Motivação: porquê estudar máquinas eléctricas?

Máquinas em casa: conseguem identificar ?

As máquinas electricas são muito usadas na geração de energia
Exemplos

Casos envolvendo geração sem utilização de máquinas elect

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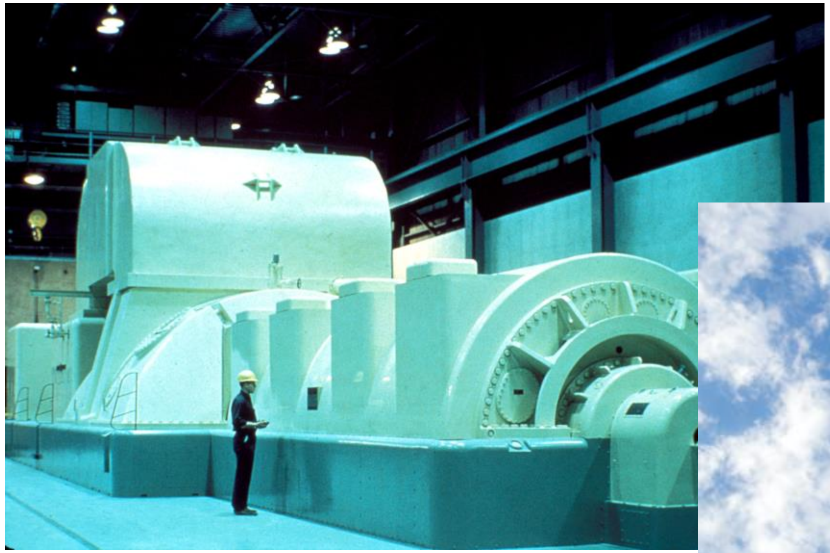
Exemplos

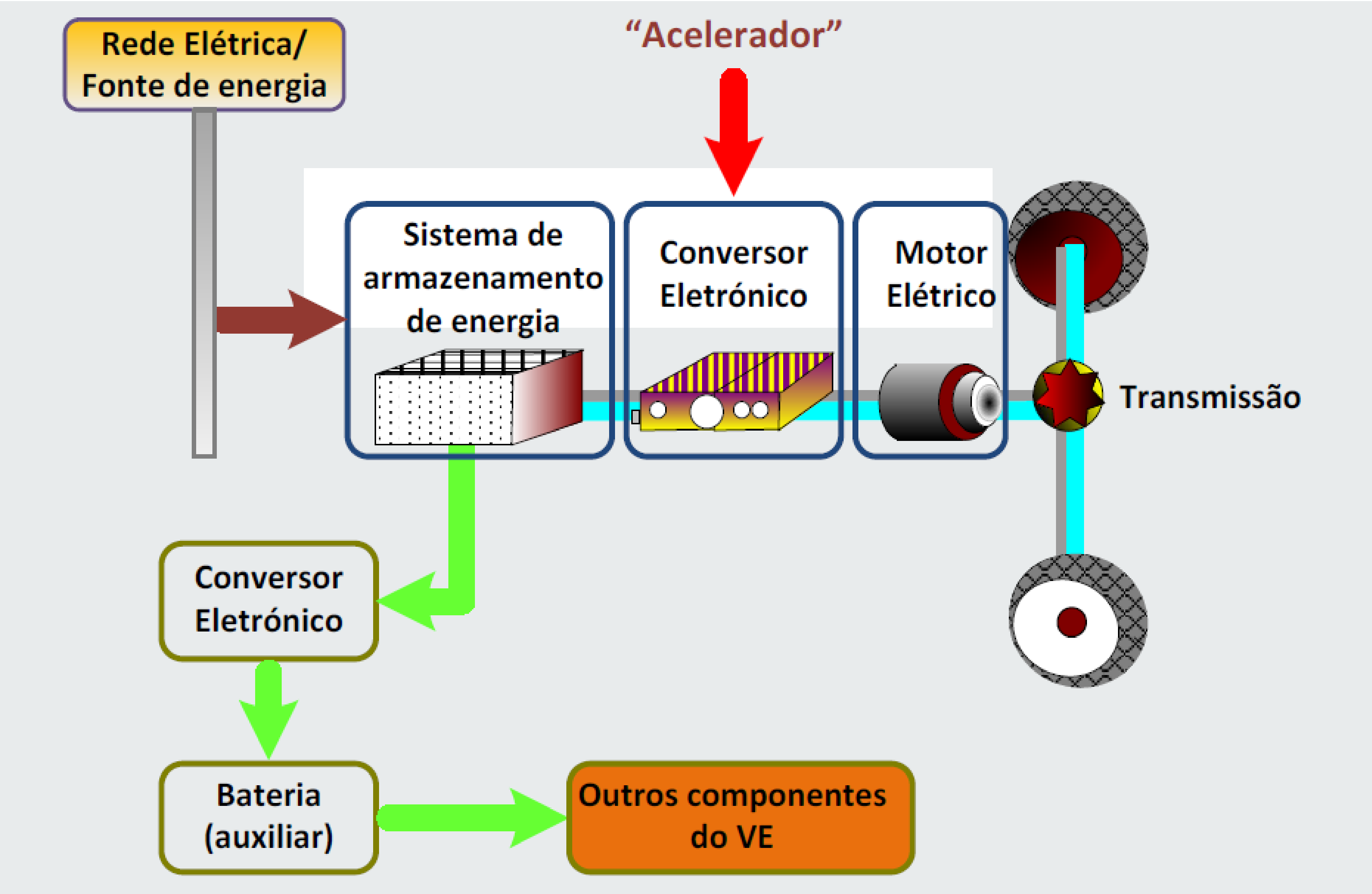
Casos envolvendo geração sem utilização de máquinas elect?

