1.

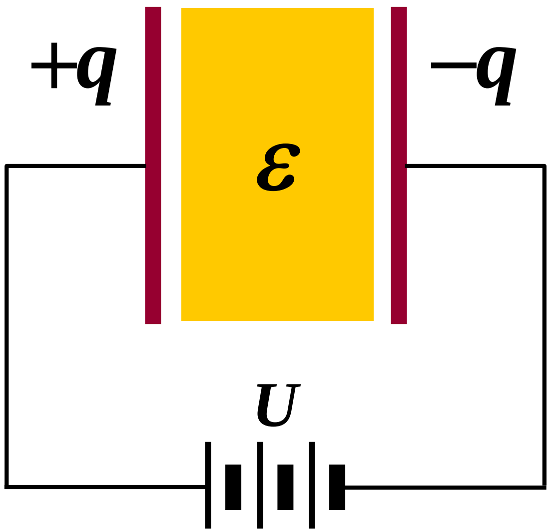
2.

☎

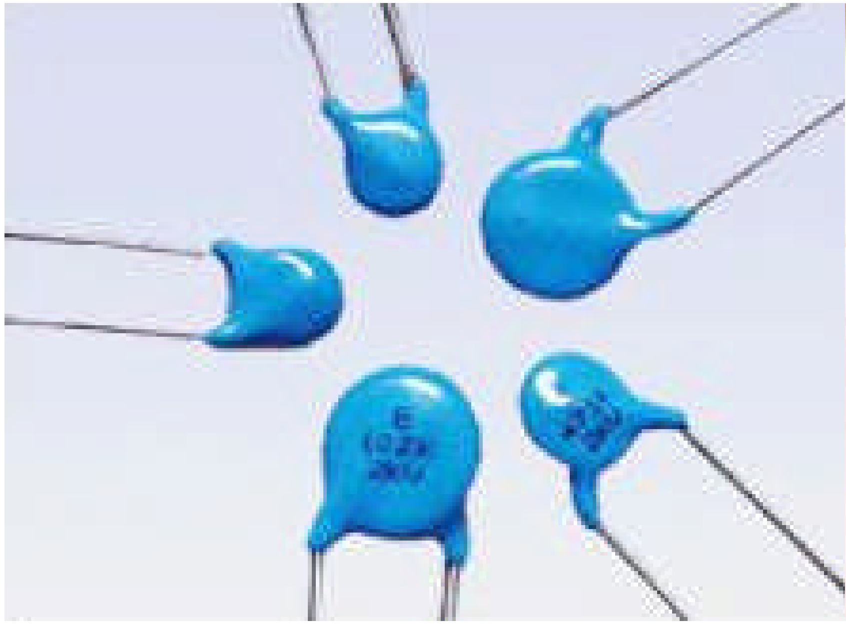
VCR KCL

KVL

6 1

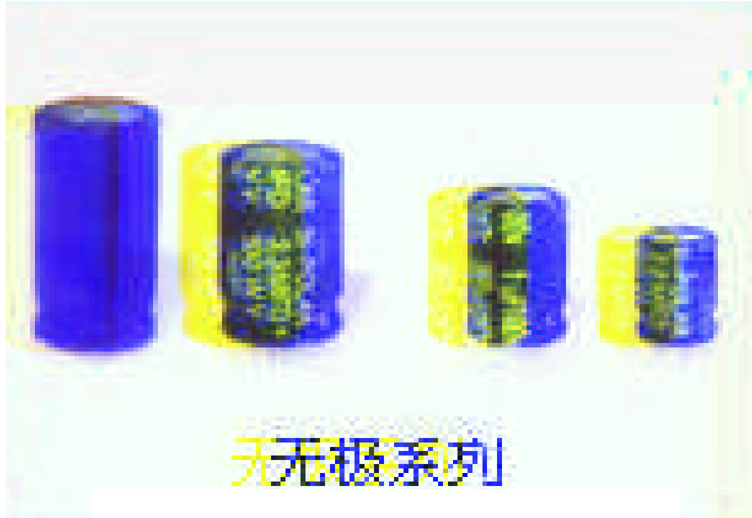


(1)



2 30kV

(2)



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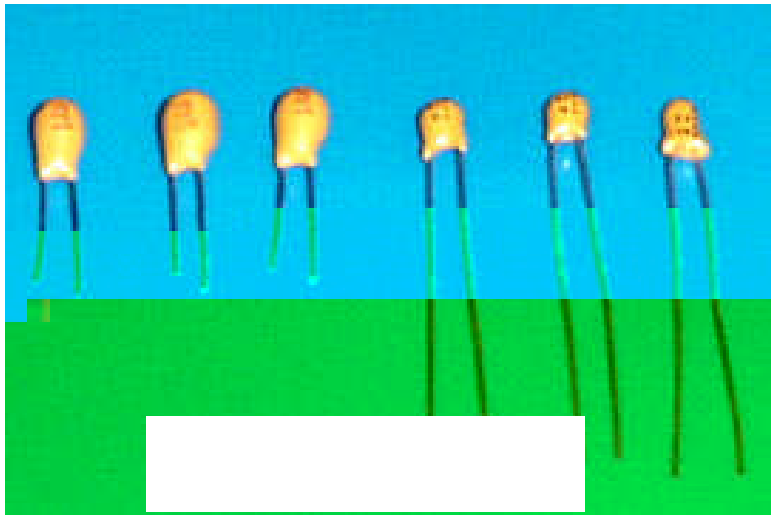
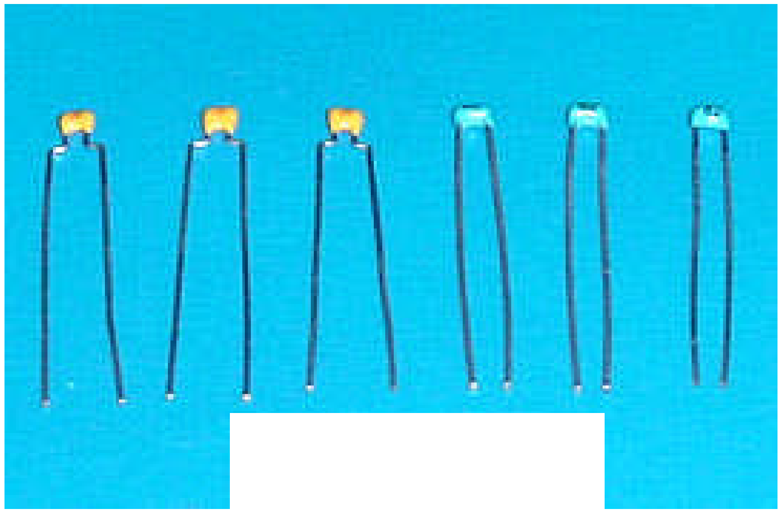
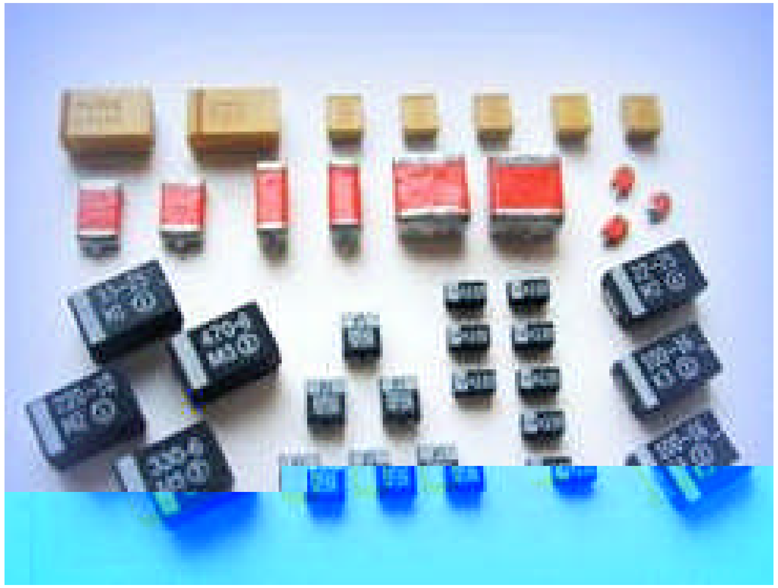


