

A decorative graphic on the left side of the slide consists of light blue lines and circles, resembling a circuit board or network diagram. The lines are vertical and horizontal, with some diagonal connections, and the circles are small and white with blue outlines.

NETWORK THEORY



LECTURE 3

SECTION A

TOPIC COVERED: TRANSIENT RESPONSE OF RC TO VARIOUS
EXCITATION SIGNALS

DISCHARGE OF A CAPACITANCE THROUGH A RESISTANCE

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

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

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

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

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

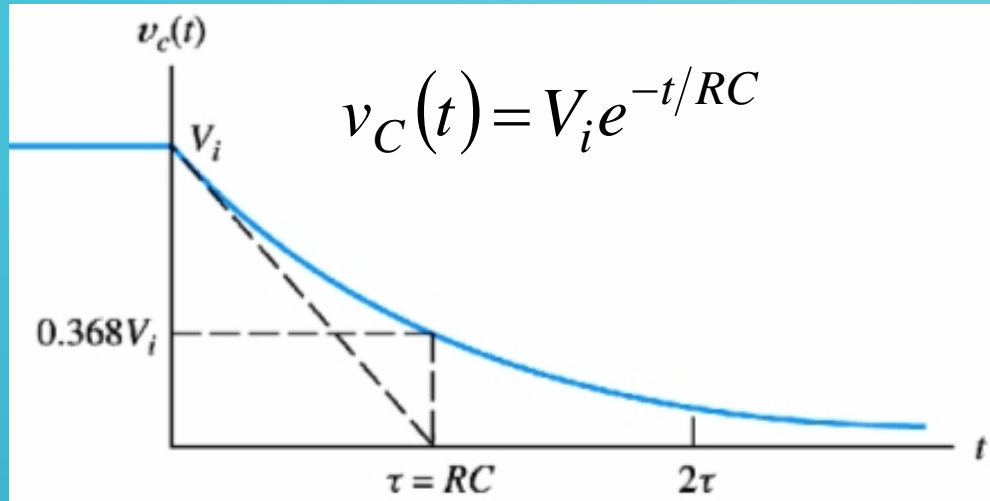
$$v_C(t) = Ke^{st}$$

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

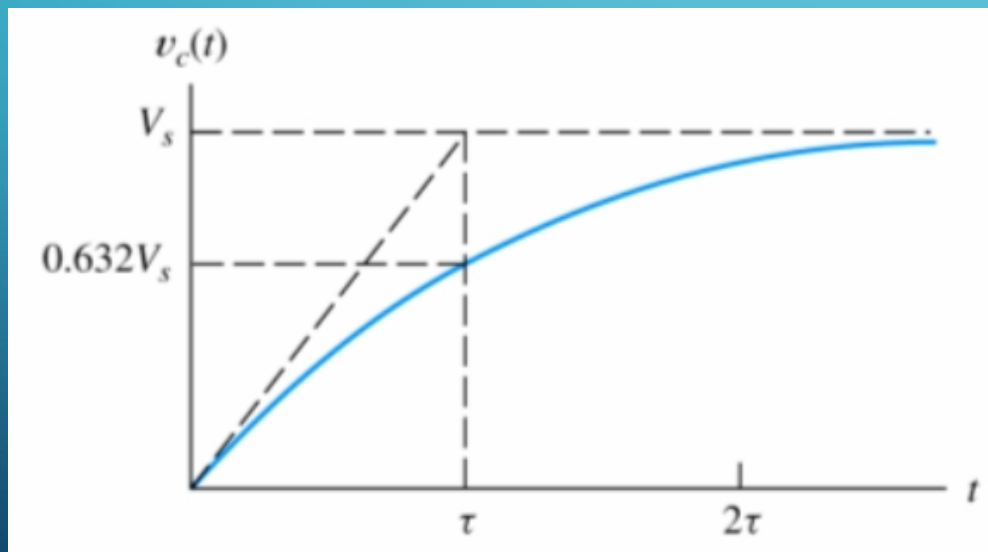
$$= K$$

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

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

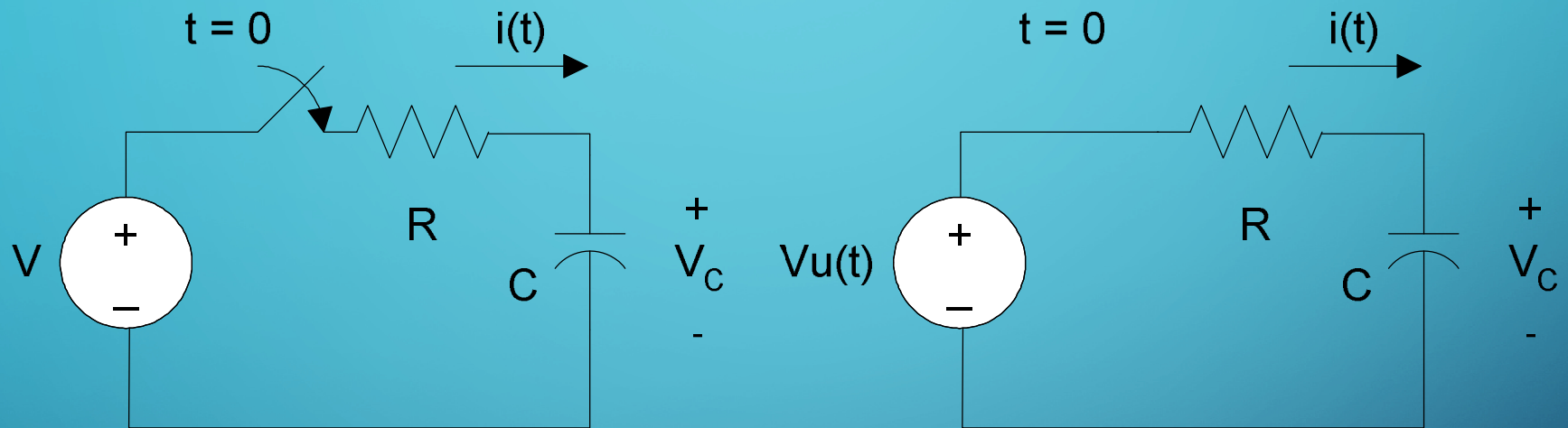


Exponential decay waveform
 RC is called the time constant.
 At time constant, the voltage is 36.8% of the initial voltage.

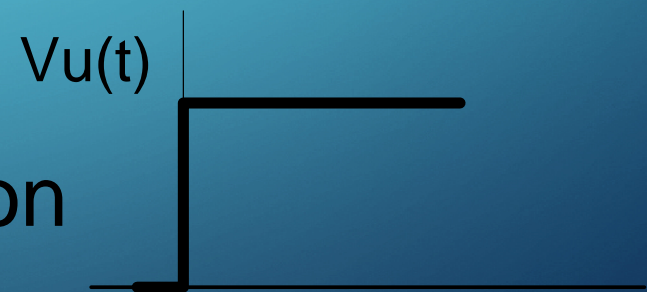


Exponential rising waveform
 RC is called the time constant.
 At time constant, the voltage is 63.2% of the initial voltage.

