NETWORK ANALYSIS AND SYNTHESIS

Unit – III
Transient Circuit Analysis

- Natural response and forced response,
- Transient response and steady state response for arbitrary inputs (DC and AC),
- Evaluation of time response both through classical and Laplace methods.

Discharge of a Capacitance through a Resistance

$$C\frac{dv_C(t)}{dt}+\frac{v_C(t)}{R}=0$$

$$RC\frac{dv_C(t)}{dt}+v_C(t)=0$$

$$v_C(t)=Ke^{st}$$

$$RCKse^{st}+Ke^{st}=0$$

$$s=\frac{-1}{RC}$$

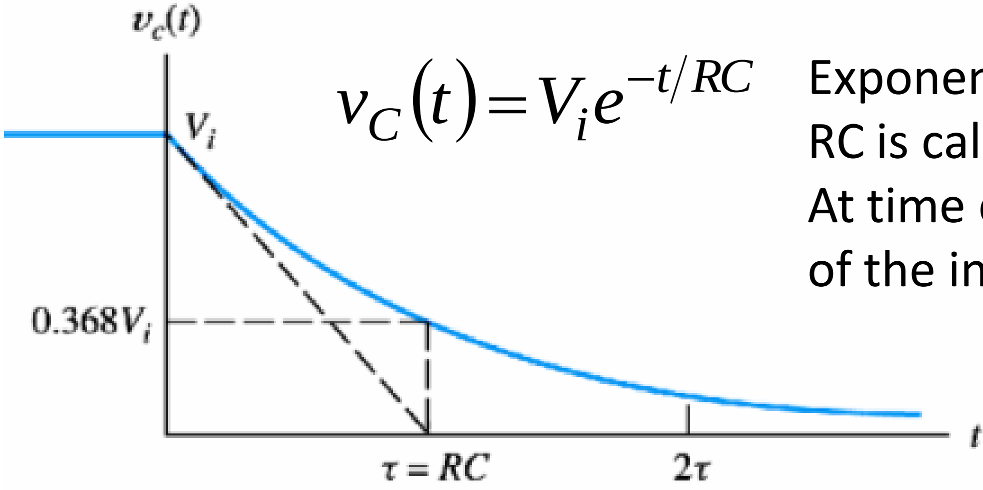
