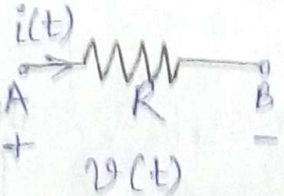
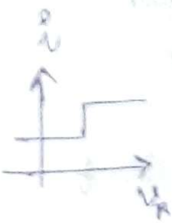
18/07/16

Resistive element $I = \frac{V}{R}$

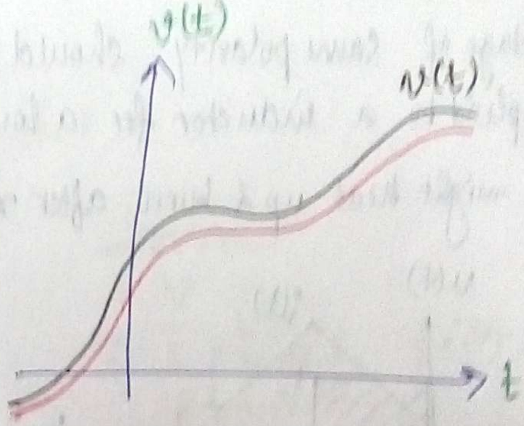
The value of current in a purely resistive networks depends on the current value of voltage (and not on voltage applied previously)

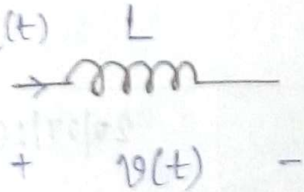


$v(t) = v_{AB}(t)$



$v(t) = iR$





$v(t) = L\frac{di}{dt}$ $di = \frac{1}{L} v(t)dt$

$$\boxed{i(t) = \frac{1}{L}\int_{-\infty}^{t} v(t)dt}$$

Volt-sec

Current through inductor cannot jump instantaneously.

$i(t^-) = i(t^+)$

$$i(t) = \frac{1}{L}\int_{-\infty}^{0^-} v(t)dt + \frac{1}{L}\int_{0^-}^{0^+} v(t)dt + \frac{1}{L}\int_{0^+}^{t} v(t)\,dt$$

$$i(t) = \frac{1}{L}\int_{-\infty}^{0^-} v(t)dt + 0 + \frac{1}{L}\int_{0^+}^{t} v\,dt$$

v(t) is a normal function (not an impulse function) eg δt

any well behaved function

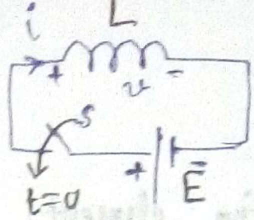
$$\boxed{i(t) = i(0^-) + \frac{1}{L}\int_{0^+}^{t} v\,dt}$$ → current in an inductor at time t

at $t=0^+$

$$i(0^+) = i(0^-) + \frac{1}{L}\int_{0^+}^{t=0^+} v(t)\,dt$$

$$\Rightarrow \boxed{i(0^+) = i(0^-)}$$ Property of inductor

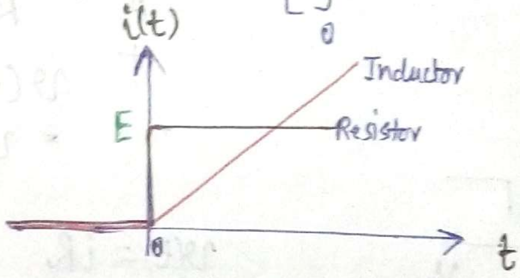
* Inductor is a device with memory.
  - It remembers what you did earlier to it.



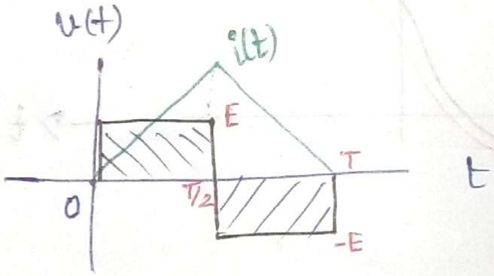
* $i(0^-) = 0$

$$\Rightarrow i(t) = \frac{1}{L}\int_{-\infty}^{t} v(t)\,dt$$

$$= \frac{1}{L}\int_{0}^{t} E\,dt = \frac{1}{L}Et$$



* Voltage of same polarity should not be applied to a inductor for a long time.
(It might heat up & burn after rated value)



i(T) goes back to zero if volt-sec is same
(Area is same)

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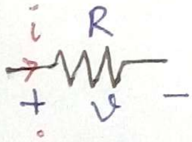
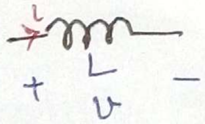


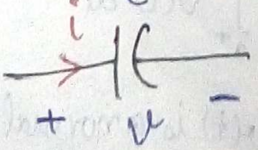
$$\boxed{i = \frac{V}{R}}$$



$$i(t) = \frac{1}{L}\int_{-\infty}^{t} v\,dt = \frac{1}{L}\int_{-\infty}^{0^-} v\,dt + \cancel{\frac{1}{L}\int_{0^-}^{0^+} v\,dt}^{\,0} + \frac{1}{L}\int_{0^+}^{t} v\,dt$$

$$\boxed{i(t) = i(0^-) + \frac{1}{L}\int_{0^+}^{t} v\,dt}$$

$$\boxed{i(0^+) = i(0^-)}$$



$$v = q/c$$

$$i = c\,\frac{dv}{dt}$$

$$v(t) = \frac{1}{c}\int_{-\infty}^{t} i\,dt$$

$$v(t) = \frac{1}{c}\int_{-\infty}^{0^-} i\,dt + \frac{1}{c}\int_{0^-}^{0^+} i\,dt + \frac{1}{c}\int_{0^+}^{t} i\,dt$$

i = Excitation = Input

v = Output = Voltage

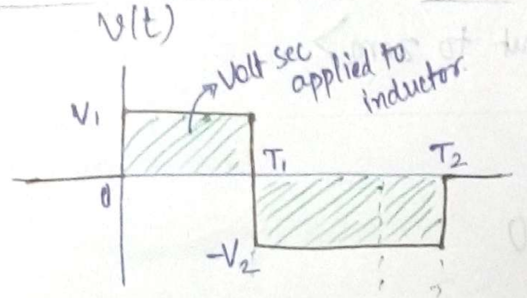
for normal well behaved function,

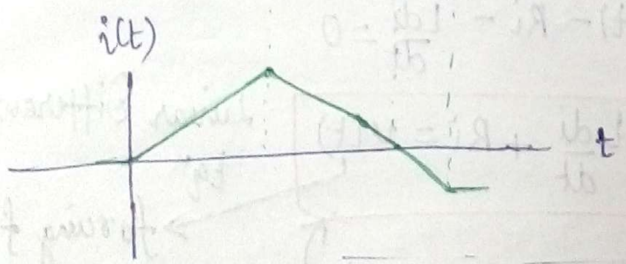
$$\int_{0^-}^{0^+} i\,dt = 0.$$

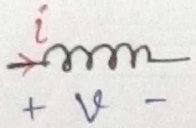
$$\Rightarrow \quad v(t) = \frac{1}{c}\int_{-\infty}^{0^-} i\,dt + \frac{1}{c}\int_{0^+}^{t} i\,dt$$

$$v(0^+) = \frac{1}{c}\int_{-\infty}^{0^-} i\,dt + \cancel{\frac{1}{c}\int_{0^+}^{0^+} i\,dt}^{\,\to 0} = \frac{1}{c}\int_{-\infty}^{0^-} i\,dt$$

