

(R,L,C)

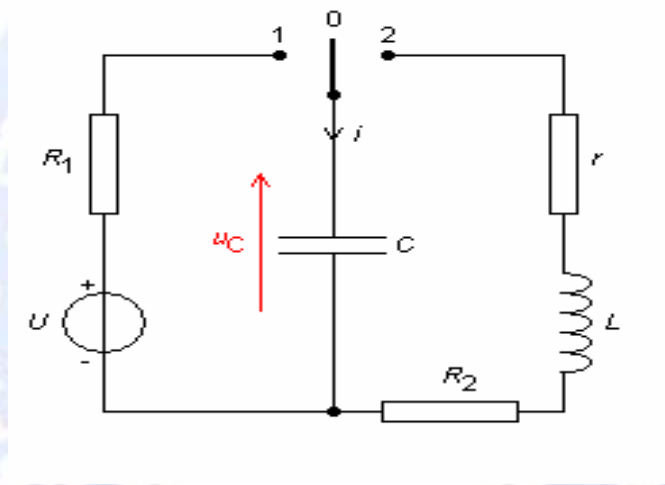
-
- 1
-
-
- 2
-
-

$$q = Q \cos(2\pi t / T + \varphi)$$

.RLC

:1

.Microméga



$r = 5 \Omega$ $L = 400 \text{ mH}$: -

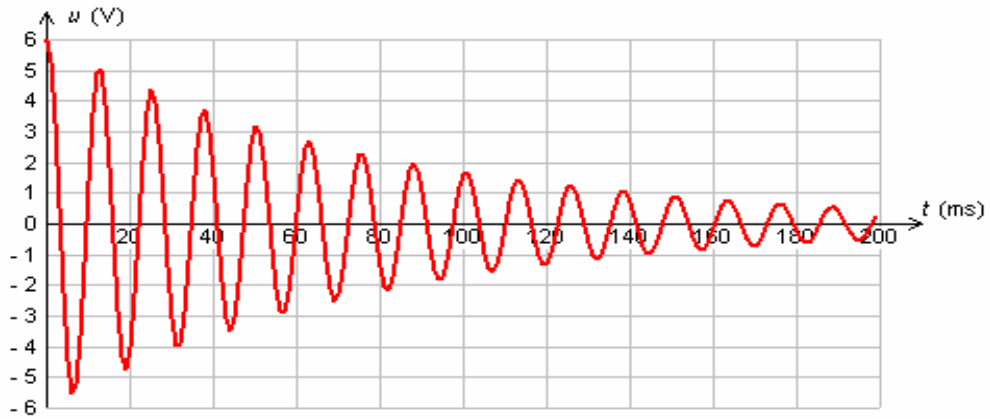
$C = 10 \mu\text{F}$: -

$R_2 = 5 \Omega$: -

200 ms : -

(2)

(1)



: - 1

$$i = - \frac{dq}{dt} \quad i = \frac{dq}{dt}$$

i R_2 u_R - 2

.RLC

$t = 0$

E_0

$u_c(t = 0^+)$

- 3

/

/

"

"

u_c

- 4

- 5

u_c

/

u_R

/

:

$$i = \frac{dq}{dt}$$

- 1

:

u_R

- 2

$$u_R = -Ri$$

- 3

: $t = 0^+$ /

$$u_c(t = 0^+) = E$$

:

$$E_0 = \frac{1}{2} CE^2$$

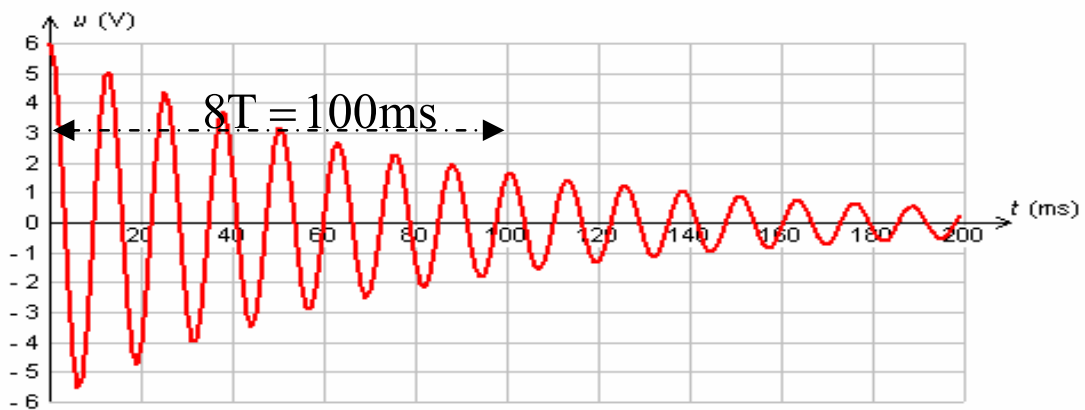
u_c - 4

- 5

/

$T = 12,5 \text{ ms}$ $8T = 100 \text{ ms}$:

/



u_c

/

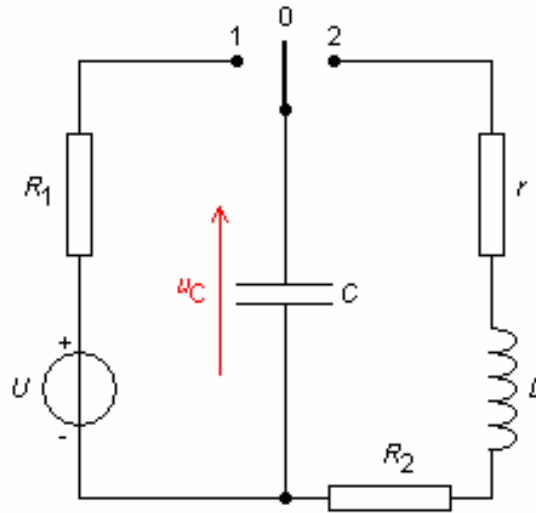
C

L

R

: 2

Microméga



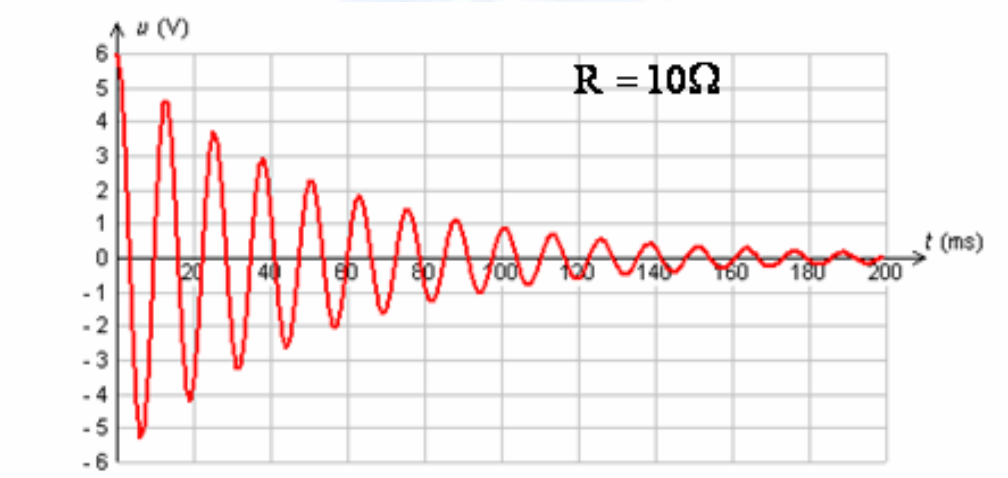
	$R_2 (\Omega)$	$L (mH)$	$C (\mu F)$
1	10	400	10
	30		
	350		
2	10	250	10
		500	
		1000	
3	10	500	20
			100
			200

$r = 5 \Omega$:

(1)

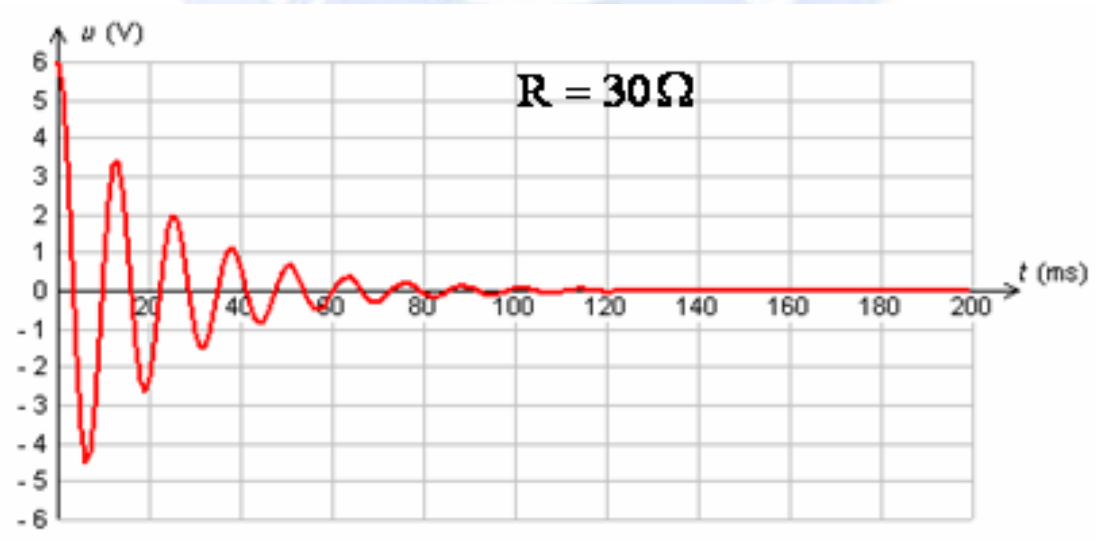
(2)

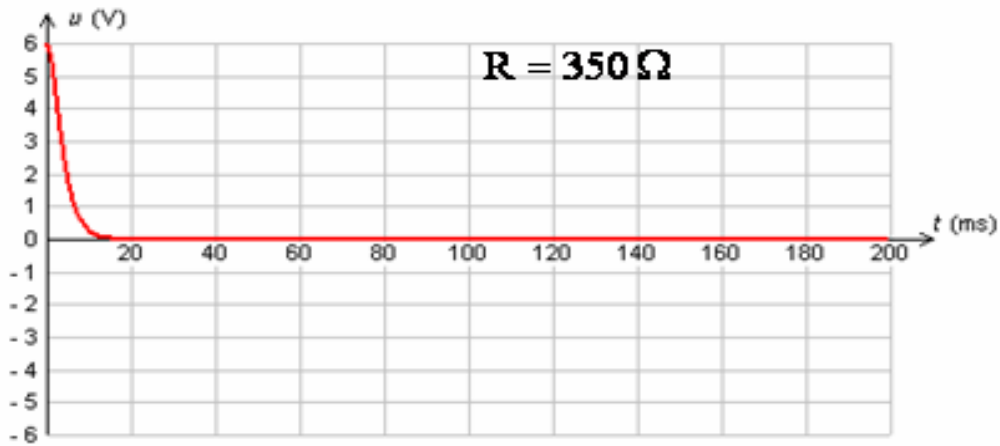
- 1 - 3
- R T .
- L T - 4
- C - 5
- 6
- :



