Today Topic is

Capacitor -2

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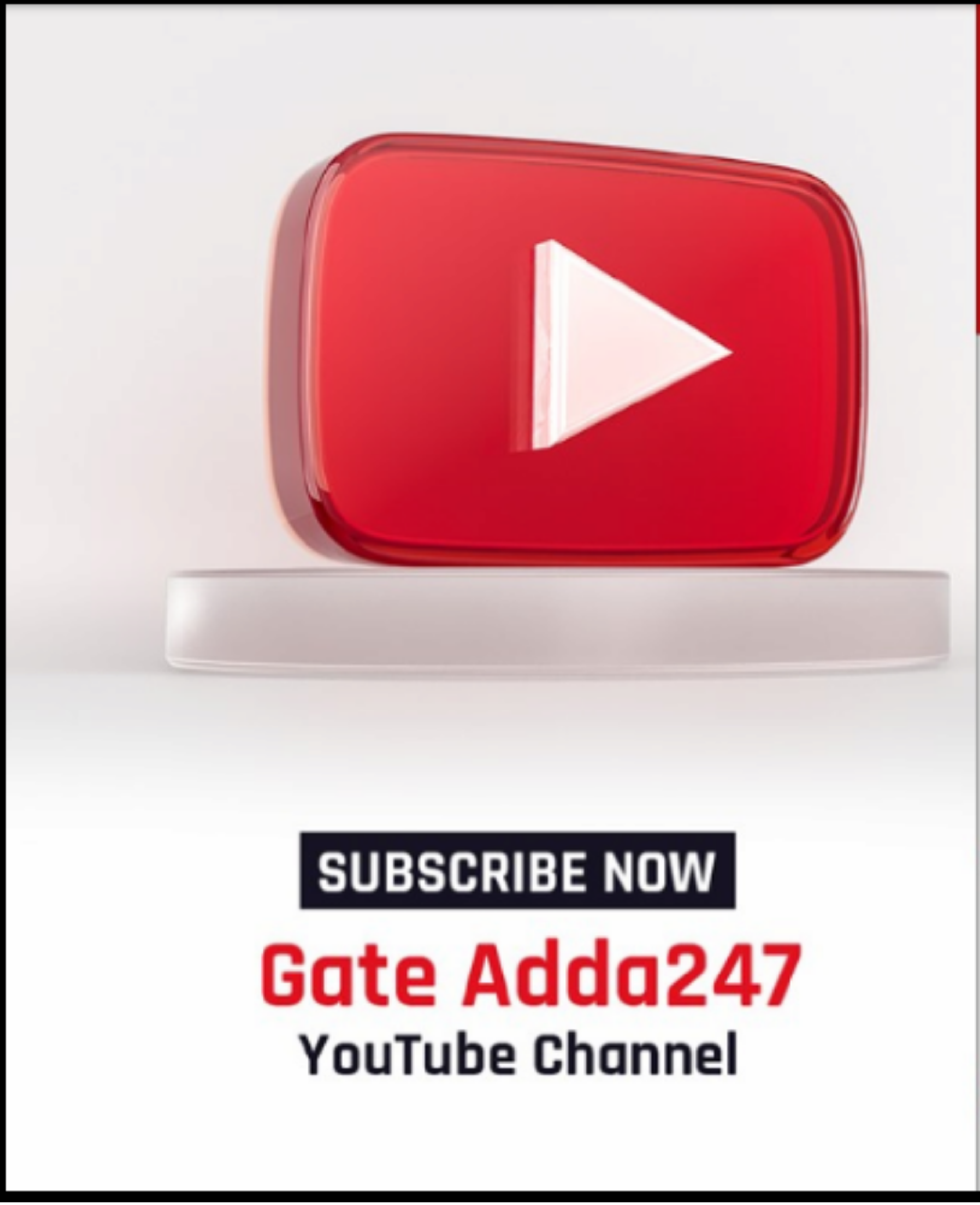
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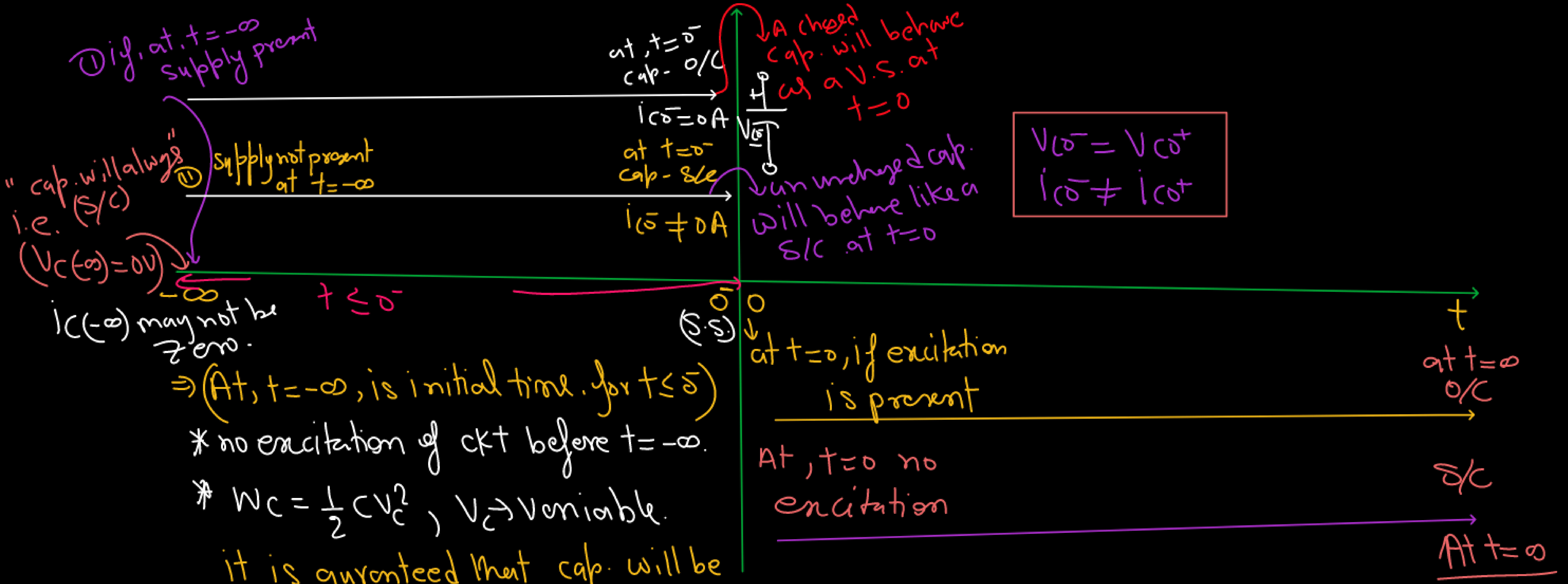
Behavior of Capacitor at different time instant with DC excitation