$$\Rightarrow \quad \boxed{v(0^+) = v(0^-)}$$

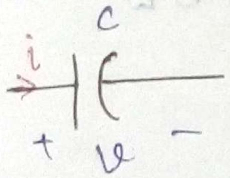




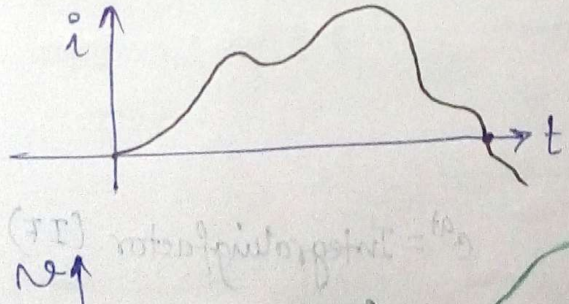


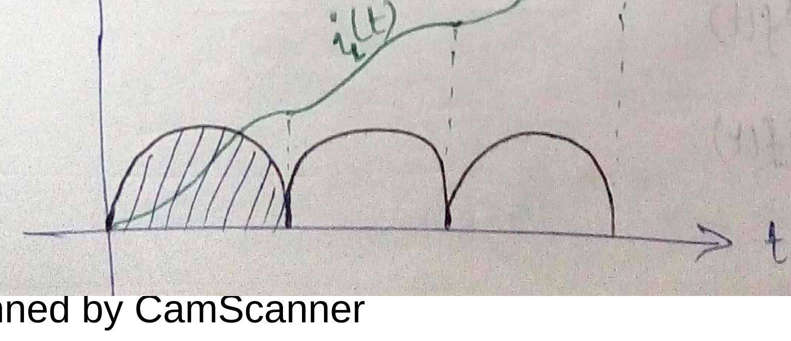
$$i = \frac{1}{L}\int_0^t v\,dt \qquad \{i(0^-) = 0.\}$$

$$v = L\frac{di}{dt} \qquad \frac{di}{dt} = \frac{v}{L}$$

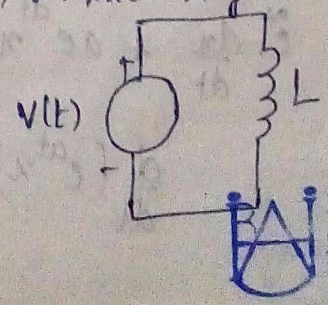


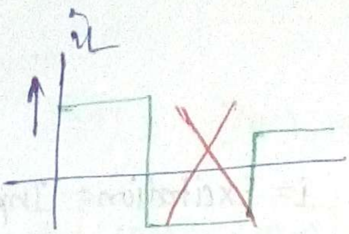
$$i = c\,\frac{dv}{dt} \qquad \frac{dv}{dt} = \frac{i}{c}$$

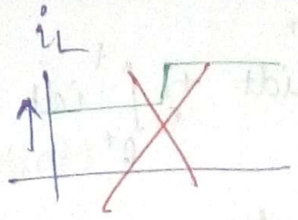


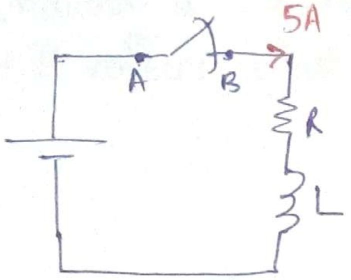


If positive voltage is applied to inductor, current in a inductor keeps on increasing.







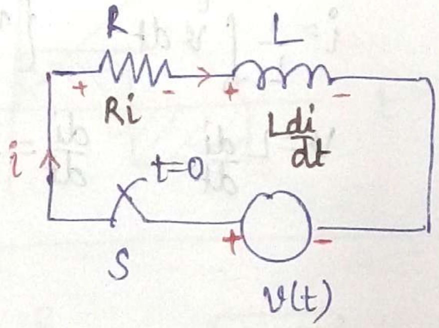


at $t=0$, circuit is opened.

$\Rightarrow \frac{di}{dt}$ is very large.

∞ voltage develops between A, B which may result in flash (due to air breakdown).

<Because current in an inductor cannot instantly turn out to zero>



$i(0^-)=0$

$v(t) - Ri - L\frac{di}{dt} = 0$

$$\boxed{L\frac{di}{dt} + Ri = v(t)}$$

Linear Differential Eq^n

forcing f^n.

1 $\underbrace{\text{Energy storing element}}$ $\Rightarrow$ 1st order D.E.

Inductor

Capacitor

1st order Linear D.E.

$$\frac{dx}{dt} + \overset{\text{constant}}{a}x = f(t)$$

e^{at} = Integrating factor. (IF)

$$e^{at}\frac{dx}{dt} + ae^{at}x = e^{at}f(t)$$

$$\frac{d}{dt}(e^{at}x) = e^{at}f(t)$$

$$\int d(e^{at}x) = \int e^{at} f(t)\, dt$$

$$\boxed{e^{at}x = \int e^{at} f(t)\, dt + \underset{\text{Const.}}{C}}$$

$$\boxed{x(t) = \underbrace{e^{-at}\int e^{at} f(t)\, dt}_{\text{PI (Particular Integral)}} + \underbrace{Ce^{-at}}_{x_n(t)}}$$

PI (Particular Integral) Response due to forcing f^n → $x_f(t)$

$x_n(t)$ → Natural Response

To get $x_n(t)$, $f(t) = 0$

$$\frac{dx}{dt} + ax = 0 \quad \text{or} \quad D \equiv \frac{d}{dt}$$

$$(D+a)x = 0$$

Ch. eq^n. $\quad m + a = 0$

$$m = -a$$

$$x_n(t) = ce^{mt} = ce^{-at}$$

$$\Rightarrow \frac{d}{dt}(ce^{-at}) + a(ce^{-at}) = 0.$$

PI or Response due to forcing f^n.

$$x_f(t) = e^{-at}\int \underset{\text{II}}{e^{at}}\, \underset{\text{I}}{f(t)}\, dt$$

$$= e^{-at}\left[f(t)\frac{e^{at}}{a} - \int \frac{df}{dt}\frac{e^{at}}{a}dt\right]$$

$$= \frac{1}{a}f(t) - \frac{e^{-at}}{a}\int \underset{\text{I}}{\frac{df}{dt}}\, \underset{\text{II}}{e^{at}}\, dt$$

$$= \frac{1}{a}f(t) - \frac{e^{-at}}{a}\left[\frac{df}{dt}\frac{e^{at}}{a} - \int \frac{d^2f}{dt^2}\frac{e^{at}}{a}dt\right]$$

$$= \frac{1}{a}f(t) - \frac{1}{a^2}\frac{df}{dt} + \frac{e^{-at}}{a^2}\int \frac{d^2f}{dt^2}e^{at}dt$$

$x_f(t)$

(Responce due to forcing function) will be linear combination of forcing function and its higher order derivatives

$$\Rightarrow \boxed{x_f(t) = K_0 f(t) + K_1 \frac{df}{dt} + K_2 \frac{d^2 f}{dt^2} + \ldots \infty}$$

$K_0 = \frac{1}{a}$, $K_1 = -\frac{1}{a^2}$, ... $\left(K_n = (-1)^n a^{-(n+1)}\right)$ ...

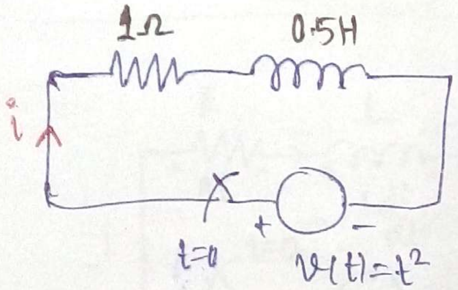
* $\frac{dx}{dt} + 3x = f(t)$

$$\boxed{x(t) = ce^{-3t} + K_0 f + K_1 \dot{f} + K_2 \ddot{f} + \ldots \infty}$$

$\left(\dot{f} = \frac{df}{dt}\right)$

$\left(\ddot{f} = \frac{d^2 f}{dt^2}\right)$

*



$i(0^-) = 0 \Rightarrow i(0^+) = 0$

$1 i + 0.5 \frac{di}{dt} = t^2$

$\frac{di}{dt} + 2i = 2t^2$

Ch. eqn. $m + 2 = 0 \Rightarrow m = -2$

$i(t) \equiv x(t) = ce^{-2t} + \underbrace{K_0 t^2 + K_1 t + K_2}_{x_f}$

$i(0) = 0 = ce^{-0} + 0 + K_2$

$\Rightarrow c = -K_2$ — (1)

$$\frac{d}{dt}\left(ce^{-2t} + K_0 t^2 + K_1 t + K_2\right) + 2\left(ce^{-2t} + K_0 t^2 + K_1 t + K_2\right) = 2t^2$$

$$2K_0 t + K_1 + 2K_0 t^2 + 2K_1 t + 2K_2 = 2t^2$$

$$2\underbrace{(K_0 - 1)}_{(2)} t^2 + 2\underbrace{(K_0 + K_1)}_{(3)} t + \underbrace{(K_1 + 2K_2)}_{(4)} = 0$$