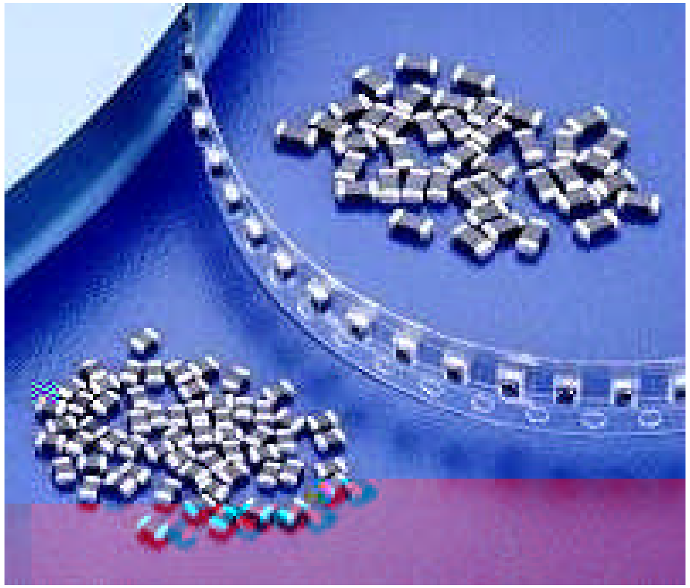


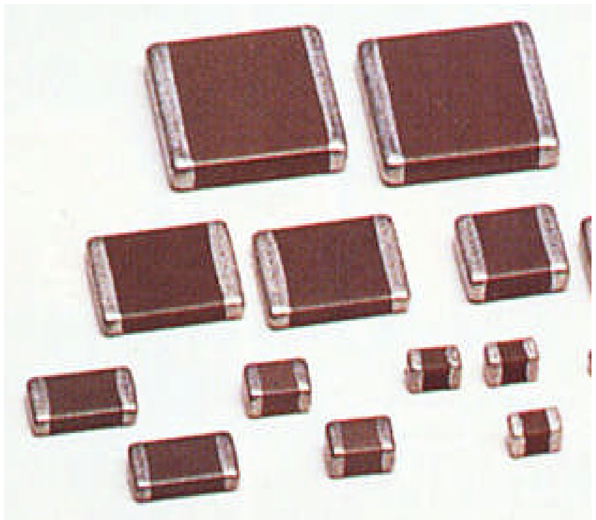
(3)

0.1-1000F

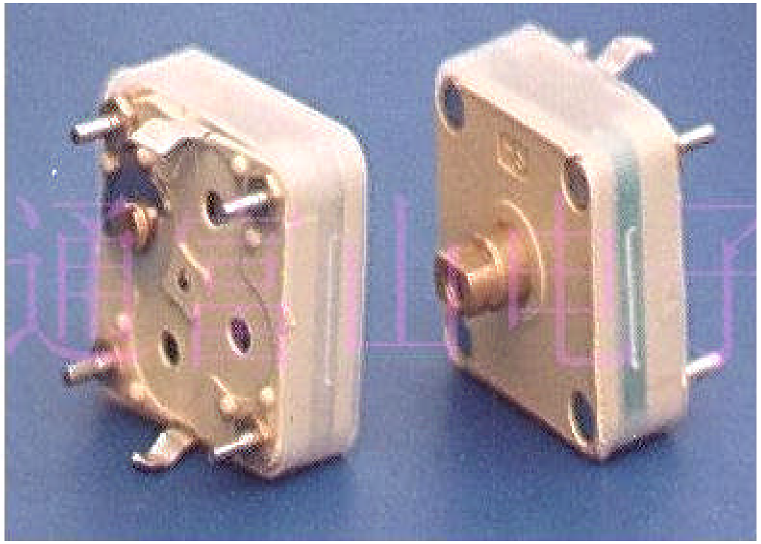
(4)

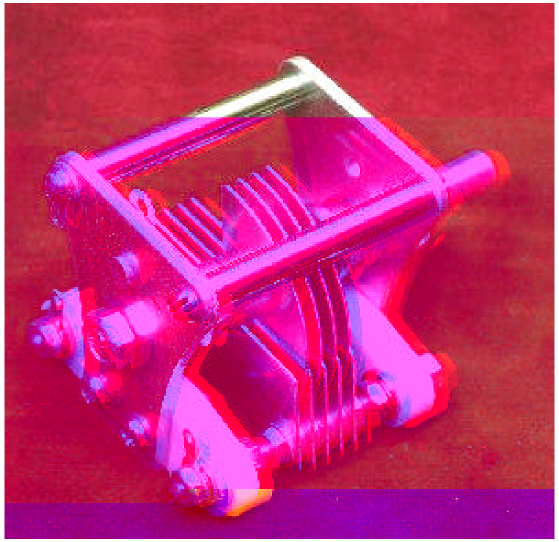


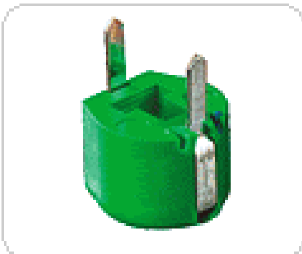




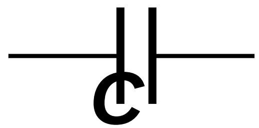
(5)

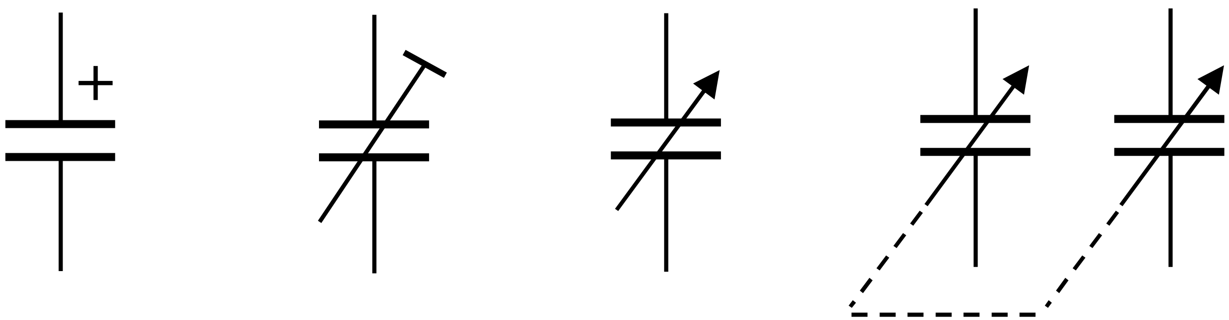






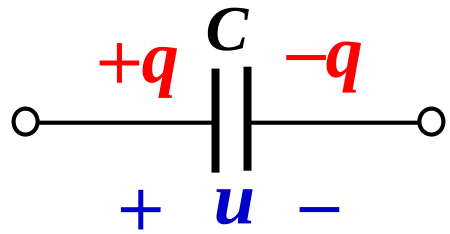
1.



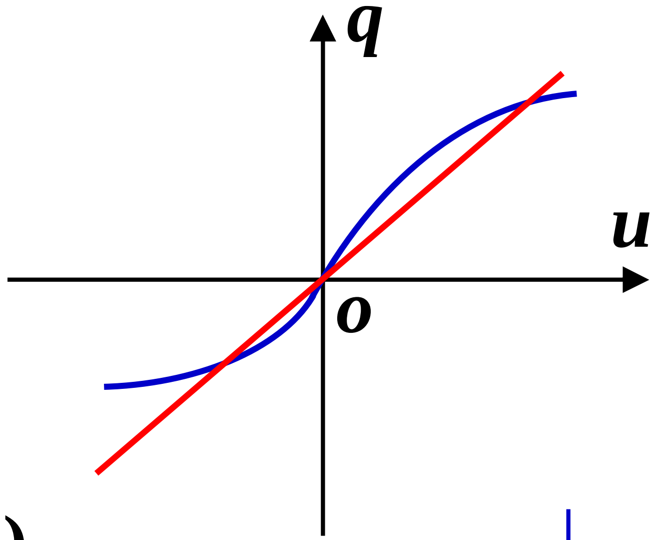


2.

q



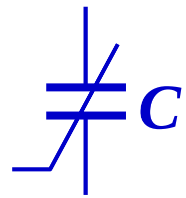
u *q* *u*



q *u*

$$q = C u$$

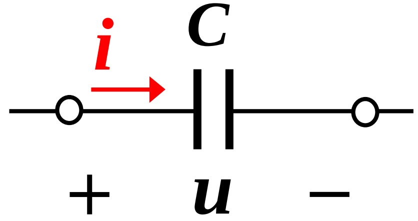
C F( )



μF pF

3.