R - 1

R



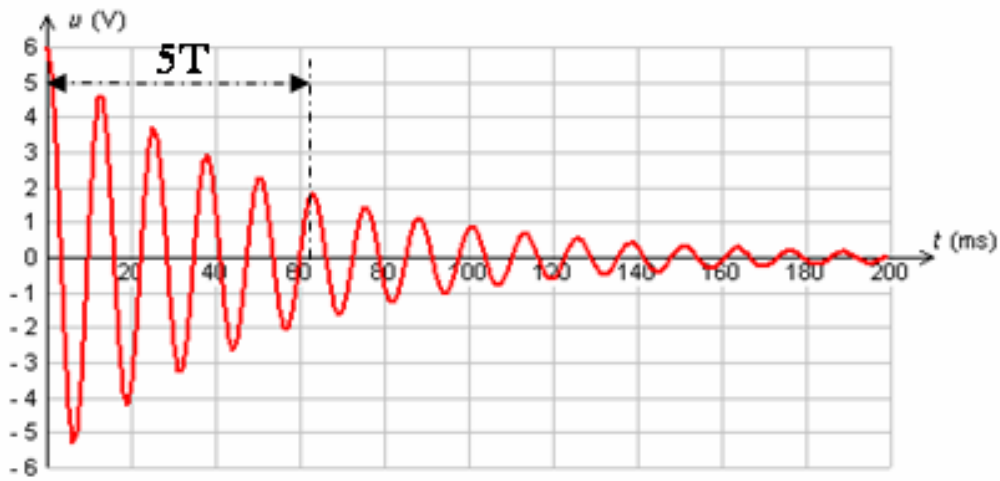


$R = 350 \Omega$

- 2

- 3

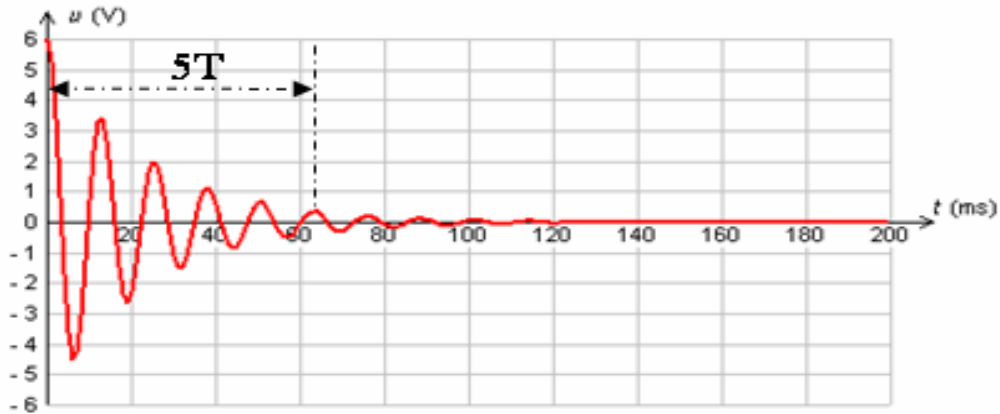
: $R_2 = 10 \Omega$



$T = 12,5 \text{ ms}$

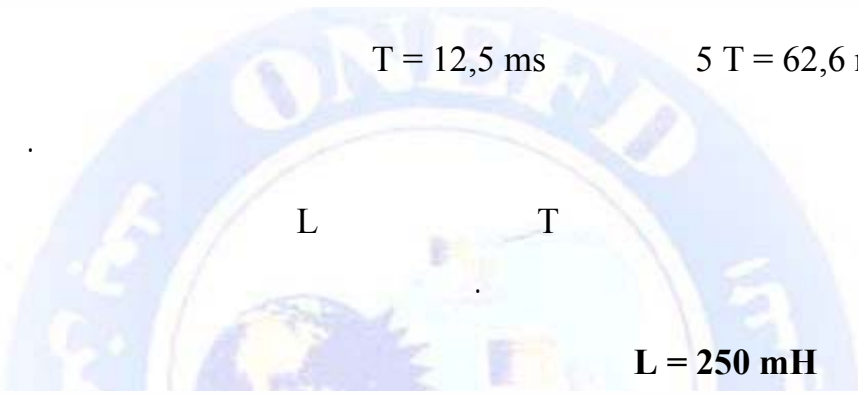
$5 T = 62,6 \text{ ms} :$

$R_2 = 30 \Omega$



$T = 12,5 \text{ ms}$

$5 T = 62,6 \text{ ms} :$



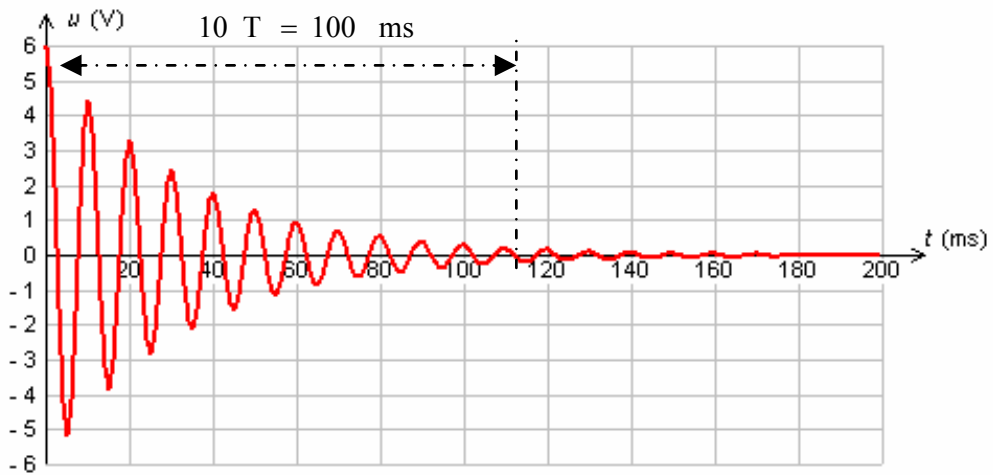
L

T

- 4

L = 250 mH

-

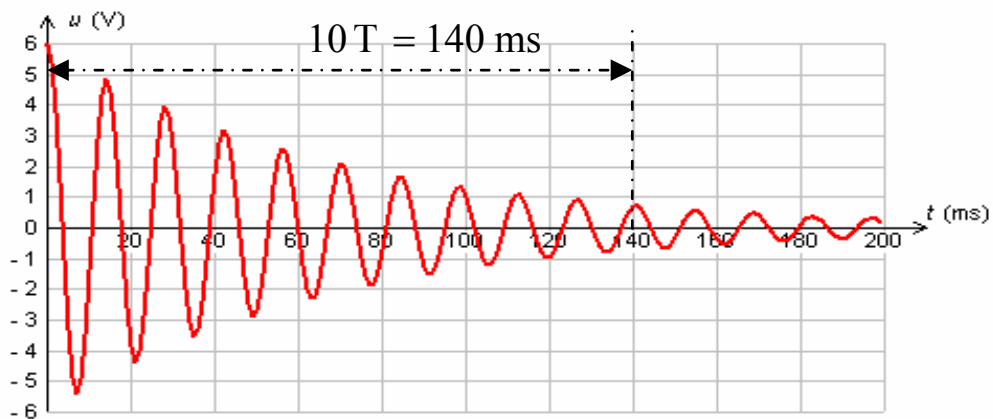


$T = 10 \text{ ms} :$

$10 T = 100 \text{ ms}$

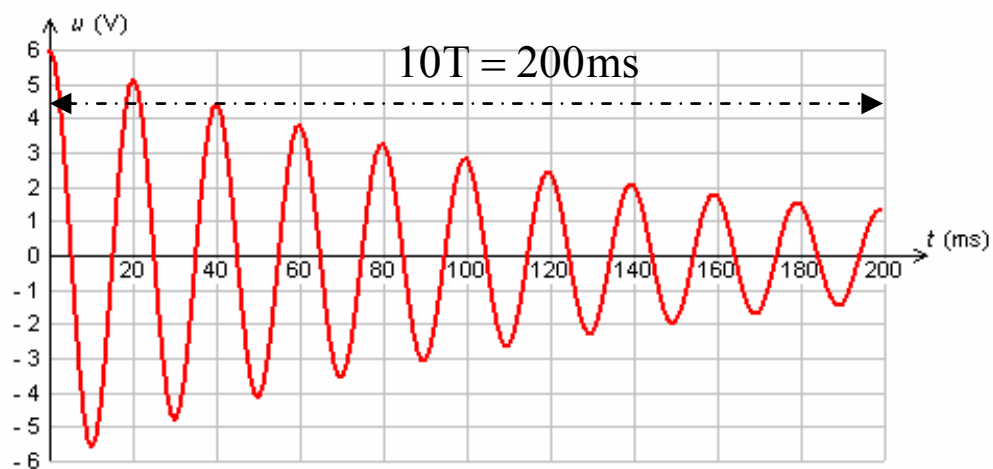
L = 500 mH

-



$T = 14$ ms : $10 T = 140$ ms

$L = 1000$ mH

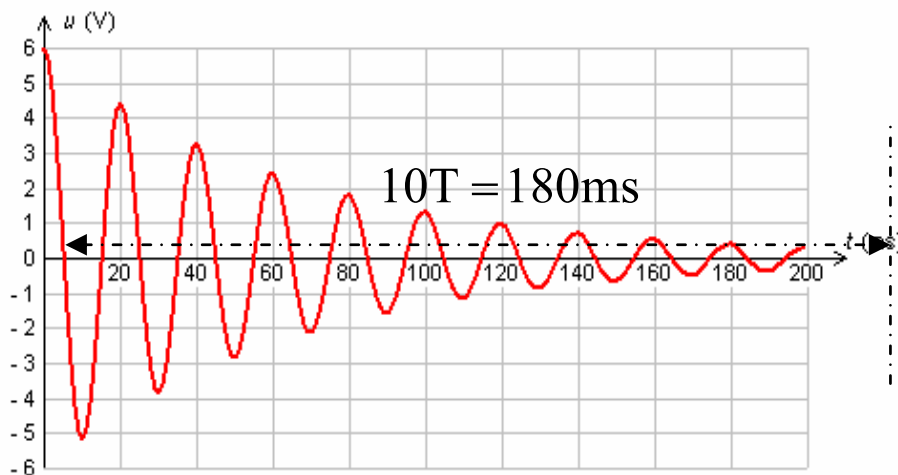


$T = 20$ ms : $10 T = 200$ ms

L T

C T

- 5

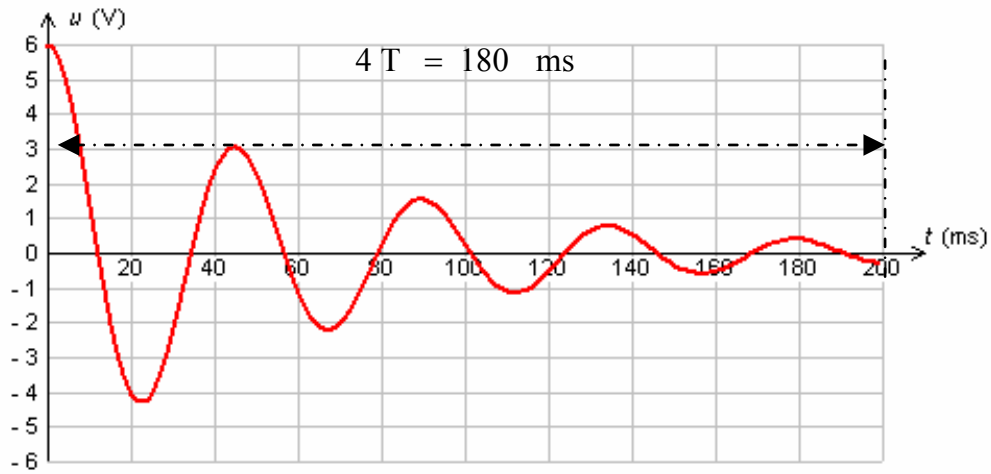


4

$T = 180 \text{ ms}$ $10 T = 180 \text{ ms}$

$C = 100 \mu\text{F}$

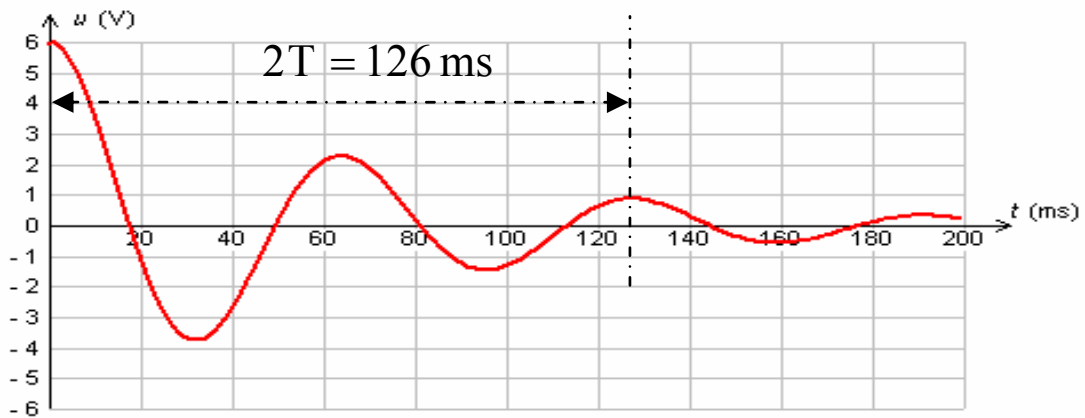
-



$T = 45 \text{ ms}$: $4 T = 180 \text{ ms}$

$C = 200 \mu\text{F}$

-



$T = 63 \text{ ms}$: $2 T = 126 \text{ ms}$

C

T

- 6

RLC R

- 1

- 2

- 3

C

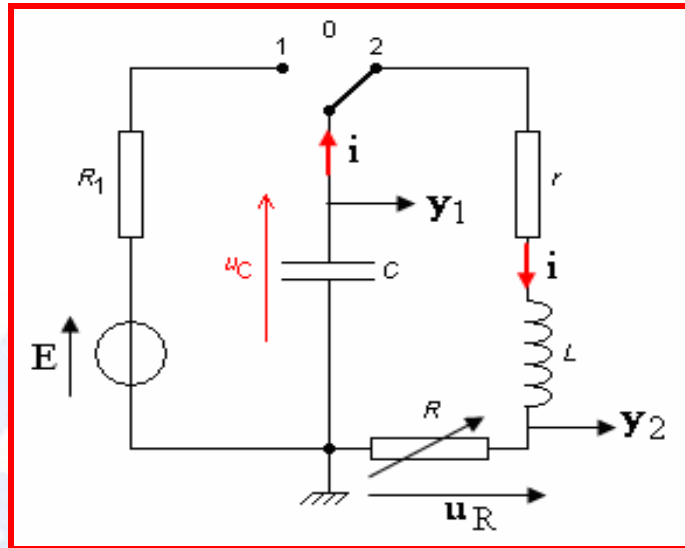
L

-

(R,L,C)

: - 1

: RL



:

C -
L -
R -

$$R_t = R + r$$

$$u_c = E$$

2 K t = 0

RLC

2

u_c

RLC

1

u_c

$$u_R = -Ri$$

2

: RLC

- 2

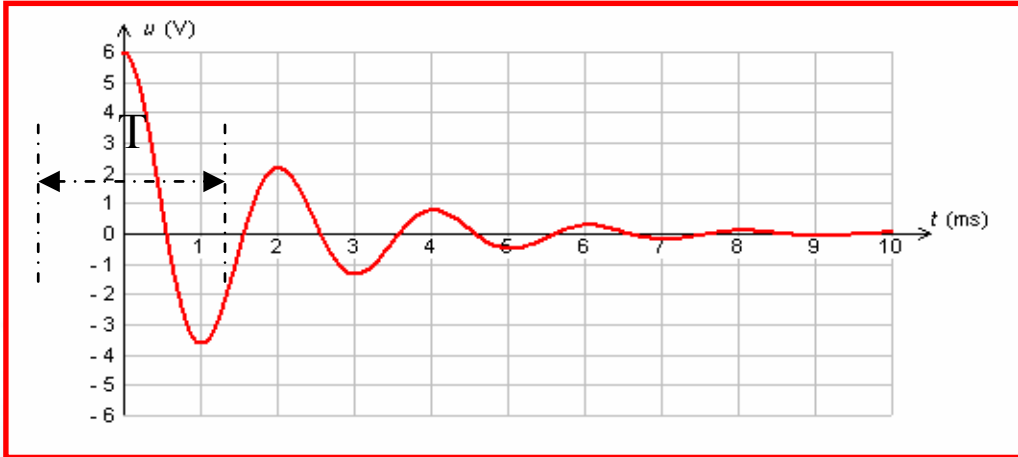
RLC

: /

u_c

R_t

:

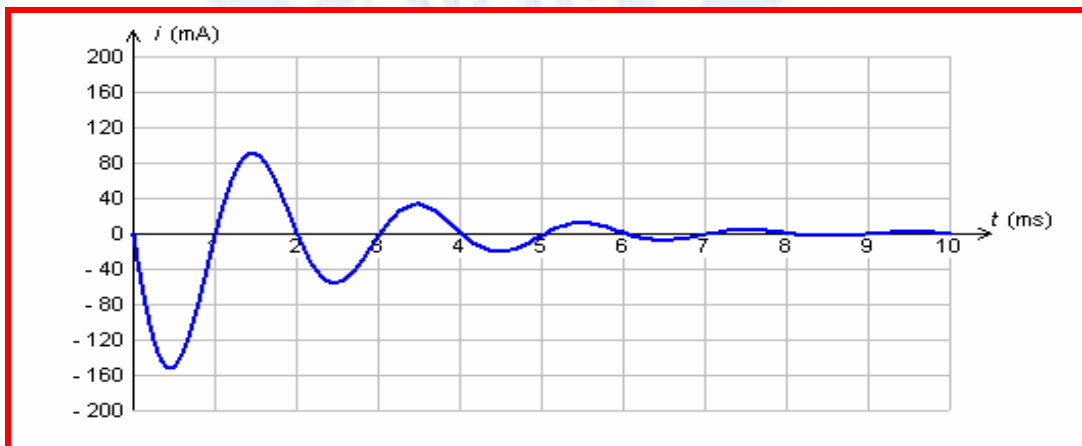


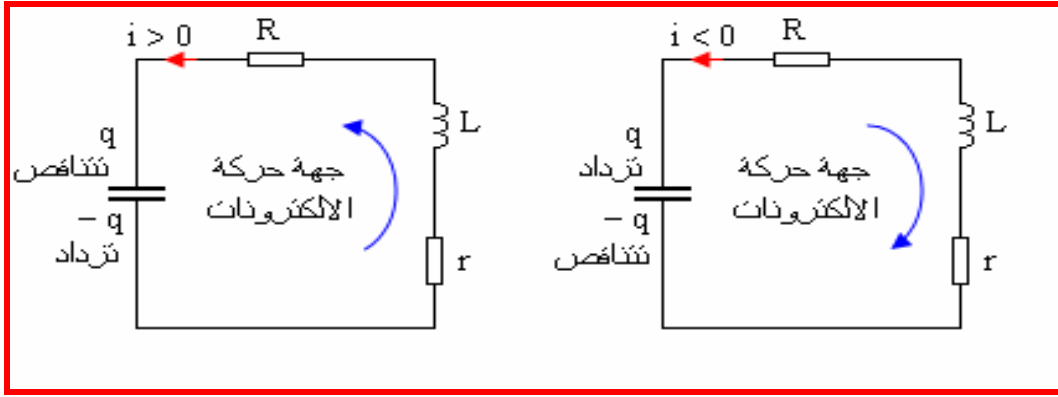
u_c

T

i

:





.RLC

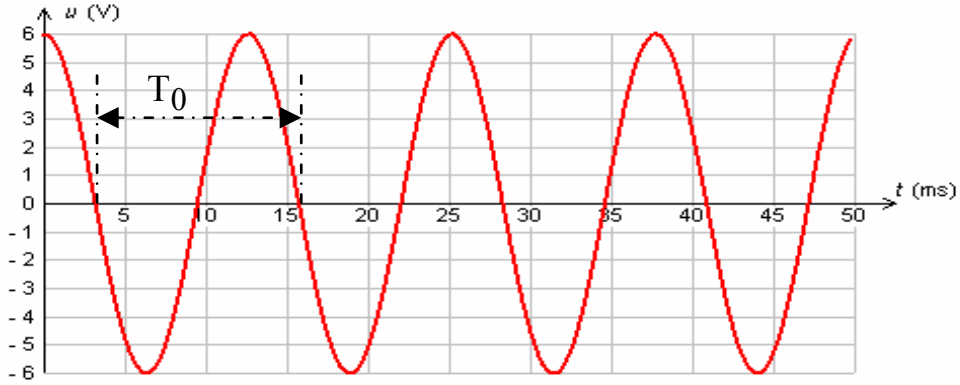
$i > 0$

-

.RLC

$i < 0$

-



.RL

RLC

u_c

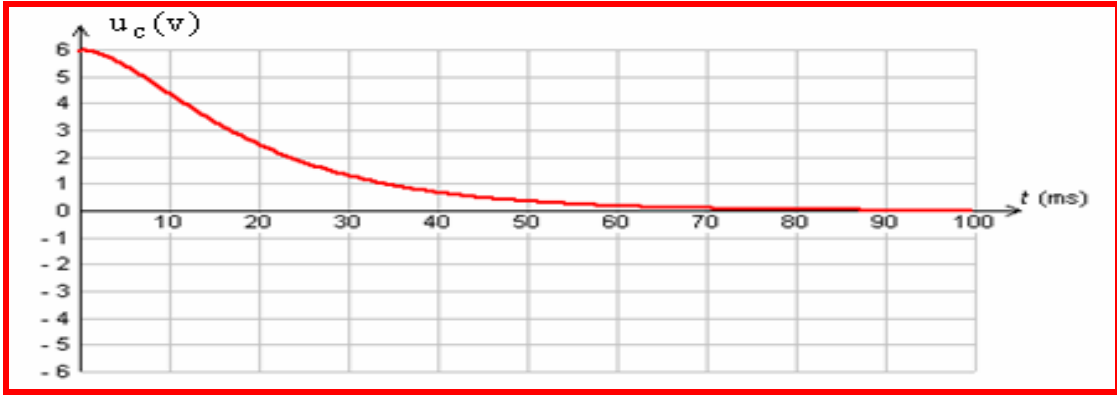
T_0

R_t

u_c

<http://www.onefd.edu.ly>

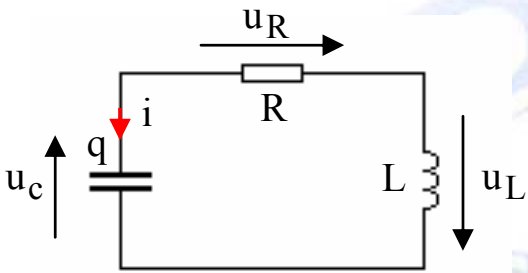
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:

RLC

- 3



.RLC

:

:

-

. R

. L

-

. C

-

$$u_c + u_R + u_L = 0$$

(1)..... $u_c + Ri + L \frac{di}{dt} = 0$

:

(2)..... $i = \frac{dq}{dt}$

:

(3)..... $\frac{di}{dt} = \frac{d^2q}{dt^2}$

: (1) (3) (2)

$$(4) \dots \dots \dots u_c + R \frac{dq}{dt} + L \frac{d^2 q}{dt^2} = 0$$

:

$$q = C \cdot u_c$$

:

$$(5) \dots \dots \dots \frac{dq}{dt} = C \frac{du_c}{dt}$$

:

$$(6) \dots \dots \dots \frac{d^2 q}{dt^2} = C \frac{d^2 u_c}{dt^2}$$

: (4) (6) (5)

$$(7) \dots \dots \dots u_c + RC \frac{du_c}{dt} + LC \frac{d^2 u_c}{dt^2} = 0$$

: LC

$$(8) \dots \dots \dots \frac{d^2 u_c}{dt^2} + \frac{R}{L} \frac{du_c}{dt} + \frac{1}{LC} u_c = 0$$

. RLC

$$\frac{R}{L} \frac{du_c}{dt}$$

R

:

: q RLC

$$(9) \dots \dots \dots LC \frac{d^2 q}{dt^2} + RC \frac{dq}{dt} + q = 0$$

RLC

.LC

(8) $R = 0$

$$(10) \dots \dots \dots \frac{d^2 u_c}{dt^2} + \frac{1}{LC} u_c = 0$$

$u_c(t)$

$$(11) \dots \dots \dots u_c(t) = A \cos \left(\frac{2\pi}{T_0} t + \varphi \right)$$

$$T_0 \cdot \left(\frac{2\pi}{T_0} t + \varphi \right)$$

$t = 0$

φ

u_c

T_0

C L

(11)

$$\frac{d \left(A \cos \left(\frac{2\pi}{T_0} t + \varphi \right) \right)}{dt} = - A \frac{2\pi}{T_0} \sin \left(\frac{2\pi}{T_0} t + \varphi \right)$$

$$\frac{d^2 \left(A \cos \left(\frac{2\pi}{T_0} t + \varphi \right) \right)}{dt^2} = - A \left(\frac{2\pi}{T_0} \right)^2 \cos \left(\frac{2\pi}{T_0} t + \varphi \right)$$

(10)

(12)

$$- A \left(\frac{2\pi}{T_0} \right)^2 \cos \left(\frac{2\pi}{T_0} t + \varphi \right) + \frac{A}{LC} \cos \left(\frac{2\pi}{T_0} t + \varphi \right) = 0$$

$$\left[\cos \left(\frac{2\pi}{T_0} t + \varphi \right) \right] \left(\frac{A}{LC} - A \left(\frac{2\pi}{T_0} \right)^2 \right) = 0$$

$$\left(\frac{A}{LC} - A \left(\frac{2\pi}{T_0} \right)^2 \right) = 0$$

$$T_0 = 2\pi\sqrt{LC}$$

φ A -

$$i(t=0) = 0$$

$$u_c(t=0) = +U_0$$

$$\begin{cases} i(t=0) = 0 \\ u_c(t=0) > 0 \end{cases}$$

$$i = \frac{dq}{dt} = C \frac{du_c}{dt}$$

$$\frac{du_c}{dt} = -A \frac{2\pi}{T_0} \sin \left(\frac{2\pi}{T_0} t + \varphi \right)$$

$$i(t=0) = -\frac{2\pi AC}{T_0} \sin(\varphi) = 0$$

$$\begin{cases} \varphi = 0 \\ \varphi = \pi \end{cases}$$

$$\varphi = 0$$

$$: u_c(t)$$

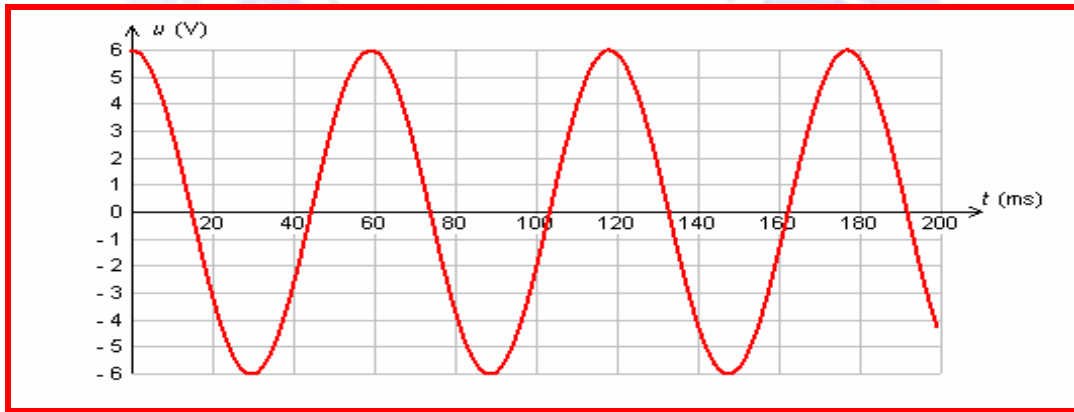
$$u_c(t = 0) = A \cos \left(\frac{2\pi}{T_0}(0) + 0 \right) = U_0$$

$$A = U_0$$

(12).....

$$u_c(t) = U_0 \cos \left(\frac{2\pi}{T_0} t \right)$$

.LC



$$: i(t) \quad q(t) \quad (12)$$

(13).....

$$q(t) = CU_0 \cos \left(\frac{2\pi}{T_0} t \right)$$

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$$i(t) = \frac{dq}{dt} = -CU_0 \frac{2\pi}{T_0} \sin \left(\frac{2\pi}{T_0} t \right) = -CU_0 \frac{2\pi}{2\pi \sqrt{LC}} \sin \left(\frac{2\pi}{T_0} t \right)$$

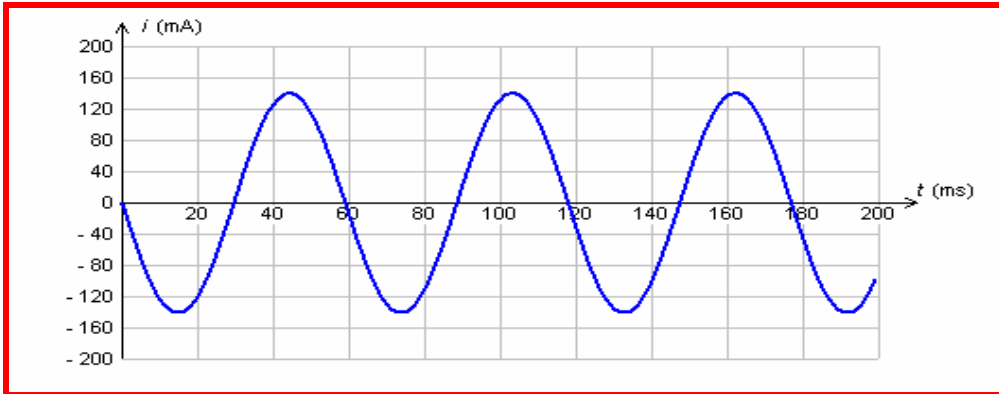
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:

(14).....

$$i(t) = -U_0 \sqrt{\frac{C}{L}} \sin\left(\frac{2\pi}{T_0} t\right)$$

$i(t)$



:

/

RLC

() RLC

T_0

RLC

$$. 2\pi\sqrt{LC}$$

RLC

:

.C L R

T

-

T_0

T_0

T

-

:

$$L \quad - 1$$

$$R \quad - 2$$

:

$$: \quad RLC \quad - 1$$

$$T_0 = 2\pi\sqrt{LC}$$

$$: \quad L$$

$$T'_0 = 2\pi\sqrt{4 \times LC}$$

:

$$T'_0 = 2\pi\sqrt{LC} \times \sqrt{4} = 2T_0$$

$$L \quad T \quad T \approx T_0$$

$$- 2$$

T_0

T

T

$$- 5$$

/

/ RLC

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

$$: \quad i = \frac{dq}{dt}$$

$$Li \frac{di}{dt} + Ri^2 + \frac{q}{C} \frac{dq}{dt} = 0$$

:

$$L \frac{d}{dt} \left(\frac{i^2}{2} \right) + Ri^2 + \frac{1}{C} \frac{d}{dt} \left(\frac{q^2}{2} \right) = 0$$

:

<http://www.onefd.edu.dz> $Ri^2 + \frac{d}{dt} \left(\frac{Li^2}{2} + \frac{q^2}{2C} \right) = 0$ جميع الحقوق محفوظة ©

$$E_L = \frac{1}{2} Li^2(t) : t -$$

$$E_C = \frac{1}{2} \frac{q^2(t)}{C} : t -$$

$$: t -$$

$$E(t) = \frac{1}{2} Li^2(t) + \frac{1}{2} \frac{q^2}{C}$$

$$E(t) = \frac{1}{2} Li^2(t) + \frac{1}{2} \frac{q^2}{C}$$

: RLC

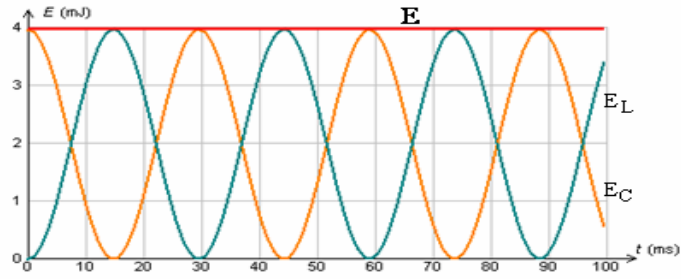
$$Ri^2 + \frac{dE}{dt}(t) = 0$$

$$\frac{dE}{dt}(t) = 0$$

$$\frac{d}{dt} \left(\frac{Li^2}{2} + \frac{q^2}{2C} \right) = 0$$

$$\frac{d}{dt} (E_L + E_C) = 0$$

LC

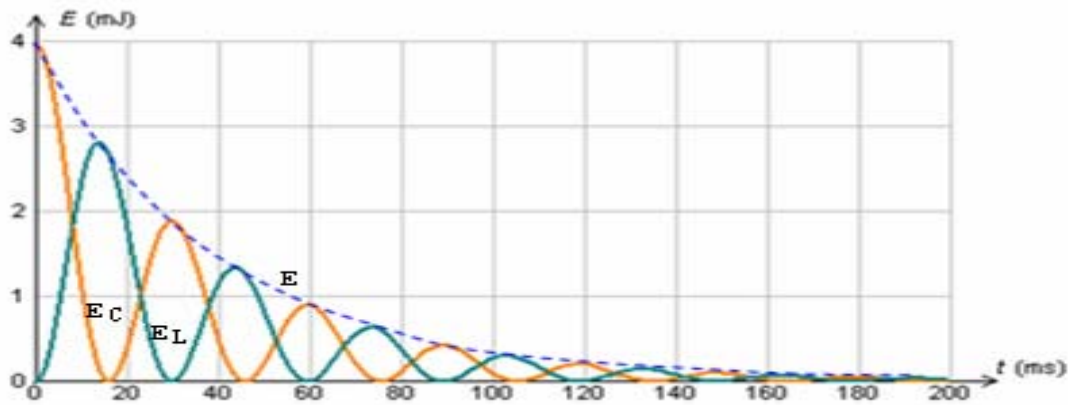


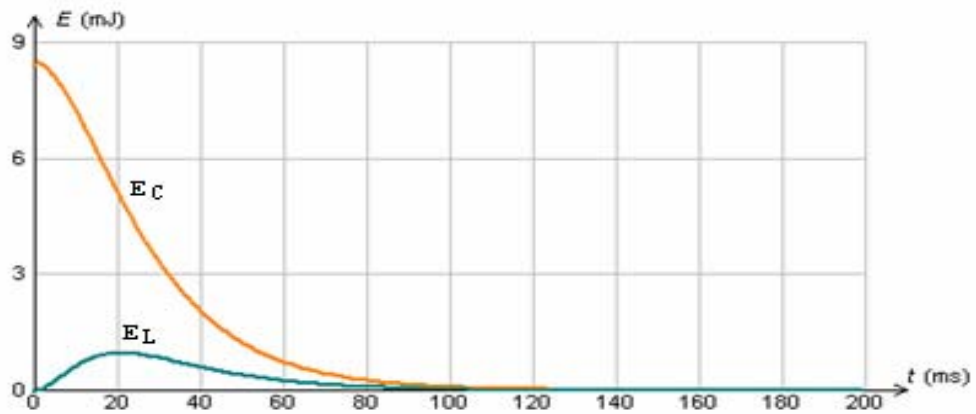
$$\frac{dE}{dt}(t) = -Ri^2(t)$$

$$\frac{dE}{dt}(t) < 0$$

RLC

$$\left(\frac{Li^2}{2} + \frac{q^2}{2C} \right)$$





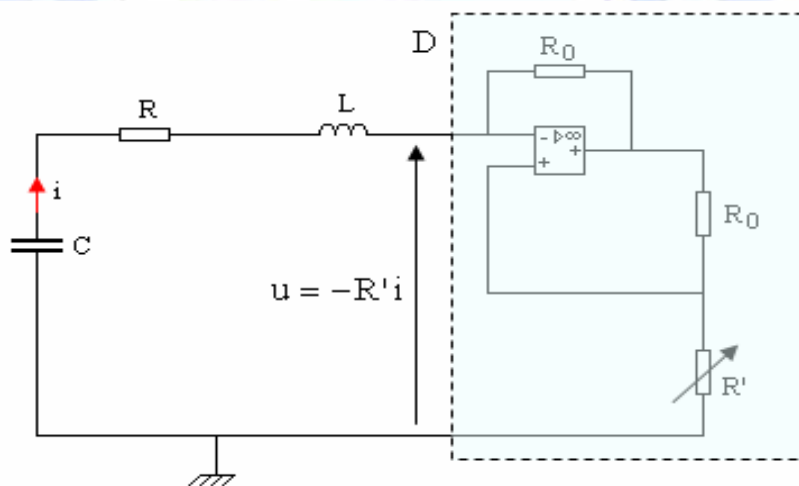
R

RLC

.RLC

RLC

:RLC



RLC

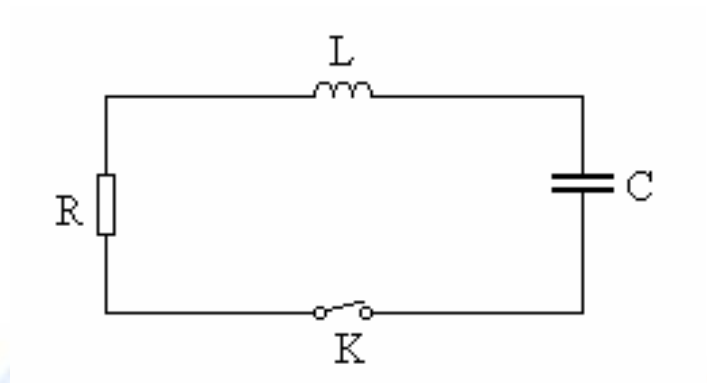
.R

.RL

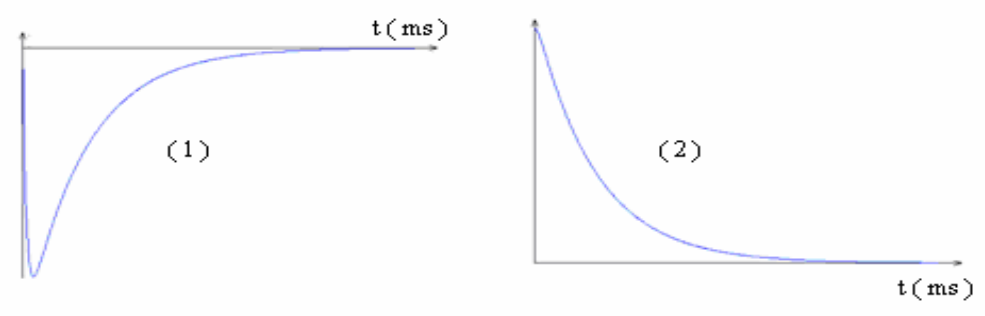
RL

: 1

. R . L C

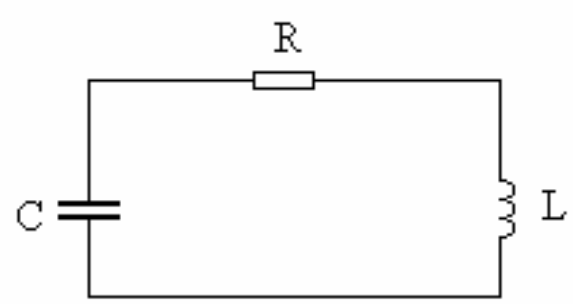


$u_R(t)$ $u_C(t)$



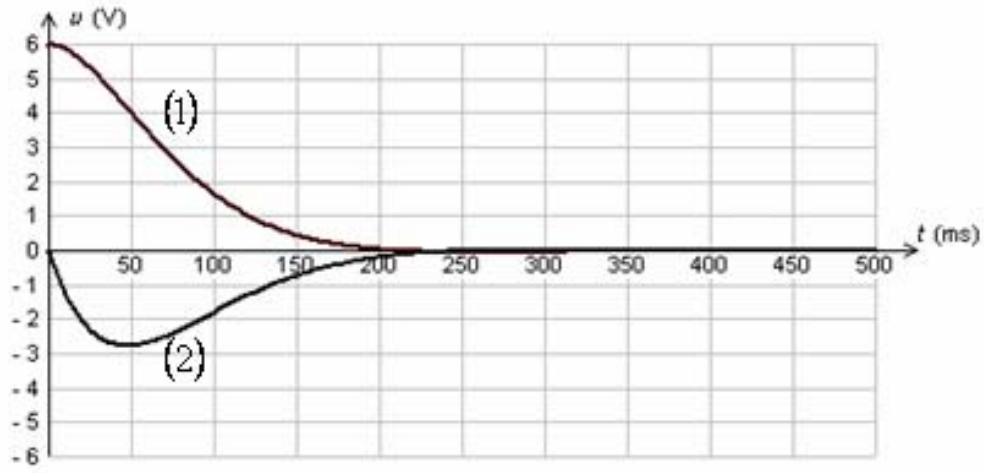
: 2

.RLC



u_C

u_R



u_R u_C

: 3

Q_0 A L

- 1

$q(t) = Q_0 \cos \frac{2\pi}{T_0} t$: A q - 2

$q(t) = Q_0 \sin \frac{2\pi}{T_0} t$: - 3

.C L - 3

4

. L = 4,9 mH C = 10 nF LC

. () 20

. . - 1

. 10 - 2

: :

1 ms / division 5 ms / division

5 μs / division 0,5 ms / division

5

. $U_0 = 3 \text{ V}$

$C = 22 \mu\text{F}$

. $L = 38 \text{ mH}$

- 1

T_0

- 2

- 3

. $u_C(t)$

6

.L

. U_0

C

u_C

- 1

. (convention récepteur)