$V_{c0^-} = V_{c0^+}$

$i_{c0^-} \neq i_{c0^+}$

⇒ (At, t = −∞, is initial time. for t ≤ 0⁻)

* no excitation of ckt before t = −∞.

* $W_C = \frac{1}{2} C V_C^2$, $V_C \rightarrow$ variable.

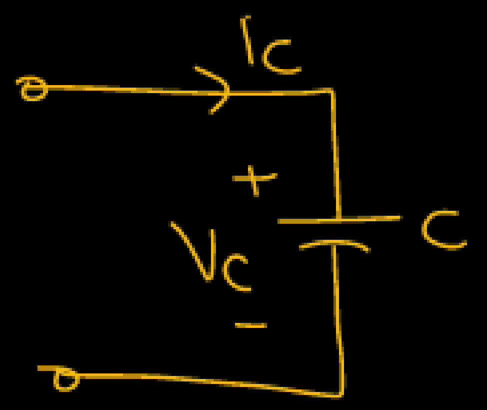
it is guranteed that cap. will be fully uncharged at, t = −∞

$$W_C(-\infty) = 0J = \frac{1}{2} C V_C^2$$

$$\therefore V_C(-\infty) = 0V$$

So, cap. always S/C at t = −∞

ex- Which of the following statement can be true-



✓ (a) $V_c(-\infty) = 0V$; Always.

✗ (b) $V_c(-\infty) \neq 0$; Always.

(c) $i_c(-\infty) = 0A$; Always

(d) $i_c(-\infty) \neq 0$; Always.

✓ (e) i_c at $t = -\infty$, may / maynot be Zero

ex-

⇒ which of the following time instant, can represent steady state time.