$q = Cu$



C i u

$$i=\frac{\mathrm{d}q}{\mathrm{d}t}=\frac{\mathrm{d}(Cu)}{\mathrm{d}t}$$ C

$$i=C\frac{\mathrm{d}u}{\mathrm{d}t}$$

i u u

u ( ) $i=0$

“ ”

i

u

$$i = \frac{dq}{dt} \qquad q(t) = {}^{t}\, i(\xi)\, d\xi = {}^{t_0}\, i(\xi)\, d\xi + {}^{t}_{t_0}\, i(\xi)\, d\xi$$

t_0

$$q(t) = q(t_0) + {}^{t}_{t_0}\, i(\xi)\, d\xi$$

$$q = C\,u \qquad u(t) = u(t_0) + \frac{1}{C}\, {}^{t}_{t_0}\, i(\xi)\, d\xi$$

$-\infty$

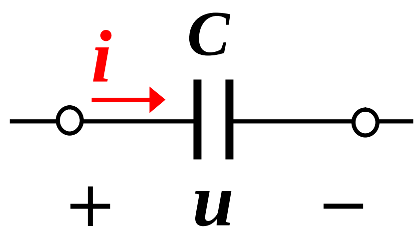
t_0 $\quad$ t_0

i $\quad$ t_0 $\quad$ $u(t_0)$

u i

$u(t_0)$

3. /



$u \quad i$

$$p = ui = u\,C\frac{\mathrm{d}u}{\mathrm{d}t}$$

(2)

t –

$$w_c = {}_{-}^{t} C\, u(\xi) \frac{du(\xi)}{dt} dt$$

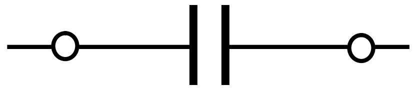
$$w_c = \frac{1}{2} Cu^2(t) - \frac{1}{2} Cu^2(\quad)$$

0

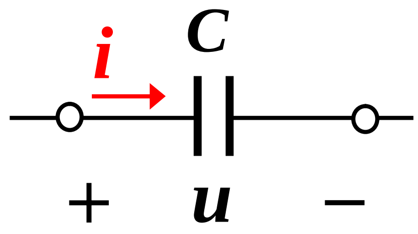
t_1 t_2

$$W_c = \frac{1}{2} Cu^2(t_2) - \frac{1}{2} Cu^2(t_1) = W_c(t_2) - W_c(t_1)$$

$$w_c = \frac{1}{2} C u^2(t)$$



C



$$q = Cu$$

$$i = C\frac{\mathrm{d}u}{\mathrm{d}t} \qquad u = \frac{1}{C}\int^{t} i\,\mathrm{d}t \quad (\qquad\qquad)$$

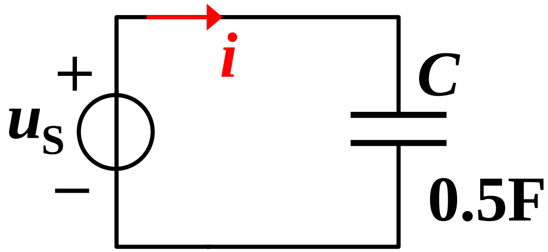
$$1\ \mathrm{F} = 10^{6}\ \mu\mathrm{F} = 10^{12}\mathrm{pF}$$

$$w_c(t) = \frac{1}{2}Cu^2(t)$$

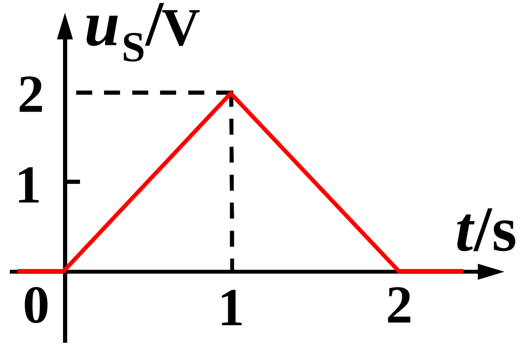
________ ______ ________ ______

i $p(t)$ $w(t)$

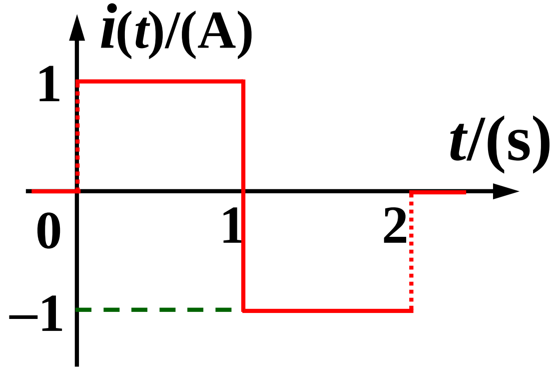
$u_S(t)$



$$u_S(t) = \begin{cases} 0 & t \quad 0 \\ 2t & 0 \quad t \quad 1\text{s} \\ -2t+4 & 1 \quad t \quad 2\text{s} \\ 0 & t \quad 2\text{s} \end{cases}$$

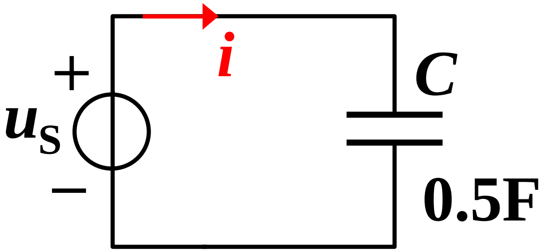


$$i(t) = C\frac{du_S}{dt} = \begin{cases} 0 & t \quad 0 \\ 1 & 0 \quad t \quad 1\text{s} \\ -1 & 1 \quad t \quad 2\text{s} \\ 0 & t \quad 2\text{s} \end{cases}$$

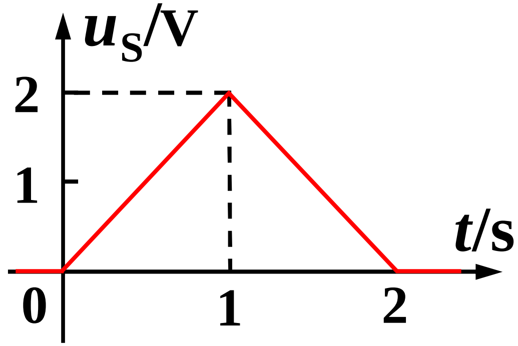


$$p(t) = u_S(t)\, i(t) \qquad w(t) = \frac{1}{2}Cu_S^2(t)$$

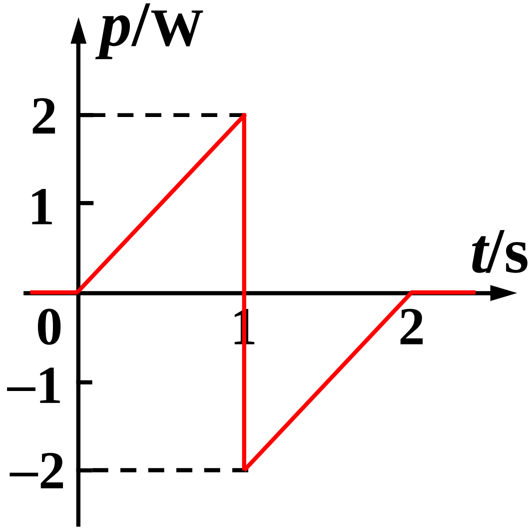
$$u_S(t)=\begin{cases}0 & t \quad 0\\ 2t & 0 \quad t \quad 1\text{s}\\ -2t+4 & 1 \quad t \quad 2\text{s}\\ 0 & t \quad 2\text{s}\end{cases}$$



