NETWORK FUNCTION

TRANSIENT RESPONSE:

- Transient Response of RC, RL, and RLC Circuits to various excitation signals such as step, ramp, impulse and sinusoidal excitations using Laplace transform.

- NETWORK ANALYSIS is concerned with determining the response ,given the excitation and the network .

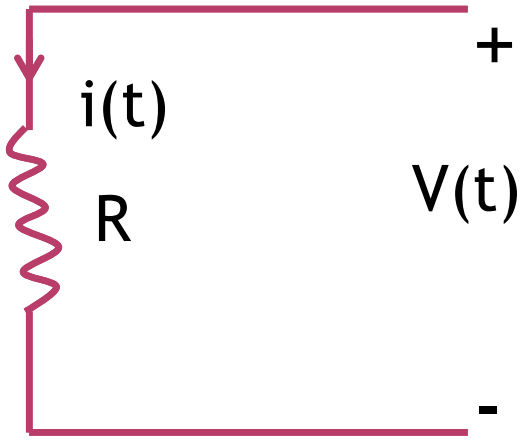
- IN NETWORK SYNTHESIS , the problem is to design the network given the excitation and the desired response

NETWORK ELEMENT

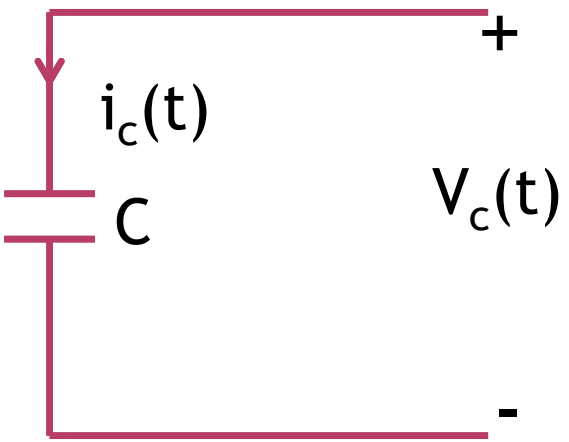
- Resistor
- Capacitor
- Inductor

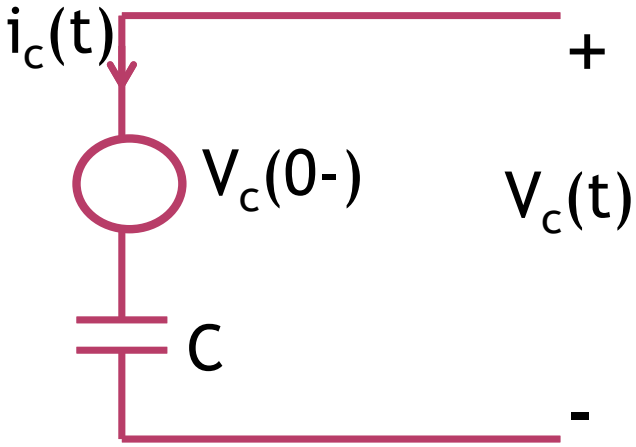
RESISITOR

- V(t)= R i(t)
- i(t)=G V(t)



