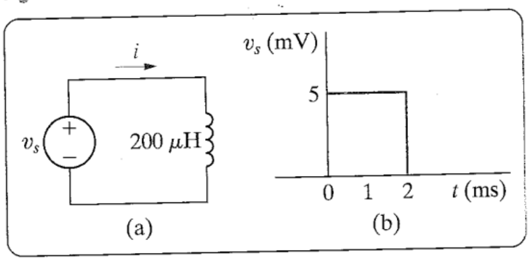
6.2 The voltage at the terminals of the 200 μH inductor in Fig. P6.2(a) is shown in Fig. P6.2(b). The inductor current i is known to be zero for $t \leq 0$.

P

a) Derive the expressions for i for $t \geq 0$.

b) Sketch i versus t for $0 \leq t \leq \infty$.

Figure P6.2



6.4 The current in a 50 μH inductor is known to be

P

$$i_L = 18te^{-10t} \text{ A} \quad \text{for } t \geq 0.$$

a) Find the voltage across the inductor for $t > 0$. (Assume the passive sign convention.)

b) Find the power (in microwatts) at the terminals of the inductor when $t = 200$ ms.

c) Is the inductor absorbing or delivering power at 200 ms?

d) Find the energy (in microjoules) stored in the inductor at 200 ms.

e) Find the maximum energy (in microjoules) stored in the inductor and the time (in microseconds) when it occurs.

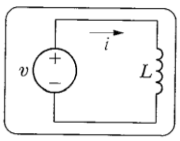
6.7 a) Find the inductor current in the circuit in Fig. P6.7 if $v = 30 \sin 500t$ V, $L = 15$ mH, and $i(0) = -4$ A.

P

b) Sketch $v, i, p,$ and w versus t. In making these sketches, use the format used in Fig. 6.8. Plot over one complete cycle of the voltage waveform.

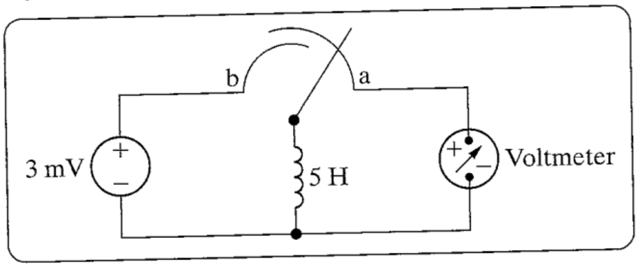
c) Describe the subintervals in the time interval between 0 and 4π ms when power is being absorbed by the inductor. Repeat for the subintervals when power is being delivered by the inductor.

Figure P6.7



6.11 Initially there was no energy stored in the 5 H inductor in the circuit in Fig. P6.11 when it was placed across the terminals of the voltmeter. At $t = 0$ the inductor was switched instantaneously to position b where it remained for 1.6 s before returning instantaneously to position a. The d'Arsonval voltmeter has a full-scale reading of 20 V and a sensitivity of 1000 Ω/V. What will the reading of the voltmeter be at the instant the switch returns to position a if the inertia of the d'Arsonval movement is negligible?

Figure P6.11



6.12 Evaluate the integral

$$\int_0^{\infty} p\,dt$$

for Example 6.2. Comment on the significance of the result.

6.14 A 20 μF capacitor is subjected to a voltage pulse having a duration of 1 s. The pulse is described by the following equations:

$$v_c(t) = \begin{cases} 30t^2 \text{ V}, & 0 \le t \le 0.5 \text{ s}; \\ 30(t-1)^2 \text{ V}, & 0.5 \text{ s} \le t \le 1.0 \text{ s}; \\ 0 & \text{elsewhere.} \end{cases}$$

Sketch the current pulse that exists in the capacitor during the 1 s interval.

6.15 The rectangular-shaped current pulse shown Fig. P6.15 is applied to a 5 μF capacitor. The ini tial voltage on the capacitor is a 12 V drop in tl reference direction of the current. Assume the pa sive sign convention. Derive the expression for tl capacitor voltage for the time intervals in (a)–(e).

a) $0 \le t \le 5\ \mu s$;

b) $5\ \mu s \le t \le 20\ \mu s$;

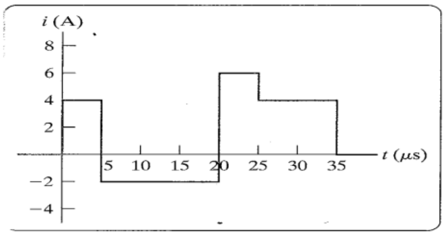
c) $20\ \mu s \le t \le 25\ \mu s$;

d) $25\ \mu s \le t \le 35\ \mu s$;

e) $35\ \mu s \le t \le \infty$;

f) Sketch $v(t)$ over the interval $-50\ \mu s \le t$ 300 μs.