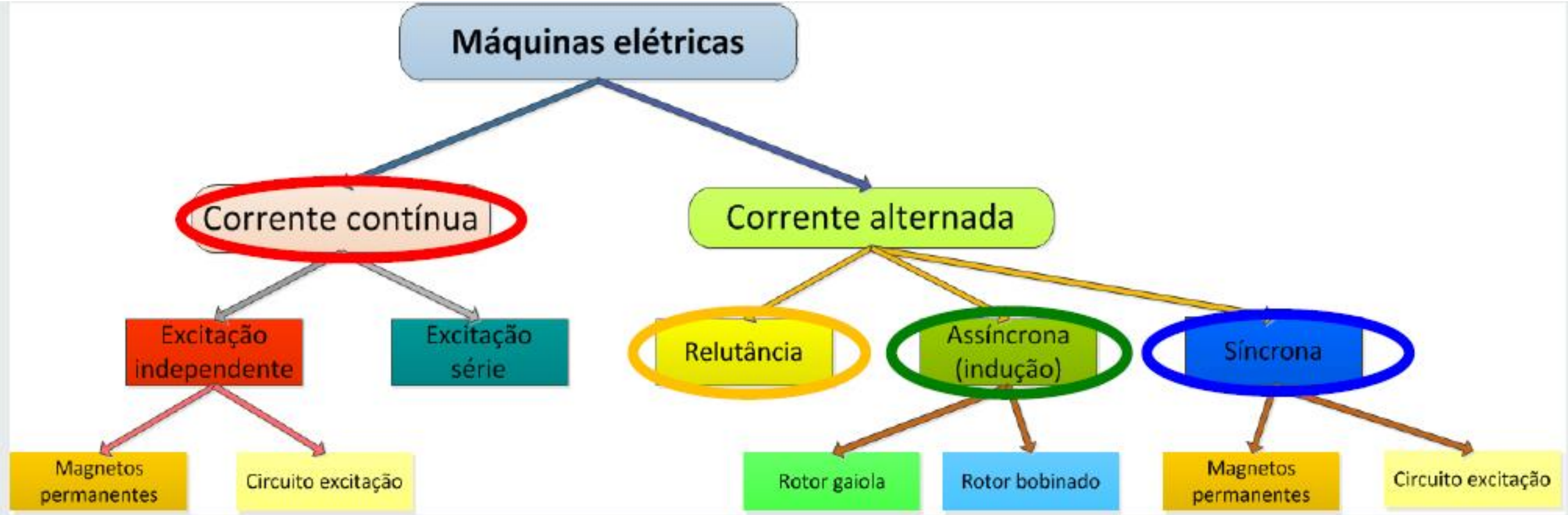
Generation

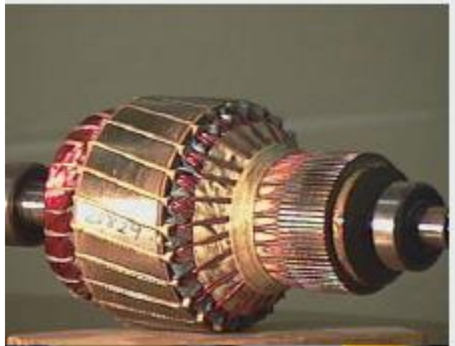


Transportation

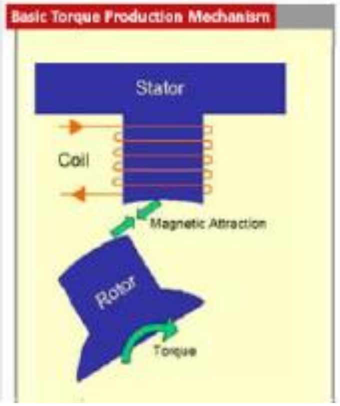
Transportation




Máquinas elétricas
Corrente contínua
Corrente alternada
Excitação independente
Excitação série
Relutância
Assíncrona (indução)
Síncrona
Magnetos permanentes
Circuito excitação
Rotor gaiola
Rotor bobinado
Magnetos permanentes
Circuito excitação