CAPACITOR





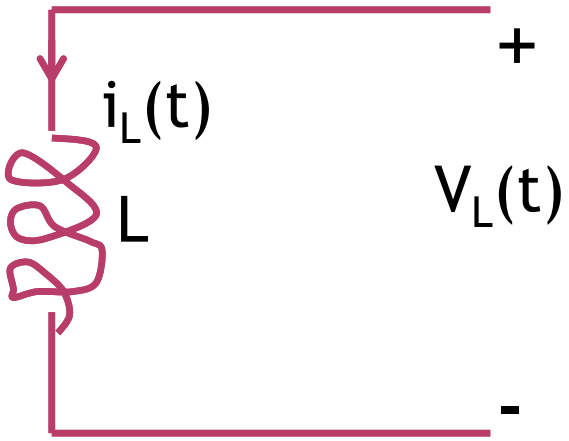
Capacitor with initial voltage

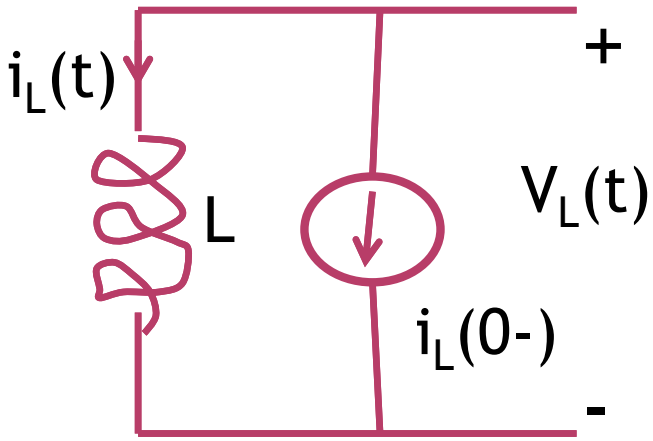
$$i_c(t) = C\frac{dV_c(t)}{dt}$$

$$i_c(t) = \frac{1}{C}\int_{0-}^{t} i_c(t)dt + V_c(0-)$$

$V_C(0-)$ is the initial value of voltage across the capacitor just before the switching action

INDUCTOR





Inductor with initial Current

$$V_L(t) = L\frac{di_L(t)}{dt}$$

$$i_L(t) = \frac{1}{L}\int_{0-}^{t} V_L(t)dt + i_L(0-)$$

$i_L(0-)$ is the initial value of current through the inductor just before the switching action

TRANSIENT RESPONSE:

- for t between 0 and T
- Means short living
- Value of voltage and current during the transient period are known as the transient responses
- Part of the total time response that goes to zero as time become large.

STEADY STATE RESPONSE

- Value of voltage and current after the transient has died out are known as steady state response
- Part of total time response which remains after the transient has passed
- Total response of a network is the sum of the transient response and a steady state response

ZERO INPUT RESPONSE

- Value of voltage and current that result from initial conditions when the excitation (input) is zero

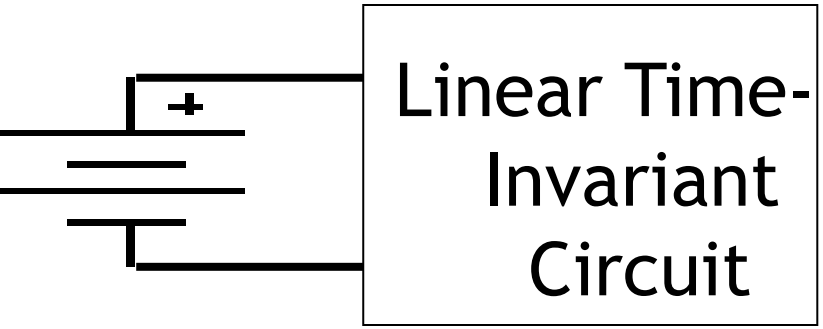
ZERO STATE RESPONSE

- Value of voltage and current for an excitation which is applied when all initial condition are zero
- Also called rest or initially relaxed network

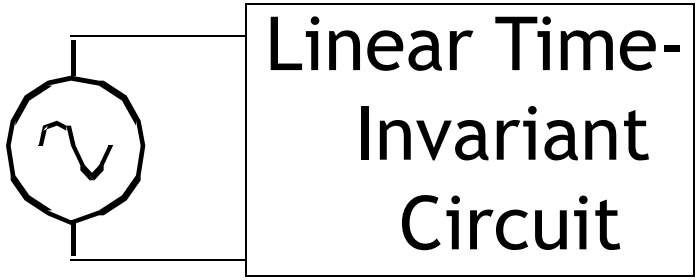
STEP AND IMPULSE RESPONSE

- The value of voltage and current for the excitation signal U(t) and δ(t) when all condition are zero.