$\boxed{K_0 = 1}$

$\boxed{K_1 = -K_0 = -1}$

$2K_2 = -K_1 \Rightarrow \boxed{K_2 = -1/2 = c}$

* $\frac{di}{dt} + 2i = 5\sin\omega t$

$\Rightarrow i = ce^{-2t} + A\sin\omega t + B\cos\omega t$

2nd order diff. eq^n

$$\frac{d^2x}{dt^2} + a\frac{dx}{dt} + bx = f(t)$$

[* When characteristic Roots are distinct]

$$(D^2 + aD + b)x = f(t)$$

$$m_1, m_2 = \frac{-a \pm \sqrt{a^2-4b}}{2}$$

$$(D+m_1)\underbrace{(D+m_2)x}_{y(t)} = f(t)$$

$$y(t) = c_1e^{-m_1t} + K_0f(t) + K_1\dot{f}(t) + K_2\ddot{f}(t) + \dots$$

$$(D+m_2)x = y(t)$$

$$x(t) = c_2e^{-m_2t} + K_0'y(t) + K_1'\dot{y}(t) + \dots$$

$$= c_2e^{-m_2t} + K_0'\left(c_1e^{-m_1t} + K_0f + K_1\dot{f} + \dots\right.$$

$\Rightarrow$ $$\frac{d^2x}{dt^2} + a\frac{dx}{dt} + bx = f(t)$$

$$(D^2 + aD + b)x = f(t)$$

$$(m+m_1)(m+m_2) = 0$$

$$\boxed{x(t) = c_1e^{-m_1t} + c_2e^{-m_2t} + K_0f + K_1\dot{f} + K_2\ddot{f} + \dots}$$

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* $\frac{dx}{dt} + ax = f(t)$

$\downarrow$

$$x(t) = ce^{-at} + [K_0f(t) + K_1\dot{f}(t) + K_2\ddot{f}(t) + \dots]$$

ANUBHAV JAIN NOTES

* $\frac{d^2x}{dt^2} + a\frac{dx}{dt} + bx = f(t)$

$$(D+m_1)\underbrace{(D+m_2)x}_{y(t)} = f(t)$$

Ch. eq^n: $(m^2 + am + b = 0)$

Assume $m_1 \neq m_2$

~~(D+m_2)y~~ * $(D+m_2)x = y(t)$

$\Rightarrow x(t) = c_2 e^{-m_2 t} + \bar{k}_0 y + k_1 \dot{y} + \cdots \infty$

* $(D+m_1)\, y(t) = f(t)$

$\Rightarrow y(t) = c_1 e^{-m_1 t} + \bar{\bar{k}}_0 f + \bar{\bar{k}}_1 \dot{f} + \cdots \infty$

$$\boxed{x(t) = \bar{c}_1 e^{-m_1 t} + c_2 e^{-m_2 t} + k_0 f + k_1 \dot{f} + \cdots \infty}$$

$\frac{dx}{dt} + ax = f(t) = Ae^{-at}$ — $-a$ = Characteristic Root

Expected solⁿ:-
$x(t) = c_1 e^{-at} + k_0 f + k_1 \dot{f} + \cdots$

Actual solⁿ:-

Remember how we derived it

$e^{at}\frac{dx}{dt} + e^{+at} ax = A$

$\frac{d}{dt}(x e^{at}) = A\,dt$

$x e^{at} = At + c$

$x(t) = At\, e^{-at} + c e^{-at}$

$\frac{d^2x}{dt^2} + a\frac{dx}{dt} + bx = f(t)$

Suppose $m_1 = m_2 = m$.

* $(D+m)\, x = y(t)$

$x(t) = c_2 e^{-mt} + \bar{k}_0 y + \bar{k}_1 \dot{y} + \cdots \infty$

* $(D+m)\, y(t) = f(t)$

$y(t) = c_1 e^{-mt} + \bar{\bar{k}}_0 f + \bar{\bar{k}}_1 \dot{f} + \cdots \infty$

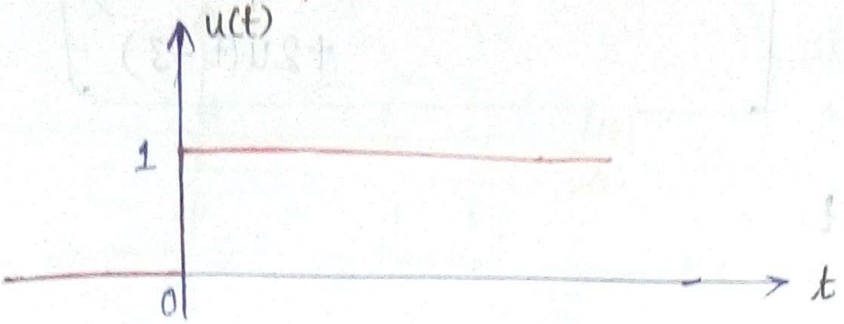
Similar type of eqⁿ

$(D+m)x = y(t) = c_1 e^{-mt} + \bar{\bar{k}}_0 f + \bar{\bar{k}}_1 \dot{f} + \cdots$ ($-m$ = Chr. Root)

$x(t) = (At\, e^{-mt}) + \cdots$

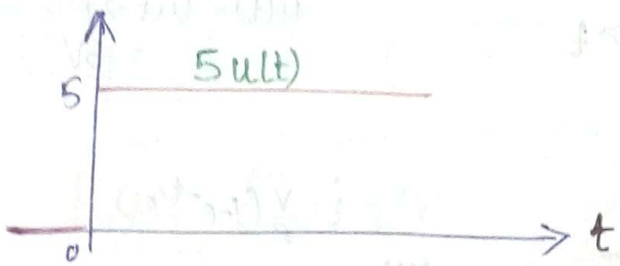
$$\boxed{x(t) = \underbrace{(At+B)\, e^{-mt}}_{\text{Natural Response}} + \underbrace{k_0 f + k_1 \dot{f} + \cdots \infty}_{\text{Response due to forcing f}^n}}$$

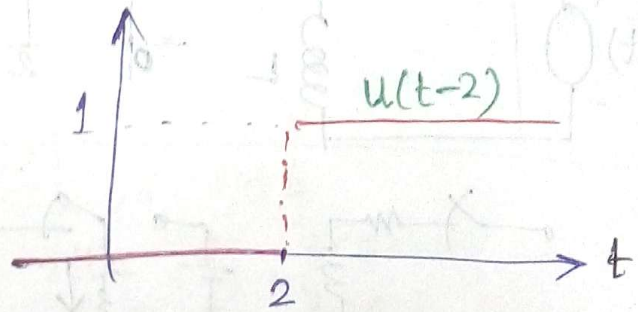
ABOUT f^n's (SINGULARITY f^n ...)



$u(t) = 0 \quad t<0$
$\quad = 1 \quad t>0$

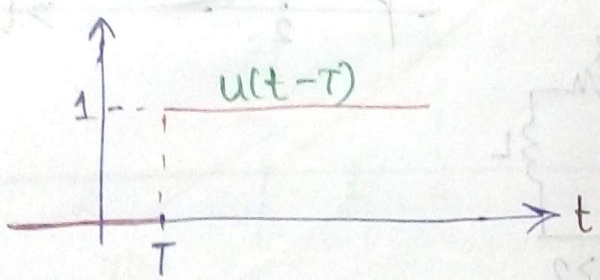
Unit Step f^n:
u(t)

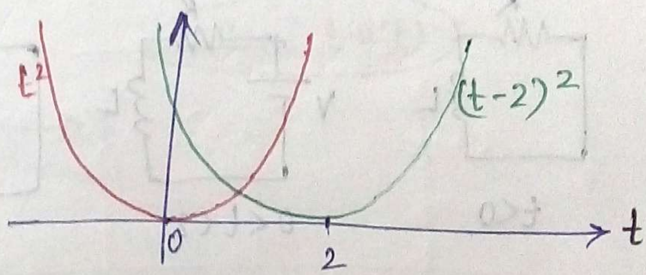


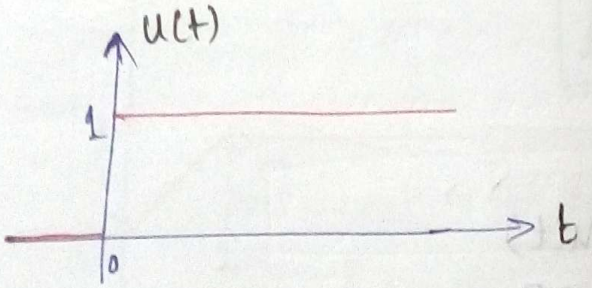


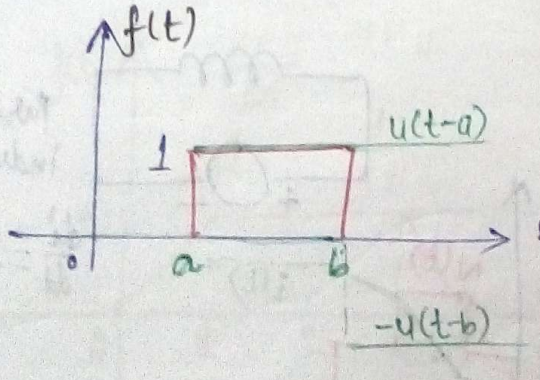
$5u(t) = 0 \quad t<0$
$\quad = 5 \quad t>0$

