What is System?

- Systems process input signals to produce output signals
- A system is combination of elements that manipulates one or more signals to accomplish a function and produces some output.

Types of Systems

- Causal & Anticausal
- Linear & Non Linear
- Time Variant &Time-invariant
- Stable & Unstable
- Static & Dynamic
- Invertible & Inverse Systems

Causal & Anticausal Systems

- Causal system : A system is said to be *causal* if the present value of the output signal depends only on the present and/or past values of the input signal.
- Example: $y[n]=x[n]+1/2x[n-1]$

Causal & Anticausal Systems Contd.

- Anticausal system : A system is said to be *anticausal* if the present value of the output signal depends only on the future values of the input signal.
- Example: $y[n]=x[n+1]+1/2x[n+1]$

Linear & Non Linear Systems

- A system is said to be linear if it satisfies the principle of superposition
- For checking the linearity of the given system, firstly we check the response due to linear combination of inputs
- Then we combine the two outputs linearly in the same manner as the inputs are combined and again total response is checked
- If response in step 2 and 3 are the same,the system is linear othewise it is non linear.

Time Invariant and Time Variant Systems

- A system is said to be *time invariant* if a time delay or time advance of the input signal leads to a identical time shift in the output signal.

Stable & Unstable Systems

- A system is said to be *bounded-input bounded-output stable* (BIBO stable) if every bounded input results in a bounded output.

Stable & Unstable Systems Contd.

Example

- $y[n]=1/3(x[n]+x[n-1]+x[n-2])$

$$y[n] = \frac{1}{3}\left|x[n] + x[n-1] + x[n-2]\right|$$

$$\leq \frac{1}{3}(|\,x[n]\,| + |\,x[n-1]\,| + |\,x[n-2]\,|)$$

$$\leq \frac{1}{3}(M_x + M_x + M_x) = M_x$$

Stable & Unstable Systems Contd.

Example: The system represented by

$$y(t) = A\,x(t) \text{ is unstable ; } A>1$$

Reason: let us assume $x(t) = u(t)$, then at every instant $u(t)$ will keep on multiplying with A and hence it will not be bonded.

Static & Dynamic Systems

- A static system is memoryless system
- It has no storage devices
- its output signal depends on present values of the input signal
- For example

LEY DE OHM I (corriente) = V (voltaje)/ R (resistencia)

$$i(t) = \frac{1}{R} v(t)$$

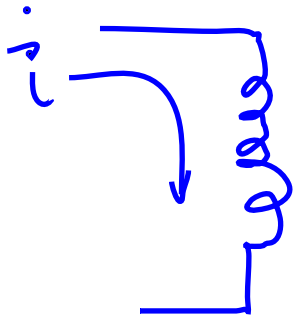
Sistema determinístico, sin memoria

Static & Dynamic Systems Contd.

- A dynamic system possesses memory
- It has the storage devices
- A system is said to possess *memory* if its output signal depends on past values and future values of the input signal

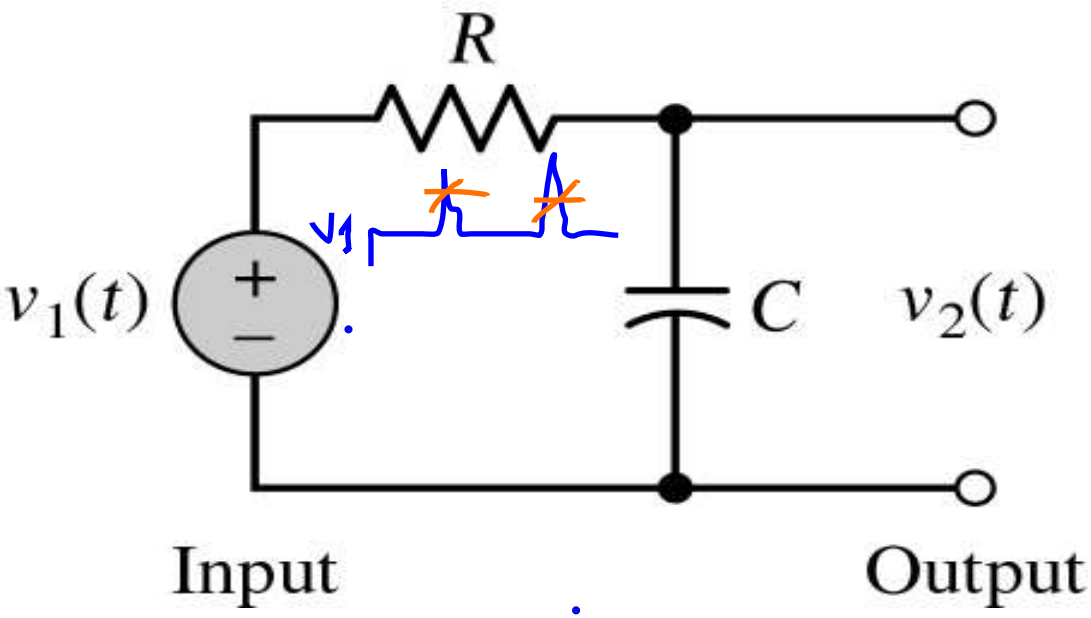
$$i(t) = \frac{1}{L}\int_{-\infty}^{t} v(\tau)d\tau$$

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



Fenómeno inductivo se opone a la variación de la corriente. Tiene memoria

Example: Static or Dynamic?



Fenómeno Capacitivo, se opone a la variación de voltaje. Tiene memoria

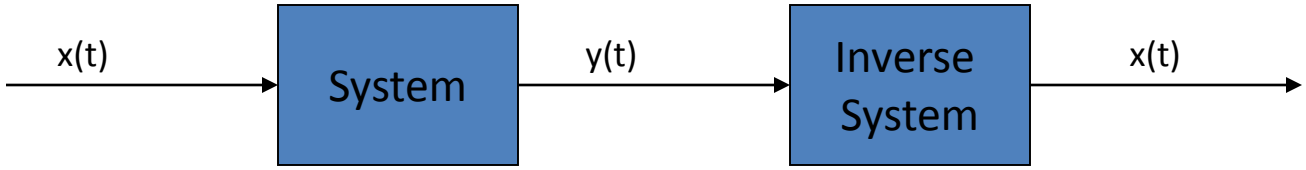
Example: Static or Dynamic?

Answer:

- The system shown above is RC circuit
- R is memoryless
- C is memory device as it stores charge because of which voltage across it can’t change immediately
- Hence given system is dynamic or memory system

Invertible & Inverse Systems

- If a system is invertible it has an Inverse System



- Example: y(t)=2x(t)
  - System is invertible→ must have inverse, that is:
  - For any x(t) we get a distinct output y(t)
  - Thus, the system must have an Inverse
    - x(t)=1/2 y(t)=z(t)