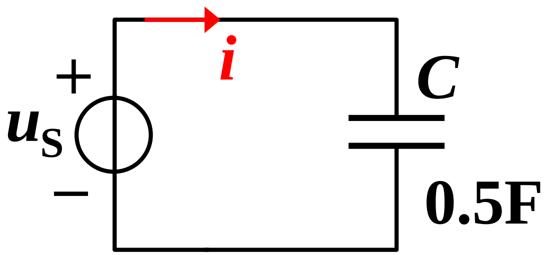
$$i(t)=\begin{cases}0 & t \quad 0\\ 1 & 0 \quad t \quad 1\text{s}\\ -1 & 1 \quad t \quad 2\text{s}\\ 0 & t \quad 2\text{s}\end{cases}$$

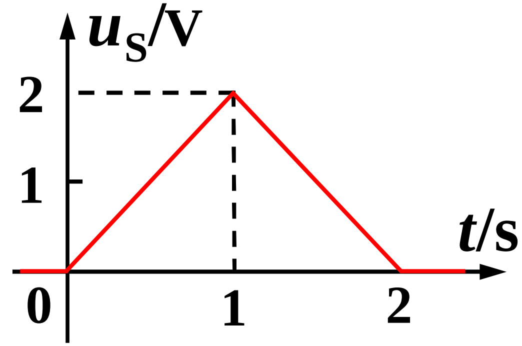


$$p(t)=u_S(t)i(t)=\begin{cases}0 & t \quad 0\\ 2t & 0 \quad t \quad 1\text{s}\\ 2t-4 & 1 \quad t \quad 2\text{s}\\ 0 & t \quad 2\text{s}\end{cases}$$

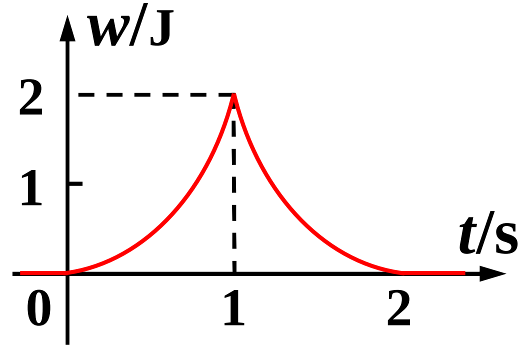


$$u_S(t) = \begin{cases} 0 & t \quad 0 \\ 2t & 0 \quad t \quad 1\text{s} \\ -2t+4 & 1 \quad t \quad 2\text{s} \\ 0 & t \quad 2\text{s} \end{cases}$$



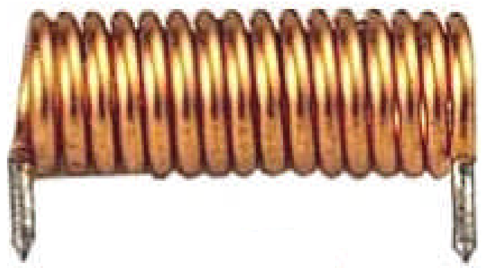


$$w(t) = \frac{1}{2} C u_S^2(t) = \begin{cases} 0 & t \quad 0 \\ t^2 & 0 \quad t \quad 1\text{s} \\ (2-t)^2 & 1 \quad t \quad 2\text{s} \\ 0 & t \quad 2\text{s} \end{cases}$$



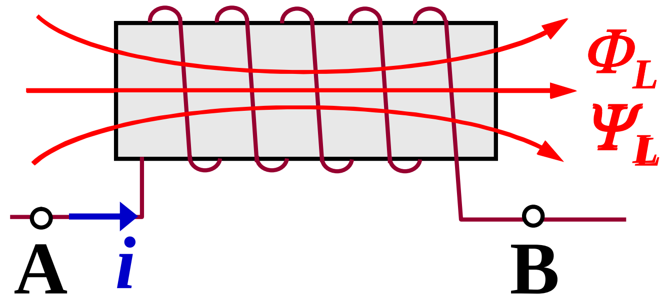
6 2

i Φ_L ,



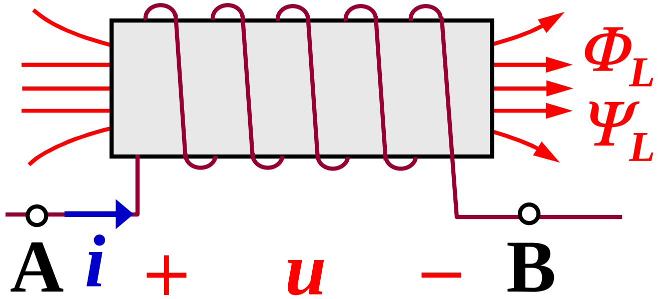
Φ_L N

$$\Psi_L = N\ \Phi_L$$



Φ_L Ψ_L

Ψ_L i

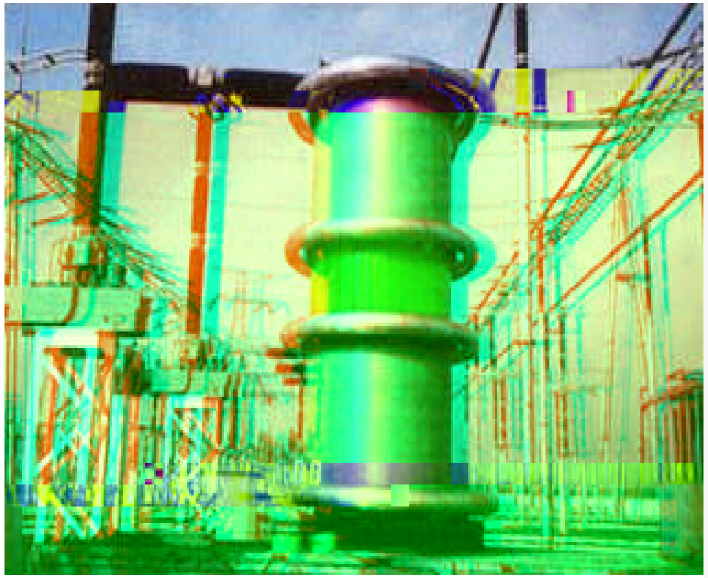


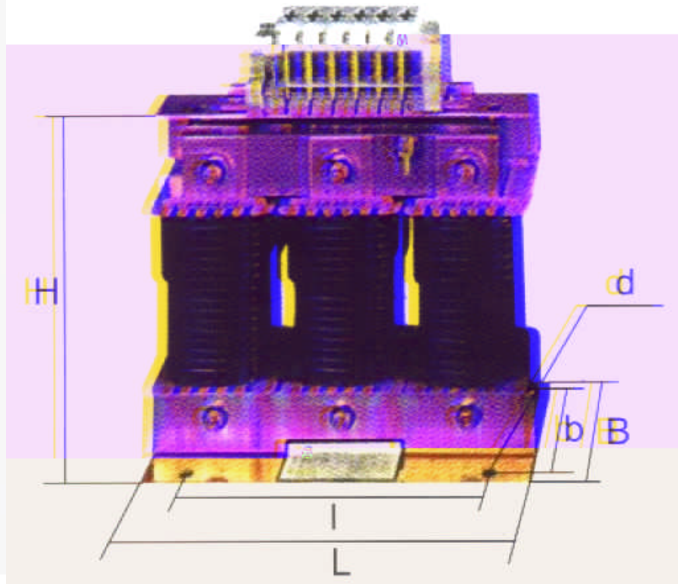
u Ψ_L

u Ψ_L

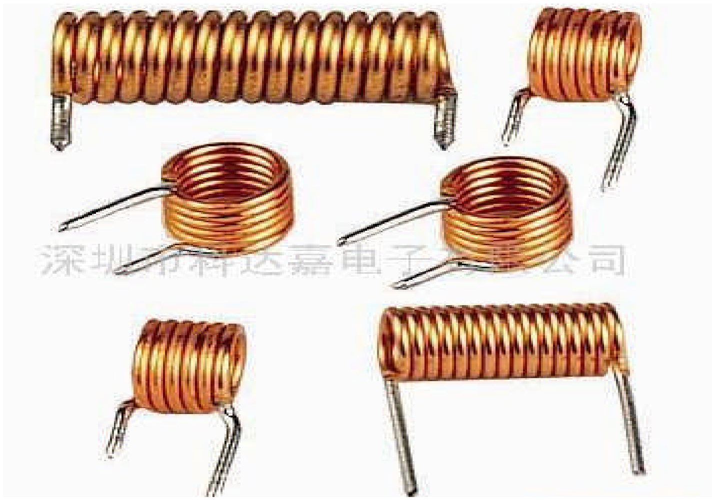
$$u = \frac{\mathrm{d}\Psi_L}{\mathrm{d}t}$$