$u(t-2) = 0 \quad t-2<0 \;$ i.e $t<2$
$\quad = 1 \quad t-2>0 \;$ i.e $t>2$



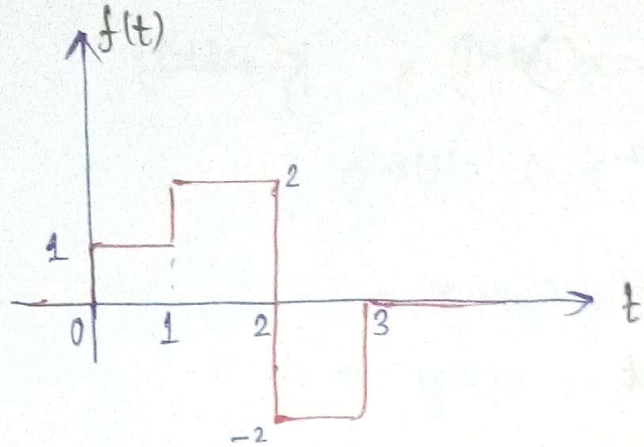




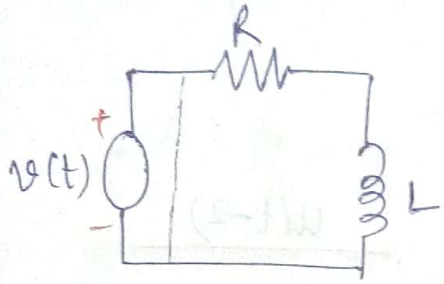


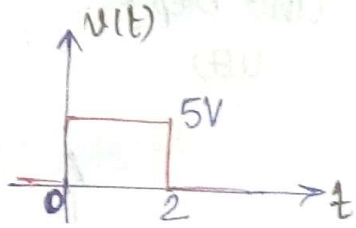
$f(t) = 0 \quad t<a$
$\quad = 1 \quad a<t<b$
$\quad = 0 \quad t>b$

$\Rightarrow \boxed{f(t) = u(t-a) - u(t-b)}$



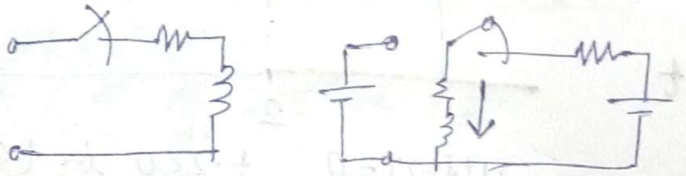
$$\boxed{f(t) = u(t) + u(t-1) - 4u(t-2) + 2u(t-3)}$$



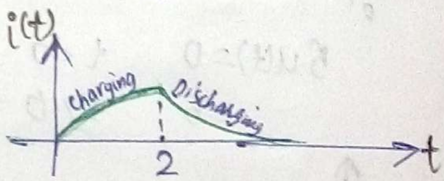


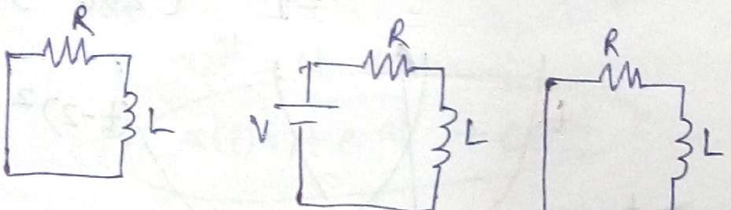
$v(t) = 5u(t) - 5u(t-2)$

$u(t) - u(t-2)$
$= 5V$

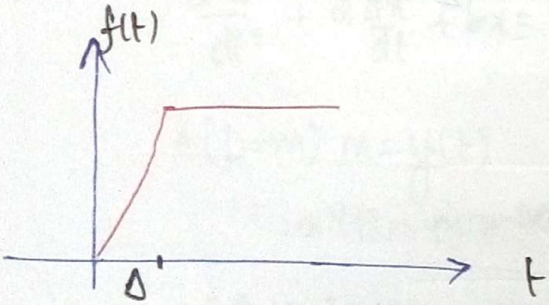


$i = \frac{V}{R}(1 - e^{-t/\tau})$



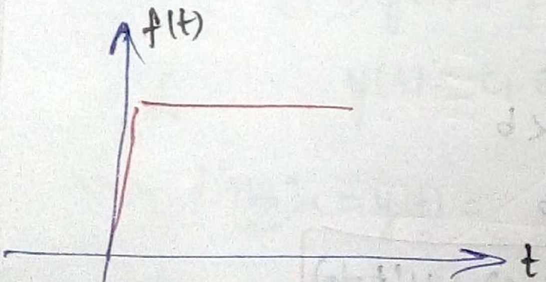


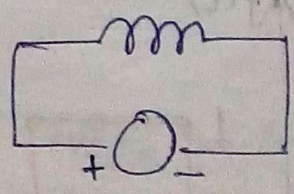
$t<0$ $\quad 0<t<2$ $\quad t>2$



$f(t) \rightarrow u(t)$

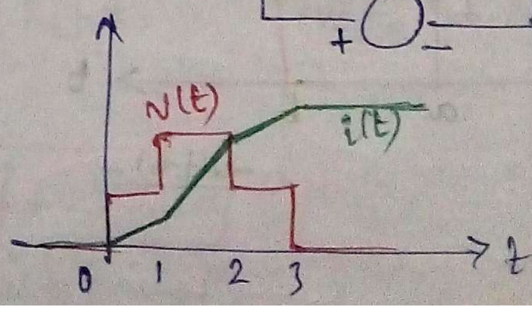
as $\Delta \rightarrow 0$





Pure inductor

$\frac{di}{dt} = \frac{v}{L}$



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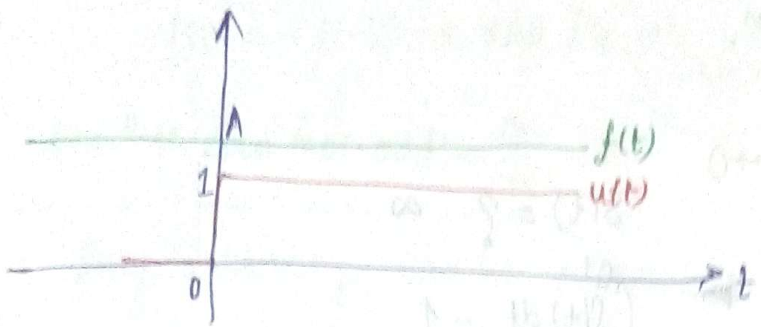
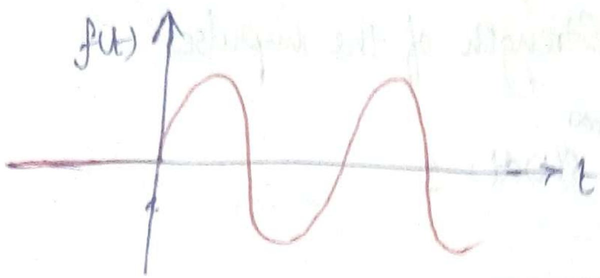
$f(t) = A \rightarrow$ const.



u(t) must not be confused with a constant function.

