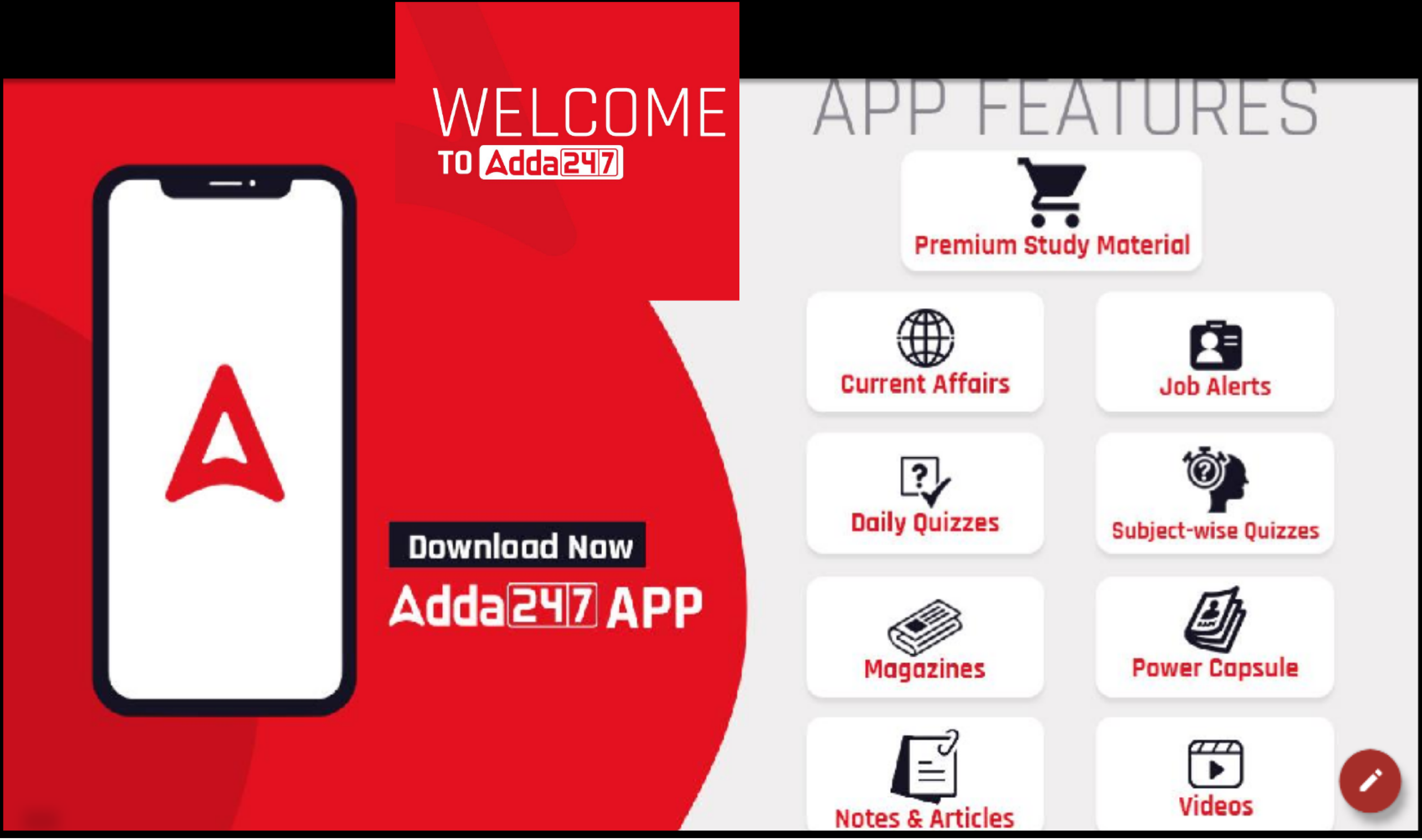
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