Three-phase SR Drive® stator and rotor


Basic Torque Production Mechanism
Stator
Coil
Magnetic Attraction
Rotor
Torque

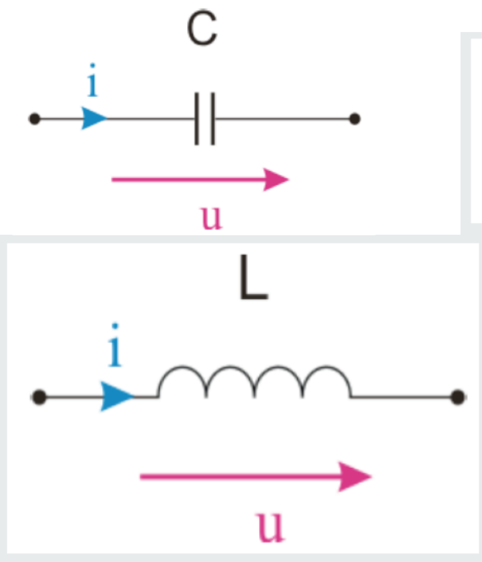
Análise de circuitos

Componentes eléctricos

Resistências

Condensadores

Indutores



$$i(t) = C\frac{du}{dt}$$

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

Teorema de Thevenin

Teorema de Norton

Principio de sobreposição

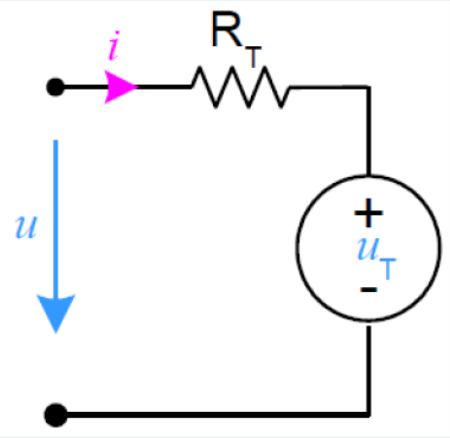
Leis de Kirkoff

Teorema de Thevenin

Teorema de Norton