$f(t) = \sin\omega t \; u(t)$

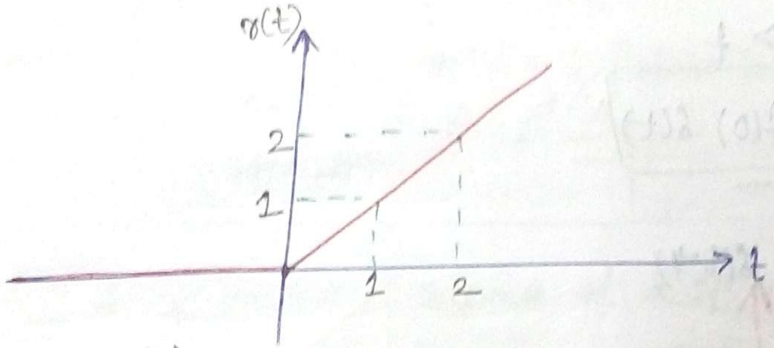


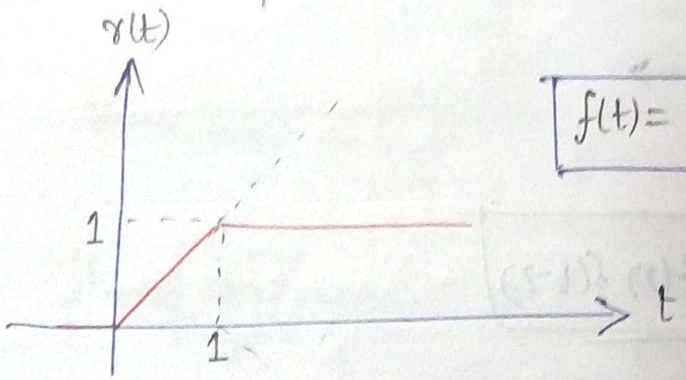
RAMP f^n : $r(t)$

$r(t) = 0 \quad , t \leq 0$
$\quad\; = t \quad , t \geq 0$

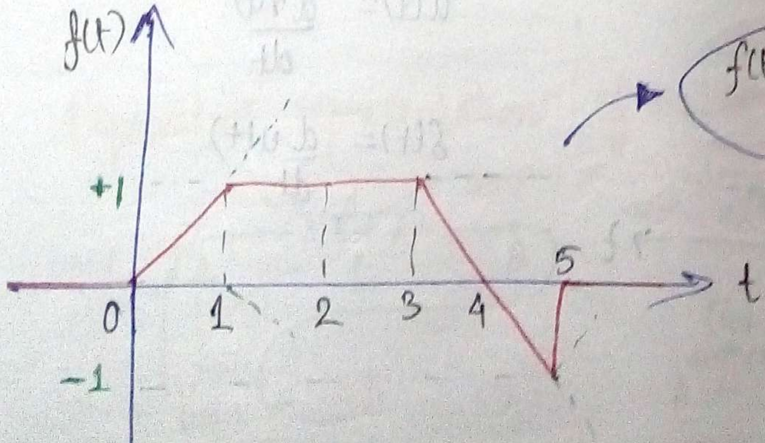
OR

$r(t) = t \cdot u(t)$





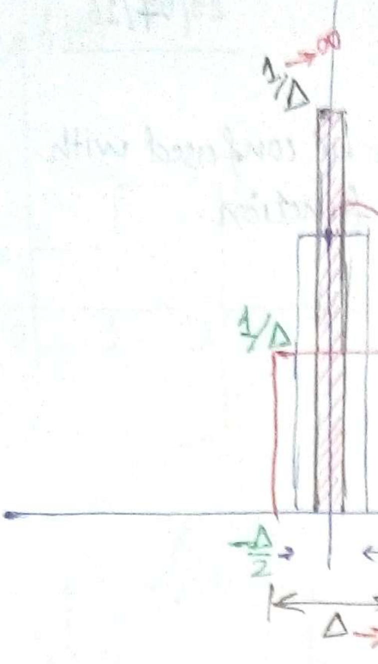
$\boxed{f(t) = r(t) - r(t-1)}$



$f(t) = r(t) - r(t-1) - r(t-3) + r(t-5) + u(t-5)$

Unit Impulse f^n.

or Delta Dirac f^n.



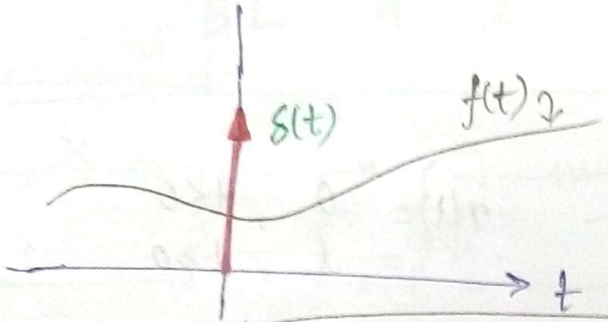
→ Area = 1 units.

$\Delta \to 0$

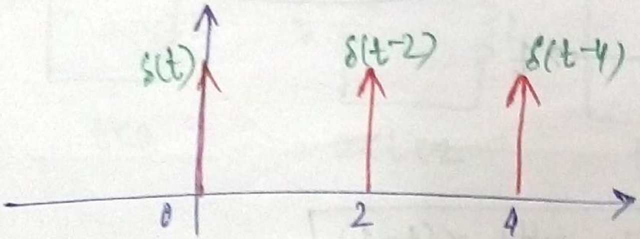
$\delta(t) = ?\ \infty$

$$\underbrace{\int_{0^-}^{0^+} \delta(t)\,dt = 1}_{\text{Strength of the impulse}}$$

$$* \int_{-\infty}^{+\infty} \delta(t)\,dt = 1$$

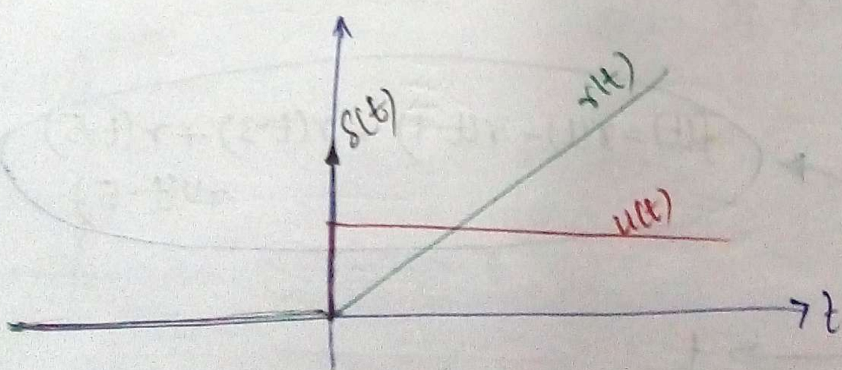


$$\boxed{f(t)\,\delta(t) = f(0)\,\delta(t)}$$



$$* \int_{-\infty}^{\infty} f(t-2)\ dt = 1.$$

$$\boxed{f(t)\ \delta(t-2) = f(2)\,\delta(t-2)}$$

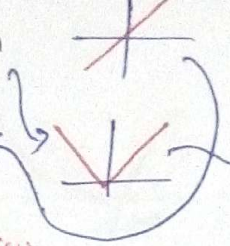


$$u(t) = \frac{d\,r(t)}{dt}$$

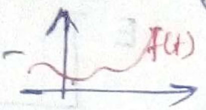
$$\delta(t) = \frac{d}{dt}u(t)$$

$f(t) = f(-t) \rightarrow$ Even f^n

$f(t) = -f(-t) \rightarrow$ odd f^n $\rightarrow$ fold along y-axis: Superposition.



Neither even nor odd:-



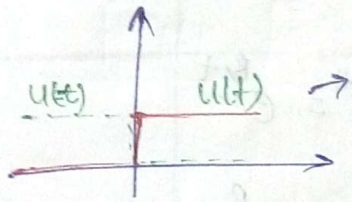
★ Any arbitrary can be broken into sum of an even & odd function.