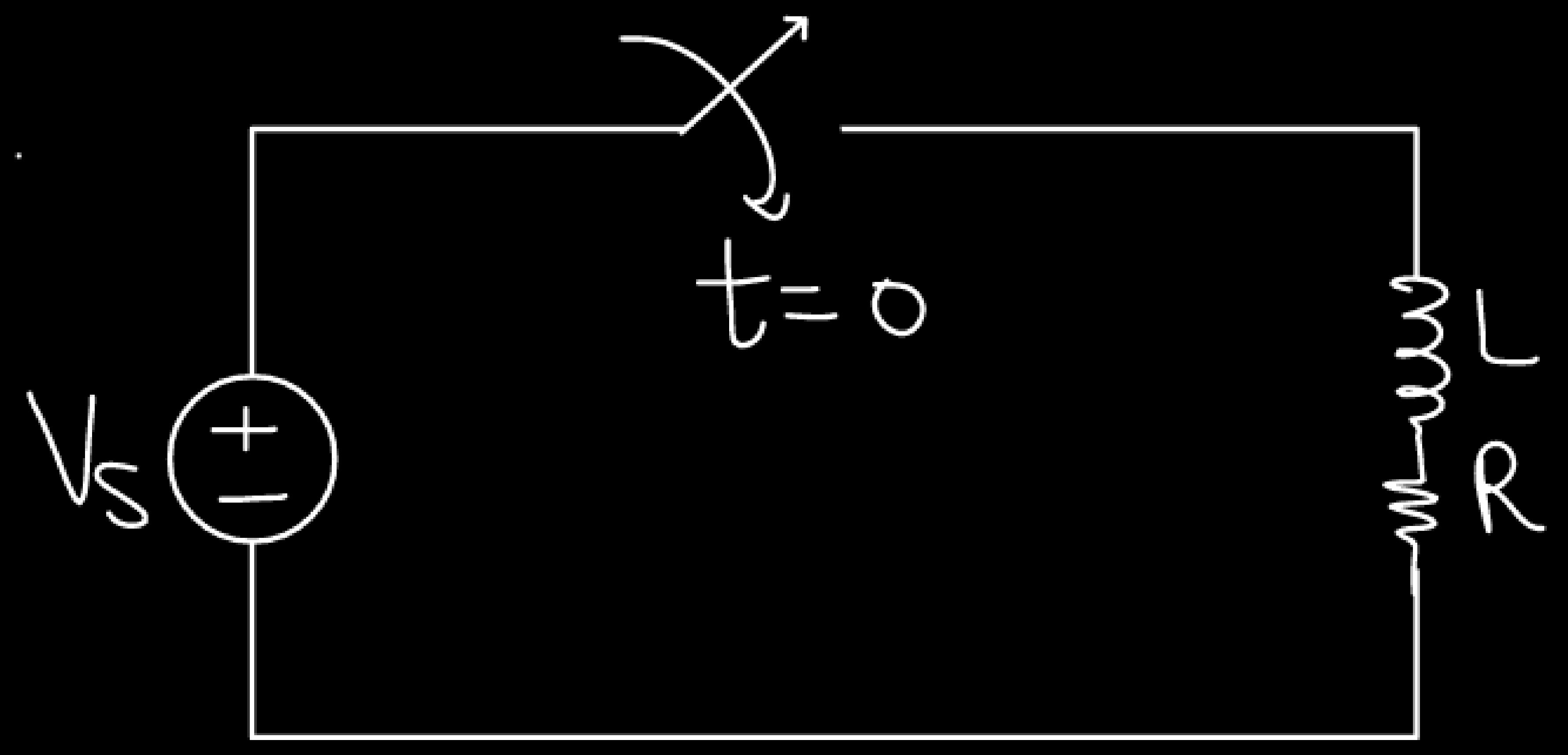
First order RL System with DC excitation