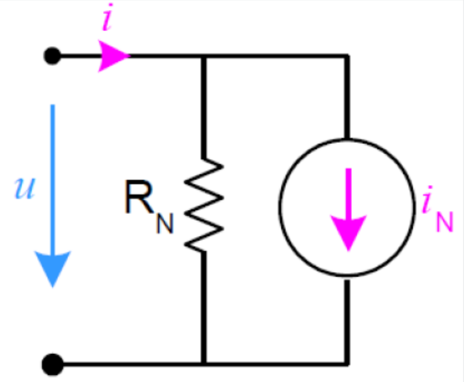
- O dipolo de Thévenin é constituído por uma fonte de tensão u_T em série com uma resistência R_T:

$$u = R_T i + u_T$$



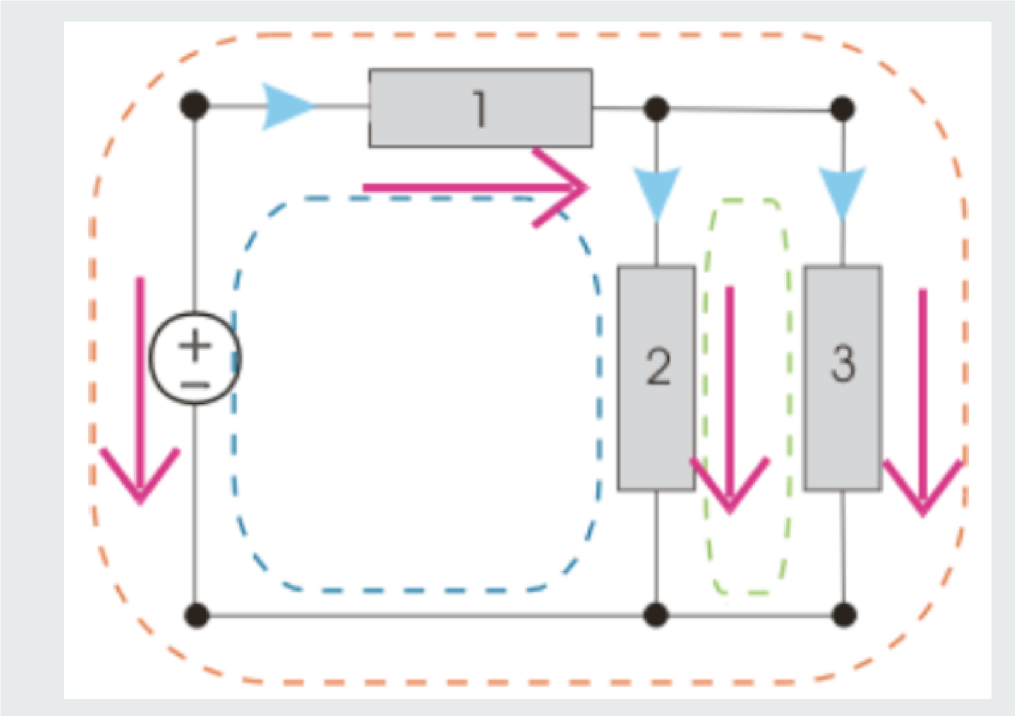
- O dipolo de Norton é constituído por uma fonte de Corrente i_T em paralelo com uma resistência R_T:

$$i = \frac{u}{R_N} + i_N$$



Principio de sobreposição

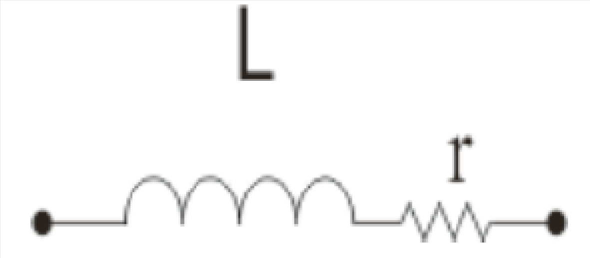
Leis de Kirchhoff



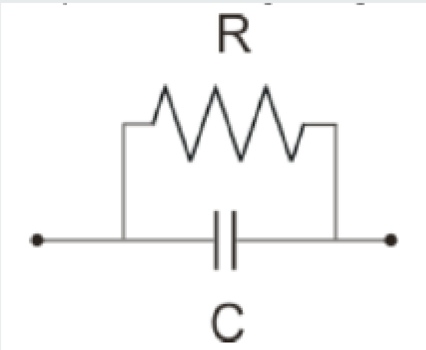
Modelos mais realistas

- Resistência real:

