Lecture 1, 9/4/19

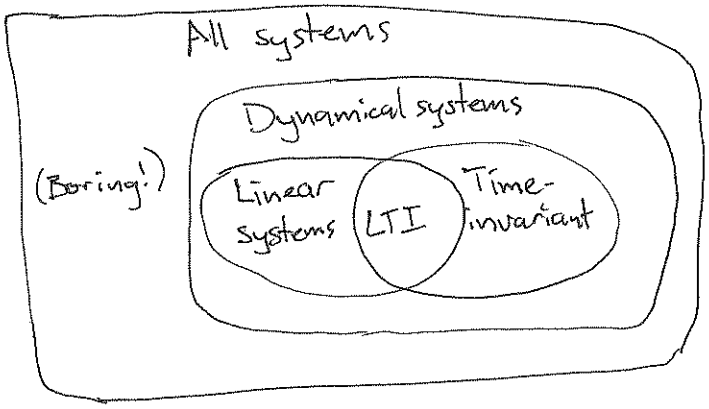
What is a "system"?

$$u \longrightarrow \boxed{H} \longrightarrow y$$

H is a system that acts on u to give y.

u and y are signals.

Taxonomy of systems



For dynamical systems,

$$y(t) = H(t)\{u(t)\}$$

For time-invariant, no $H(t)$.

Why LTI?

$$u_1(t) \longrightarrow \boxed{H} \longrightarrow y_1(t)$$

$$u_2(t) \longrightarrow \boxed{H} \longrightarrow y_2(t)$$

$$\Downarrow$$

Double $u_1(t) \Rightarrow$ double $y_1(t)$ (scaling)

$$\alpha u_1(t) + \beta u_2(t) \longrightarrow \boxed{H} \longrightarrow \alpha y_1(t) + \beta y_2(t) \quad \text{(superposition)}$$

(Assuming the system is at rest. If it's already moving, we have to account for that)

convolution, Fourier/Laplace transform, etc all work on LTI.

What things are LTI?

- Linear circuits
- Physics of many things in 1-D
- Mechanical things (springs, dashpots, mass)

What things are LTI, cont:

Electrical + mechanical systems

current	velocity
capacitor	spring
$V = \frac{1}{C}\int i\,dt$	$F = K\int v\,dt$
resistor	dashpot / damper
$V = R \cdot i$	$F = b \cdot v$
inductor	mass
$V = L\frac{di}{dt}$	$F = ma = m\frac{dv}{dt}$

Fluids + pneumatics have equivalents as well.