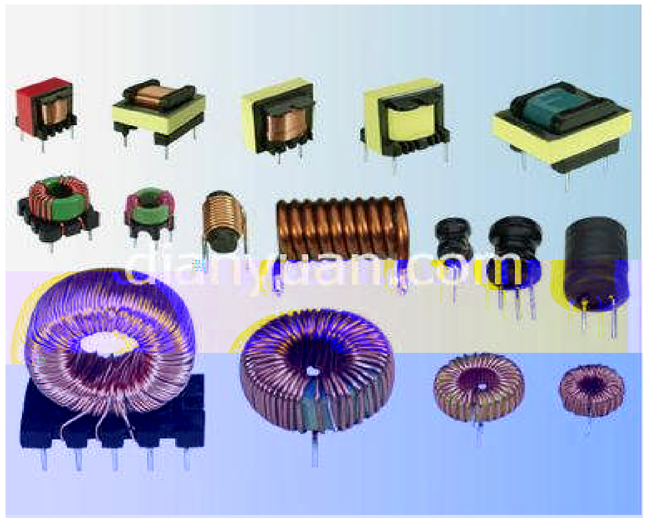
(1)





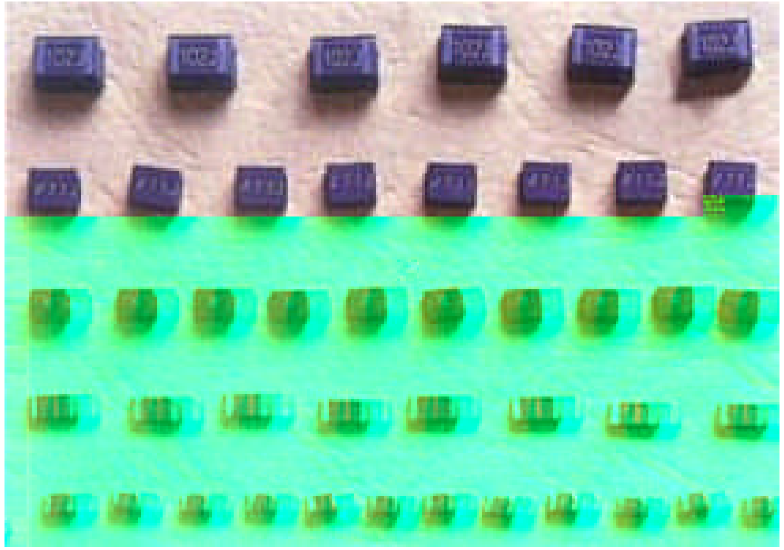
(2)

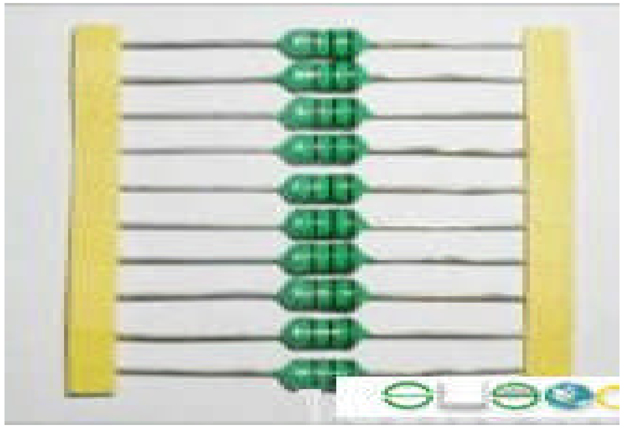




(　　)

(3)





1.

ψ i

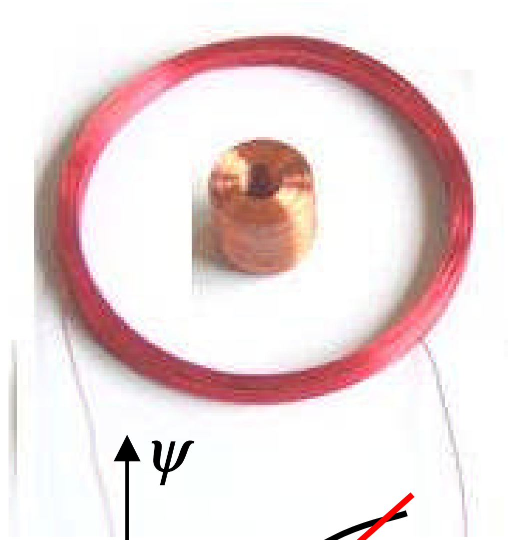
2.

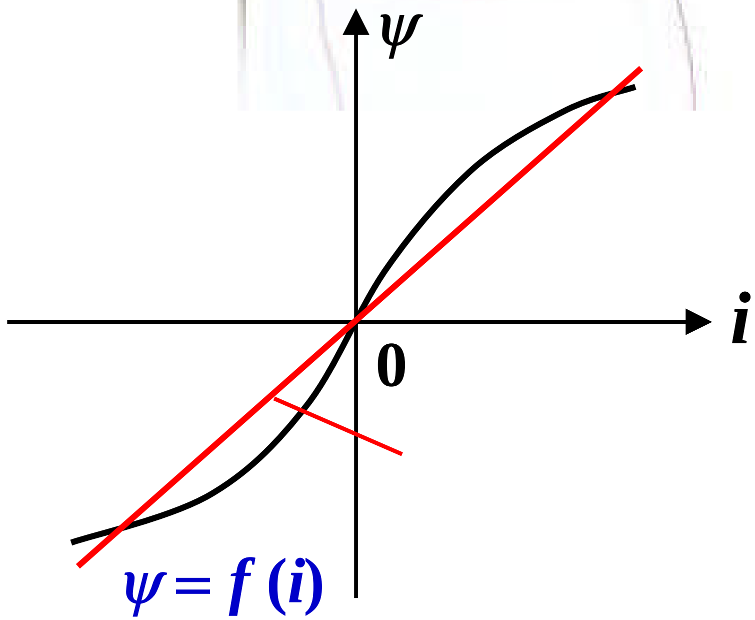
i

ψ $\psi \sim i$

(1) $\psi(t) = L\, i(t)$

L



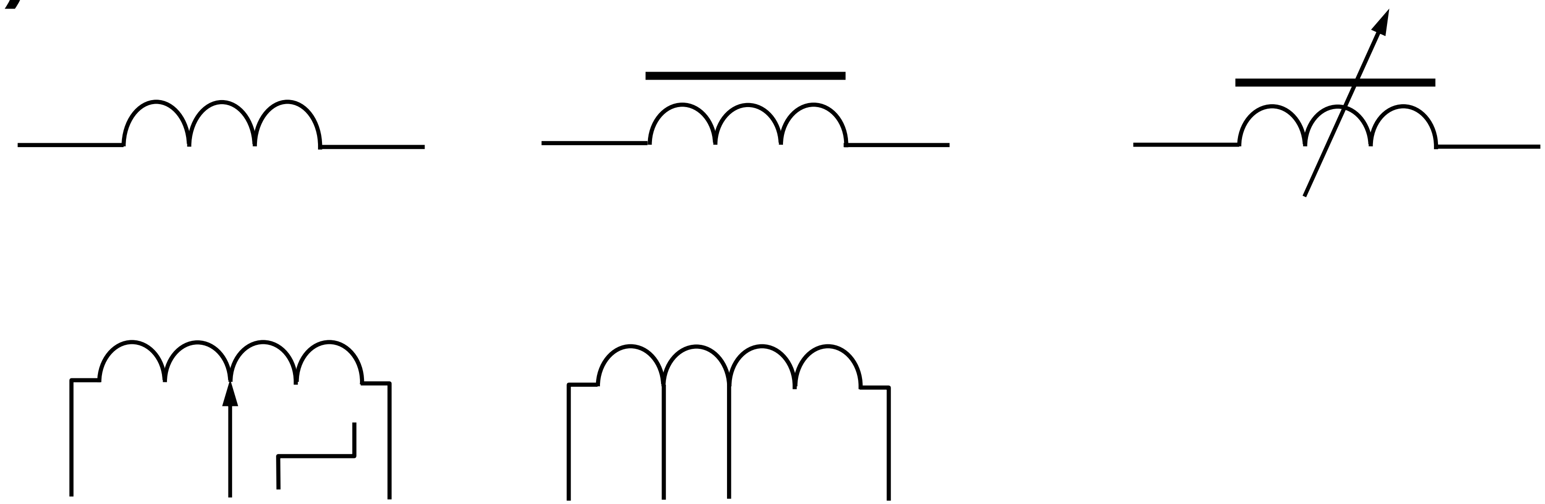


(2) $\psi(t) = L\, i(t)$

Ψ Wb i A L H

μH mH 1H=10^3mH=10^6μH

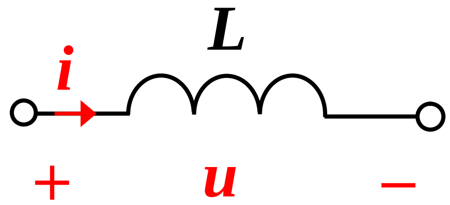
(3)