. $u_C(t)$

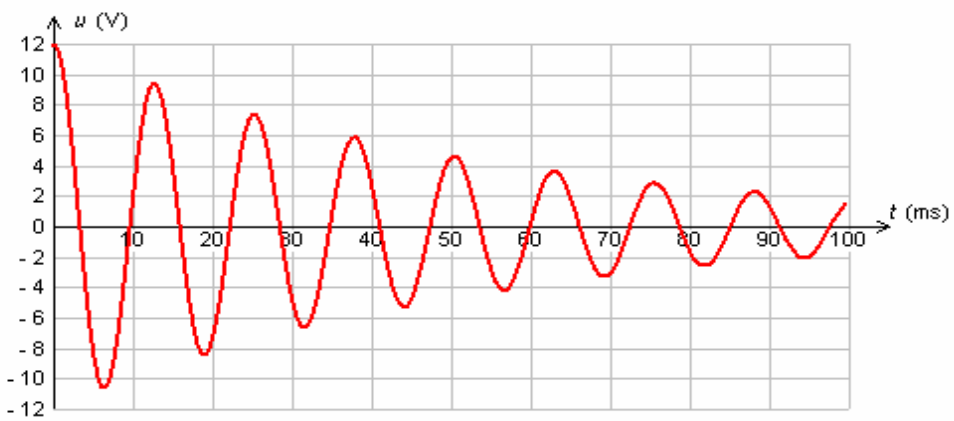
- 2

- 3

. $i(t)$ $u_C(t)$

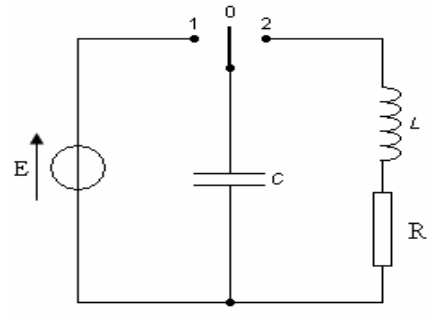
- 4

: 7

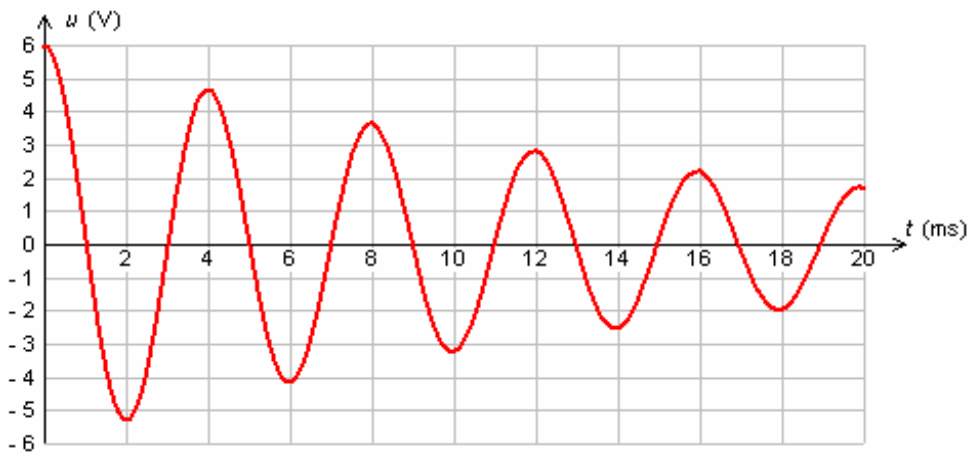


- 1

- 2



(1) . $C = 2 \mu\text{F}$

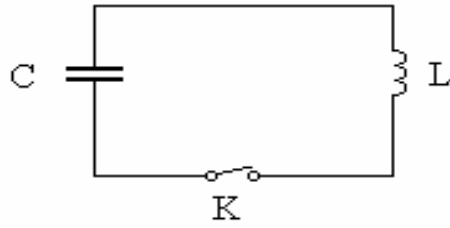


- 1
- 2
- 3
- 4

LC

: 9

.K L C :



$t = 0$. Q_0

Q_0

. q i

- 1

. t

- 2

. t

- 3

. $q(t)$

- 4

- 5

: 10

C

L

. 6 V

. = 0,1 μ F

10

8

0,2 ms/ division :

.2 V / division :

. $u_C(t)$

. $u_C(t)$

- 1

.L

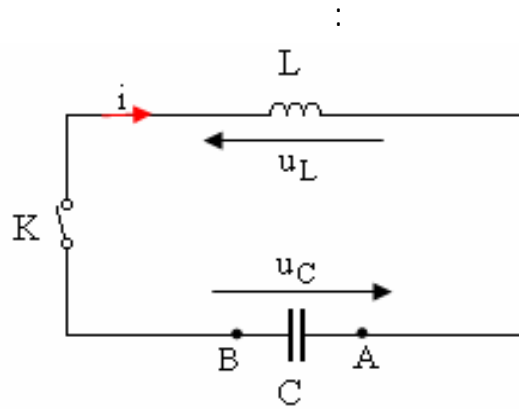
- 2

- 3

- 4

- 5

: 11



- 1. U_0 - 1
- 2. $q(t)$ - 2
- 3. $q(t) = Q_m \cos\left(\frac{2\pi}{T_0} t\right)$ - 3
- 4. Q_m - 4
- 5. $U_0 = 10 \text{ V}$ $C = 2 \mu\text{F}$ $L = 0,02 \text{ H}$: Q_m T_0 - 5
- 6. $t < 0$ - 6
- 7. $t \geq 0$ - 7
- 8. I_{max} - 8
- 9. - 9

: 12

.150 μA

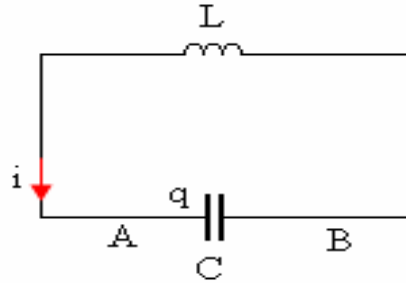
I

.C = 18 μF

8 - 1

$L = 0,5 \text{ H}$

E_C /
 $t = 8 \text{ s}$ - 2



A

$q(t)$

/

.t

$$q(t) = Q_m \cos\left(\frac{2\pi}{T_0}t + \varphi\right)$$

$q(t)$

φ

E

.q

t

E

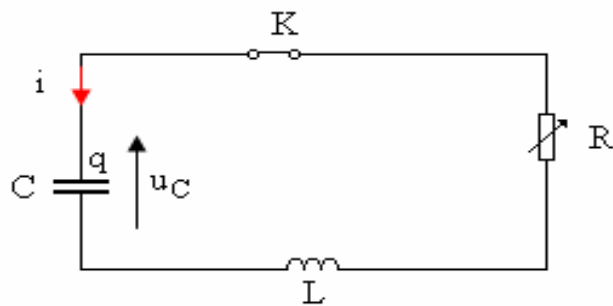
- 3

E

- 4

$q(t)$

13



R

$L = 0,2 \text{ H}$

$C = 5 \mu\text{F}$

.K

$q = Q_0$

$$q(t) \quad - 1$$

$$q \quad R \quad - 2$$

$$u_C \quad - 3$$

R

$$E \quad - 4$$

t

$$\frac{dE}{dt} \quad - 5$$

R

$$\frac{dE}{dt}$$

1

$$- 6$$

i

: 14

$$U_0 = 12 \text{ V}$$

$$R = 30 \Omega$$

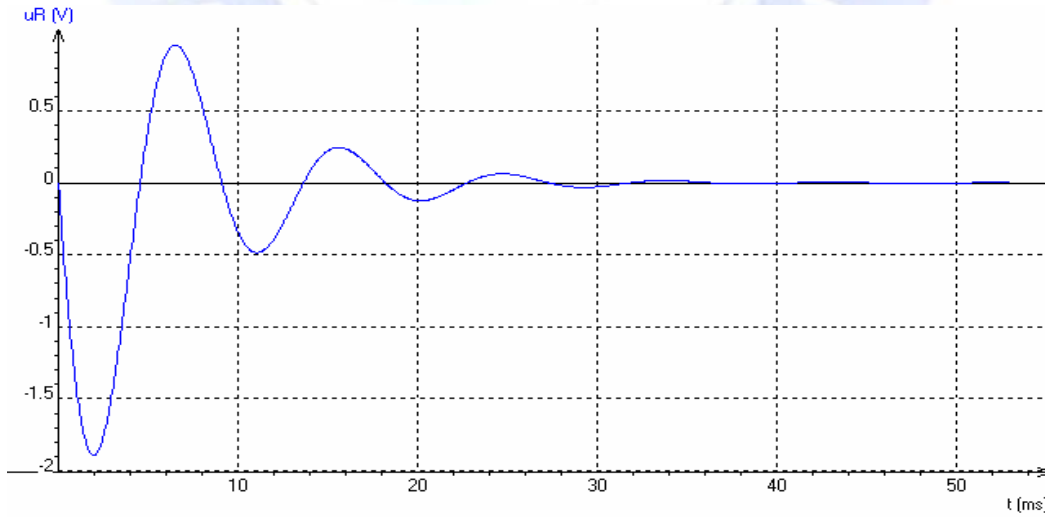
L

C

R

u_R

$$R' = 30 \Omega$$



$$- 1$$

u_R

$$u_R = Ri \quad - 2$$

t = 0

$$- 3$$

<http://www.onefd.edu> t = 0

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$$- 4$$

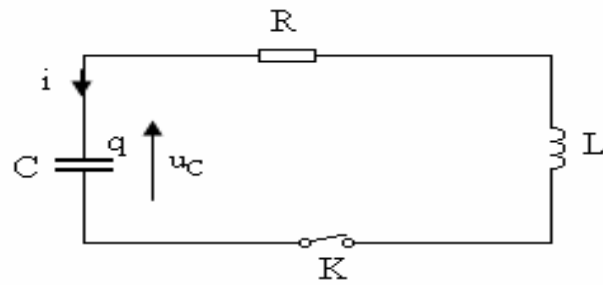
$$\frac{di}{dt} \quad i \quad R' \quad L : \quad - 5$$

$$t = 0 \quad u_R (t) \quad - 6$$

$$.L \quad \frac{di}{dt} \quad \frac{du_R}{dt} = - 1,76 \cdot 10^3 \quad V / s \quad - 7$$

$$.C$$

: 15



$$L = 0,5 \text{ H} \quad -$$

$$C = 2 \mu\text{F} \quad -$$

$$R \quad -$$

$$t = 0 \quad u_C = 100 \text{ V}$$

$$u_1 = 90 \text{ V}$$

$$t = 0$$

$$u_C (t) \quad - 1$$

$$T \quad - 2$$

$$.T \quad LC \quad T_0$$

$$t = n T \quad i (t) \quad - 3$$

n

$$u_C (nT) = U_0 e^{-\frac{nRT}{2L}} : \quad - 4$$

$$u_C (nT) = U_1 \quad /$$

<http://www.onefd.edu.dz>

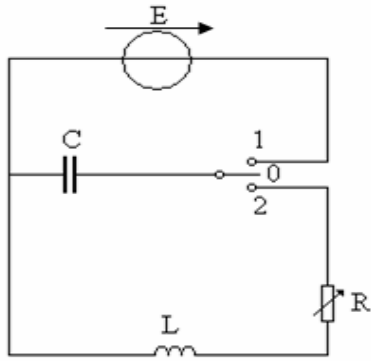
جميع الحقوق محفوظة ©

$$. n \quad U_0 \quad U_1 \quad u_C (t = nT) \quad /$$

$$\frac{U_0}{100}$$

/

16



(1)

(2)

