Bobinas (Inductores)

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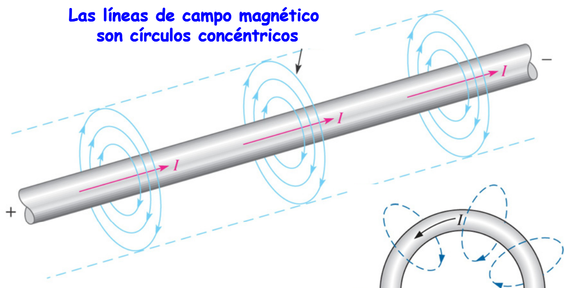
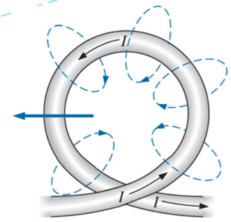
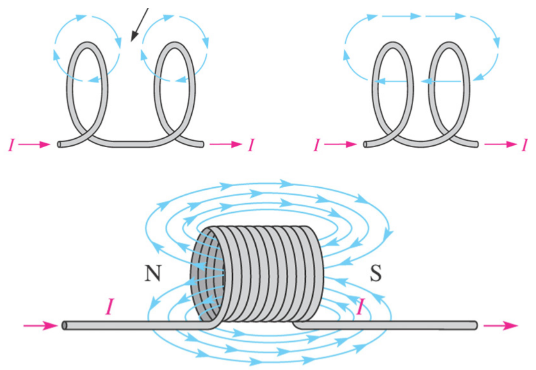


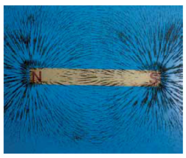
$$|B| = \frac{\mu_o I}{2\pi a}$$



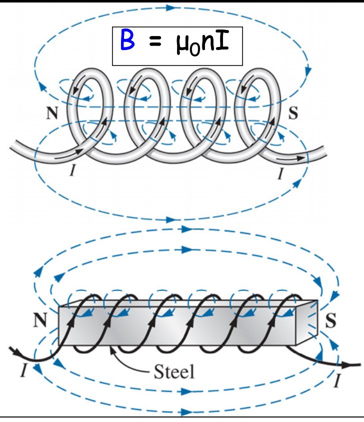
Inductor



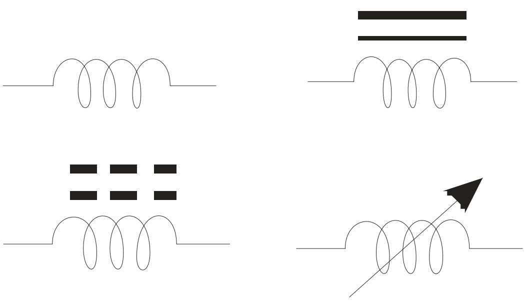
Inductor



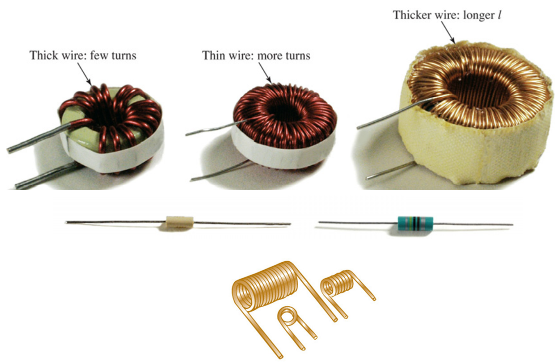
$$B = \mu_0 n I$$

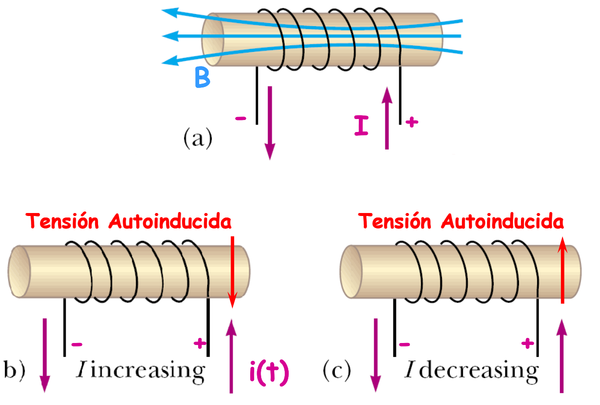


Símbolo eléctrico de un Inductor



Inductores Comerciales:





Ley de Faraday:

$$\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$$

$\Phi_B \sim i(t)$

$\Phi_B = Ki(t)$

$$\varepsilon = -(KN)\frac{di(t)}{dt}$$

$L = (KN)$

Tensión Autoinducida

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

L es la *AUTOINDUCTANCIA* del Inductor ó simplemente *INDUCTANCIA*

La INDUCTANCIA es la propiedad que tiene todo conductor, de oponerse a que la corriente eléctrica cambie, generando una tensión inducida que se opone al cambio que la produce. (Ley de Lenz)

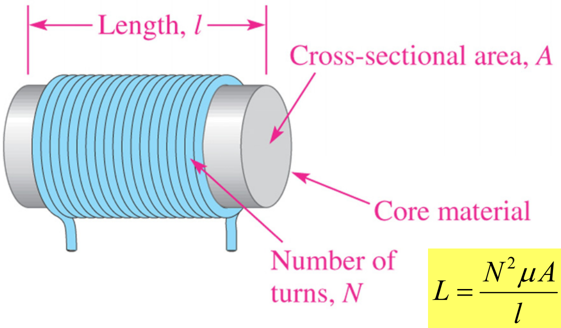
L se mide en Henry (H)

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

H = s.Volts/A

Joseph Henry: (1797-1878) Físico y Matemático estadunidense. Fue el primer director del Instituto Smithsonian.

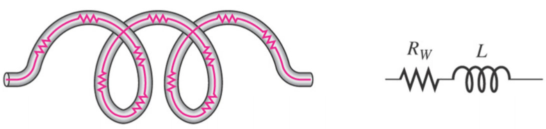
Características de los inductores:



$$L = \frac{N^2\mu A}{l}$$

La Inductancia sólo depende de factores geométricos y del material.

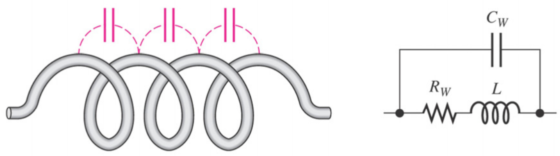
Características de los inductores:



(a) The wire has resistance distributed along its length.

(b) Equivalent circuit

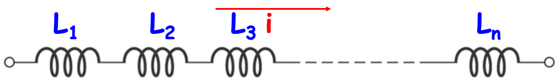
Características de los inductores:



(a) Stray capacitance between each loop appears as a total parallel capacitance (C_W).

(b) Equivalent circuit

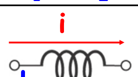
Combinación de Inductores en Serie:



$v_1 = L_1 \frac{di}{dt}$ $v_2 = L_2 \frac{di}{dt}$ $v_3 = L_3 \frac{di}{dt}$ $v_n = L_n \frac{di}{dt}$

$$v_{Total} = v_1 + v_2 + v_3 + \dots v_n = (L_1 + L_2 + L_3 + \dots L_n)\frac{di}{dt}$$

$$L_{equivalente} = L_1 + L_2 + L_3 + \dots L_n$$

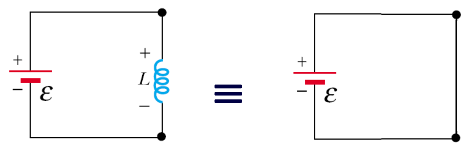


Comportamiento de un Inductor en Continua

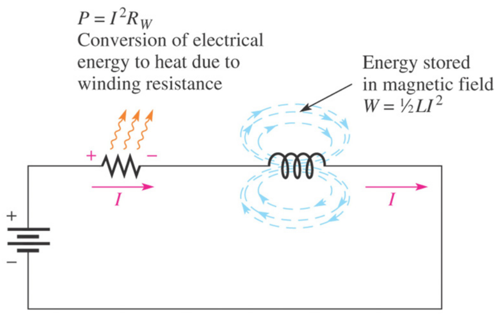
$$v = L\frac{di(t)}{dt}$$

* La i no puede cambiar en forma instantánea en un inductor

En Continua un Inductor se comporta como un corto circuito



Energía Almacenada en el campo magnético del Inductor:



Energía Almacenada en el campo magnético del Inductor:

p(t)=v(t)i(t) p(t)=dw(t)/dt

v(t)=Ldi(t)/dt

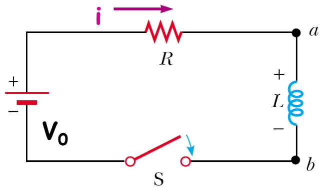
dw(t)/d(t)=Li(t)di(t)/dt

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

Estado Estacionario

Estado Transitorio

Circuitos RL:



$V_0 - V_L(t) - V_R(t) = 0$

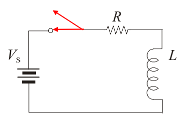
$V_L(t) = L\,di(t)/dt$

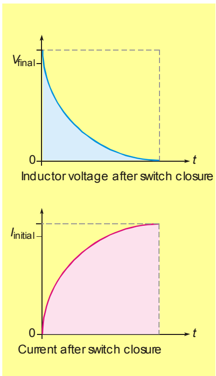
$V_R(t) = i(t)R$

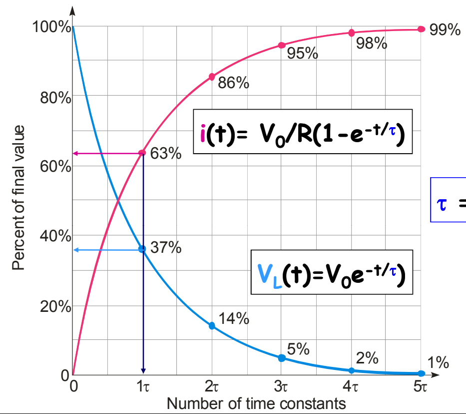
$V_0 - L\,di(t)/dt - i(t)R = 0$

$i(t) = V_0/R(1-e^{-t/\tau})$ $\tau = L/R$ $V_L(t) = V_0 e^{-t/\tau}$

Cuando un inductor es conectado en serie con una resistencia y una fuente de tensión continua:







$\tau = L/R$

Capacitores (Condensadores)

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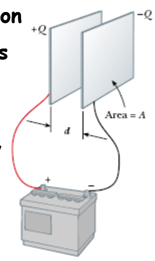
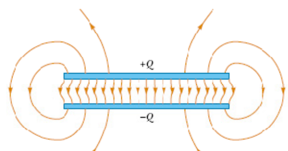
Capacitor: es un par de conductores con cargas de igual magnitud pero signos opuestas

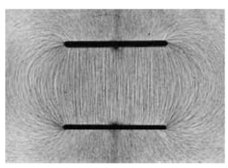


Definición de Capacidad: $C = Q/\Delta V$

La capacitancia de un capacitor es la cantidad de carga que puede almacenar por unidad de Tensión.

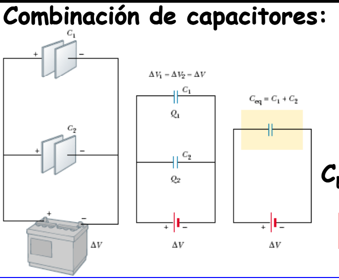
Unidad [Faraday]=[Cuolombs]/[Volts]





Combinación de capacitores:

$C = Q/\Delta V$

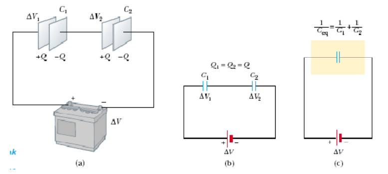


Paralelo

$Q_{total} = Q_1 + Q_2$

$C_{Equiv}\Delta V = C_1\Delta V + C_2\Delta V$

$C_{Equivalente} = C_1 + C_2$



Serie

$\Delta V = \Delta V_1 + \Delta V_2$

$Q/C_{Equiv} = Q/C_1 + Q/C_2$

$1/C_{Equiv} = 1/C_1 + 1/C_2$

Energía Almacenada en un capacitor cargado

$C = Q/\Delta V$

$dW = \Delta V dq = (q/C)dq$

$W = Q^2/2C$

$U = Q^2/2C = Q\Delta V/2 = C\Delta V^2/2$

360 Joules en 2 ms. 3000 Veces la potencia de una Lamparita de 60 W!

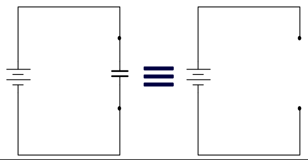
Comportamiento de los Capacitores en Continua.

$Q = C\Delta V$

$\Delta Q/\Delta t = C\Delta V/\Delta t$

$I = CdV/dt$

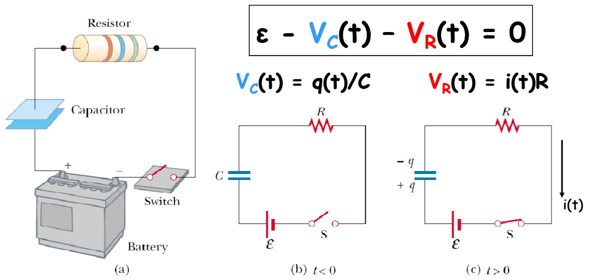
En Continua, un capacitor se comporta como un circuito abierto



Estado Estacionario

Estado Transitorio

Transitorios en circuitos RC: Carga de un Capacitor



$\varepsilon - V_C(t) - V_R(t) = 0$

$V_C(t) = q(t)/C$ $\quad$ $V_R(t) = i(t)R$

$\varepsilon - q(t)/C - i(t)R = 0$ $\quad$ $i(t) = dq(t)/dt$

$\varepsilon - q(t)/C - Rdq(t)/dt = 0$

$\varepsilon - q(t)/C - Rdq(t)/dt = 0$

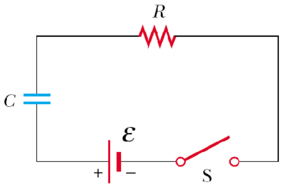
$q(t) = \varepsilon C(1 - e^{-t/(RC)})$

$q(t) = Q_{Máx}(1 - e^{-t/\tau})$ $\quad Q_{Máx} = \varepsilon C$ $\quad$ $\tau = RC$

$V_C(t) = (Q_{Máx}/C)(1 - e^{-t/\tau}) = \varepsilon(1 - e^{-t/\tau})$

$i(t) = dq(t)/dt$

$i(t) = I_{Máx}e^{-t/\tau} = (\varepsilon/R)\, e^{-t/\tau}$



Ejemplo:

ε=12 V

R= 800 kΩ = 8×10^{5} Ω

C= 5 μF = 5×10^{-6}F

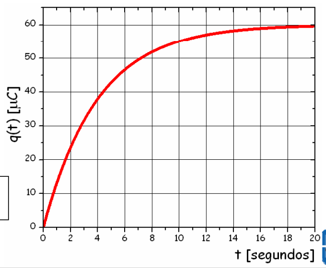
$Q_{máx} = \varepsilon C$ = (12V)(5×10^{-6}μF)