L

3.

i u i Ψ_L



$$\Psi_L = Li \qquad u = \frac{\mathrm{d}\Psi_L}{\mathrm{d}t} \Rightarrow u = L\frac{\mathrm{d}i}{\mathrm{d}t}$$ VCR

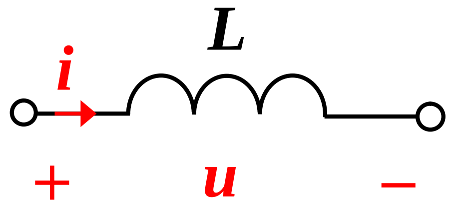
u i i

i ( ) $u=0$

u

i

$$i=\frac{1}{L}\int^{t} u\,\mathrm{d}\xi=\frac{1}{L}\int^{t_0} u\,\mathrm{d}\xi+\frac{1}{L}\int_{t_0}^{t} u\,\mathrm{d}\xi$$



$$i=i(t_0)+\frac{1}{L}\int_{t_0}^{t} u\,\mathrm{d}\xi$$

∞

t_0

t_0 t_0

u t_0 $i(t_0)$

$$i = i(t_0) + \frac{1}{L}\int_{t_0}^{t} u\,\mathrm{d}\xi$$

L

$$\Psi_L = \Psi_L(t_0) + \int_{t_0}^{t} u\,\mathrm{d}\xi$$

u i

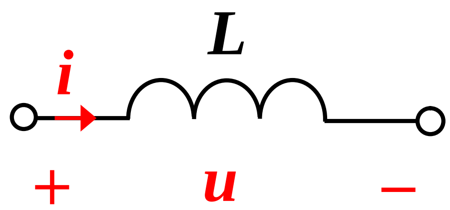
$$u = -L\frac{\mathrm{d}i}{\mathrm{d}t} \qquad i = i(t_0) - \frac{1}{L}\int_{t_0}^{t} u\,\mathrm{d}\xi$$

$i(t_0)$

4.

(1)

$$p = ui = L\frac{\mathrm{d}i}{\mathrm{d}t}i$$



$p \quad 0$

$p \quad 0$

(2)

$-\infty \sim t$

$$w_L = \int_{-}^{t} L\, i(\xi) \frac{\mathrm{d}i(\xi)}{\mathrm{d}t}\,\mathrm{d}t = L \int_{i(-\ \ )}^{i(t)} i(\xi)\,\mathrm{d}i(\xi)$$

$$w_L = \frac{1}{2} L i^2(t) - \frac{1}{2} L i^2(-\ \ )$$

$t = -\infty$ $\quad$ $i(-\infty) = 0$

$$w_L = \frac{1}{2} L i^2(t)$$

t_1 t_2

$$W_L = \frac{1}{2}Li^2(t_2) - \frac{1}{2}Li^2(t_1) = W_L(t_2) - W_L(t_1)$$

$|i|$ W_L 0

$|i|$ W_L 0

$\Psi_L = f(i)$ $i = h(\Psi_L)$

L

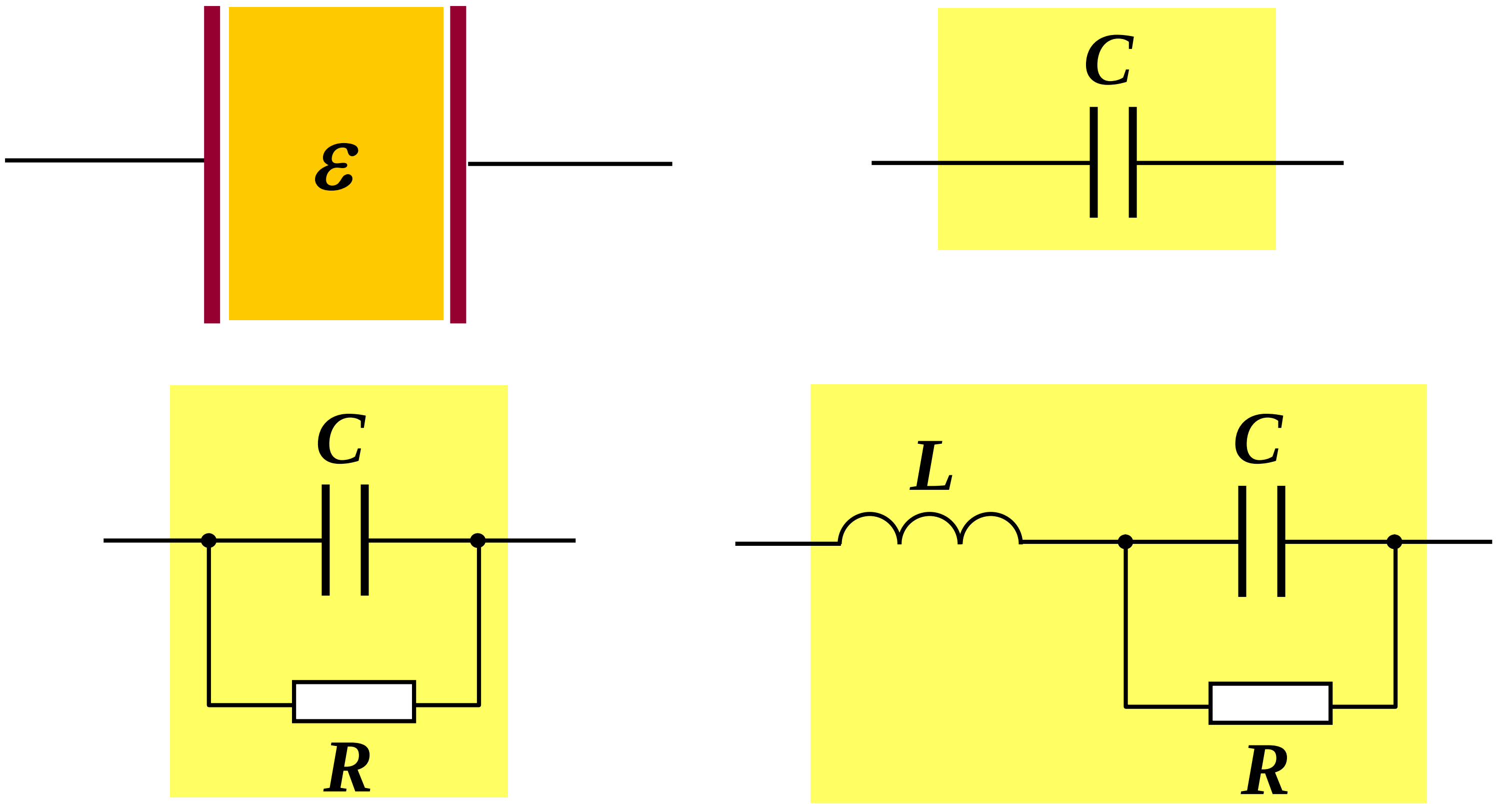
$$\Psi_L = Li$$

$$u = L\frac{\mathrm{d}i}{\mathrm{d}t} \qquad i = \frac{1}{L}\int^{t} u\,\mathrm{d}t$$