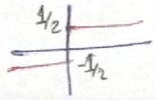
Let $f(t)$ be a general $f^n \rightarrow$ neither even nor odd.

$$f(t) = f_o(t) + f_e(t)$$

$$f(-t) = f_o(-t) + f_e(-t) = -f_o(t) + f_e(t)$$

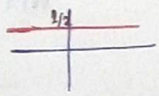
$$\Rightarrow \boxed{f_e(t) = \frac{f(t) + f(-t)}{2}} \quad \& \quad \boxed{f_o(t) = \frac{f(t) - f(-t)}{2}}$$





$$\rightarrow u_o(t) = \frac{1}{2}[u(t) - u(-t)] = \begin{cases} = 1/2, & t \geq 0 \\ = -1/2, & t < 0 \end{cases}$$

$$u_e(t) = \frac{1}{2}[u(t) + u(-t)] = 1/2$$



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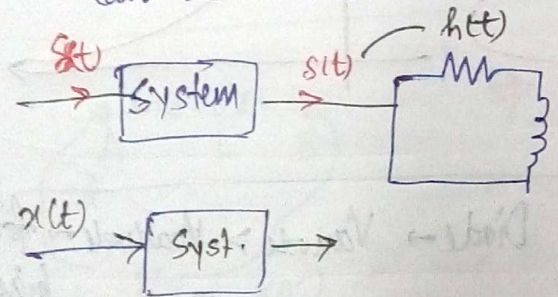
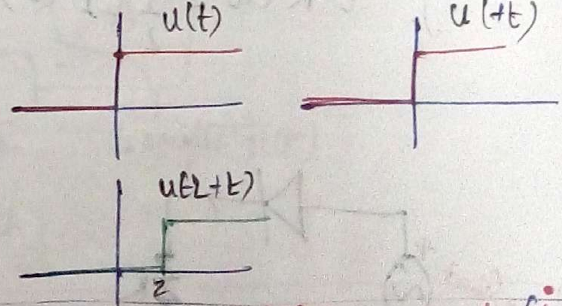
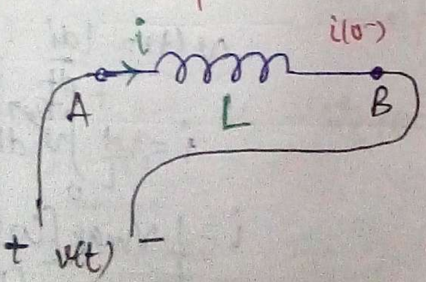
Note : If you know response of a system, then output because of any arbitrary function can be reconstructed.



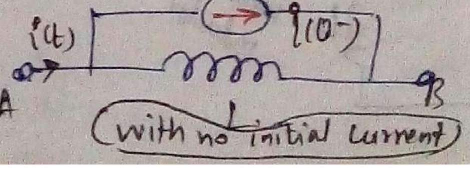
$$f(t)\,\delta(t) = f(0)\,\delta(t).$$

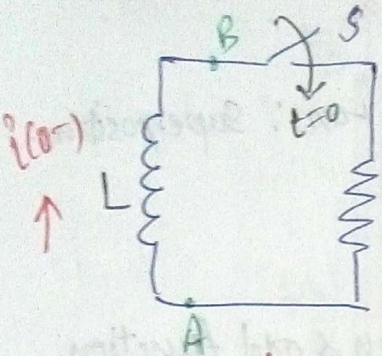


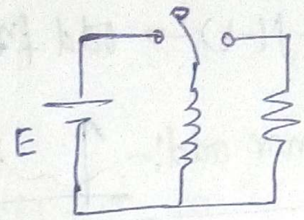
Equivalent representation of an inductor having initial current (i_{0^-})

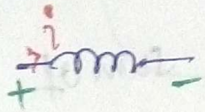


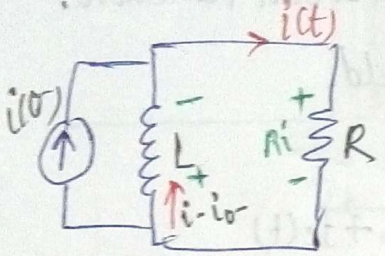
$$i(t) = i(0^-) + \frac{1}{L}\int_0^t v\,dt$$











$$L\frac{d(i-i(0^-))}{dt} + Ri = 0$$

$$L\frac{di}{dt} - 0 + Ri = 0$$

$$\frac{di}{dt} + \frac{R}{L} i = 0 \qquad IF = e^{\int \frac{R}{L} dt} = e^{R/L\, t}$$

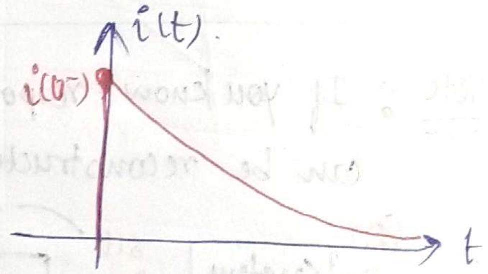
$$m + R/L = 0 \Rightarrow m = -\frac{R}{L}$$

$$i = Ae^{-R/L\, t}$$

$$i(0) = ? = i(0^-)$$

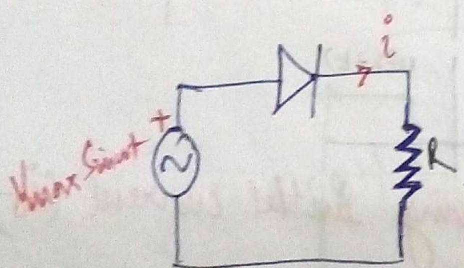
$$i - i(0^-) = 0$$

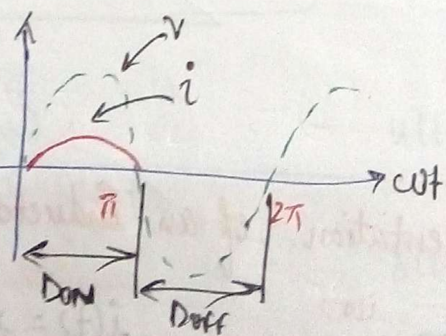
$$\Rightarrow i(t) = (e^{-R/L\, t})\, i(0^-).$$

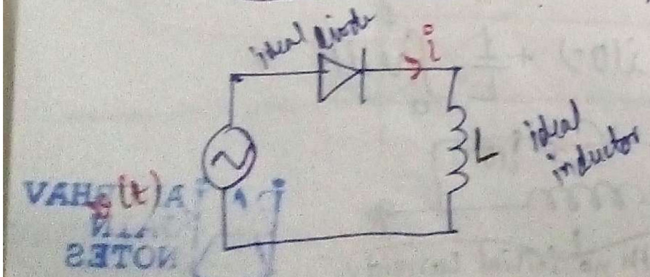


$$\int_0^\infty i^2 R\, dt = \frac{1}{2} L i(0^-)^2$$

Diode → Vanode > Vcathode → forward biased.
p n





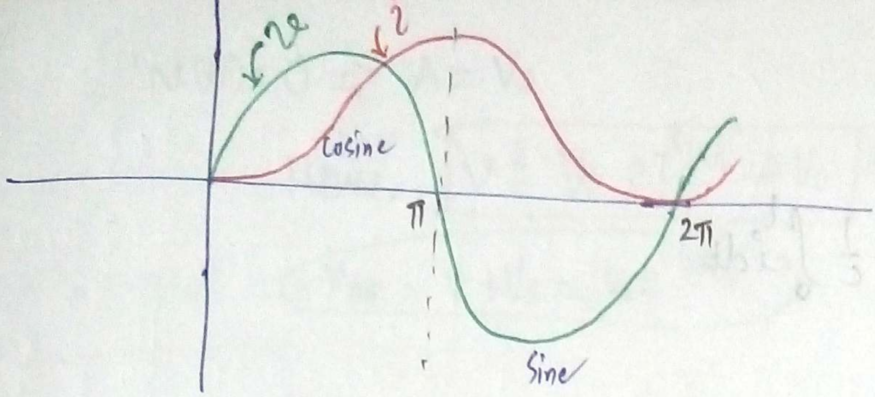


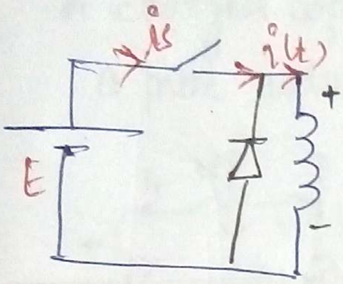
$$v(t) = L\frac{di}{dt}$$

$$i = \frac{1}{L}\int_0^{t} v\, dt \quad \text{Vmax Sinwt}$$

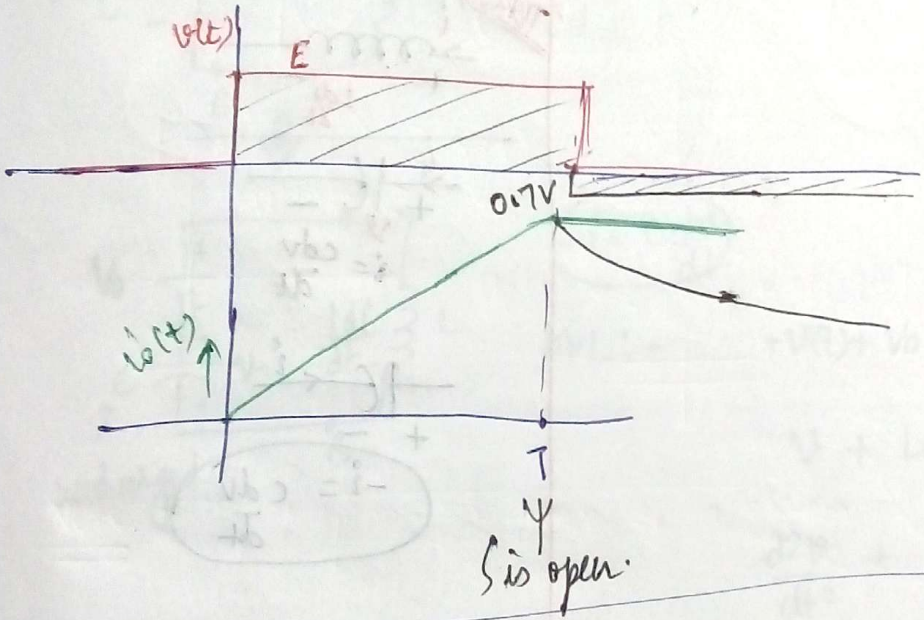
$$i = \frac{1}{L} V_{max} [\cos \omega t]_0^{\omega t}$$