- Bobine real:



- Condensador real:



Regimes de funcionamento

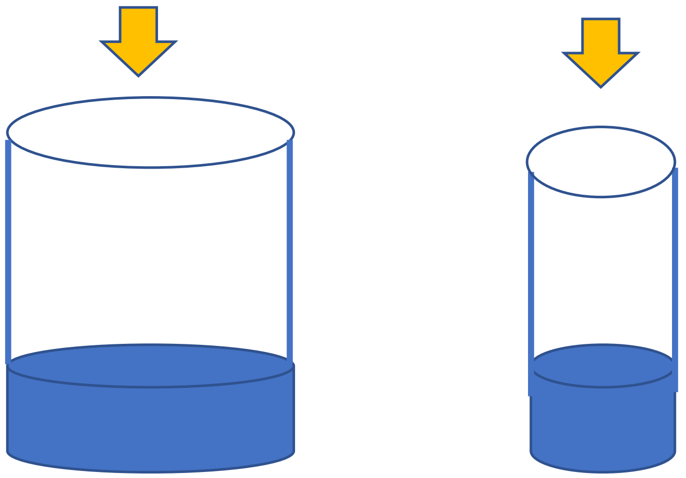
Permanente (DC ou estacionário)

Transitório

A lei de Ohm não envolve o tempo. Portanto em circuitos puramente resistivos não há transien.

Num condensador já não é assim

$$v(t) = v(t_0) + \frac{1}{C}\int_{t_0}^{t} i(u)\, du$$



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

Integrating,

$$\int_{I_0}^{i} \frac{di}{i} = -\int_0^t \frac{R}{L}\,dt \qquad \text{or} \qquad i = I_0 e^{-Rt/L}$$

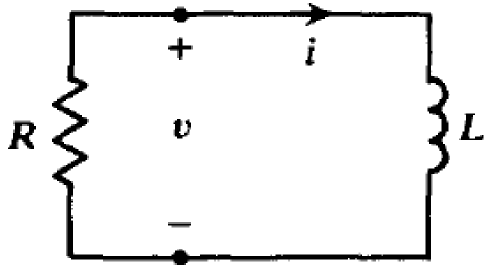


Fig. 4-1

Now replace the inductance of Fig. 4-1 by a capacitance C.

$$C\frac{dv}{dt} + \frac{v}{R} = 0$$

The solution to (4.5) is

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

where V_0 is the initial voltage across the capacitance.