Inductor is initially unchaged.

$$\boxed{i_{L}(0^-) = 0 \text{ Amp}}$$

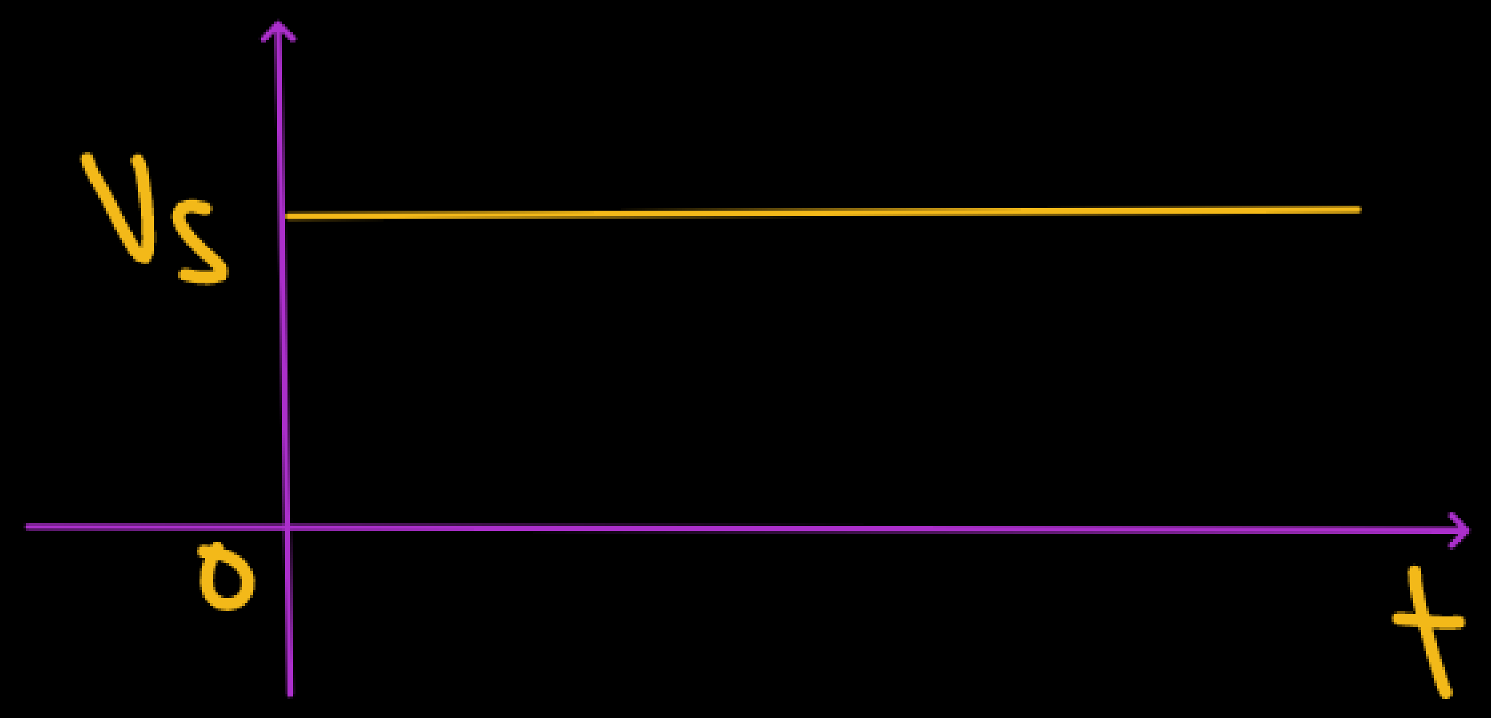


Task- to Draw inductor current, inductor Vol and resis. Vol.