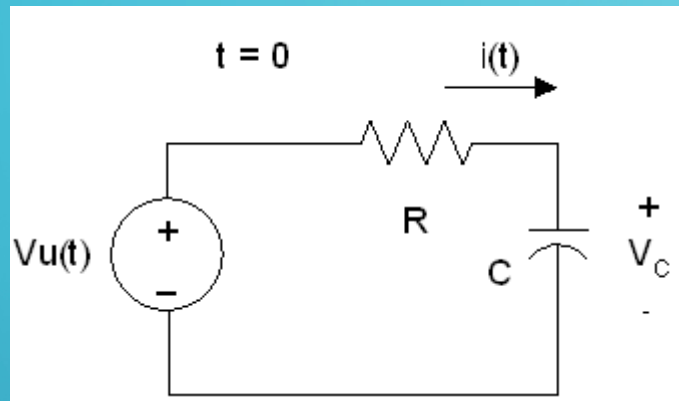
RC CIRCUIT



for $t = 0^-$, $i(t) = 0$
 $u(t)$ is voltage-step function



RC CIRCUIT

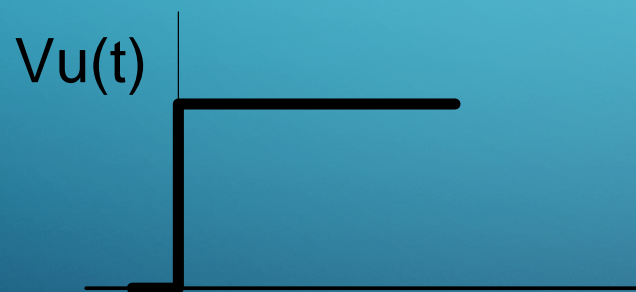


$$i_R = i_C$$

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

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

Solving the differential equation



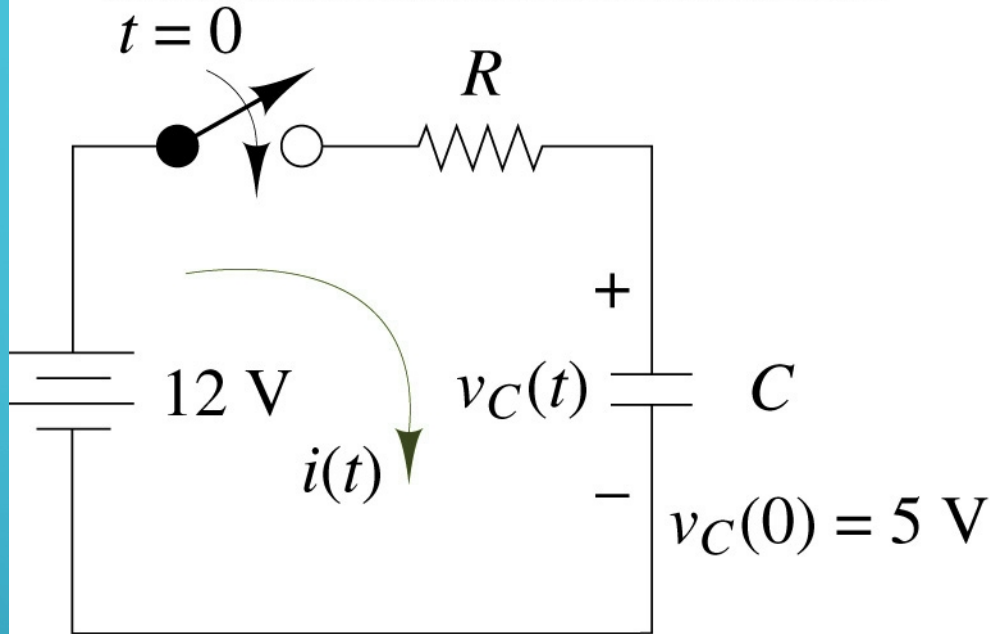
COMPLETE RESPONSE

Complete response

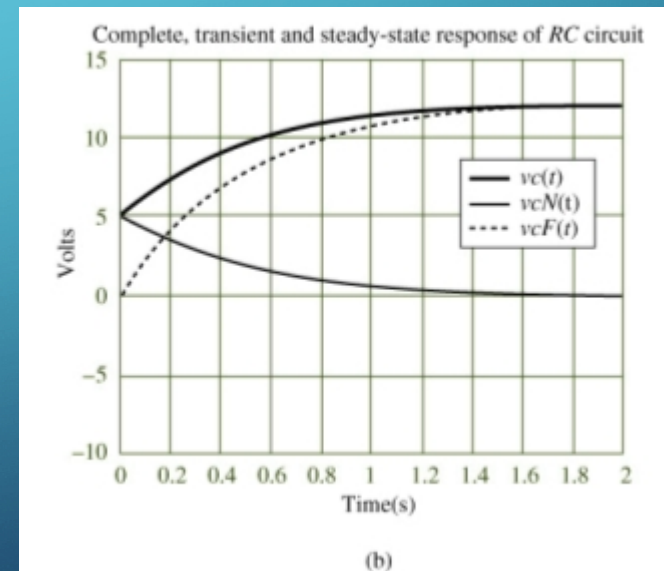
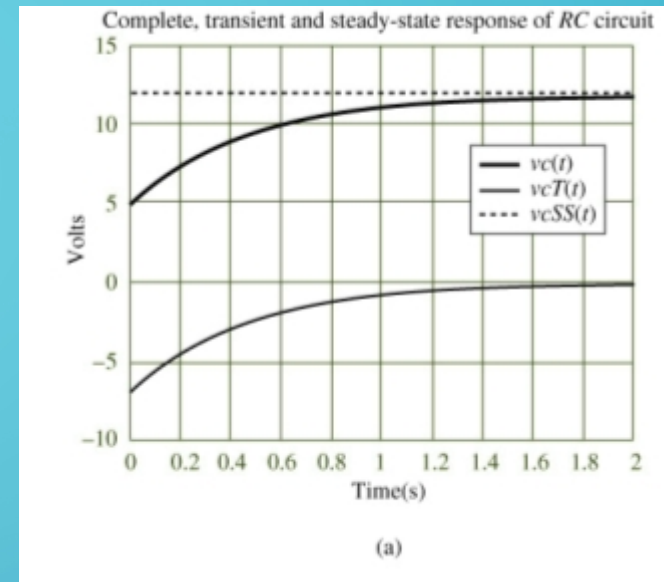
= natural response + forced response

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

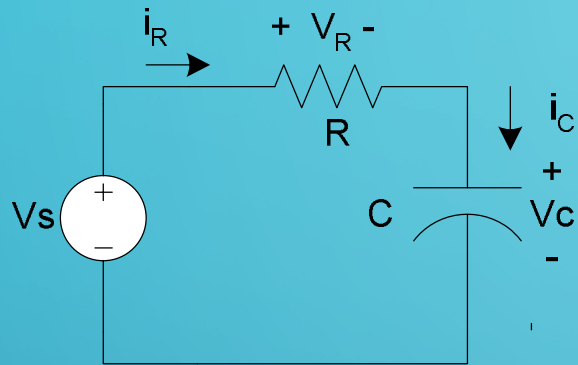
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- a). Complete, transient and steady state response
- b). Complete, natural, and forced responses of the circuit



CIRCUIT ANALYSIS FOR RC CIRCUIT



Apply KCL

$$i_R = i_C$$

$$i_R = \frac{v_s - v_R}{R}, i_C = C \frac{dv_C}{dt}$$

$$\frac{dv_C}{dt} + \frac{1}{RC} v_R = \frac{1}{RC} v_s$$

v_s is the source applied.

SOLUTION TO FIRST ORDER DIFFERENTIAL EQUATION

Consider the general Equation

$$\tau \frac{dx(t)}{dt} + x(t) = K_s f(t)$$

Let the initial condition be $x(t=0) = x(0)$, then we solve the differential equation:

$$\tau \frac{dx(t)}{dt} + x(t) = K_s f(t)$$

The complete solution consists of two parts:

- the homogeneous solution (natural solution)
- the particular solution (forced solution)