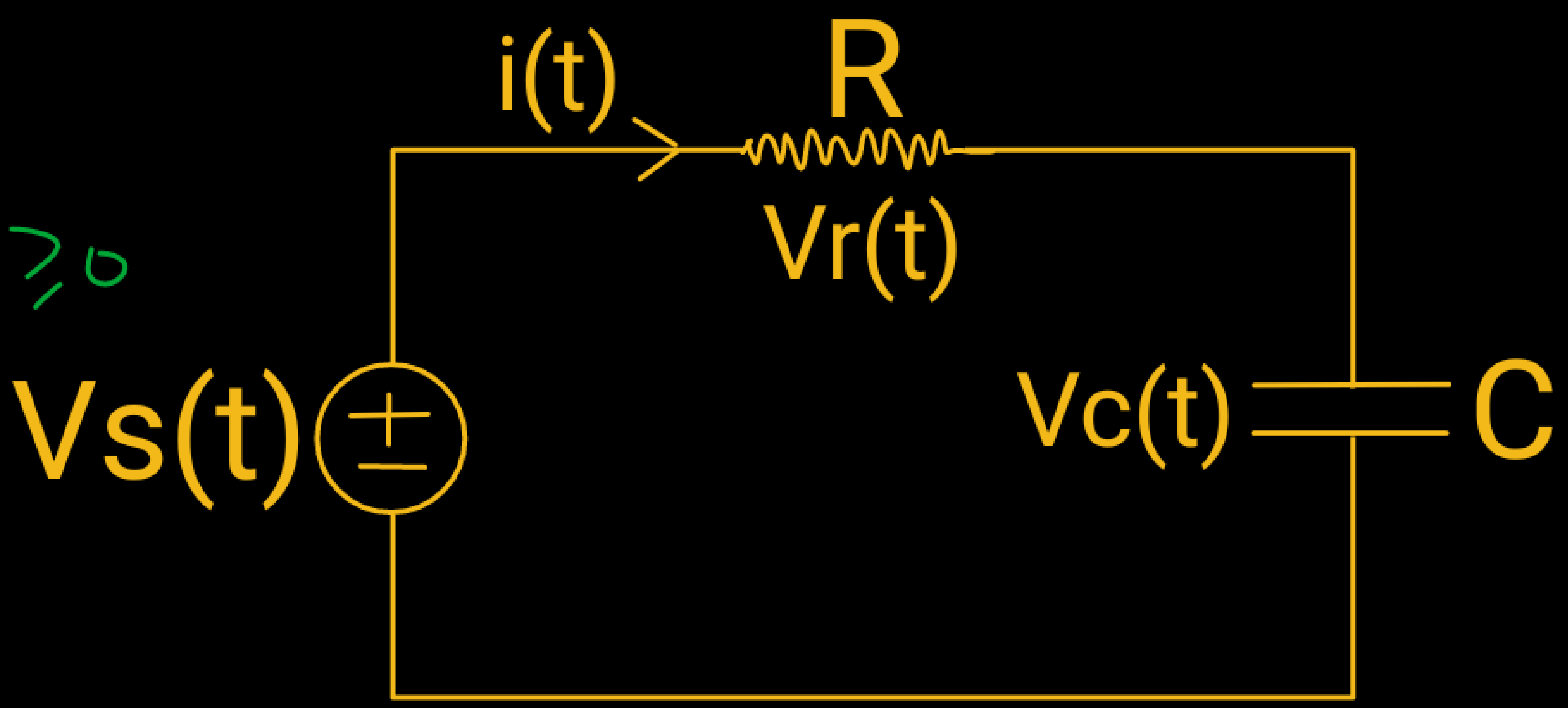
(a) $t = 0^-$ ✓ (b) At, $t = -\infty$ (c) at $t = 0^+$ (d) at, $t = \infty$ ✓

Solu^n S.S. time ⇒ $t = 0^-$, $t \leq 0^-$

$t = \infty$, $t \geq 0$

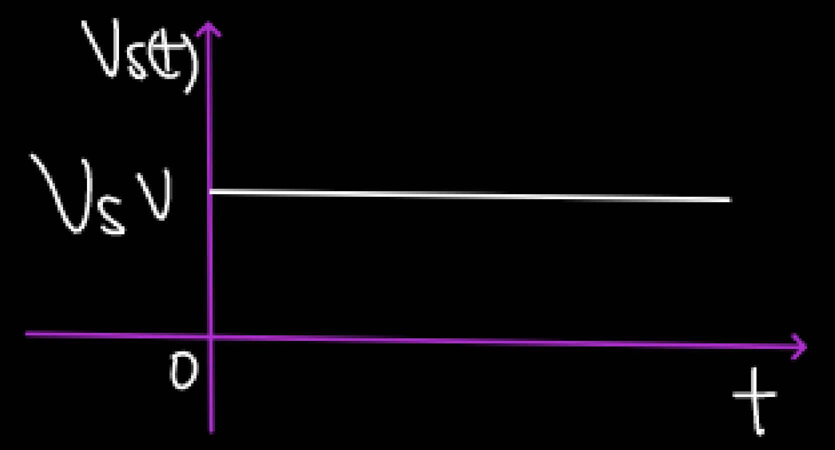
ex:- Draw the cap. Vol.