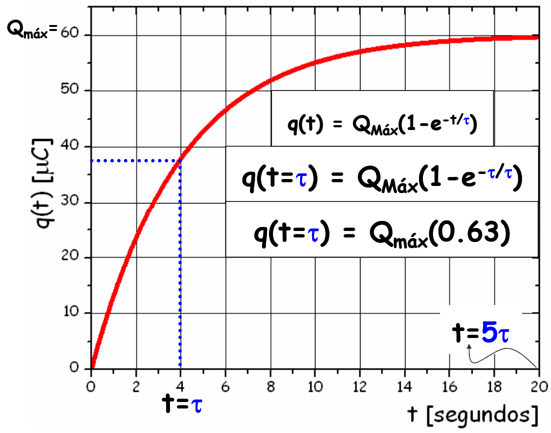
= 60×10^{-6}C = 60μC

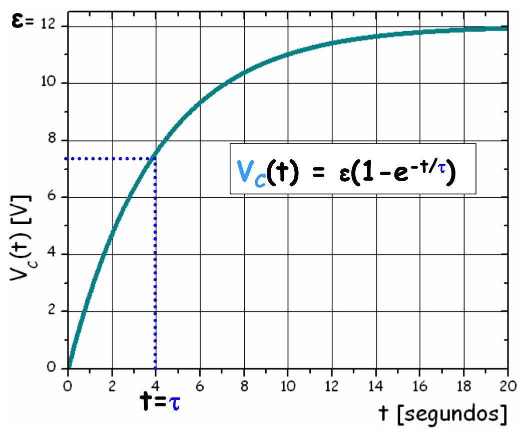
τ = RC =

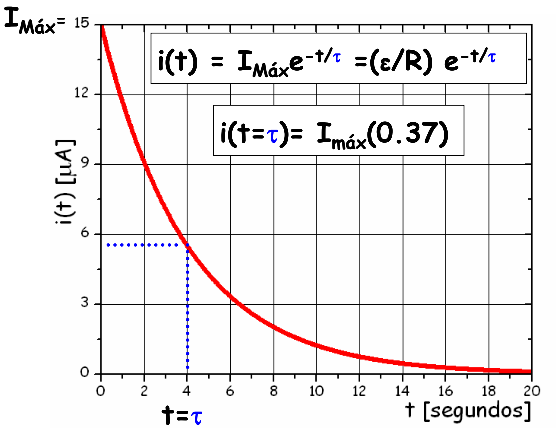
(8×10^{5}Ω)(5×10^{-6}μF)= 4s

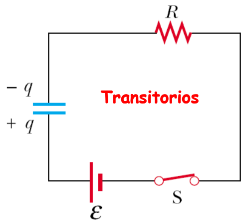
$q(t) = 60(1-e^{-t/4})$ [mC]