Supply Vol ⇒ V_s ⇒ Pure D.C. Vol. ; $t \geq 0$

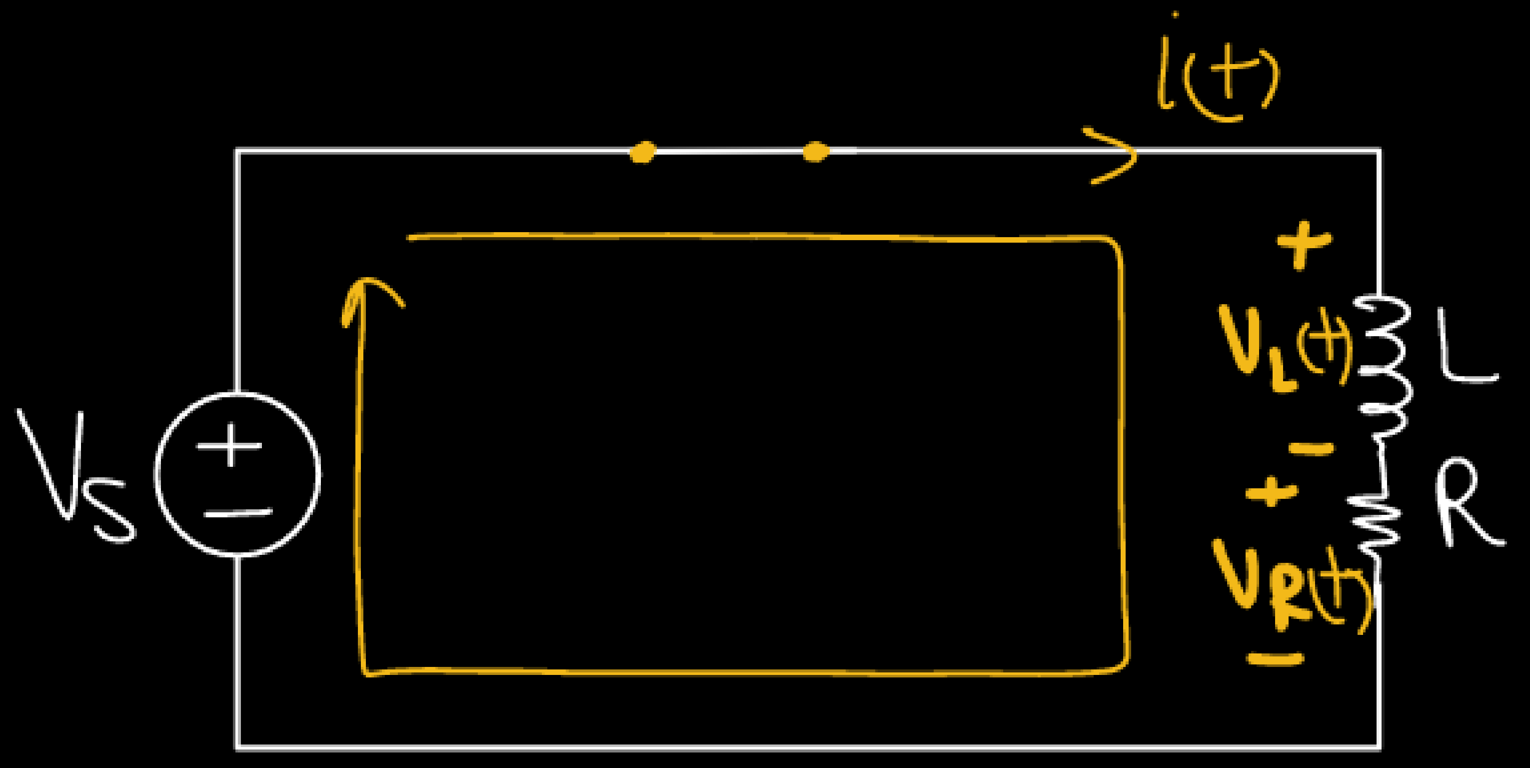
Supply Vol. = $V_s\, u(t)$

lap. trafm = $\dfrac{V_s}{S}$.



Analysis of circuit in time domain:-

$t \geq 0$; $SW \rightarrow$ closed.