$$v_C(t)=Ke^{-t/RC}$$

$$v_C(0^+)=V_i$$

$$=Ke^{0/RC}$$

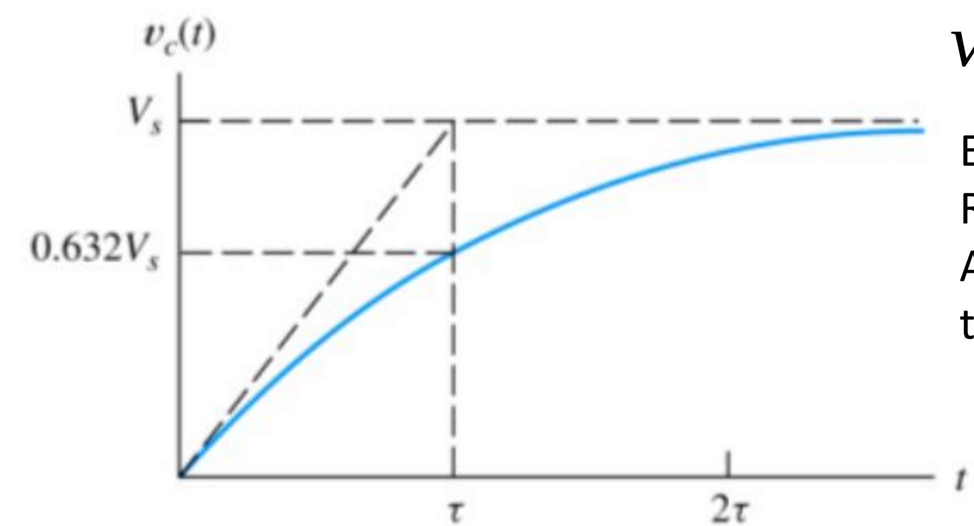
$$=K$$

$$v_C(t)=V_ie^{-t/RC}$$



$$v_C(t) = V_i e^{-t/RC}$$

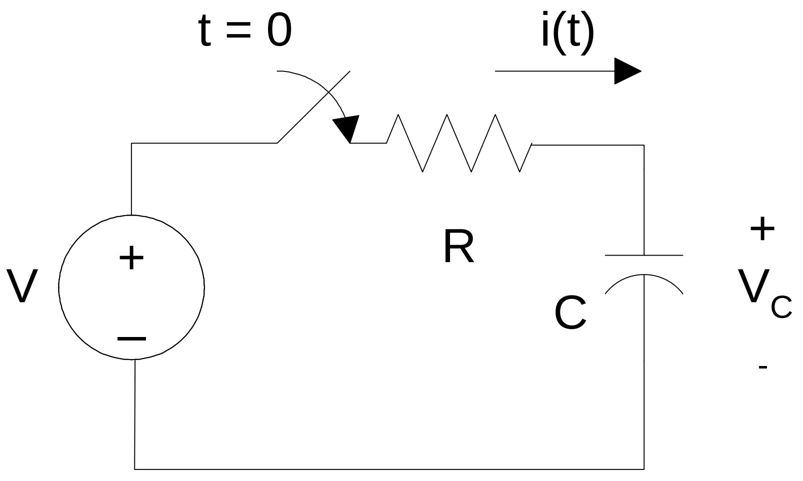
Exponential decay waveform
RC is called the time constant.
At time constant, the voltage is 36.8% of the initial voltage.

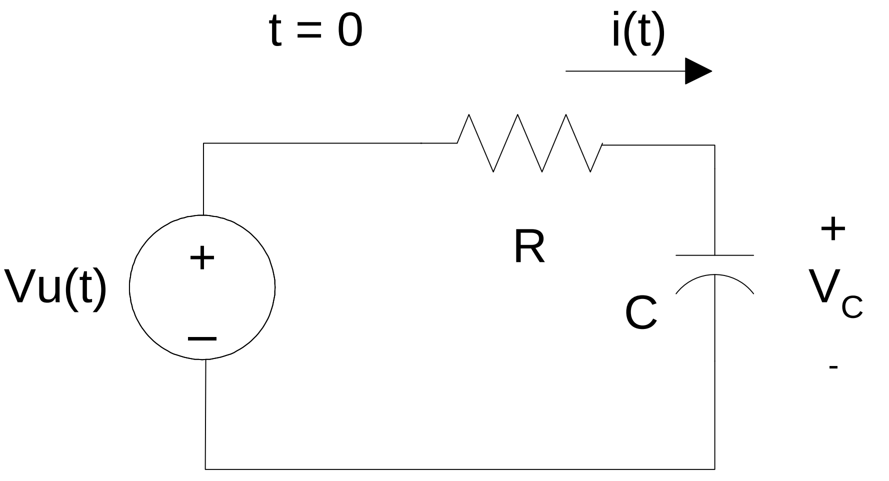


$$v_C(t) = V_i(1 - e^{-t/RC})$$

Exponential rising waveform
RC is called the time constant.
At time constant, the voltage is 63.2% of the initial voltage.

