Goals:
- Introduce Course
- Administration
- Review Prerequisites.

— This course is about signals and systems.

— Signals are patterns of variation of some interest, with respect to some independent variable.

Example: voltages, currents, forces, positions, concentrations, pressures, temperatures

time signals

$t \in \mathbb{R}$ is the independent variable

Images

Space signals

$I(x,y)$ = intensity at position x,y.

$I(x,y,t)$ intensity at position x,y at time t.

Signals are represented Mathematically as functions.

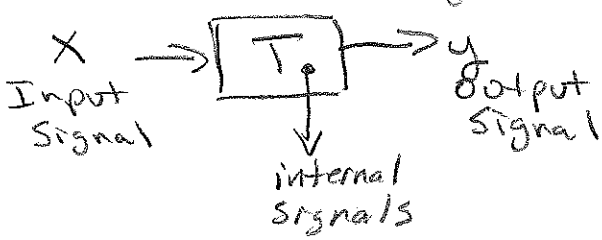
The above are examples of continuous time (or space) signals.

Analog vs Digital

$$x, y, t \in \mathbb{R}$$

The independent variable can be discrete, e.g. temperature by day, stock price, state machine

— Systems transform signals into other signals.



The most common mathematical representation of systems a differential equations or difference equations.

Example $\ddot{y} + a\dot{y} + by = cx$

AND similar representations, E.g. Laplace

Aside on Notation. Given a function $f(t)$

$$\frac{df}{dt} = f' = \dot{f} = Df \qquad \frac{d^2f}{dt^2} = f'' = \ddot{f} = D^2f$$

are time derivatives.

- Why are signals and systems important?
  - analysis
  - prediction
  - control
  - simulation
  - optimization
  - detection
  - identification
  - filter

The Focus of this course is on CT signals + Systems,

CT Signals
- periodic
  - Fourier Series → Fourier
- aperiodic (non periodic)
  - causal
    - Laplace
    - Steady State → Fourier
  - acausal (noncausal)
    - Fourier
    - Bilateral Laplace

CT Systems
- external description (steady state)
  - time domain (impulse response)
  - Freq Domain
    - Laplace
    - Fourier (stable)
- internal description (transient + steady state)
  - time domain
  - frequency domain
    - Laplace
    - Fourier (stable)

Prerequisite Review (if time)

- Linear, constant coefficient Differential Eq.

$$\frac{d^n y}{dt^n} + a_1 \frac{d^{n-1} y}{dt^{n-1}} + a_2 \frac{d^{n-2} y}{dt^{n-2}} + \dots a_n y = x(t)$$

Again it is notationally convrienient to write

$$\frac{d^n y}{dt^n} \text{ as } D^n y$$

to give

$$\underbrace{(D^n + a_1 D^{n-1} + a_2 D^{n-2} + \cdots a_n)}_{\text{characteristic polynomial, } P(D)} y = x(t)$$

- To solve this equation completely we also need n auxillary conditions.

- Methods of Solution

  1. solve homogeneous equation $P(D)y = 0$

     (we will call this the zero-input response)

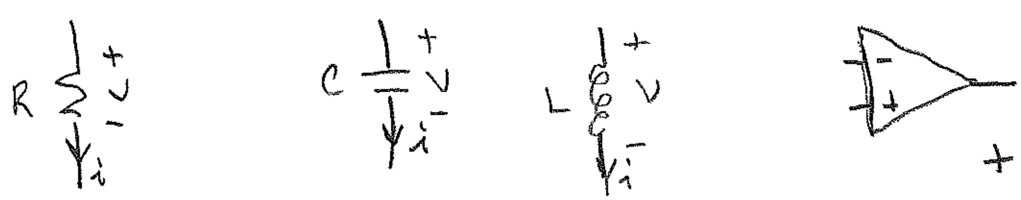
  2. find the particula solution using a combination of the solutions to 1.

     - variation of parameters.
     - method of undetermined coefficients
     - Laplace transform.

* PSO will remind you of this material *

- We will be using this as the basis for time domain analysis.

- Circuits



$V = Ri$ $\quad$ $i = C\frac{dv}{dt}$ $\quad$ $V = L\frac{di}{dt}$ $\quad$ + KCL + KVL.