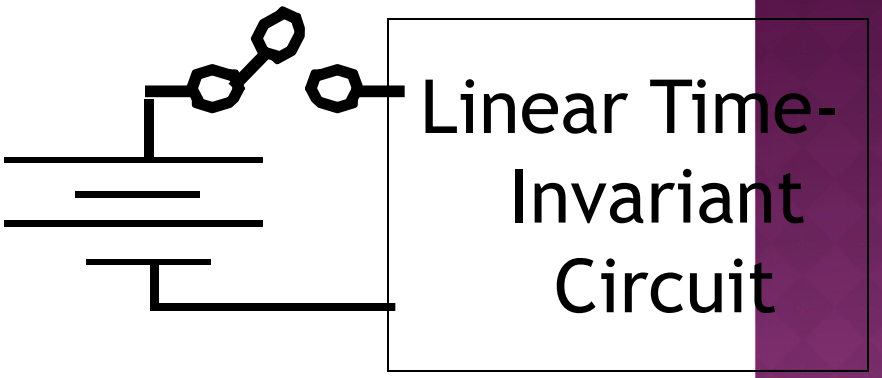
Types of Circuit Excitation



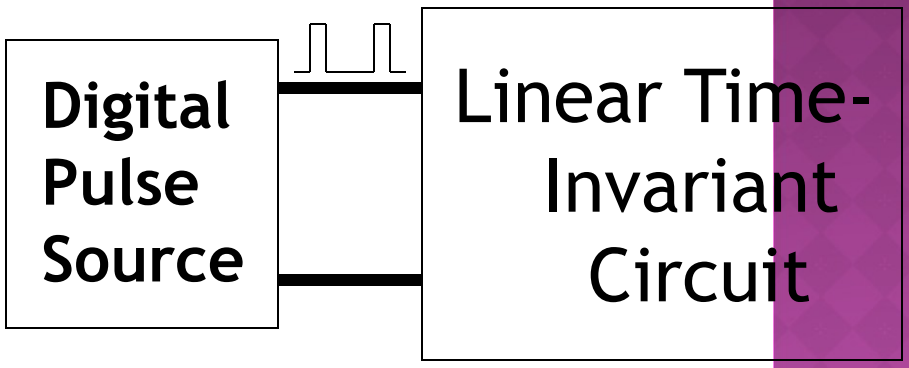
Steady-State Excitation (DC Steady-State)