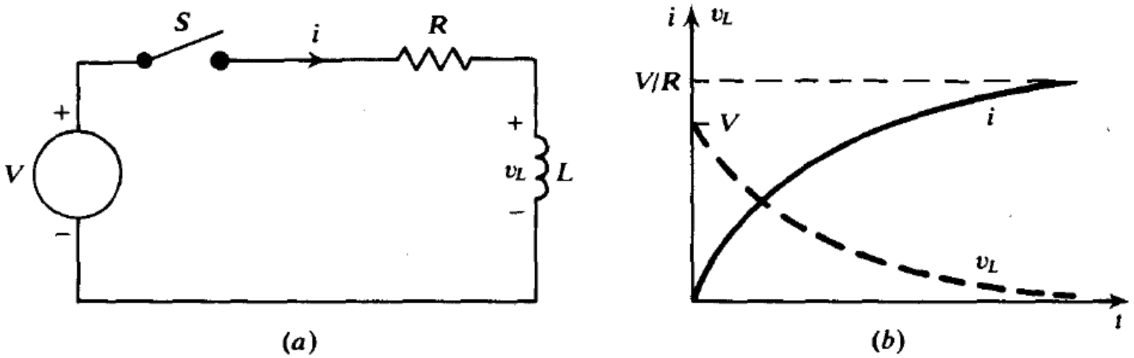


Fig. 4-2

For this case (4.3) is replaced by

$$L\frac{di}{dt} + Ri = V \tag{4.7}$$

which may be solved by separating the variables as

$$\frac{L}{V - Ri}\,di = dt$$

By integration we obtain

$$-\frac{L}{R}\ln(V - Ri) = t + A \tag{4.8}$$

Using the initial condition to evaluate the constant of integration,

$$A = -\frac{L}{R}\ln V \tag{4.9}$$

Substituting (4.9) in (4.8) and simplifying the resulting expression yields

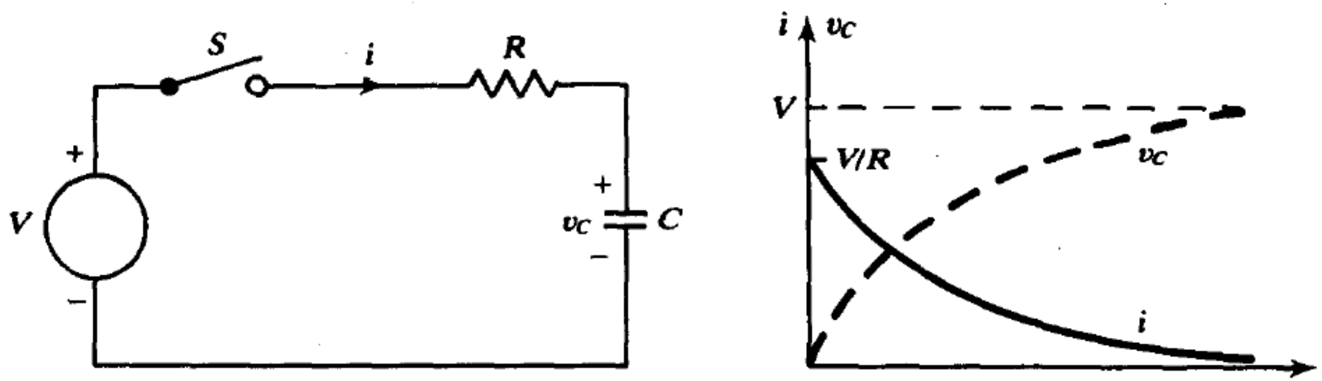
$$i = \frac{V}{R}(1 - e^{-Rt/L}) \tag{4.10}$$

Observe that the complete current response, (4.10), has the predicted form:

$$i = i_n + i_f = -\frac{V}{R}e^{-Rt/L} + \frac{V}{R} \tag{4.11}$$

where i_n is given by (4.4) together with the initial condition, and where i_f is a constant solution to (4.7). Current i, as well as inductor voltage v_L, is graphed in Fig. 4-2(b).

Example 4.2 In Fig. 4-3(a), the switch is closed at $t = 0$, with no initial charge on C. Solve for i and v_C.



(a)   (b)

Fig. 4-3

For $t > 0$, KVL gives

$$Ri + \frac{1}{C}\int_0^t i\,dt = V$$

which (since $i = dq/dt$) may also be written as

$$R\frac{dq}{dt} + \frac{1}{C}q = V \tag{4.12}$$

Notice that (*4.12*) and (*4.7*) are of the same form. The solution becomes, as in (*4.11*),

$$q = q_n + q_f = Q_0 e^{-t/RC} + CV \tag{4.13}$$

where, from the initial condition, $Q_0 = -CV$. Thus

$$q = CV(1 - e^{-t/RC}) \tag{4.14}$$

and from (*4.14*),

$$i = \frac{dq}{dt} = \frac{V}{R}e^{-t/RC} \qquad v_C = \frac{q}{C} = V(1 - e^{-t/RC})$$

The two functions are plotted in Fig. 4-3(b).