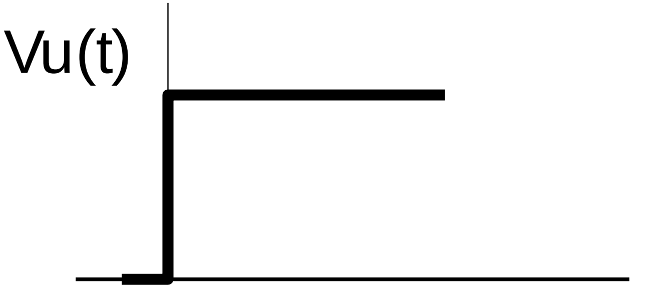
RC CIRCUIT



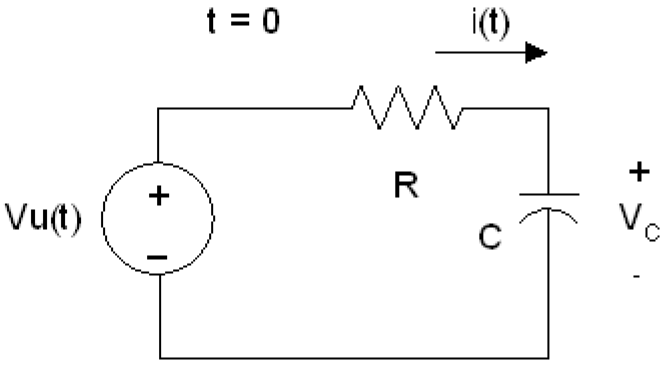


for $t = 0^-$, $i(t) = 0$

$u(t)$ is voltage-step function



RC CIRCUIT

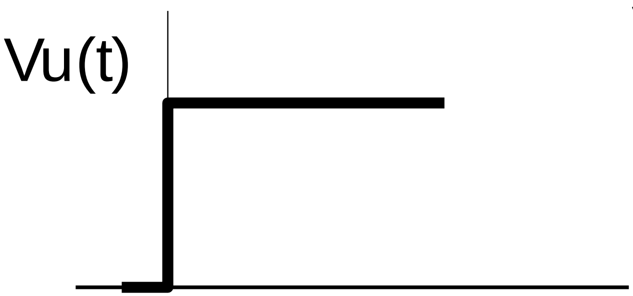


$$i_R = i_C$$

$$i_R = \frac{vu(t) - v_C}{R}, \quad i_C = C\frac{dv_C}{dt}$$

$$RC\frac{dv_C}{dt} + v_C = V, \quad vu(t) = V \; for \; t \geq 0$$

Solving the differential equation

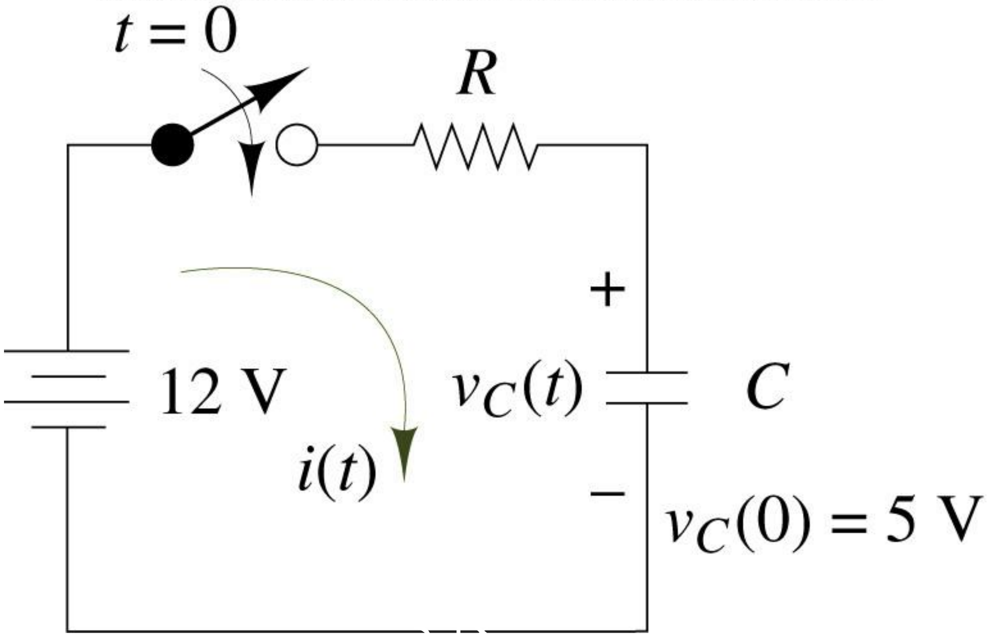


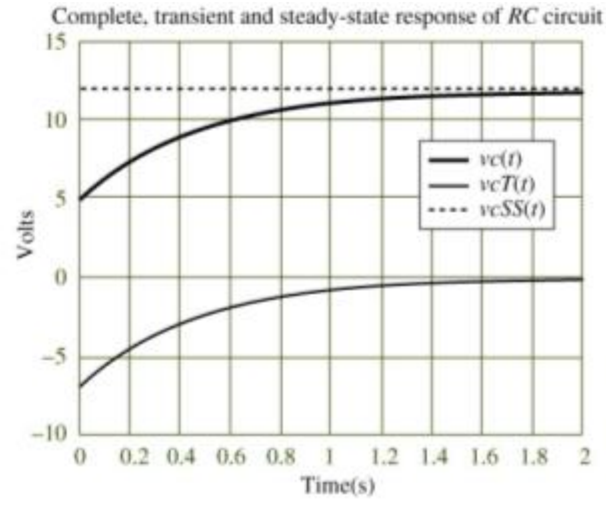
Complete Response

Complete response

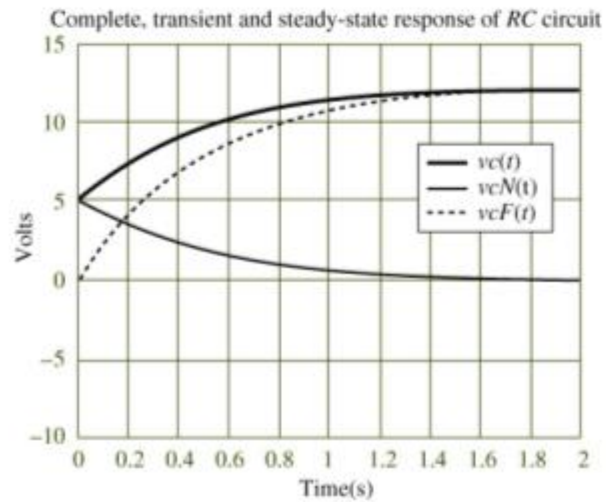
= natural response + forced response

- Natural response (source free response) is due to the initial condition
- Forced response is the due to the external excitation.





(a)



(b)

- **a). Complete, transient and steady state response**
- **b). Complete, natural, and forced responses of the circuit**

THANKS….

Queries Please…