By KVL $\Rightarrow$

$$V_s = V_L(t) + V_R(t) \quad \text{(I)}$$

By ohm's law.

$$V_R(t) = R\,i(t) \quad \text{(II)}$$

and

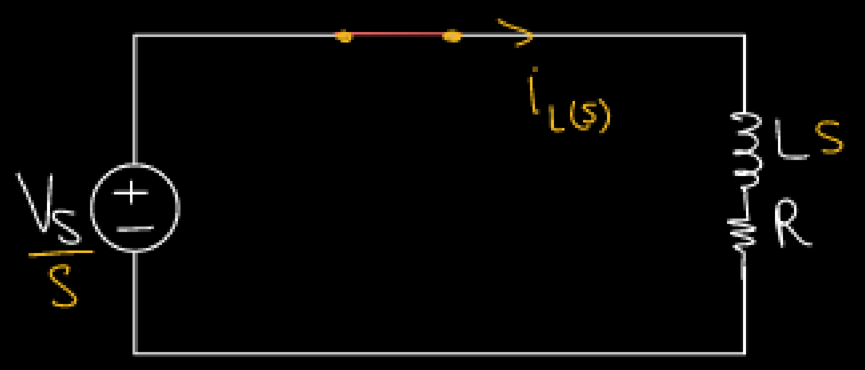
$$V_L(t) = L\frac{di_L(t)}{dt} \quad \text{; by F.L.O.I.} \quad \text{(III)}$$

from eqns (I), (II) and (III)

$$\boxed{V_S = R\,i(t) + L\frac{di_L(t)}{dt}}$$

Analysis of circuit :-

$t \geq 0$



By KVL:-

$$\frac{V_s}{S} = i_{L(s)}(R+SL)$$

$$\frac{V_s}{S} = i_{L(s)}\left[S+R/L\right]L$$

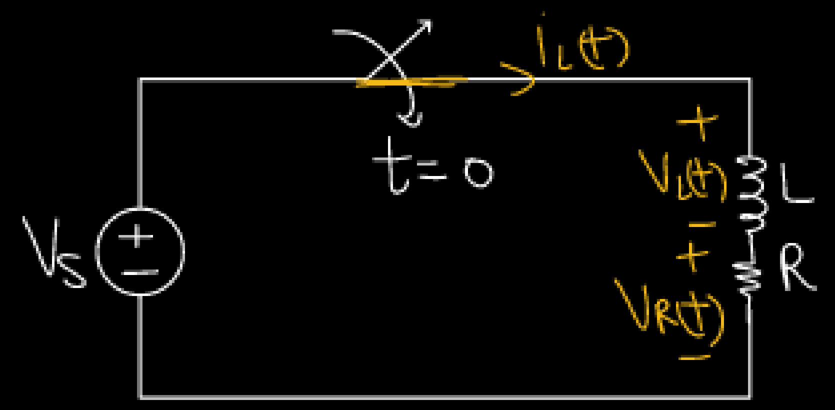
$$\therefore i_{L(s)} = \frac{V_s}{L}\left[\frac{1}{S(S+R/L)}\right]$$ Break by partial fraction.

$$i_{L(s)} = \frac{V_s}{R}\left[\frac{1}{S} - \frac{1}{(S+R/L)}\right]$$; take inverse lap. trafm.

$$\boxed{i_L(t) = \frac{V_s}{R}\left(1-e^{-R/L\,t}\right)}$$

$$\boxed{i_L(t) = \frac{V_s}{R}\left(1-e^{-t/\tau}\right)}$$; where $\tau = \frac{L}{R}$ Secs.