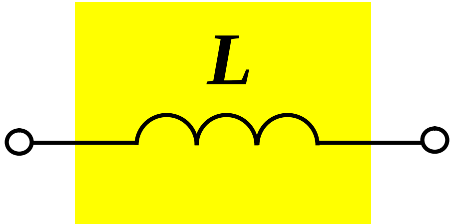
$$1\ \mathrm{H} = 10^3\ \mathrm{mH} = 10^6\ \mu\mathrm{H}$$

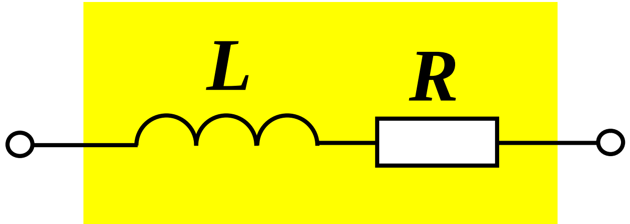
$$w_L(t) = \frac{1}{2}Li^2(t)$$

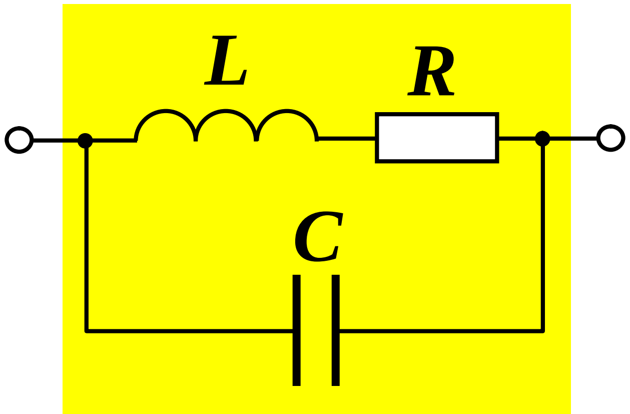
1.



2.

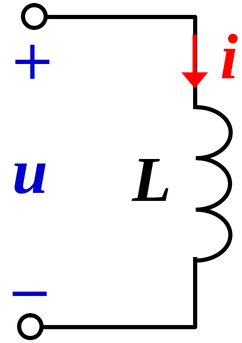






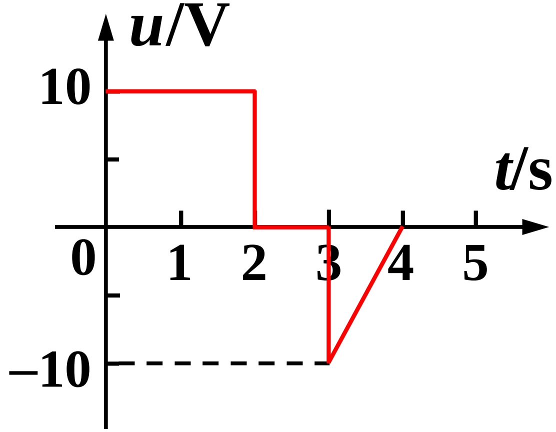
6 4 L=4H $i(0)$=0 t=1s

t=2s t=3s t=4s i



VCR

$$i = i(t_0) + \frac{1}{L}\int_{t_0}^{t} u \, d\xi$$



$$u(t) = \begin{cases} 10\text{V} & 2\text{s} \quad t \quad 0 \\ 0 & 3\text{s} \quad t \quad 2\text{s} \\ 10t-40 & 4\text{s} \quad t \quad 3\text{s} \end{cases}$$

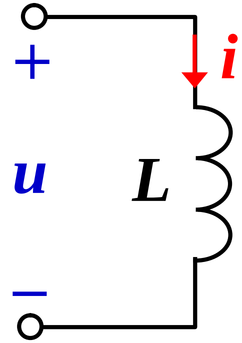
t=1s

$$i(1) = 0 + \frac{1}{4}\int_{0}^{1} 10 \, dt = \frac{10}{4} t \Big|_0^1 = [2.5(1-0)] = 2.5\text{A}$$

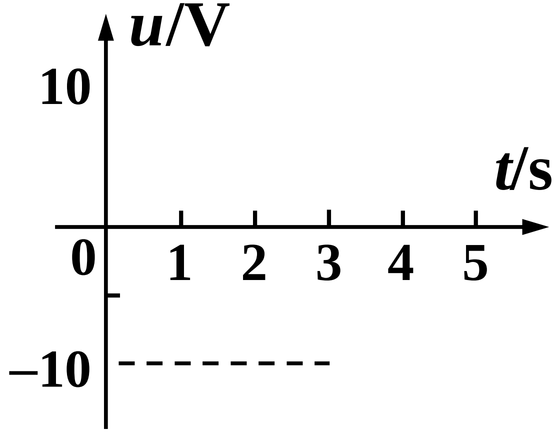
$$i(1) = 2.5\text{A}$$

t=2s

$$i(2) = 0 + \frac{1}{4}\int_0^2 10\,\mathrm{d}t = \frac{10}{4}t\Big|_0^2 = [2.5(2-0)] = 5\text{A}$$



$$i(2) = 2.5 + \frac{1}{4}\int_1^2 10\,\mathrm{d}t = 5\text{A}$$



t=3s

$$i(3) = 5 + \frac{1}{4}\int_1^2 0\,\mathrm{d}t = 5\text{A}$$

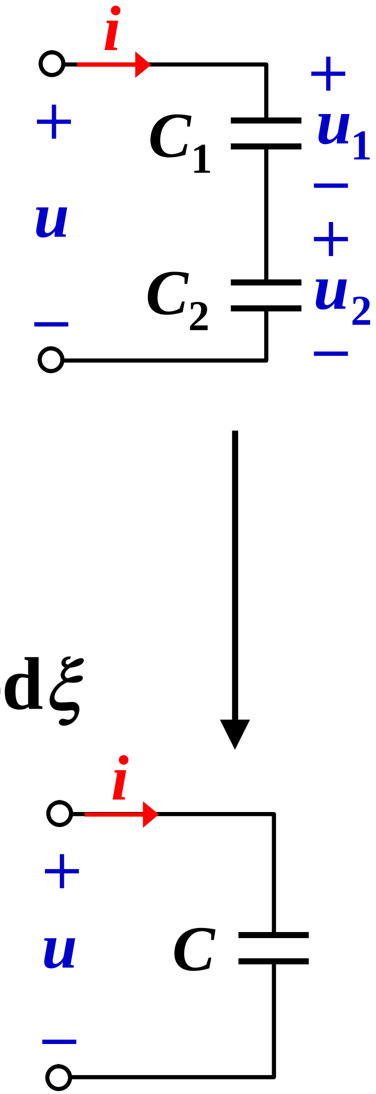
t=4s

$$i(4) = 5 + \frac{1}{4}\int_3^4 (10t-40)\,\mathrm{d}t = 5 + \frac{1}{4}(5t^2-40t)\Big|_3^4 = 3.75\text{A}$$

6 3

1.

(1) VCR KVL



$$u_1 = u_1(t_0) + \frac{1}{C_1}\int_{t_0}^{t} i(\xi)\mathrm{d}\xi$$

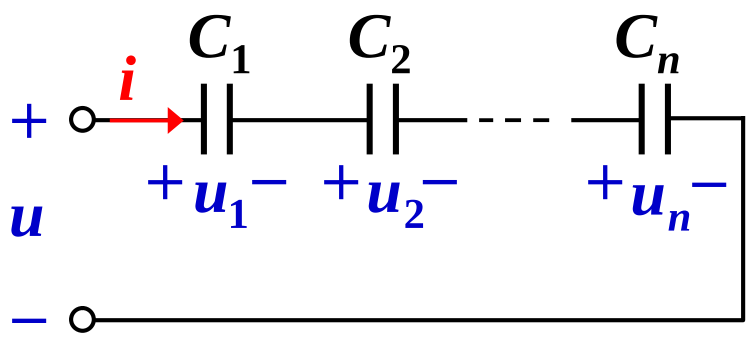
$$u_2 = u_2(t_0) + \frac{1}{C_2}\int_{t_0}^{t} i(\xi)\mathrm{d}\xi$$

$$u = u_1 + u_2 = u_1(t_0) + u_2(t_0) + \left(\frac{1}{C_1} + \frac{1}{C_2}\right)\int_{t_0}^{t} i(\xi)\mathrm{d}\xi$$

