Power System Transients

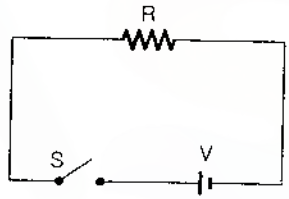
8

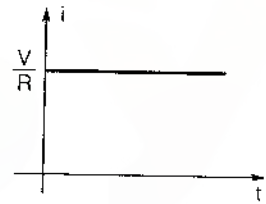
Transient in Simple Circuits

The transients will depend upon the driving source, whether it is d.c. source or an a.c. source

DC Source

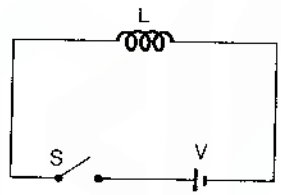
1. Resistance only

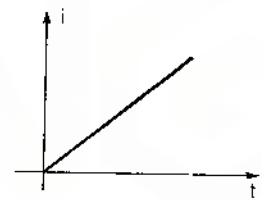




Transient current: $$I = \frac{V}{R}$$

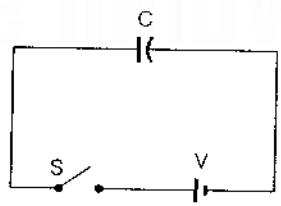
2. Inductance only

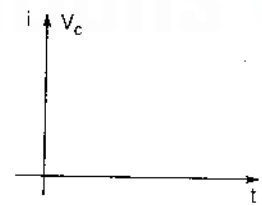




Transient current: $$i(t) = \frac{V}{L}t$$

3. Capacitance only

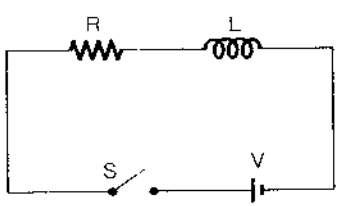


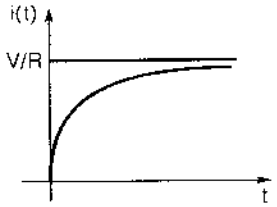


Transient current: $$I(s) = \frac{V(s)}{Z(s)} = \frac{V}{s} \cdot sC = VC$$

which is an impulse of magnitude VC.

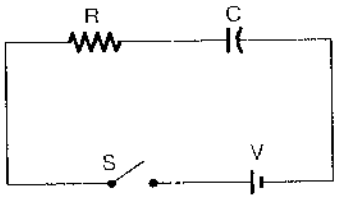
4. R-L circuit

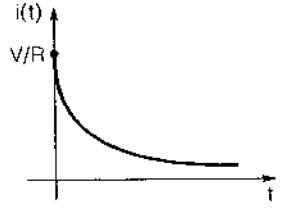




Transient current: $$i(t) = \frac{V}{R}\left[1 - \exp\left(-\frac{R}{L}t\right)\right]$$

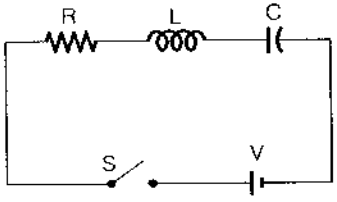
5. R-C circuit





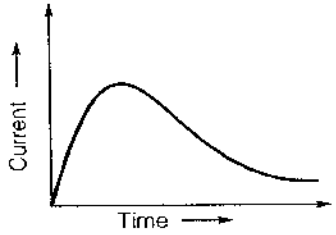
Transient current: $$i(t) = \frac{V}{R}\exp\left(-\frac{t}{RC}\right)$$

6. R-L-C circuit



Transient current

$$i(t) = \frac{V}{2bL}\left[e^{-(a-b)t} - e^{-(a+b)t}\right]$$



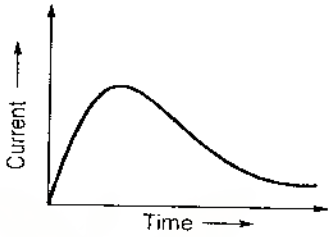
where, $a = \frac{R}{2L}$ and $b = \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}$

(a) Case-1

When b is real

then $$\frac{R^2}{4L^2} > \frac{1}{LC}$$

and $$i(t) = \frac{V}{2bL}\left[e^{-(a-b)t} - e^{-(a+b)t}\right]$$



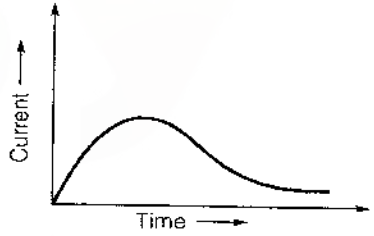
(b) Case-2

When b = 0

$$i(t) = \frac{V}{2bL}\left(e^{-at} - e^{-at}\right)$$

which is indeterminate form or $\left(\frac{0}{0}\right)$ form

$$i(t) = \frac{V}{L}te^{-at}$$

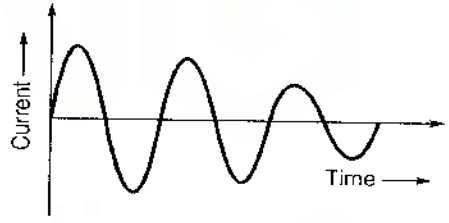


(c) Case-3

When b is imaginary

then $$\frac{1}{LC} > \frac{R^2}{4L^2}$$

and $$i(t) = \frac{V}{2bL}e^{-at} \cdot 2\sin kt$$



where , $k = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$

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