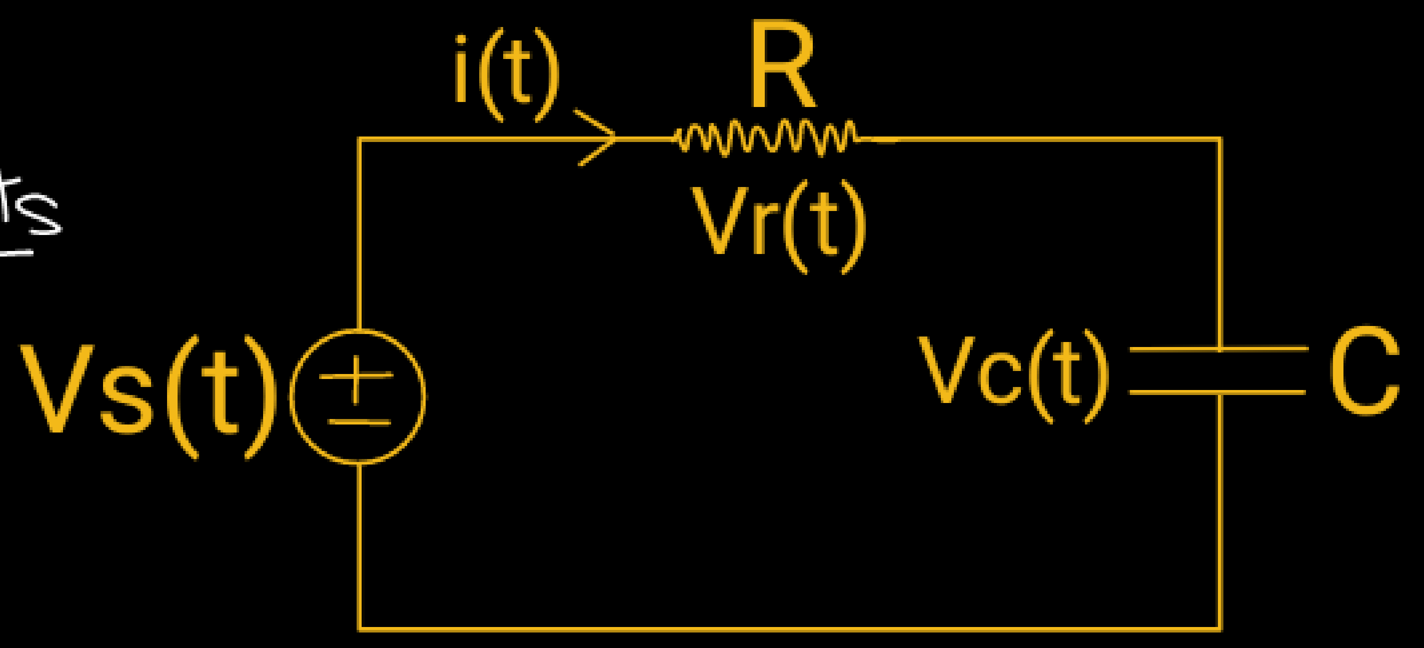
if $V_s(t) = 10t^2$ Volt ; $t \geq 0$



Determine all voltages and current Response in time domain alsso Draw all the Responsess

given $V_s(t) = V_s \cdot u(t)$ Volts





$V_s(t) = V_s \, V, \; t \geq 0$.