$u_C(t)$

R

- 1

R = 0

- 2

$q(t)$

$$T_0 = 2\pi\sqrt{LC}$$

$q(t)$

$$q(t) = Q_M \cos\left(\frac{2\pi}{T_0}t + \Phi_0\right)$$

Φ_0 Q_M

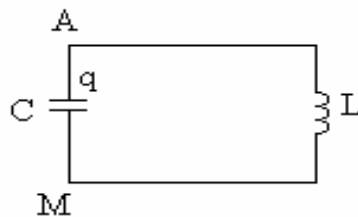
: 17

$$U_0 = 12 \text{ V}$$

$$C = 0,2 \mu\text{F}$$

$$L = 1,0 \text{ H}$$

$$t = 0$$



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$q(t)$

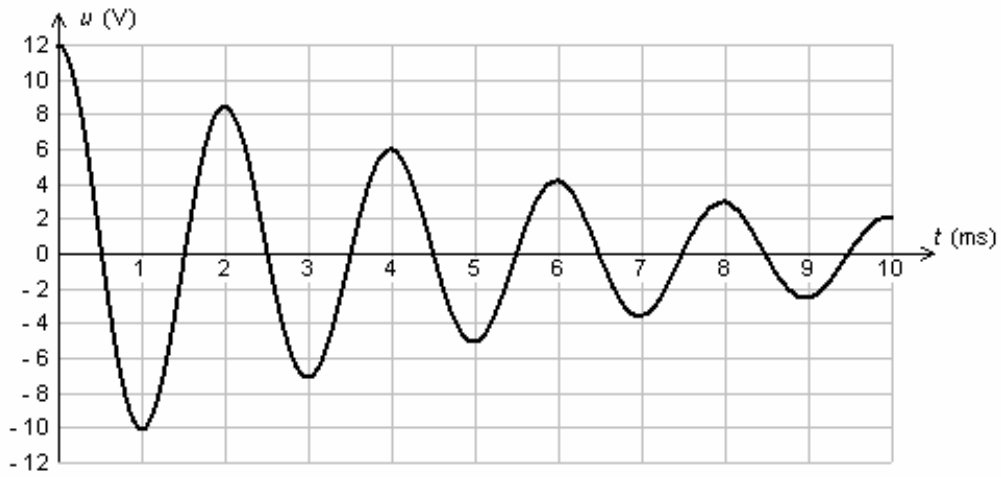
/ - 1

$q(t)$ /

: [0 ; 6 ms] $u_{AM}(t)$ /

. 1cm \rightarrow 5V 1cm \rightarrow 0,5ms

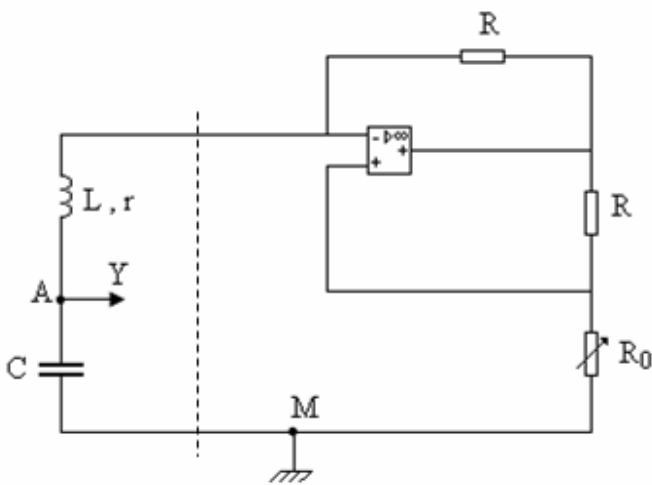
: $u_{AM}(t)$ - 2



/

/

- 3



$r = 350 \Omega$

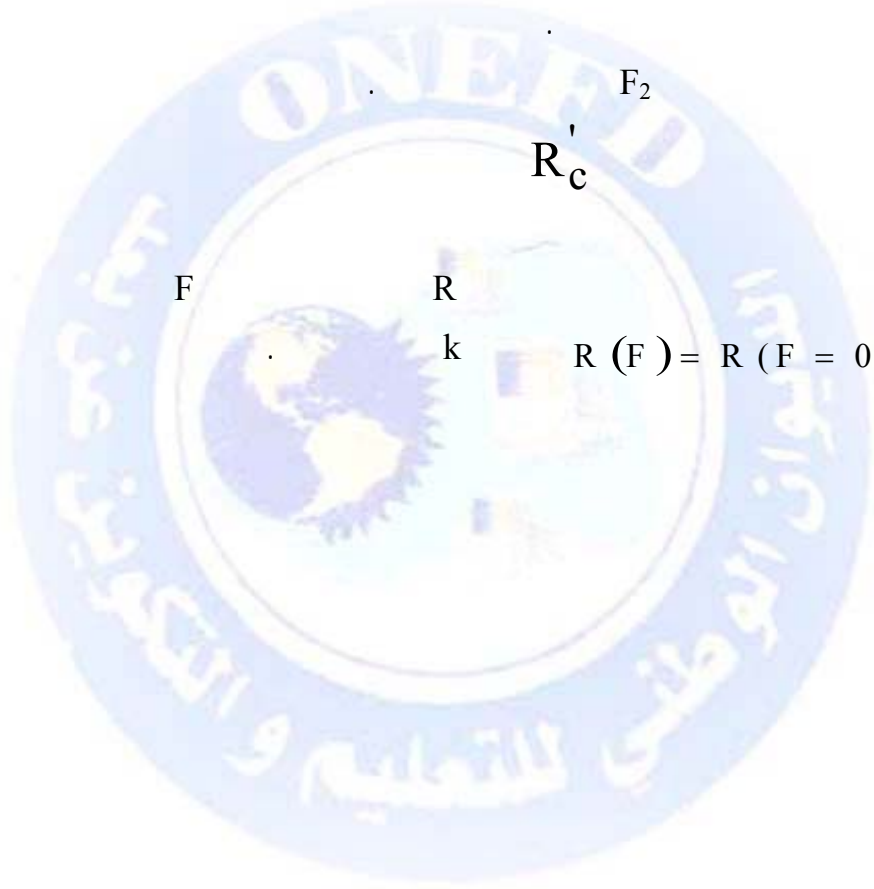
R_0

/

/

$R'_c = 66 \Omega$ $C = 10 \text{ nF}$

$R(F) = R(F=0) + k F^2$

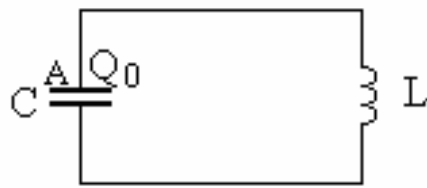


$$u_C(t) \quad (2) \quad u_R(t) \quad (1) \quad : 1$$

$$. u_R \quad (2) \quad u_C \quad (1) \quad : 2$$

$$: 3$$

- 1



$$q(t=0) = Q_0 \quad t=0 \quad - 2$$

$$: \quad t=0$$

$$q(t=0) = Q_0 \cos \frac{2\pi}{T_0}(0) = Q_0$$

$$q(t=0) = Q_0 \sin \frac{2\pi}{T_0}(0) = 0$$

: q

$$q(t) = Q_0 \cos \frac{2\pi}{T_0} t$$

: 4

:

- 1

$$T_0 = 2\pi\sqrt{LC}$$

:

$$T_0 = 4,4 \cdot 10^{-5} \text{ s}$$

- 2

$4,4 \mu\text{s}$ $4,4 \cdot 10^{-6} \text{ s}$

1 div

$5 \mu\text{s} / \text{division}$

: 5

$i(t)$ $u_C(t)$ $q(t)$:

- 1

:

- 2

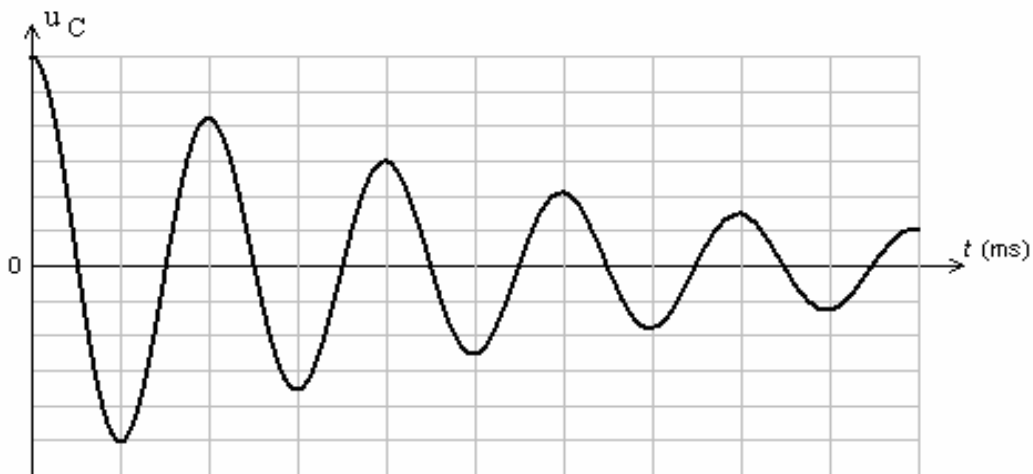
$$T_0 = 2\pi\sqrt{LC}$$

:

$$T_0 = 5,7 \text{ ms}$$

- 3

:



LC

T_0

RLC

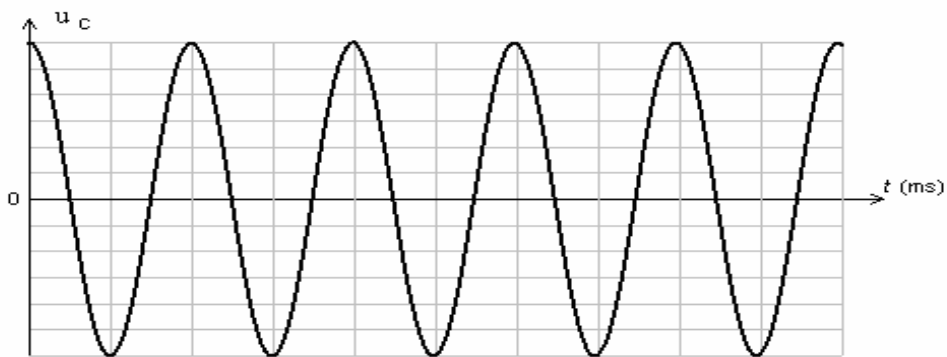
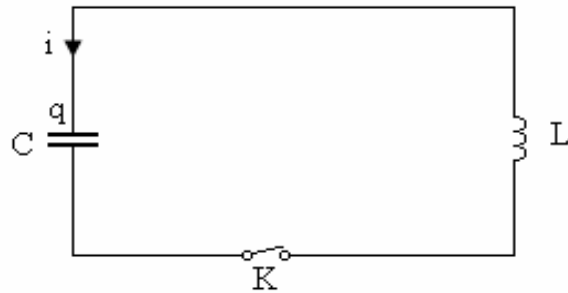
T

:

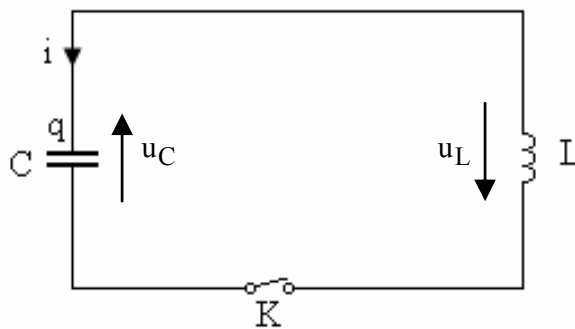
$$T = T_0 = 5,7 \text{ ms}$$

: 6

- 1



- 2



$$u_C + u_L = 0$$

: u_L

$$u_C + L \frac{di}{dt} = 0$$

<http://www.oneff.com> $\frac{d^2 q}{dt^2} = C \frac{d^2 u_C}{dt^2}$: $q = C \cdot u_C$ $\frac{di}{dt} = \frac{d^2 q}{dt^2}$

$$u_C + LC \frac{d^2 u_C}{dt^2} = 0$$

$u_C(t) =$:

$t = 0$ - 3

$i(t=0) = 0$ U_0

$\omega_0 = \frac{1}{\sqrt{LC}}$ - 4

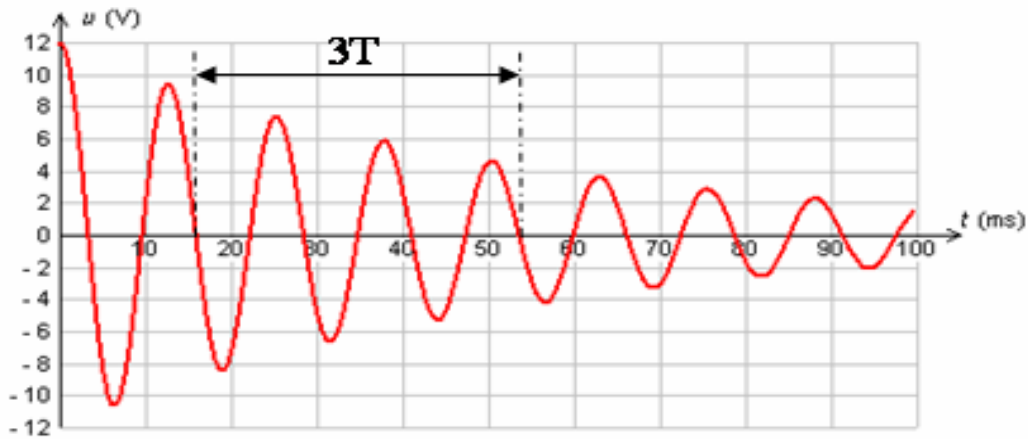
$u_C(t) = U_0 \cos(\omega_0 t)$

$i(t) = -C\omega_0 U_0 \sin(\omega_0 t)$: $i(t)$

: 7

$U_0 = 12 \text{ V}$: - 1

$T = 12,6 \text{ ms}$ $3T = 37,9 \text{ ms}$:

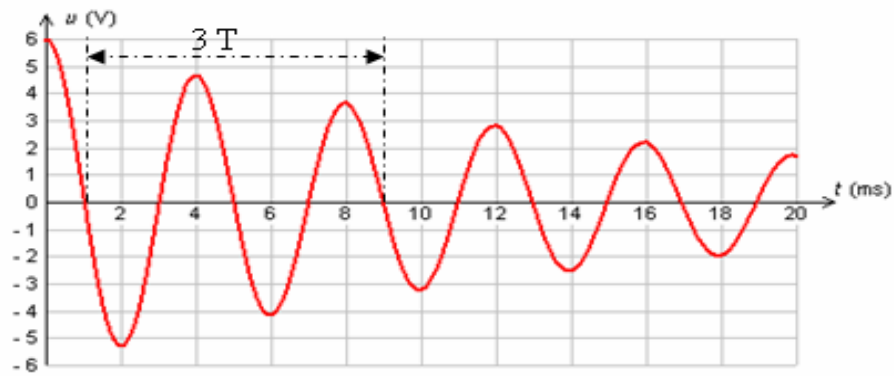


: 8

- 1

- 2

- 3



T

- 4

: LC T₀

RLC

$$T = T_0 = 2\pi\sqrt{LC}$$

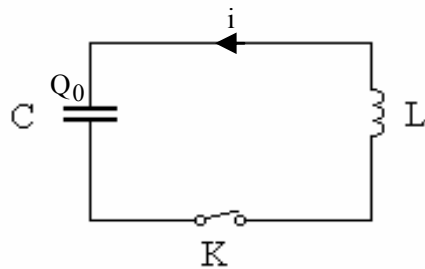
$$L = \frac{T^2}{4\pi^2 C}$$

$$L = \frac{(4 \cdot 10^{-3})^2}{4 \times 3,14^2 \times 2 \cdot 10^{-6}}$$

$$L = 0,2 \text{ H}$$

: 9

- 1



$$i = \frac{dq}{dt}$$

: t - 2

$$E_C = \frac{1}{2} C q^2$$

: t

$$E_L = \frac{1}{2} L i^2$$

: t

- 3

$$E = \frac{1}{2} C q^2 + \frac{1}{2} L i^2$$

- 4

- 5

$$\frac{dE}{dt} = \frac{d}{dt} \left[\frac{1}{2} C q^2 + \frac{1}{2} L i^2 \right] = 0$$

$$\frac{dE}{dt} = \frac{1}{2} C \cdot 2 \cdot q \frac{dq}{dt} + \frac{1}{2} L \cdot 2 \cdot i \frac{di}{dt} = 0$$

