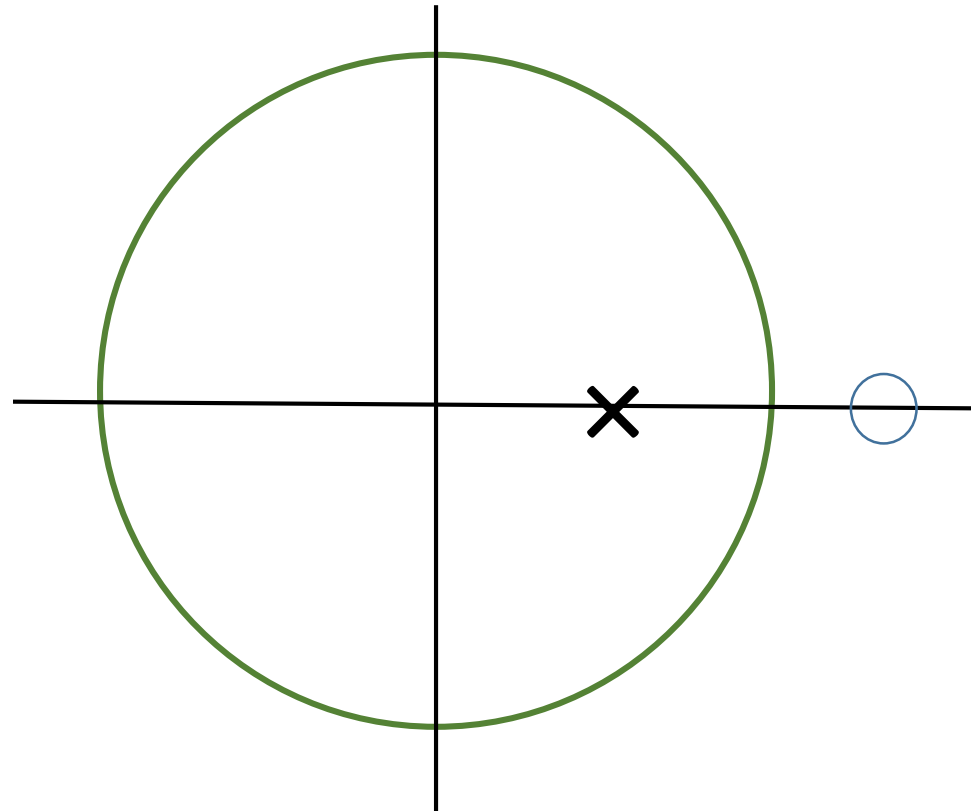


$|H(e^{j\Omega})|$



Which kind of filter is this system ?

$$H(e^{j\Omega}) = \frac{e^{j\Omega} - \frac{1}{a}}{e^{j\Omega} - a}$$



1) Low pass filter

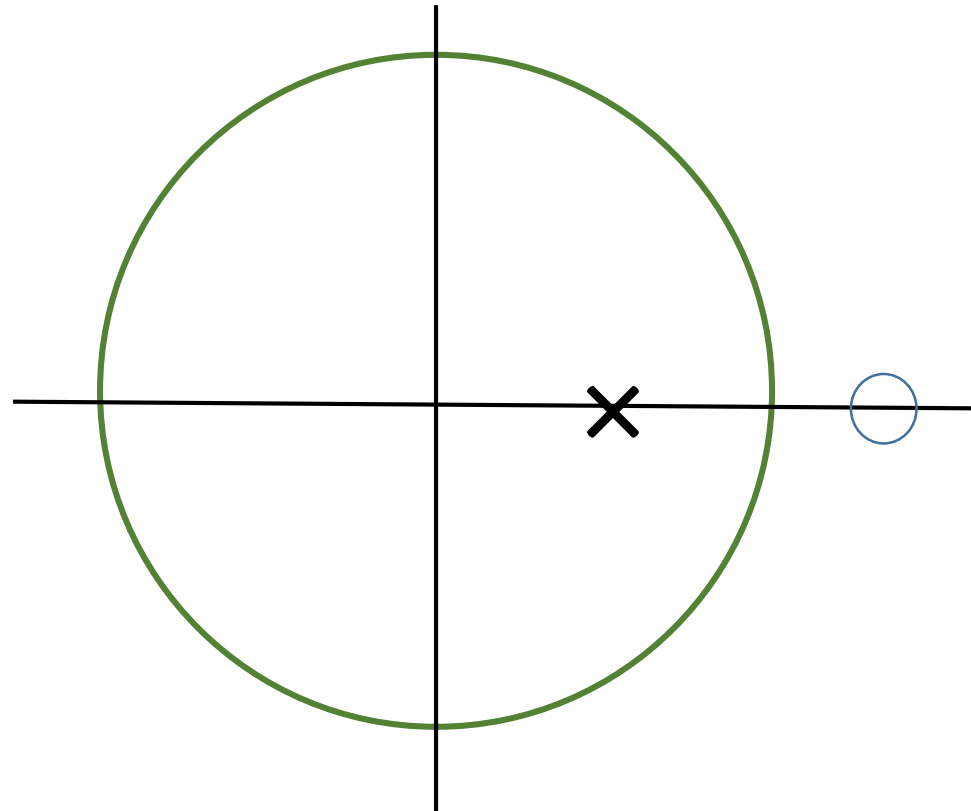
2) High pass filter

3) All pass filter

4) Band pass filter

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$$H(e^{j\Omega}) = \frac{e^{j\Omega} - \frac{1}{a}}{e^{j\Omega} - a}$$