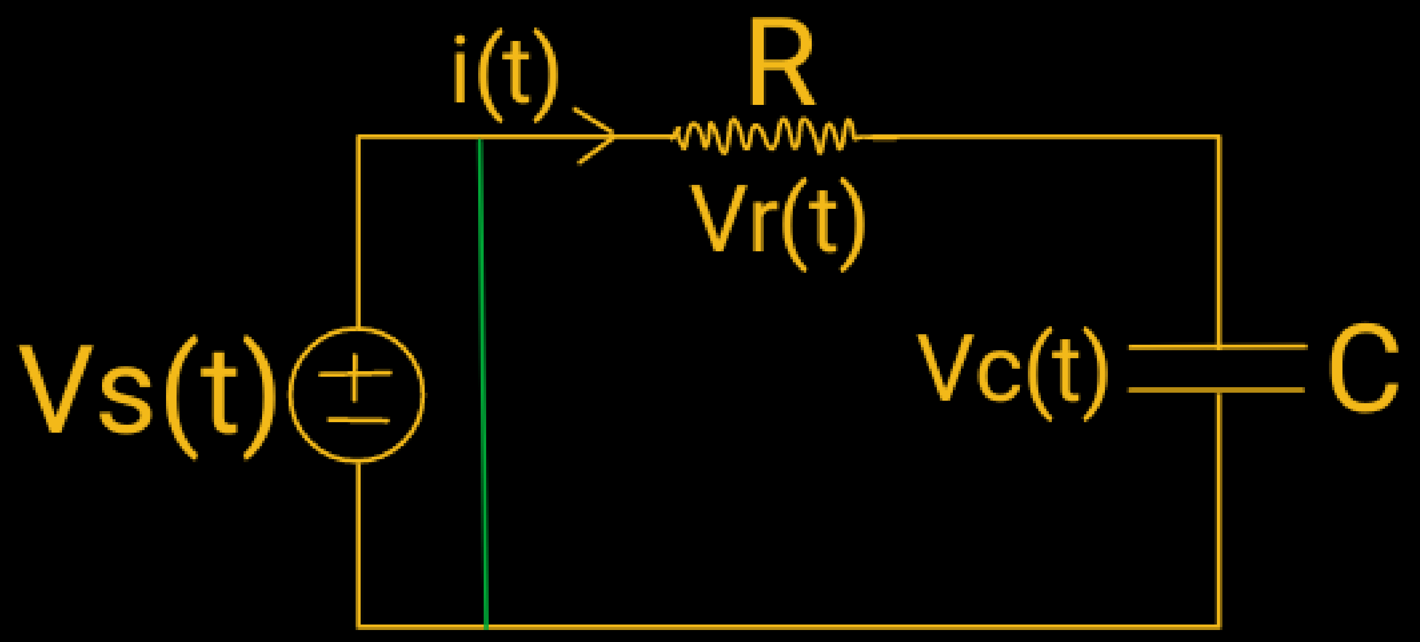
Case ①

⇒ ckt, $t \leq 0^-$

$V_s = 0V$

no excitation for $t \leq 0^-$

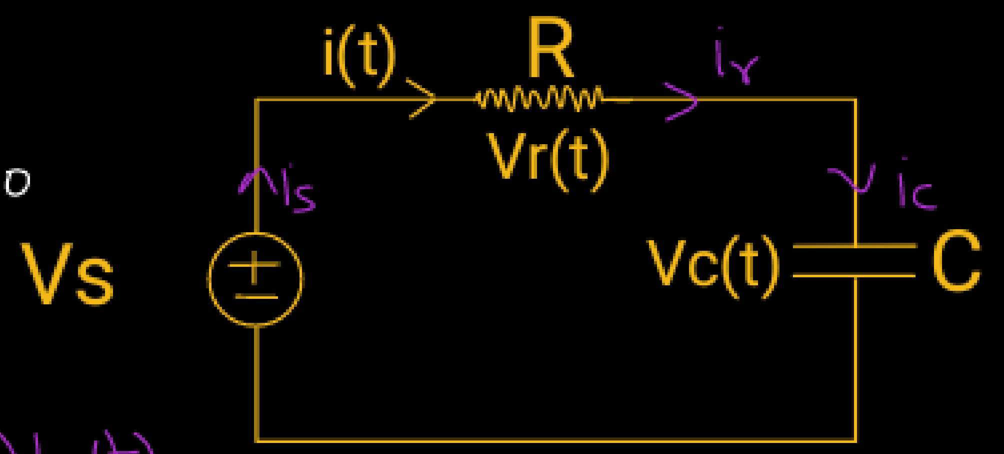
So cap. will not charge.