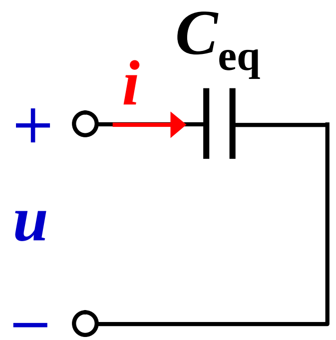
$$= u(t_0) + \frac{1}{C}\int_{t_0}^{t} i(\xi)\mathrm{d}\xi$$

$$u(t_0) = u_1(t_0) + u_2(t_0) \qquad \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

n



$$\frac{1}{C_{eq}}=\frac{1}{C_1}+\frac{1}{C_2}+\cdots+\frac{1}{C_n}$$



$$u(t_0)=u_1(t_0)+u_2(t)+\cdots+u_n(t_0)$$

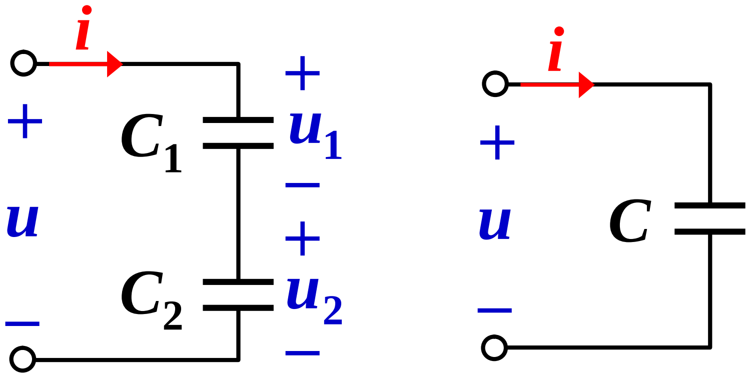
( ) $u(t_0)=0$

(2)

$$u_1 = \frac{1}{C_1}\int^{t} i(\xi)\,\mathrm{d}\xi$$

$$u_2 = \frac{1}{C_2}\int^{t} i(\xi)\,\mathrm{d}\xi$$

$$u = \frac{1}{C}\int^{t} i(\xi)\,\mathrm{d}\xi$$



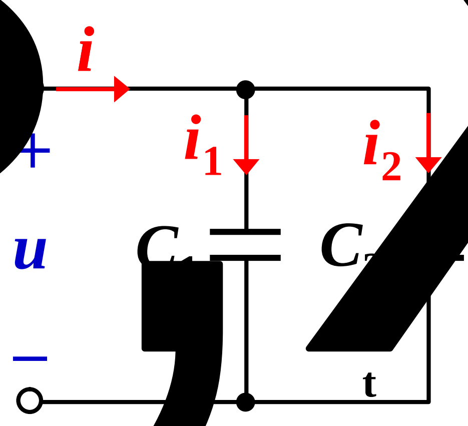
$$C = \frac{C_1 C_2}{C_1 + C_2}$$

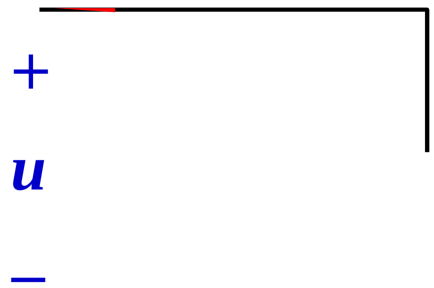
$$\frac{u_1}{u} = \frac{C}{C_1} \quad \Rightarrow \quad u_1 = \frac{C}{C_1}u = \frac{C_2}{C_1 + C_2}u$$

$$u_2 = \frac{C}{C_2}u = \frac{C_1}{C_1 + C_2}u$$

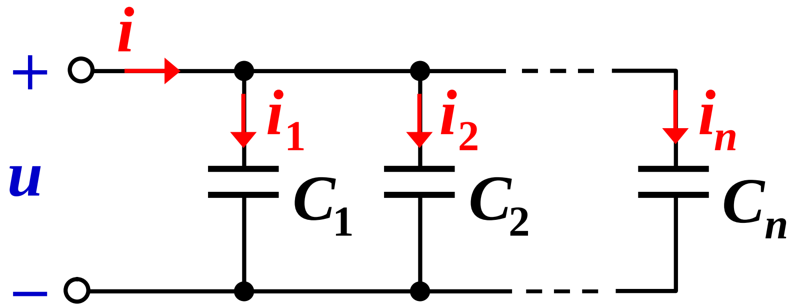
2.

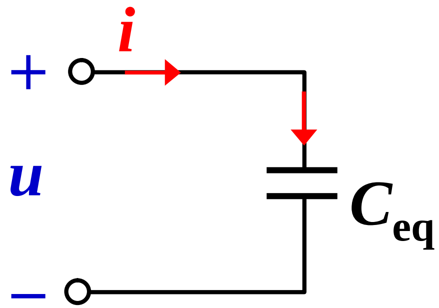
$$i_1 = C_1 \frac{du}{dt}$$





(3) *n*



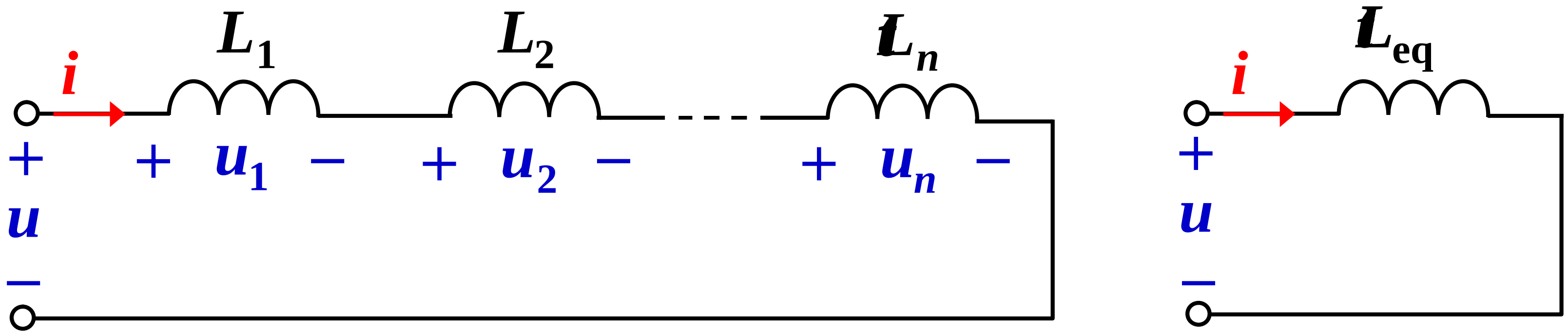


VCR

$$u(t_0) = u_1(t_0) = u_2(t_0) = \cdots = u_n(t_0)$$

$$C_{eq} = C_1 + C_2 + \cdots + C_n$$

3.

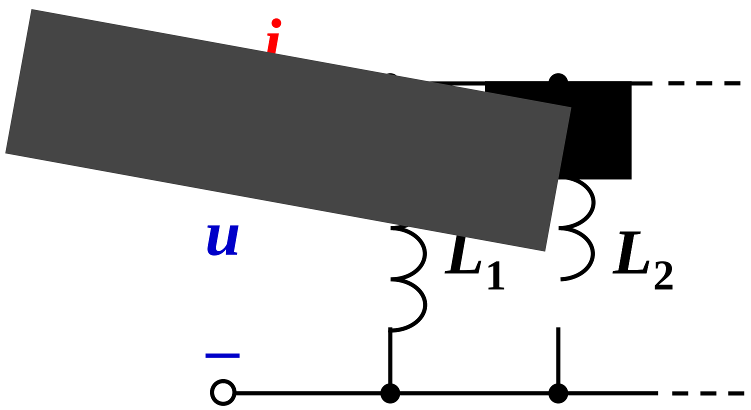


VCR

(1)

$i(t_0) = i_1(t_0) =$ "B# Â%5ø Ã ñ 1!0 13• p 1!0 9ô '– ñ

4.



[redacted]

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots +$$ [redacted]

(2)

$$i(t_0) = i_1(t_0) + i_2(t) +$$ [redacted]