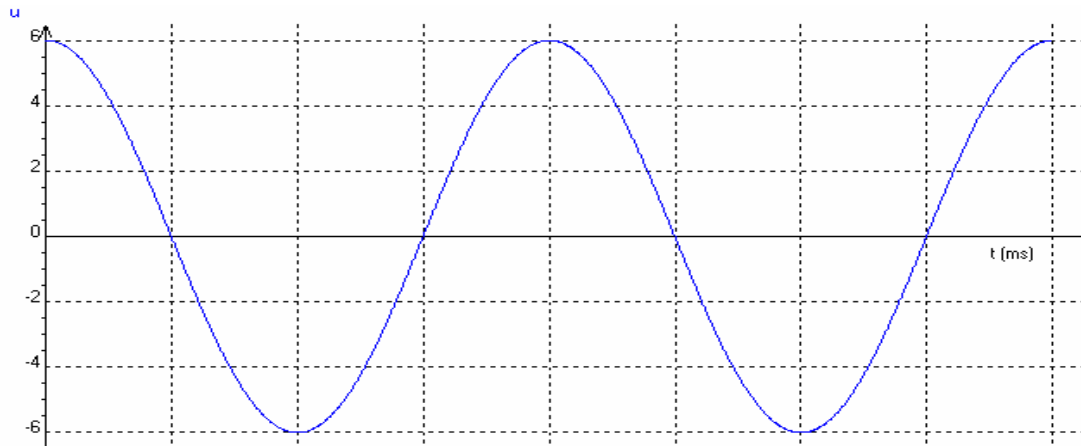
$$\frac{di}{dt} = \frac{d^2 q}{dt^2} \quad i = \frac{dq}{dt}$$

$$L \frac{d^2 q}{dt^2} + \frac{q}{C} = 0$$

.q(t)

: 10

- 1



$$T_0 = 2\pi\sqrt{LC} :$$

- 2

T_0

0,2 ms

8

. = 0,8 ms

$$L = \frac{T^2}{4\pi^2 C}$$

$$L = 162 \text{ mH}$$

- 3

$$E_C = \frac{1}{2} C U_{\max}^2$$

$$E_C = \frac{1}{2} \times 0,1 \cdot 10^{-6} \times 6^2$$

$$E_C = 1,8 \cdot 10^{-6} \text{ j}$$

t . - 4

- 5

:

$$E_L = \frac{1}{2} L I_{\max}^2 = E_C = 1,8 \cdot 10^{-6} \text{ joule}$$

:

$$I_{\max} = 3,8 \text{ mA}$$

: 11

: $u_L(t)$ $u_C(t)$ - 1

$$u_L(t) = L \frac{di}{dt} = L \frac{d^2 q}{dt^2} \quad u_C(t) = \frac{1}{C} q(t)$$

:

- 2

$$u_C(t) + u_L(t) = 0$$

:

$$L \frac{d^2 q(t)}{dt^2} + \frac{1}{C} q(t) = 0$$

: $q(t)$ - 3

$$\frac{dq}{dt} = -Q_m \frac{2\pi}{T_0} \sin \frac{2\pi}{T_0} t$$

:

$$\frac{d^2 q}{dt^2} = -Q_m \frac{4\pi^2}{T_0^2} \cos \frac{2\pi}{T_0} t$$

:

$$-Q_m L \frac{4\pi^2}{T_0^2} \cos \frac{2\pi}{T_0} t + \frac{1}{C} Q_m \cos \frac{2\pi}{T_0} t = 0$$

$$Q_m \cos \frac{2\pi}{T_0} t \left[-L \frac{4\pi^2}{T_0^2} + \frac{1}{C} \right] = 0$$

$$: \quad t \geq 0$$

$$\left[-L \frac{4\pi^2}{T_0^2} + \frac{1}{C} \right] = 0$$

$$T_0 = 2\pi\sqrt{LC}$$

.A

Q_m

- 4

$$Q_m = CU_0$$

:

- 5

$$T_0 = 1,3 \text{ ms}$$

$$Q_m = 2 \cdot 10^{-5} \text{ C}$$

- 6

:

$$i = \frac{dq}{dt}$$

- 7

$$i = \frac{dq}{dt} = -Q_m \frac{2\pi}{T_0} \sin \frac{2\pi}{T_0} t$$

:

T_0

$$i = -Q_m \frac{2\pi}{2\pi\sqrt{LC}} \sin \frac{2\pi}{T_0} t = -\frac{CU_0}{\sqrt{LC}} \sin \omega_0 t$$

:

$$i = -U_0 \sqrt{\frac{C}{L}} \sin \omega_0 t$$

:

- 8

$$I_{\max} = U_0 \sqrt{\frac{C}{L}}$$

:

$$I_{\max} = 0,1 \text{ A}$$

12

: 8 - 1 /

$$dq_A(t) = i dt \quad ; \quad i = \frac{dq_A(t)}{dt}$$

:

$$q_A(t) = It + Cst$$

:

$$q_A(t=0) = I \times (0) + Cst = 0$$

: A

$$q_A(t) = I \cdot t$$

:

$$q_B(t) = -1,2 \cdot 10^{-3} \text{ C}$$

$$q_A(t) = 1,2 \cdot 10^{-3} \text{ C}$$

: /

$$q_A = C(V_A - V_B)$$

:

$$(V_A - V_B) = \frac{q_A}{C}$$

:

$$(V_A - V_B) = 66,7 \text{ V}$$

:

E_C

/

$$E_C = \frac{1}{2} C(V_A - V_B)^2$$

:

$$E_C = 4 \cdot 10^{-2} \text{ J}$$

- 2

/

$$L \frac{d^2 q(t)}{dt^2} + \frac{1}{C} q(t) = 0$$

:

/

$$T_0 = 2\pi \sqrt{LC}$$

:

$$T_0 = 1,9 \cdot 10^{-2} \text{ s}$$

:

/

$$q(t = 0) = Q_m$$

:

$$q(t = 0) = Q_m \cos(\varphi)$$

$$\cos(\varphi) = 1 :$$

$$\varphi = 0$$

$$: \quad q(t)$$

$$q(t) = Q_m \cos\left(\frac{2\pi}{T_0} t\right)$$

:

$$q(t) = 1,2 \cdot 10^{-3} \cos(333 t)$$

$$i(t = 0) = 0 \quad q(t = 0) = q_A$$

:

- 3

$$E = \frac{1}{2} Cq^2 + \frac{1}{2} Li^2$$

E

- 4

$$\frac{dE}{dt} = \frac{d}{dt} \left[\frac{1}{2} C q^2 + \frac{1}{2} L i^2 \right] = 0$$

$$\frac{dE}{dt} = \frac{1}{2} C \cdot 2 \cdot q \frac{dq}{dt} + \frac{1}{2} L \cdot 2 \cdot i \frac{di}{dt} = 0$$

$$: \quad \frac{di(t)}{dt} = \frac{d^2 q(t)}{dt^2} \quad i = \frac{dq(t)}{dt} :$$

$$L \frac{d^2 q(t)}{dt^2} + \frac{q(t)}{C} = 0$$

$q(t)$

13

$q(t)$

- 1

$$\frac{d^2 q(t)}{dt^2} + \frac{R}{L} \frac{dq}{dt} + \frac{q(t)}{LC} = 0$$

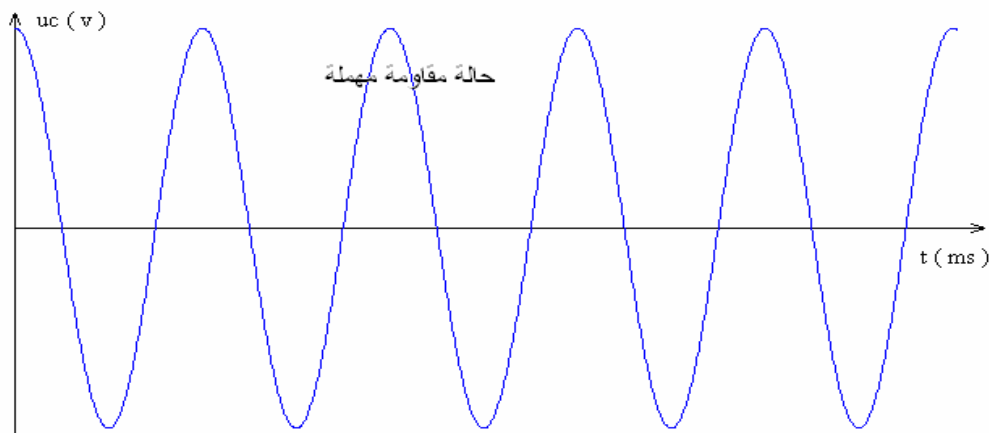
(R = 0)

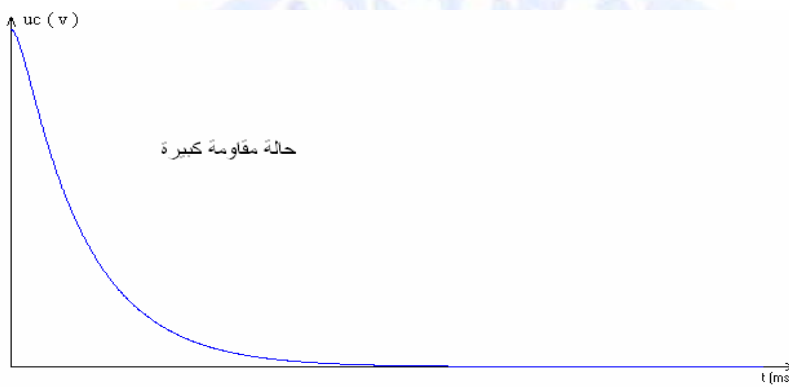
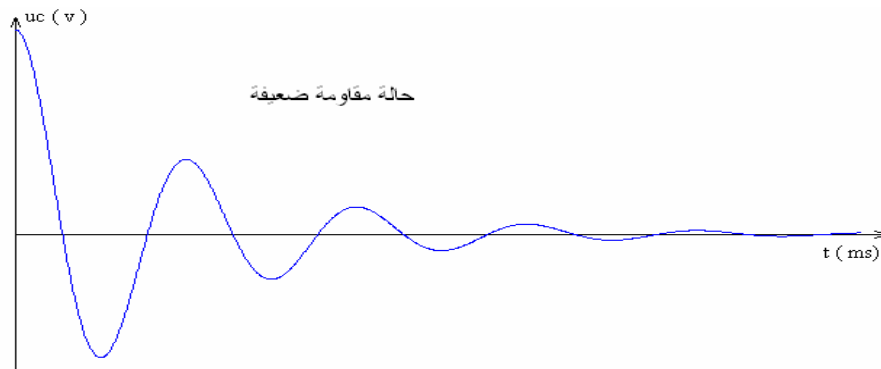
- 2

$$T_0 = 2 \pi \sqrt{LC}$$

$$T_0 = 6,3 \text{ ms}$$

- 3





: t E - 4

$$E = \frac{1}{2} L i^2(t) + \frac{q}{2C} q^2(t)$$

:E $\frac{dE}{dt}$ - 5

$$\frac{dE}{dt} = \frac{1}{2} L \cdot 2 \cdot i \cdot \frac{di}{dt} + \frac{q}{2C} \cdot 2 \cdot \frac{dq}{dt}$$

$$\frac{dE}{dt} = L \cdot \frac{dq}{dt} \cdot \frac{di}{dt} + \frac{q}{C} \cdot \frac{dq}{dt}$$

$$\frac{dE}{dt} = \frac{dq}{dt} \left(L \frac{di}{dt} + \frac{q}{C} \right)$$

$$i = \frac{dq}{dt}$$

htt

$$\frac{dE}{dt} = \frac{dq}{dt} \left(L \frac{d^2 q}{dt^2} + \frac{q}{C} \right)$$

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$$\frac{di}{dt} = \frac{d^2 q}{dt^2}$$

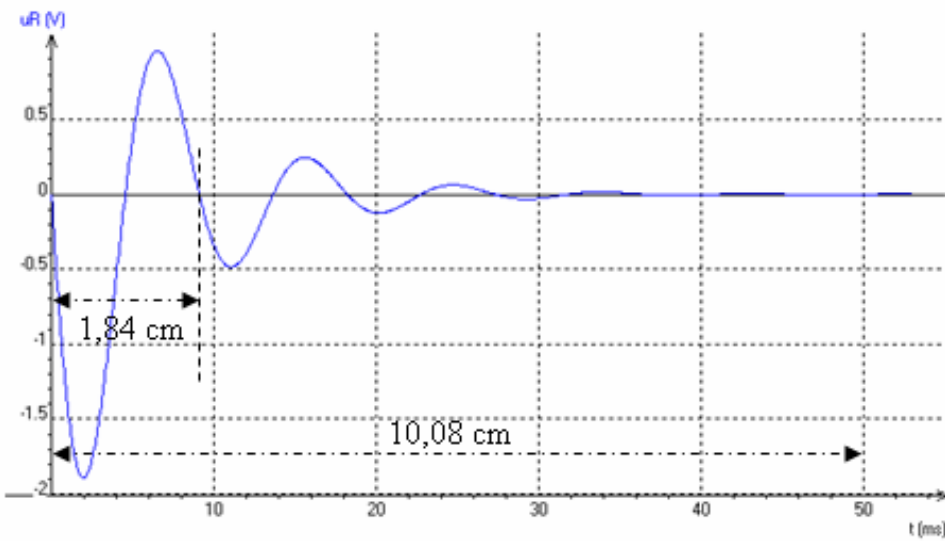
$$L \frac{d^2 q(t)}{dt^2} + \frac{q(t)}{C} = -R \frac{dq}{dt} = -Ri$$

$$\frac{dE}{dt} = \frac{dq}{dt} (-Ri) \quad ; \quad \frac{dE}{dt}$$

$$\frac{dE}{dt} = -Ri^2$$

: 14

- 1




$$. T = 9,1 \text{ ms}$$

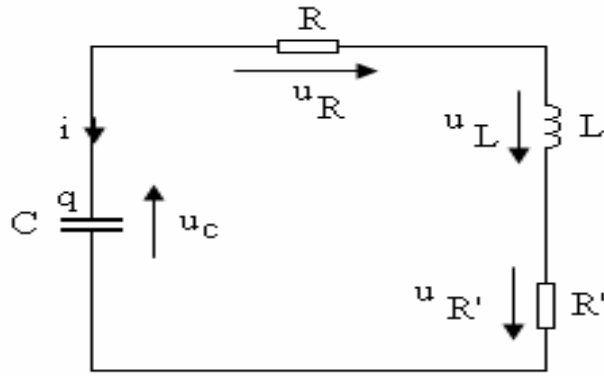
$$i = \frac{dq}{dt} < 0 \quad ; \quad q \quad - 2$$

$$u_R = Ri = R \frac{dq}{dt} < 0$$

$$t = 0 \quad - 3$$

<http://www.onefd.edu.dz> $i(t=0) = 0$  جميع الحقوق محفوظة

- 4



$$u_C + u_L + Ri + R'i = 0$$

$$: \quad i(t=0) = 0 \quad t=0$$

$$u_C = -u_L = -12 \text{ V}$$

:

- 5

$$u = L \frac{di}{dt} + R'i$$

$$i = \frac{u_R}{R} :$$

$$u_R = Ri$$

- 6

$$\frac{di}{dt} = \frac{1}{R} \frac{du_R}{dt}$$

$$\frac{di}{dt} = -57,7 \text{ A/s}$$

$$: \quad t=0$$

$$u = u_L = L \frac{di}{dt} = -12 \text{ V}$$

:

$$L = - \frac{12}{\frac{di}{dt}}$$

:

$$L = 208 \text{ mH}$$

- 7

. LC

RLC

$$T = T_0 = 2\pi\sqrt{LC} = 9,1 \cdot 10^{-3} \text{ s}$$

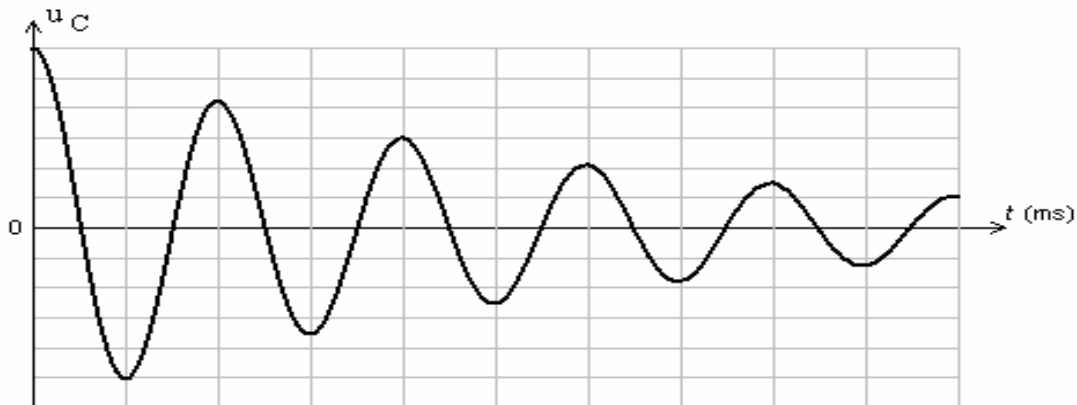
:

$$C = 10 \mu\text{F}$$

: 15

. $u_C(t)$

- 1



- 2

$$T = T_0 = 2\pi\sqrt{LC}$$

:

$$T = T_0 = 6,3 \text{ ms}$$

- 3

$$E_C = \frac{1}{2} C U_0^2 \quad : \quad t=0$$

$$E_C = \frac{1}{2} C U_1^2 \quad : \quad t=T$$

$$\Delta E_C = \frac{1}{2} C (U_1^2 - U_0^2)$$

$$\Delta E_C = -1,9 \cdot 10^{-3} \text{ j}$$

- 4

$$n=1 \quad \cdot u_C(nT) = U_0 e^{-\frac{nRT}{2L}} \quad :$$

$$u_1 = U_0 e^{-\frac{RT}{2L}}$$

$$\frac{u_1}{U_0} = e^{-\frac{RT}{2L}}$$

$$\text{Ln} \left(\frac{u_1}{U_0} \right) = \text{Ln} \left(e^{-\frac{RT}{2L}} \right)$$

$$R = -\frac{2L \cdot \text{Ln} \left(\frac{u_1}{U_0} \right)}{T}$$

$$R = 16,7 \text{ } \Omega$$

$$: \quad u_C(nT) = U_0 e^{-\frac{nRT}{2L}} \quad /$$

$$u_C(nT) = U_0 \left(e^{-\frac{RT}{2L}} \right)^n$$

$$\frac{u_1}{U_0} = e^{-\frac{RT}{2L}} \quad :$$

$$u_C(nT) = U_0 \left(\frac{u_1}{U_0} \right)^n$$

$$u_C(nT) = U_0 \left(\frac{u_1}{U_0} \right)^n = \frac{U_0}{100}$$

$$\left(\frac{u_1}{U_0} \right)^n = \frac{1}{100} :$$

$$\text{Ln} \left(\frac{u_1}{U_0} \right)^n = \text{Ln} \frac{1}{100} :$$

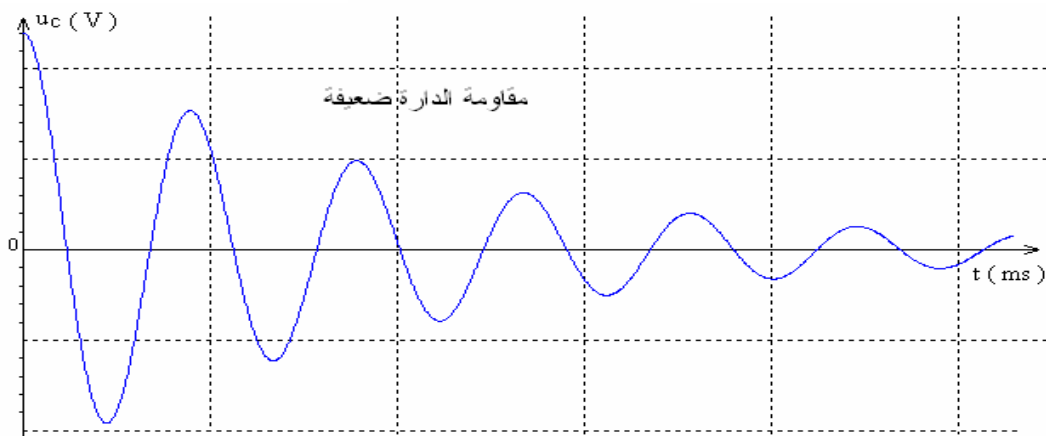
$$n = \frac{\text{Ln} \frac{1}{100}}{\text{Ln} \frac{u_1}{U_0}}$$

$$n = 44$$

: 16

- 1

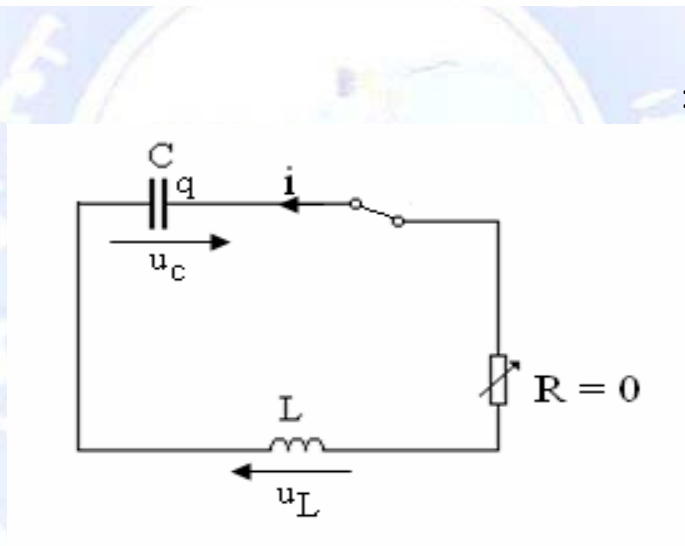
نمط شبه دوري



نمط لا دوري



- 2 /



/

$$u_C + u_L = 0$$

$$u_L = L \frac{di}{dt} = L \frac{d^2q}{dt^2} \quad u_C = \frac{q}{C}$$

$$\frac{d^2q}{dt^2} + \frac{1}{LC}q = 0$$

$$q(t) = Q_M \cos \left(\frac{2\pi}{T_0} t + \Phi_0 \right)$$

$$\frac{dq}{dt} = -Q_M \frac{2\pi}{T_0} \sin \left(\frac{2\pi}{T_0} t + \Phi_0 \right)$$

$$\frac{d^2 q}{dt^2} = - Q_M \frac{4 \pi^2}{T_0^2} \cos \left(\frac{2 \pi}{T_0} t + \Phi_0 \right)$$

$$Q_M \cos \left(\frac{2 \pi}{T_0} t + \Phi_0 \right) \left[- \frac{4 \pi^2}{T_0^2} + \frac{1}{LC} \right] = 0$$

$$\left[- \frac{4 \pi^2}{T_0^2} + \frac{1}{LC} \right] = 0$$

$$T_0 = 2 \pi \sqrt{LC}$$

$$Q_M = CU_0$$

$$\begin{cases} q(t=0) = ? \\ i(t=0) = ? \end{cases}$$

$$\frac{d^2 q}{dt^2} + \frac{1}{LC} q = 0$$

$$q(t) = A \cos \left(\frac{2 \pi}{T_0} t + \varphi \right)$$

$$i(t=0) = 0 \quad q(t=0) = CU_0$$

$$\varphi = \pi$$

$$q(t) = CU_0 \cos \left(\frac{2 \pi}{T_0} t + \pi \right)$$

$$i = \frac{dq}{dt} = -A \frac{2 \pi}{T_0} \sin \left(\frac{2 \pi}{T_0} t + \varphi \right)$$

t = 0

$$i(t = 0) = -A \frac{2\pi}{T_0} \sin(\varphi)$$

$$i(t = 0) = -A \frac{2\pi}{T_0} \sin(\varphi) = 0$$

$$\varphi = \pi \quad \varphi = 0$$

$$q(t = 0) = CU_0 > 0 \quad t = 0$$

$$\boxed{\varphi = 0}$$

$$\varphi = 0 \quad t = 0 \quad q(t)$$

$$q(t = 0) = A \cos(0) = CU_0$$

$$\boxed{A = CU_0}$$

i(t)

$$\frac{di}{dt} = \frac{d^2 q}{dt^2} = -A \frac{4\pi^2}{T_0^2} \cos\left(\frac{2\pi}{T_0}t + \varphi\right)$$

$$A \cos\left(\frac{2\pi}{T_0}t + \varphi\right) \left[-\frac{4\pi^2}{T_0^2} + \frac{1}{LC}\right] = 0$$

$$t \geq 0$$

$$\left[-\frac{4\pi^2}{T_0^2} + \frac{1}{LC}\right] = 0$$

$$\boxed{T_0 = 2\pi \sqrt{LC}}$$

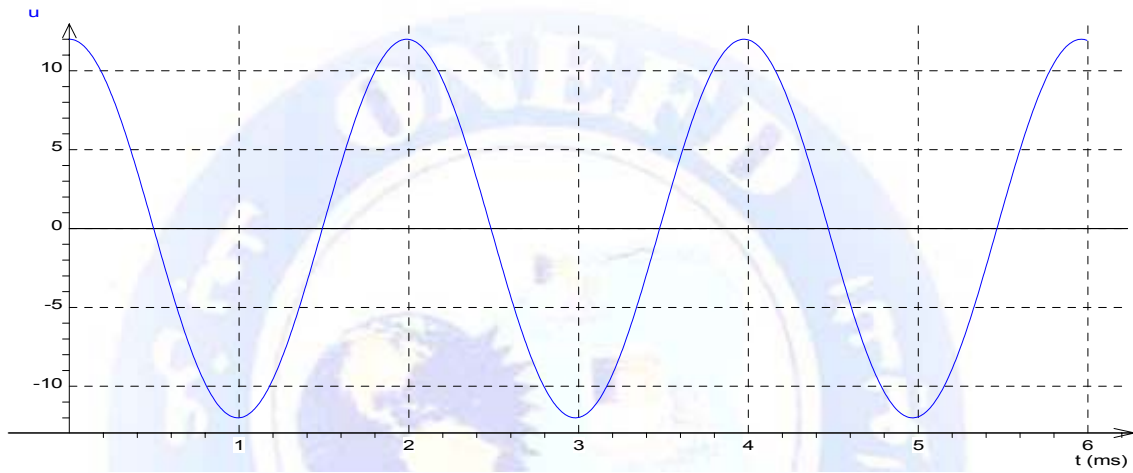
q(t)

$$\boxed{q(t) = CU_0 \cos\left(\frac{1}{\sqrt{LC}}t\right)}$$

$$\boxed{q(t) = 1,2 \cdot 10^{-6} \cos(3200 t)}$$

$$T_0 = \frac{2\pi}{\omega_0}$$

$$T_0 = \frac{2 \times 3,14}{3200} = 2 \text{ ms}$$



$- 2$
 u_{AM} /
 /
 $- 3$
 R_0 /
 /

$$r = 350 \ \Omega$$

$$T_0 = 2 \text{ ms}$$

$$T_0 = 2\pi\sqrt{LC}$$

$$T_0 = 2 \text{ ms}$$

.RLC

: 18

- 1
/
/

- 2
- 3

$$F_1 = \frac{1}{2\pi\sqrt{LC}}$$

$$F_1 = 1,6 \text{ KHz}$$

R R'c - 4

- 5
/

$$F_2 = 5,0 \text{ KHz}$$

R R'c F R'c /

F R'c R'c = R

$$R = 35 \Omega$$

F

: /

$$R(F_1) = 35 + k F_1^2$$

:

$$K = \frac{39 - 35}{1,6^2} = 1,56$$

: F2

$$K = \frac{66 - 35}{5^2} = 1,24$$

R