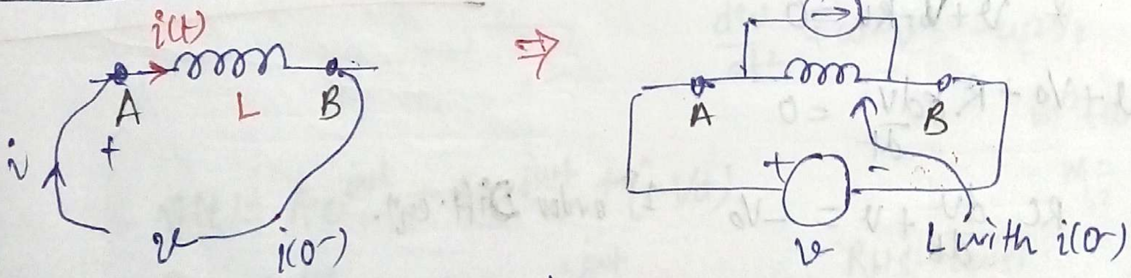
$(1 - \cos\omega t)$





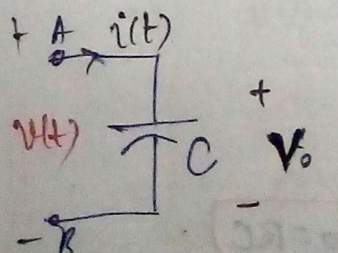
$$i(t) = \frac{E}{L}t$$





$$i(t) = i(0) + \frac{1}{L}\int_0^t v\,dt$$

HOW to represent a capacitor having some initial voltage in form of equivalent ckt.



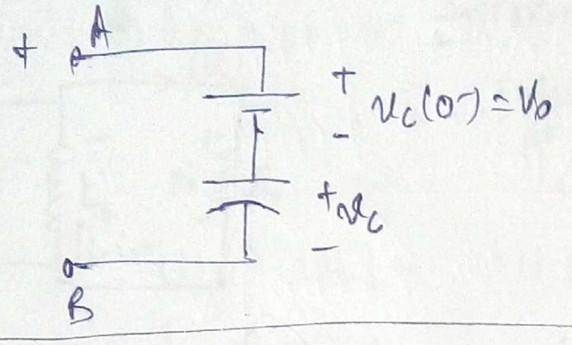
$$v_C(0^-) = V_0$$

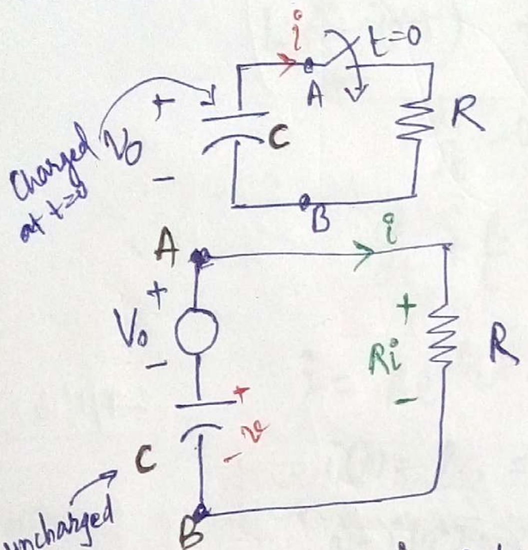
$$i = C\frac{dv}{dt}$$

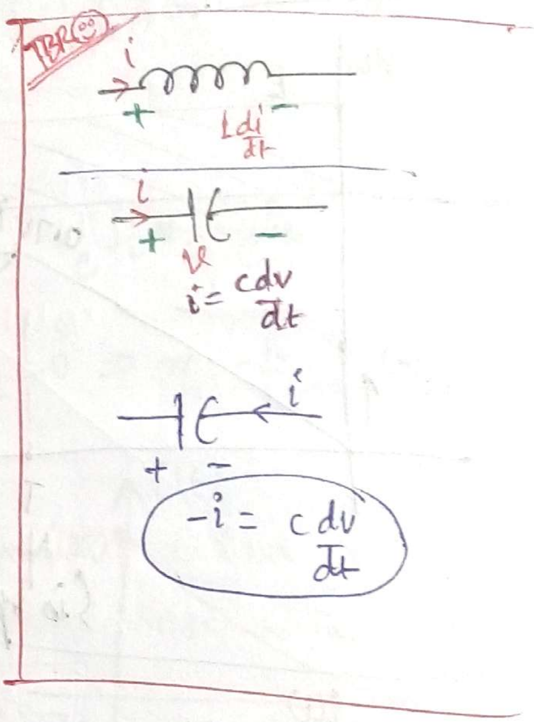
$$v(t) = \frac{1}{C}\int_{-\infty}^{t} i\,dt$$

$$= v_c(0^-) + \frac{1}{C}\int_0^t i\,dt$$

Eq. ckt.







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

$* \ v + V_0 - Ri = 0$

$\Rightarrow v + V_0 + RC\frac{dv}{dt} = 0$

$\Rightarrow RC\frac{dv}{dt} + v = -V_0$ 1st order Diff. eqn.

$$\frac{dv}{dt} + \frac{1}{RC}v = \frac{-V_0}{RC} \quad \text{— (1)}$$

$$v = Ae^{-t/RC} - K_0\frac{V_0}{RC}$$

$$Ae^{-t/RC}\cdot\left(\frac{-1}{RC}\right) + \frac{1}{RC}\left(Ae^{-t/RC} - \frac{K_0V_0}{RC}\right) = \frac{-V_0}{RC}$$

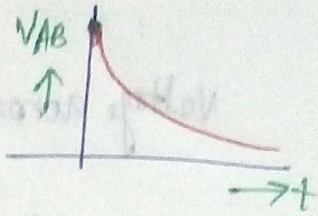
$$\frac{-K_0V_0}{(RC)^2} = \frac{-V_0}{RC} \Rightarrow \boxed{K_0 = RC}$$

ANUBHAV JAIN NOTES

$v(0)=0 \Rightarrow A = V_0$

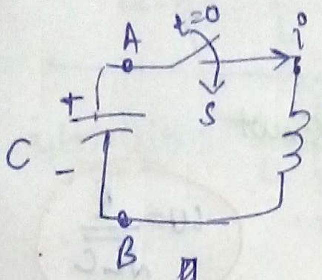
Hence, $\boxed{v = V_0 e^{-t/RC} - V_0}$

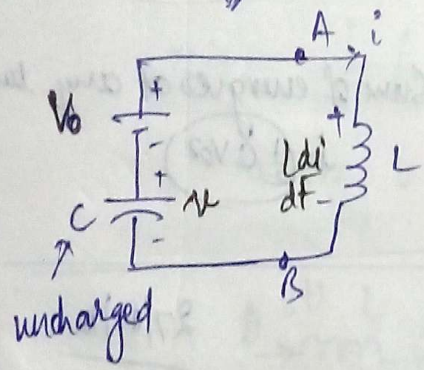
$V_{AB} = v + V_0 = V_0 e^{-t/RC}$



A charged capacitor is suddenly connected (at $t=0$) across a pure inductor L.

L is uncharged initially.