$$\left[\begin{array}{ll} V_C = 0V & -\infty \leq t \leq 0^- \\ i = 0A & \text{"} \\ V_R = 0V & \text{"} \end{array}\right]$$

ae (11) $t \geq 0$

$V_s = V_s$ Volts $t \geq 0$



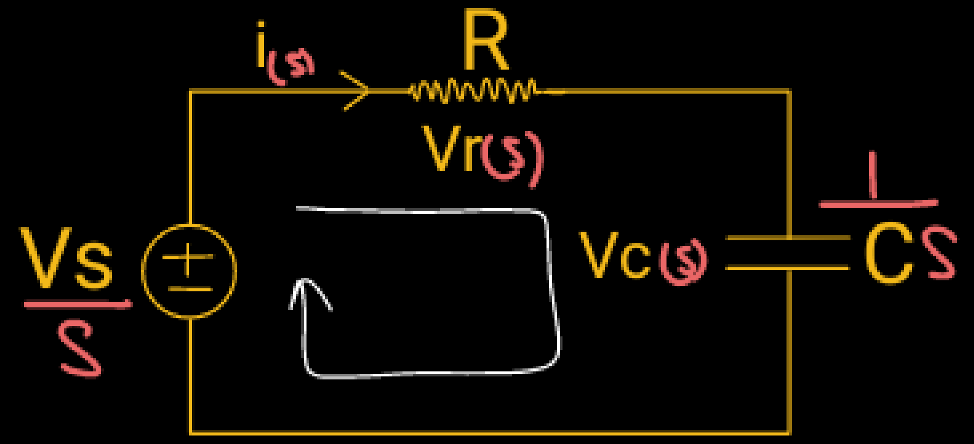
By KVL:-

$$V_s = V_r(t) + V_c(t)$$

$$i_r(t) = i_c(t) = i_s(t) = i(t)$$

⇒ given ckt in freq. domain:-

$[V_{C0^-} = 0V = V_{C0^+}]$



By KVL-

$$\frac{V_s}{S} = I_s\left(R + \frac{1}{CS}\right)$$

$$\frac{V_s}{S} = I_s\left(\frac{RCS+1}{CS}\right) = I_s\left(\frac{S+\frac{1}{RC}}{S\,C}\right)RC$$

$$\therefore I_s = \frac{V_s}{R}\left[\frac{1}{\left(S+\frac{1}{RC}\right)}\right]$$; take inv. Lap. trfm.

$$i(t) = \frac{V_s}{R} \cdot e^{-t/RC} = \frac{V_s}{R} \cdot e^{-t/\tau}$$

$i = C\frac{dv}{dt}$

time constant $= \tau = RC$

Unit of τ:

$\tau = RC$

$= \left(\frac{V}{A}\right)\left(\frac{A}{V}\right)$ sec resis. Vol.

$$V_r(t) = R \cdot i(t)$$

$$= R \cdot \frac{V_s}{R} \cdot e^{-t/\tau}$$

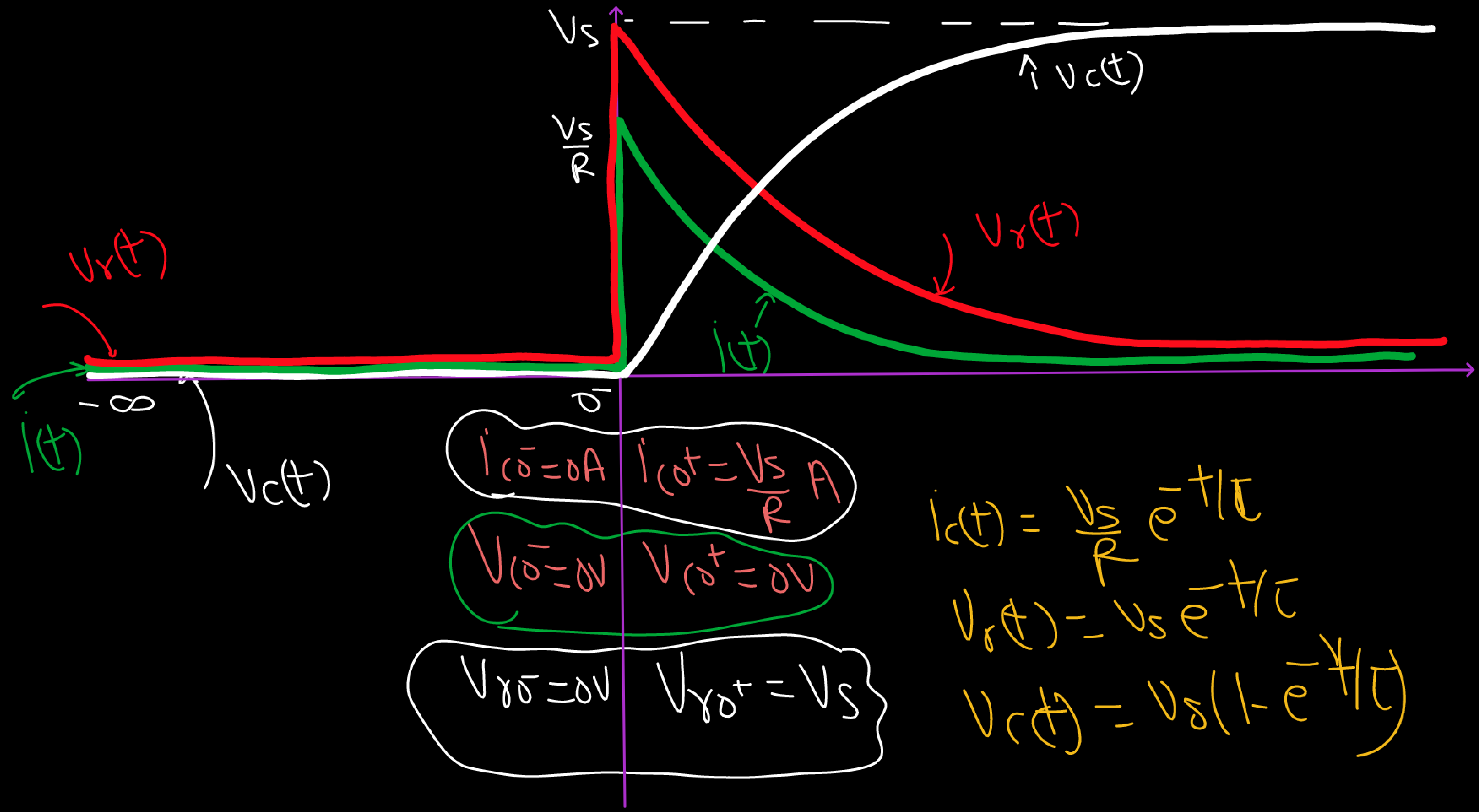
$$V_r(t) = V_s \cdot e^{-t/\tau} \quad ; \; t \geq 0$$