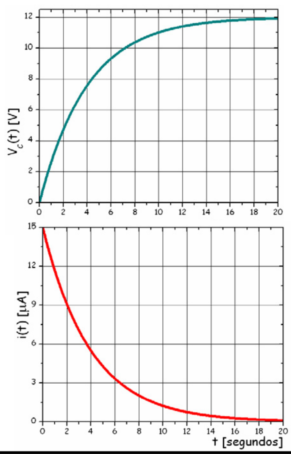


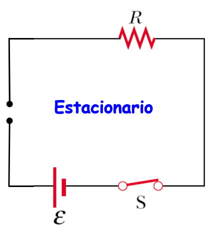


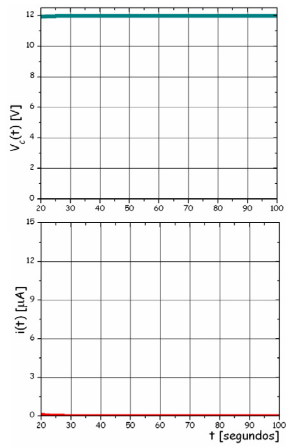






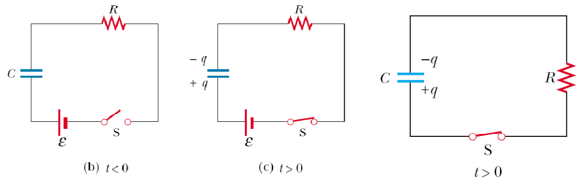






Transitorios en circuitos RC: Descarga de un Capacitor

$- q(t)/C - i(t)R = 0$

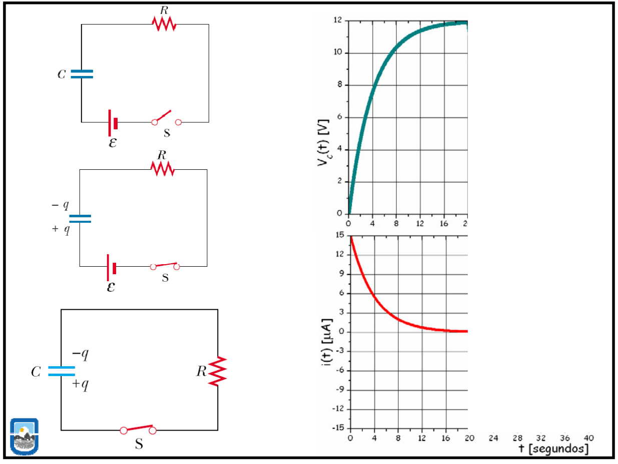


$-q(t)/C - R\,dq(t)/dt = 0$

$q(t) = Q_{Máx}(e^{-t/\tau})$

$V_C(t) = \varepsilon e^{-t/\tau}$

$i(t) = -I_{Máx} e^{-t/\tau}$



Resumen: Inductores y Capacitores

R, L y C sólo dependen de factores geométricos y del material. No Dependen ni de V ni de I ni de q

$i(t)=(V_0/R)(1-e^{-t/\tau})$

$i(t)=(V_0/R)e^{-t/\tau}$

$V_L(t)=V_0 e^{-t/\tau}$

$V_L(t)=-V_0 e^{-t/\tau}$

$\tau = L/R$

$i(t)=(V_0/R)e^{-t/\tau}$

$i(t)=-(V_0/R)e^{-t/\tau}$

$V_C(t)=V_0(1-e^{-t/\tau})$

$V_C(t)=V_0 e^{-t/\tau}$

$\tau = RC$

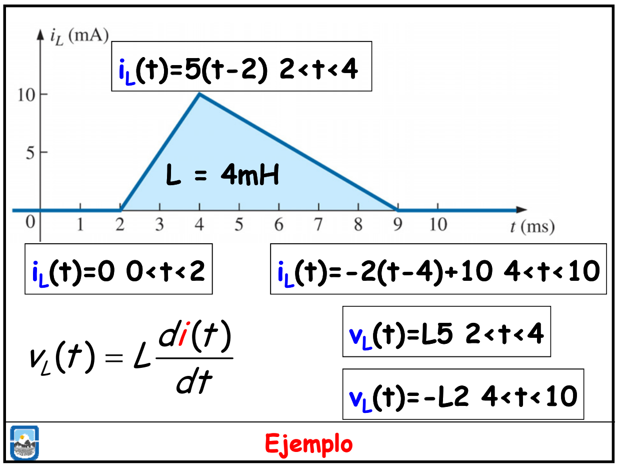
Estado Transitorio.

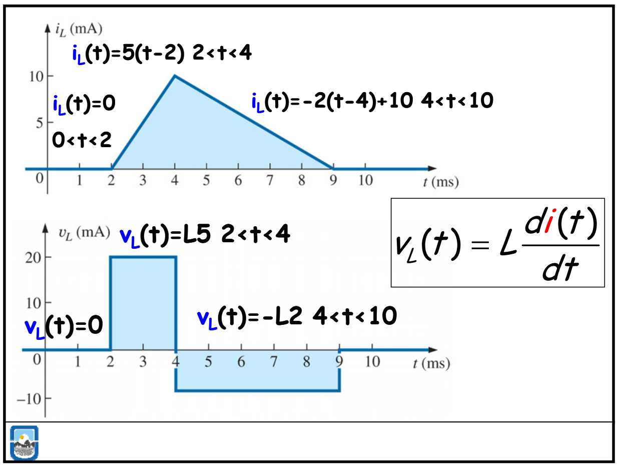
$$I = \frac{V_R}{R} \qquad V_R = IR$$

$$i_L(t) = \frac{1}{L}\int_{t=0}^{t=t} v_L(t)\,dt \qquad v_L(t) = L\frac{di(t)}{dt}$$

$$i_C(t) = C\frac{dv_C(t)}{dt} \qquad v_C(t) = \frac{1}{C}\int_{t=0}^{t=t} i_C(t)\,dt$$

Válidas para todo tiempo





Que pasaría con señales senoidales?