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3) **All pass filter**

4) Band pass filter

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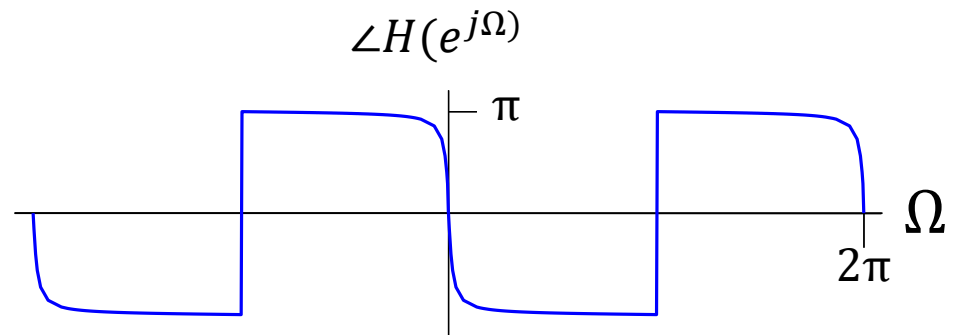
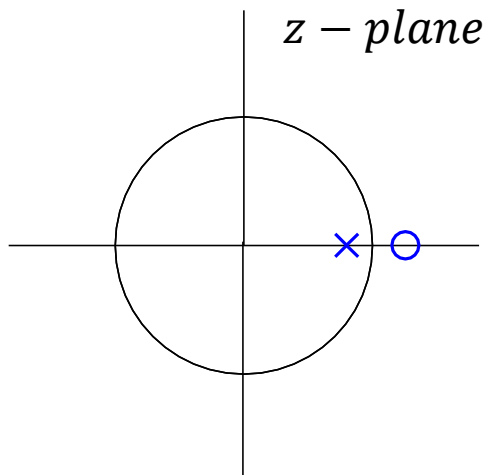
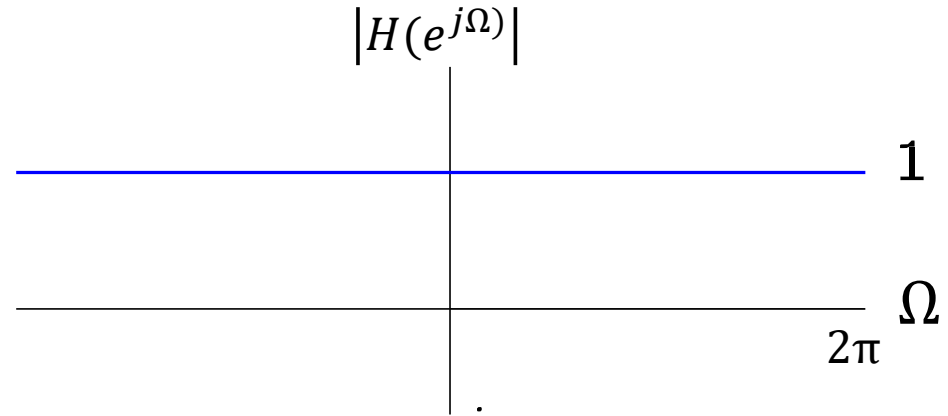
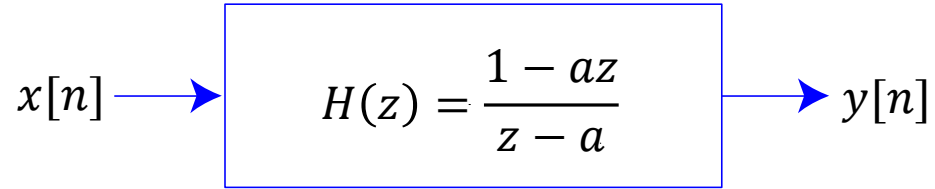
$$H(e^{j\Omega}) = \frac{e^{j\Omega} - \frac{1}{a}}{e^{j\Omega} - a}$$

$$H(e^{j\Omega}) = \frac{1}{a} \frac{ae^{j\Omega} - 1}{e^{j\Omega} - a}$$

$$H(e^{j\Omega}) = \frac{1}{a} e^{j\Omega} \frac{a - e^{-j\Omega}}{e^{j\Omega} - a}$$

$$|H(e^{j\Omega})| = \left| \frac{1}{a} \right|$$

# Effect of all-pass filter



How does applications react to amplitude and phase distortions?

$x(t)$

All pass filters

$y(t)$



# Effect of phase change on Music and Speech

- Music (without phase distortions)
- Music (with phase distortions)
- Speech ('bat' without phase distortions)
- Speech ('bat' with phase distortions)

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