cap. Vol. :→

$$V_c(t) = \frac{1}{C}\int_0^t i_c(t)\, dt$$

$$= \frac{1}{C}\int_0^t \frac{V_s}{R} \cdot e^{-t/\tau}\, dt$$

$$V_c(t) = V_s\left(1 - e^{-t/\tau}\right) \quad ; \; t \geq 0$$



$$i_c(t) = \frac{V_s}{R} e^{t/\tau}$$

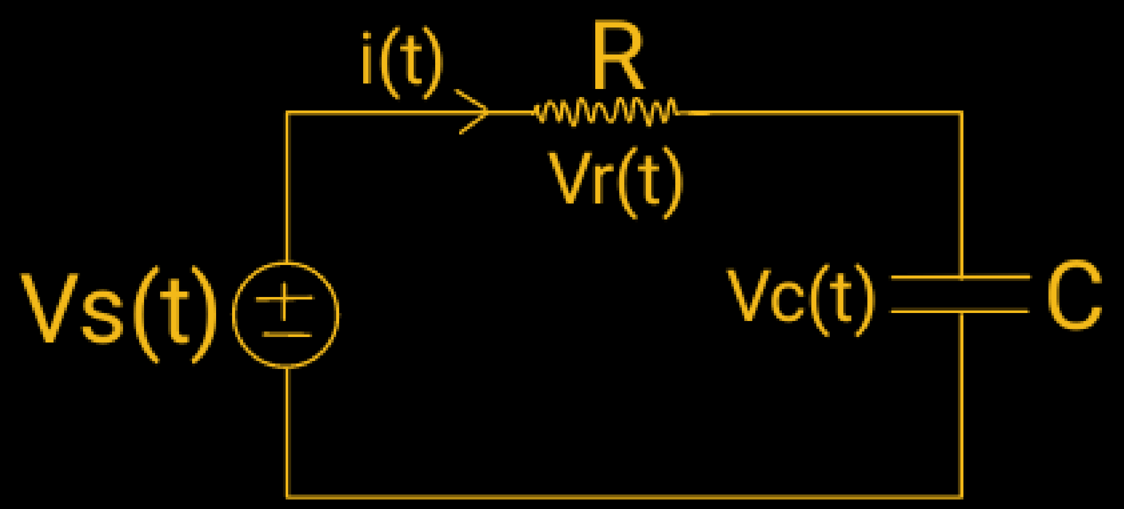
$$V_r(t) = V_s e^{t/\tau}$$

$$V_c(t) = V_s(1 - e^{-t/\tau})$$

Ex- calculate cap. Vol. at ⇒ $t = 2\,msec$ if $V_s(t) = 10\,u(t)\,V$

$R = 10\,\Omega$

$C = 0.1\,mF$



Soln ⇒ no excitation for ckt ; $t \le 0^-$

i.e. $V_c(0^-) = 0V$.