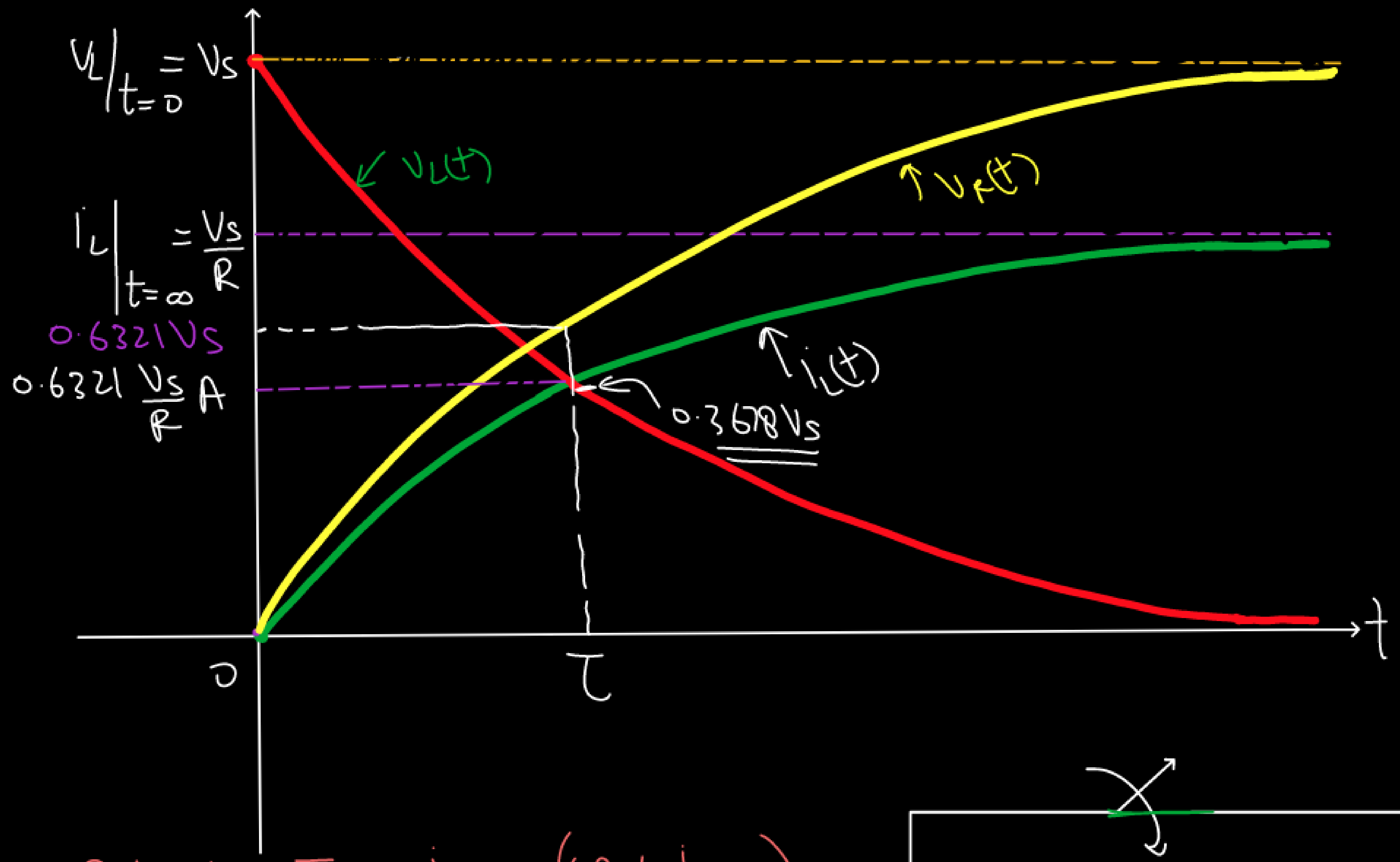
$$V_L(t) = L\frac{di_L(t)}{dt}$$

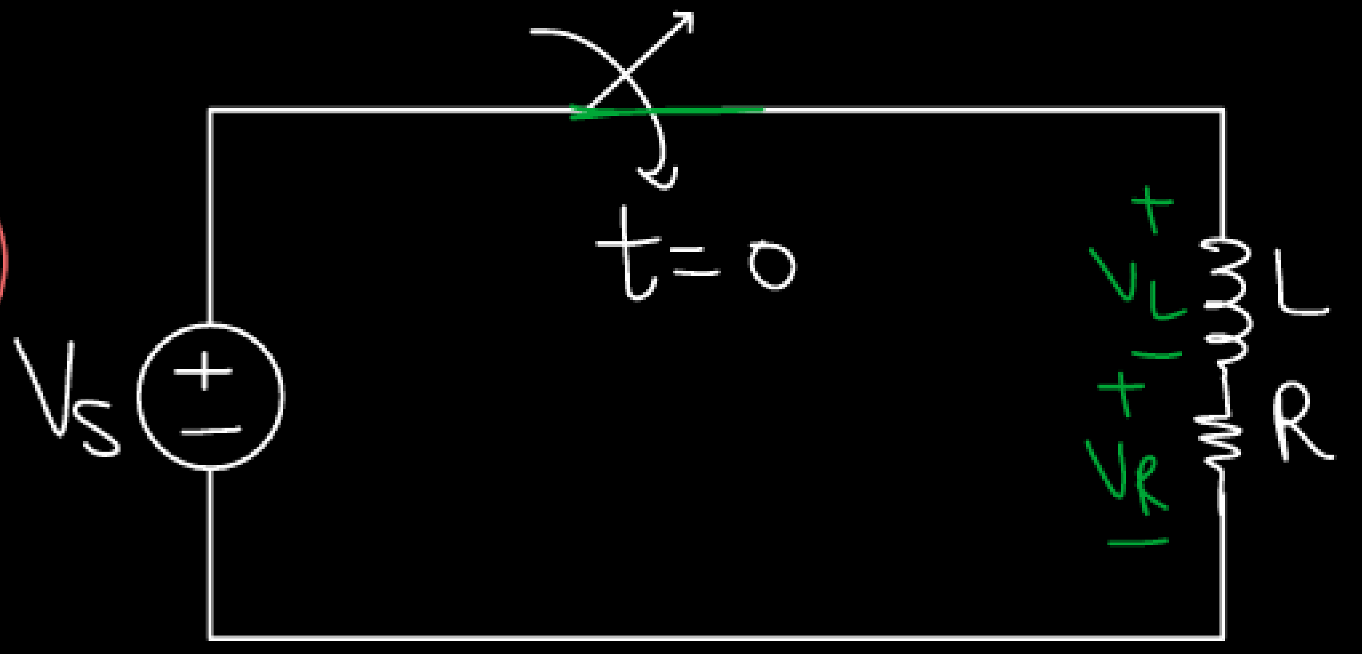


$$\boxed{V_L(t) = V_s \cdot e^{-t/\tau}}$$

$$\Rightarrow V_R(t) = R\, i_L(t) = R\left[\frac{V_s}{R}\left(1-e^{-t/\tau}\right)\right]$$

