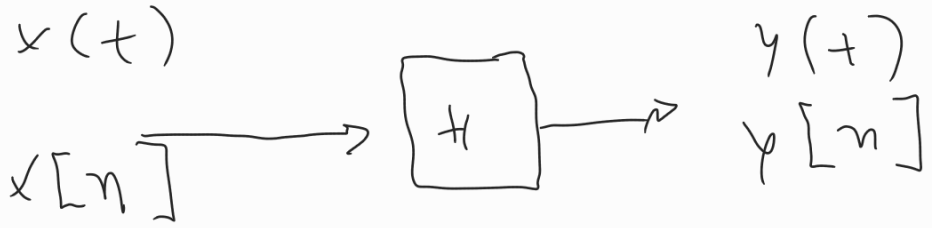
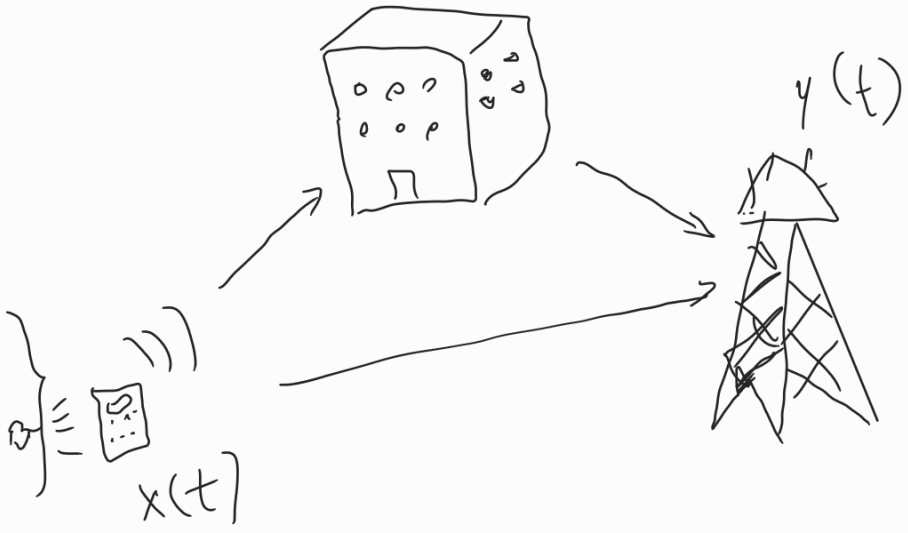
System: Maps an input signal to an output signal



1) Model physical phenomenon



$$y(t) \approx x(t) + \alpha x(t - \tau)$$

$$|\alpha| < 1$$

2) Implement a desired effect

$$z(t) = y_1(t) - \alpha y(t-\tau) + \alpha^2 y(t-2\tau) - \alpha^3 y(t-3\tau)$$

$$\Downarrow$$

$$z(t) = x(t) - \alpha^4 x(t-4\tau)$$

$$\approx x(t$$

Linear System

Superposition holds: sum of inputs => sum of outputs

$x_1[n] \rightarrow \boxed{H} \rightarrow y_1[n]$

$x_2[n] \rightarrow \boxed{H} \rightarrow y_2[n]$

$ax_1[n] + bx_2[n] \rightarrow \boxed{H} \rightarrow ay_1[n] + by_2[n]$

Time Invariant

System responds the same now as it does later

$x[n] \rightarrow$ [H] $\rightarrow y[n]$

$\Downarrow n$

$x[n-n_0] \rightarrow$ [H] $\rightarrow y[n-n_0]$

Causal system

output depends on past/present inputs

Noncausal: present output depends on future inputs

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

causal

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

noncausal

Stored data

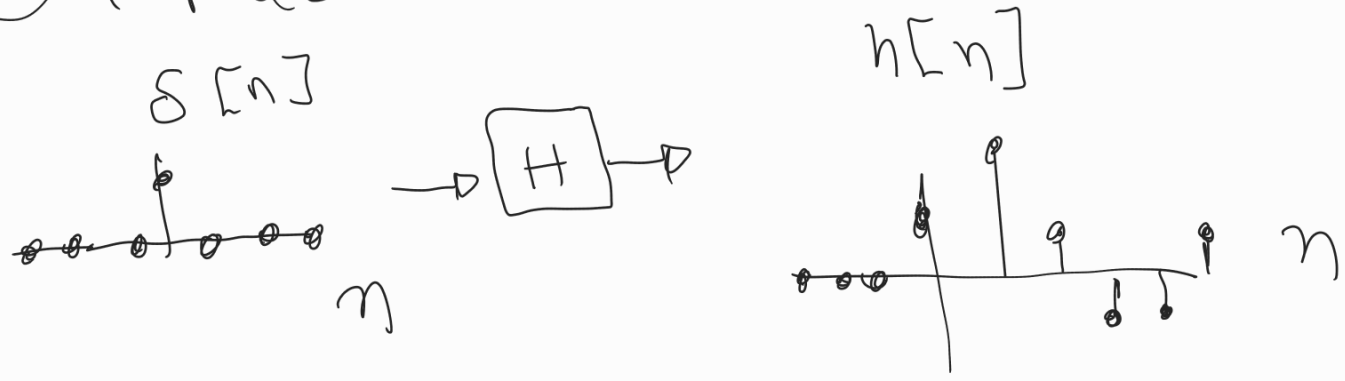
Four LTI System Descriptions

	Computation	Intuition
Difference Equation	★★★★★	★
Impulse response	★★★	★★★
Frequency Response	★	★★★★★
System Function (poles / zeros)	★	★★★★

① Difference Equation

$$y[n] = -\sum_{k=1}^{N} a_k y[n-k] + \sum_{l=0}^{M} b_l x[n-l]$$

(2) impulse response



(3) Frequency Response

$$e^{jwn} \longrightarrow \boxed{H} \longrightarrow H(e^{jw})e^{jwn}$$

(4) System Function (poles/zeros)

$$z^n \longrightarrow \boxed{H} \longrightarrow H(z)z^n$$