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

KVL:- $+v(t) + V_0 - L\frac{di}{dt} = 0$

$v + LC\frac{d^2v}{dt^2} = -V_0$

$\frac{d^2v}{dt^2} + \frac{1}{LC}v = -\frac{V_0}{LC}$ (Let $\frac{1}{LC} = \omega^2$)

$\frac{d^2v}{dt^2} + \omega^2 v = -\omega^2 V_0$

CE:- $m^2 + \omega^2 = 0$

$m_{1,2} = \pm j\omega$ $\quad j = \sqrt{-1}$.

$v(t) = Ae^{j\omega t} + Be^{-j\omega t} + (-V_0)$

RHS→const.

Do→ $\omega^2 v = -\omega^2 V_0 \Rightarrow v = -V_0$.

$i = -C\frac{dv}{dt} = -ACj\omega e^{+j\omega t} + BCj\omega e^{-j\omega t} + 0$

$v(0) = 0$ $\quad \therefore A + B = +V_0$ — (1)

$i(0) = 0$ $\quad -A + B = 0$ — (2)

$\therefore A = B = +\frac{V_0}{2}$

$\Rightarrow \boxed{v(t) = +\frac{V_0}{2}e^{j\omega t} + \frac{V_0}{2}e^{-j\omega t} - V_0}$

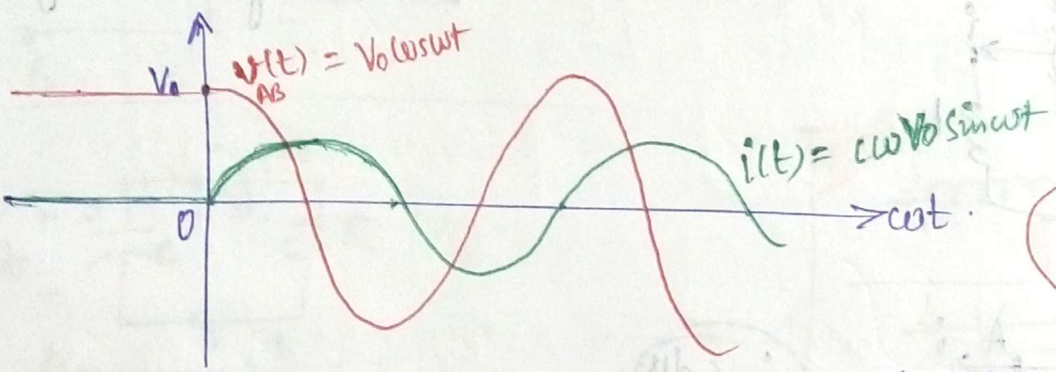
$$v(t) = \frac{V_0}{2}(2\cos\omega t) - V_0$$

$$\Rightarrow \boxed{v(t) = V_0\cos\omega t - V_0}$$

Voltage across initially charged capacitor → $\boxed{v(t) + V_0 = V_{AB}(t) = V_0\cos\omega t}$

$$i(t) = jC\omega\frac{V_0}{2}\left(-e^{+j\omega t} + e^{-j\omega t}\right)$$

$$\boxed{i(t) = C\omega V_0 \sin\omega t}$$



$$\omega = \frac{1}{\sqrt{LC}}$$

$$* \quad \frac{1}{2}CV_0^2 = \frac{1}{2}L V_0^2\omega^2C^2$$

Sum of energies at any time is $\frac{1}{2}CV_0^2$

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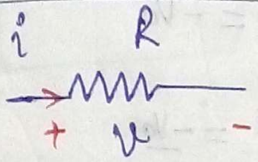
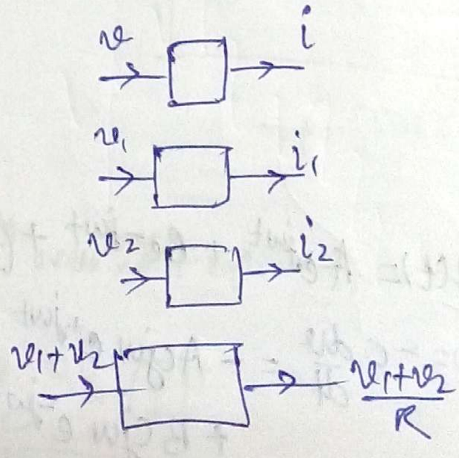


$$i = \frac{v}{R}$$

$$i_1 = \frac{v_1}{R}$$

$$i_2 = \frac{v_2}{R}$$

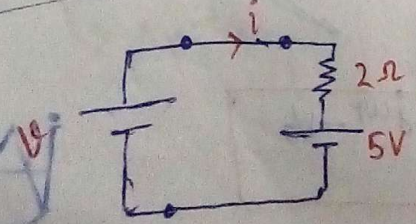
$$i_1 + i_2 = \frac{v_1}{R} + \frac{v_2}{R}$$



Principle of Superposition

$$\alpha v_1 + \beta v_2 = \alpha i_1 + \beta i_2$$

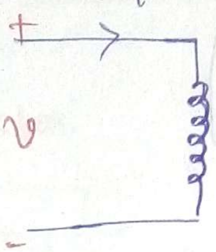
linear system.



$$v = v_1 = 10V$$

$$i = \frac{v-5}{2}$$

~~Not a linear system~~



$$i(t) = i(0^-) + \frac{1}{L}\int_0^t v\,dt$$

$$i(0^-) = 0$$

$$i(t) = 0 + \frac{1}{L}\int_0^t v\,dt$$

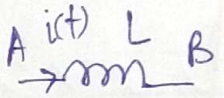
$$i_1(t) = \frac{1}{L}\int_0^t v_1\,dt$$

$$i_2(t) = \frac{1}{L}\int_0^t v_2\,dt$$

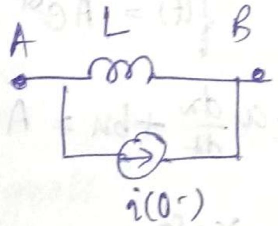
$$i_1(t) + i_2(t) = \frac{1}{L}\int_0^t (v_1 + v_2)\,dt$$

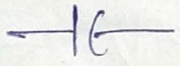
$$v(t) = \frac{1}{C}\int_{-\infty}^t i\,dt$$

$$v(t) = v(0) + \frac{1}{C}\int_0^t i\,dt$$

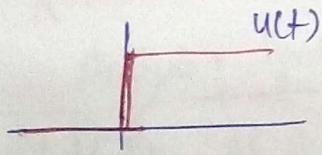


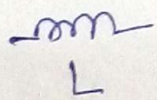
$i(0^-)$

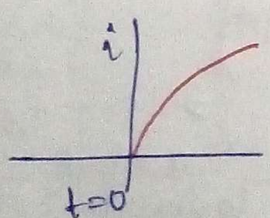




Linear & Time invarient system.



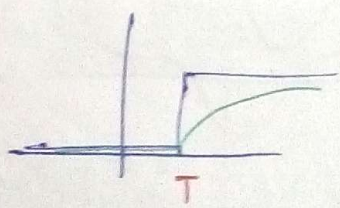


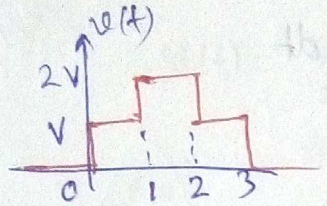


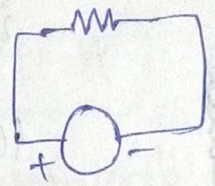
$x(t) \rightarrow y(t)$

I/p $\quad$ O/p.

$\Rightarrow x(t-T) \rightarrow y(t-T)$



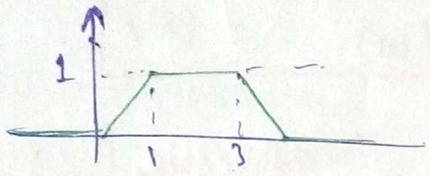


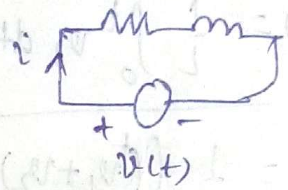


v(t)

$v(t) = u(t) + u(t-1) + \ldots$

v_1





$v(t) = r(t) - r(t-1) - \ldots$

Casual.

$(D^2 + aD + b)x = f(t)$

for a class of f^n's

$f(t) = A e^{st}$; s const

$$\frac{d^2x}{dt^2} + a\frac{dx}{dt} + bx = Ae^{st}$$

P.I.

Let $x(t) = Xe^{st}$

$$Xe^{st}s^2 + Xe^{st}sa + Xe^{st}b = Ae^{st}$$