Engineering College
Electrical Engineering
Department

Electric Circuits II

Chapter 6: Inductance and Capacitance

EE 2020– Credits : 4

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Inductor (Homework) due to one week

✓ ASSESSMENT PROBLEM

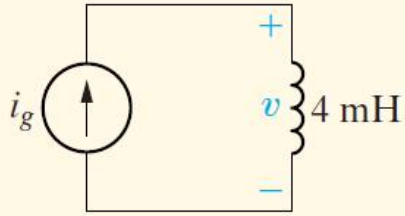
Objective 1—Know and be able to use the equations for voltage, current, power, and energy in an inductor

6.1 The current source in the circuit shown generates the current pulse

$$i_g(t) = 0, \qquad t < 0,$$

$$i_g(t) = 8e^{-300t} - 8e^{-1200t}\ \text{A}, \qquad t \geq 0.$$

Find (a) $v(0)$; (b) the instant of time, greater than zero, when the voltage v passes through zero; (c) the expression for the power delivered to the inductor; (d) the instant when the power delivered to the inductor is maximum; (e) the maximum power; (f) the instant of time when the stored energy is maximum; and (g) the maximum energy stored in the inductor.



Answer: (a) 28.8 V;
(b) 1.54 ms;
(c) $-76.8e^{-600t} + 384e^{-1500t} - 307.2e^{-2400t}$ W, $t \geq 0$;
(d) 411.05 μs;
(e) 32.72 W;
(f) 1.54 ms;
(g) 28.57 mJ.

NOTE: Also try Chapter Problems 6.2 and 6.8.

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

$\frac{di}{dt} = -2400 e^{-300t} + 9600 e^{-1200t}$

$v_L(t) = 38.4 e^{-1200t} - 9.6 e^{-300t}$

$v(0) = 38.4 - 9.6 = \boxed{28.8\,V}$

b) $v(t) = 0$

$$38.4\, e^{-1200t} - 9.6\, e^{-300t} = 0$$

$$\Rightarrow \quad e^{-900t} = \frac{9,6}{38.4} = 0,25$$

$$t = -\frac{\ln(0,25)}{900} = \boxed{1.54 \text{ ms}}$$

c) $p = v\,i$

$= (38.4\,e^{-1200t} - 9.6\,e^{-300t})(8e^{-300t} - 8e^{-1200t})$

$\Rightarrow \boxed{p(t) = 384\,e^{-1500t} - 307{,}2\,e^{-2400t} - 76{,}8\,e^{-600t}}$

d) $\frac{dP}{dt} = 0$

$$-576000\, e^{-1500t} + 737280\, e^{-2400t} + 460800\, e^{-600t} = 0$$

$$\Longrightarrow \boxed{t = 411,0514\ ms}$$

e) $P = 384\, e^{-1500 \times 411.05 \times 10^{-6}} - 307{,}2\, e^{-2400 \times 411.05 \times 10^{-6}} - 76{,}8\, e^{-600 \times 411.05 \times 10^{-6}}$

$$P_{max} = 32{,}72\, w$$

b) max energy time :-

= max current time

$$\Rightarrow \boxed{t = 7.54\,ms}$$

g) $W = \int_{0}^{1,54 \times 10^{-3}} p(t)\, dt$

$$W = \int_{0}^{1,54 \times 10^{-3}} 384\, e^{-1500t} - 307,2\, e^{-2400t} - 76,8\, e^{-600t}$$

$$\Rightarrow \boxed{W = 28,57\ mJ}$$