Sinusoidal (Single-Frequency) Excitation →AC Steady-State



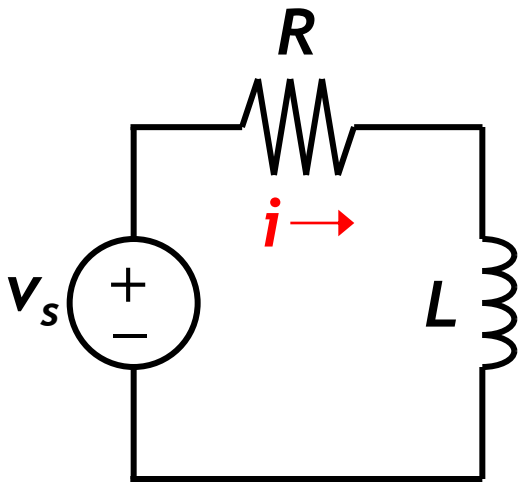
OR

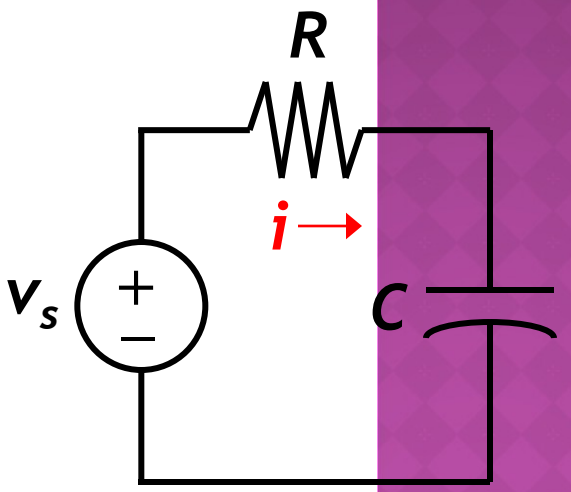


Transient Excitation

FIRST-ORDER CIRCUITS

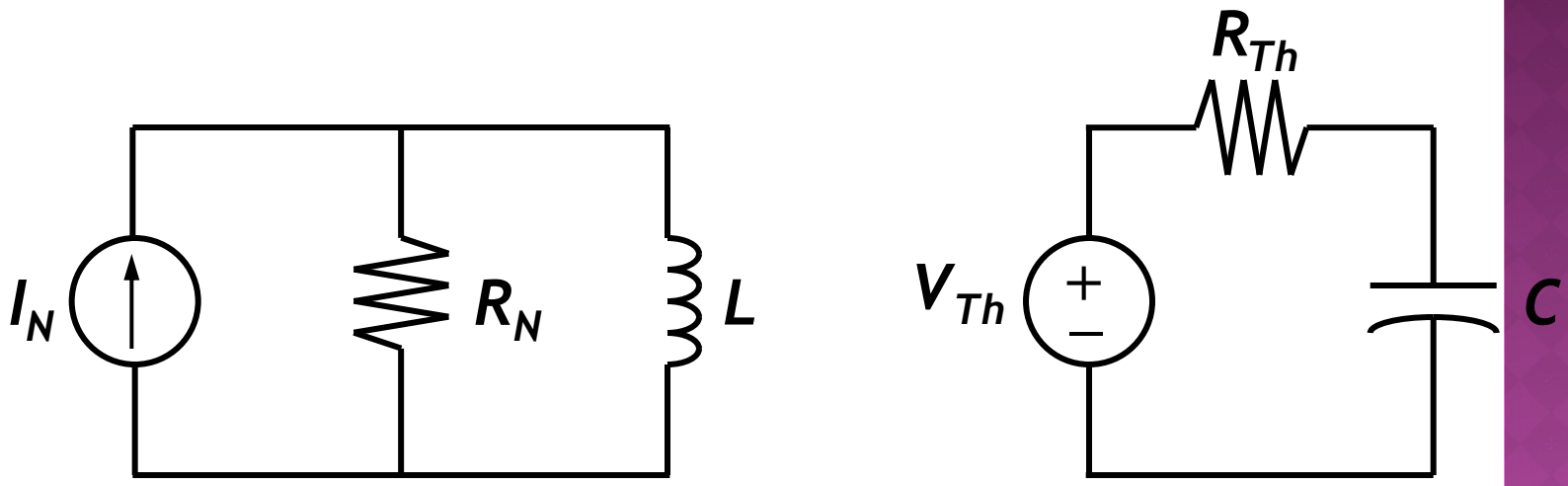
- A circuit that contains only sources, resistors and an inductor is called an ***RL circuit***.
- A circuit that contains only sources, resistors and a capacitor is called an ***RC circuit***.
- RL and RC circuits are called first-order circuits because their voltages and currents are described by first-order differential equations.





REVIEW (CONCEPTUAL)

- Any first-order circuit can be reduced to a Thévenin (or Norton) equivalent connected to either a single equivalent inductor or capacitor.



- In steady state, an inductor behaves like a short circuit
- In steady state, a capacitor behaves like an open circuit

- The ***natural response*** of an RL or RC circuit is its behavior (*i.e.*, current and voltage) when stored energy in the inductor or capacitor is released to the resistive part of the network (containing no independent sources).

- The ***step response*** of an RL or RC circuit is its behavior when a voltage or current source **step** is applied to the circuit, or immediately after a switch state is changed.