$$\boxed{V_R(t) = V_s\left(1-e^{-t/\tau}\right)}$$





At, $t=\tau$, $i_L = (63\%\ i_{L(ss)})$

$t=\tau$, $V_R = (63\%)V_s$

$$i_L(t) = \frac{V_s}{R}\left(1-e^{-t/\tau}\right)$$

$$V_s = V_R(t) + V_L(t)$$

$$i_L\Big|_{t=\tau} = \frac{V_s}{R}\left(1-e^{-1}\right) = 0.6321\frac{V_s}{R}$$

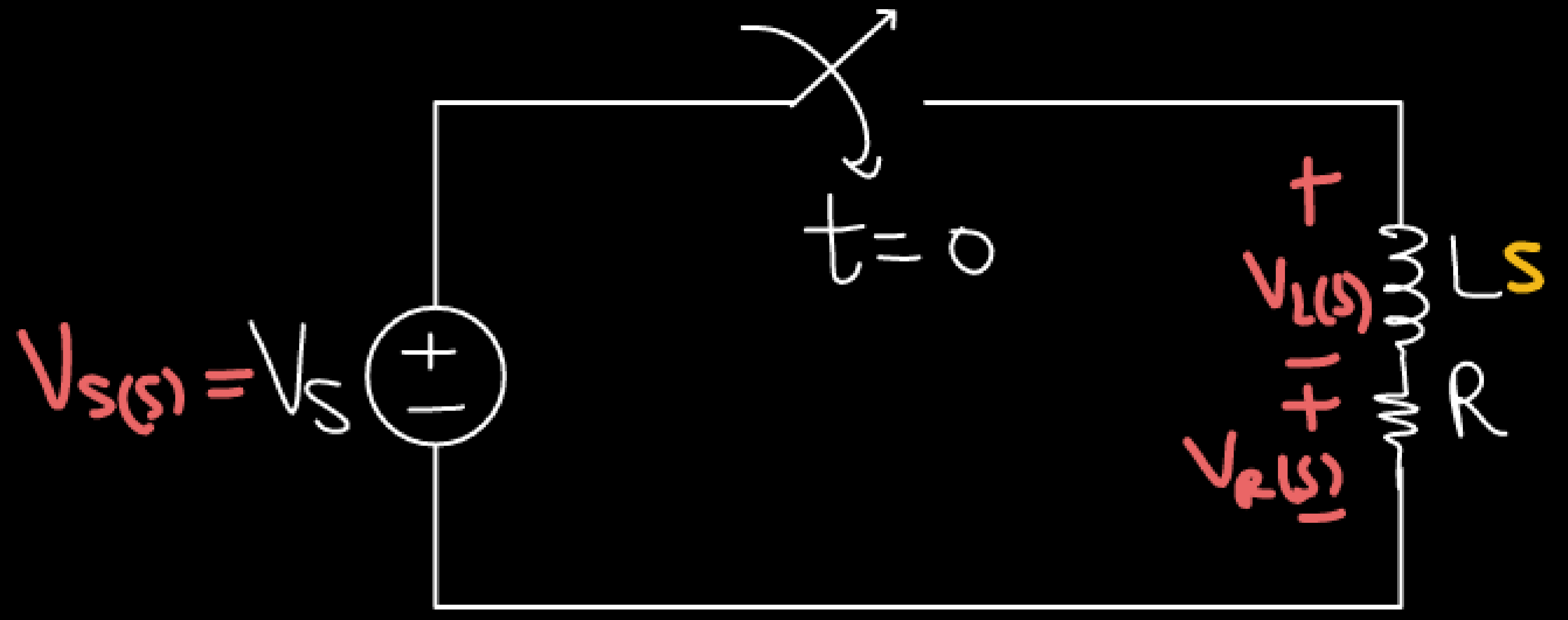
Trasfer function ÷

$$\frac{V_L(s)}{V_s(s)} = \frac{SL}{(R+SL)}$$

$$= \frac{SL}{\left[(S+R/L)\right]L}$$

$$= \frac{S}{\left[\left(\frac{S}{R/L}\right)+1\right]R/L}$$

$$= \frac{S(L/R)}{\left[\frac{L}{R}S+1\right]} = \frac{SK}{\left[S\tau+1\right]}$$; H.T.C.T.F.



* $V_s \rightarrow$ unknown D.C. Vol.

$$\frac{V_R(s)}{V_s(s)} = \frac{R}{(SL+R)} = \frac{(R/L)}{(S+R/L)} = \frac{(R/L)}{\left[\frac{S}{(R/L)}+1\right]R/L} = \frac{1}{(S\tau+1)}$$

$$\frac{V_s(s)}{I_s(s)} = (R+SL) = (S+R/L)L$$

inductor current ⇒

$$i_L(t) = \frac{V_s}{R}\left(1 - e^{-R/L\,t}\right)$$

$$i_L(t) = i_L(\infty)\left(1 - e^{-t/\tau}\right)$$

$$i_L(t) = i_{L(ss)}\left(1 - e^{-t/\tau}\right)$$

inductor's Vol ⇒

$$V_L(t) = V_s \cdot e^{-t/\tau}$$

$$V_L(t) = V_{L0^+}\, e^{-t/\tau}$$

$$V_L(t) = V_L\big|_{initial} \cdot e^{-t/\tau}$$