$\tau = RC$
$= 10 \times 0.1m$
$= 1\,msec$

$t \ge 0$

$$V_c(t) = V_s(1 - e^{-t/\tau})$$

$$= 10(1 - e^{-t/1m})$$

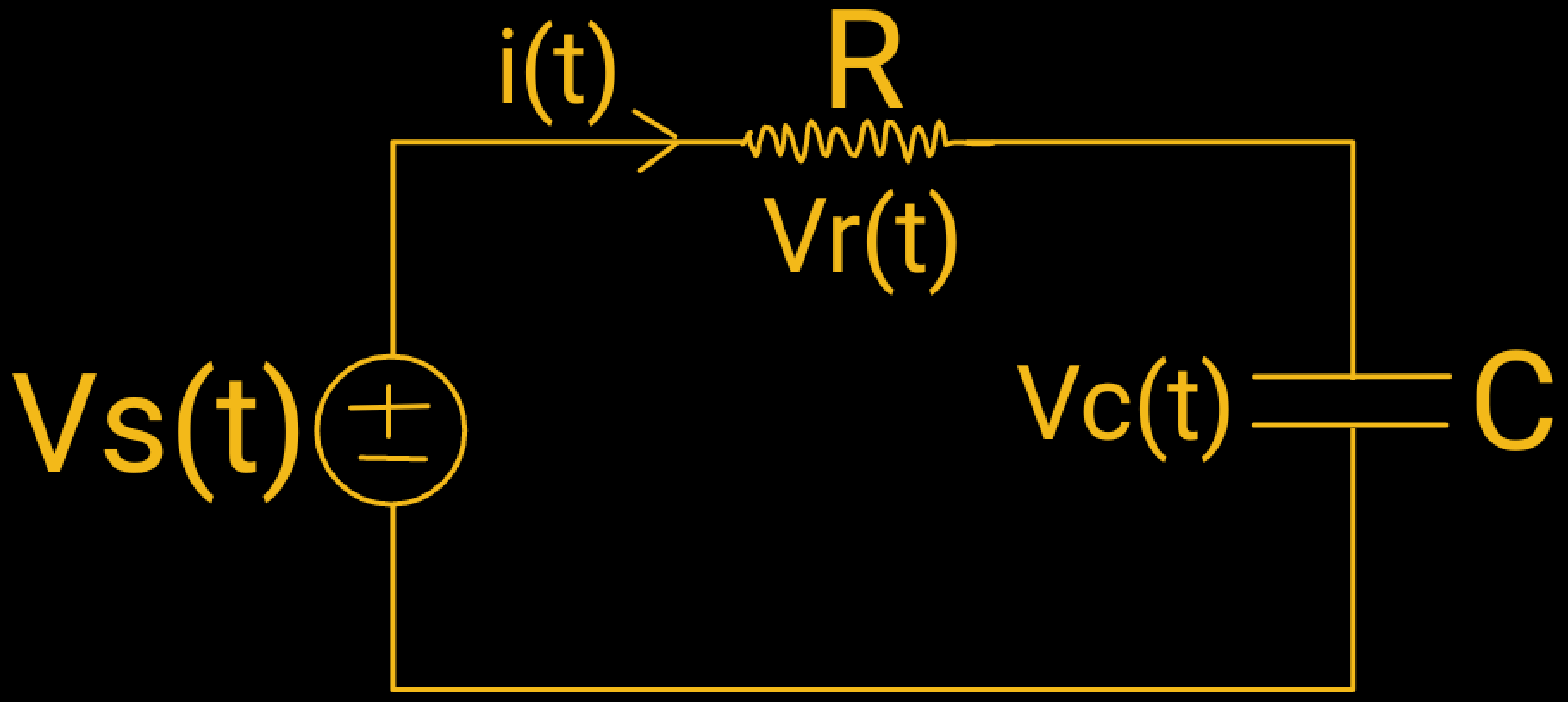
$$V_c(t) = 10(1 - e^{-1000t}) \quad ; t \ge 0$$

$$V_c\Big|_{t=2msec} = 10(1 - e^{-1000 \times 2m})$$

$$= 10(1 - e^{-2})$$

$$= 8.6466 \text{ Volts}$$

Determine all voltages and current Response in time domain alsso Draw all the Responsess



Determine all voltages and current Response in time domain alsso Draw all the Responsess