Figure P6.15



6.16 The voltage at the terminals of the capacitor in Fig. 6.10 is known to be

$$v = \begin{cases} -10\ \text{V}, & t \le 0; \\ 40 - 1e^{-1000t}(50\cos 500t + 20\sin 500t)\ \text{V} & t \ge 0. \end{cases}$$

Assume $C = 0.8\ \mu$F.

a) Find the current in the capacitor for $t < 0$.

b) Find the current in the capacitor for $t > 0$.

c) Is there an instantaneous change in the voltage across the capacitor at $t = 0$?

d) Is there an instantaneous change in the current in the capacitor at $t = 0$?

e) How much energy (in microjoules) is stored in the capacitor at $t = \infty$?

6.17 The current pulse shown in Fig. P6.17 is applied to a 0.25 μF capacitor. The initial voltage on the capacitor is zero.

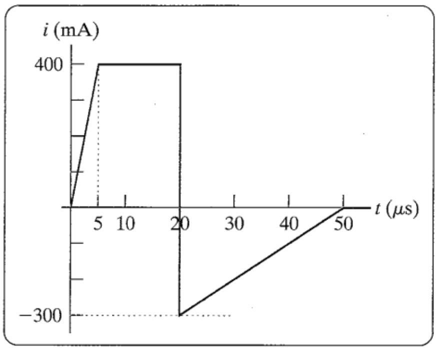
P

a) Find the charge on the capacitor at $t = 30\,\mu$s.

b) Find the voltage on the capacitor at $t = 50\,\mu$s.

c) How much energy is stored in the capacitor by the current pulse?

Figure P6.17



6.18 The initial voltage on the 0.5 μF capacitor shown in Fig. P6.18(a) is -20 V. The capacitor current has the waveform shown in Fig. P6.18(b).

P

a) How much energy, in microjoules, is stored in the capacitor at $t = 500\,\mu$s?

b) Repeat (a) for $t = \infty$.

6.19 The voltage across the terminals of a 0.25 μF capacitor is

P

$$v = \begin{cases} 50 \text{ V}, & t \le 0; \\ A_1 t e^{-4000t} + A_2 e^{-4000t} \text{ V}, & t \ge 0. \end{cases}$$

The initial current in the capacitor is 400 mA. Assume the passive sign convention.

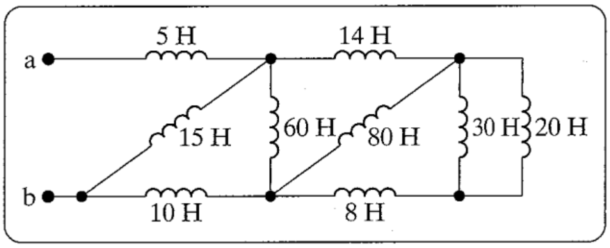
a) What is the initial energy stored in the capacitor?

b) Evaluate the coefficients A_1 and A_2.

c) What is the expression for the capacitor current?

6.21 Assume that the initial energy stored in the inductors of Fig. P6.21 is zero. Find the equivalent inductance with respect to the terminals a,b.

Figure P6.21



23 The three inductors in the circuit in Fig. P6.23 are connected across the terminals of a black box at $t = 0$. The resulting voltage for $t > 0$ is known to be

$$v_o = 160e^{-4t}\ \text{V}.$$

If $i_1(0) = 1$ A and $i_2(0) = 3$ A, find

a) $i_o(0)$;

b) $i_o(t), t \geq 0$;

c) $i_1(t), t \geq 0$;

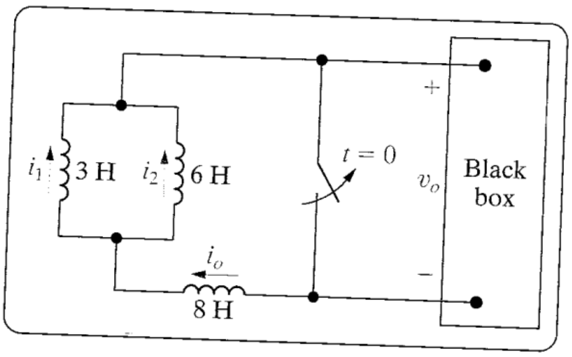
d) $i_2(t), t \geq 0$;

e) the initial energy stored in the three inductors;

f) the total energy delivered to the black box; and

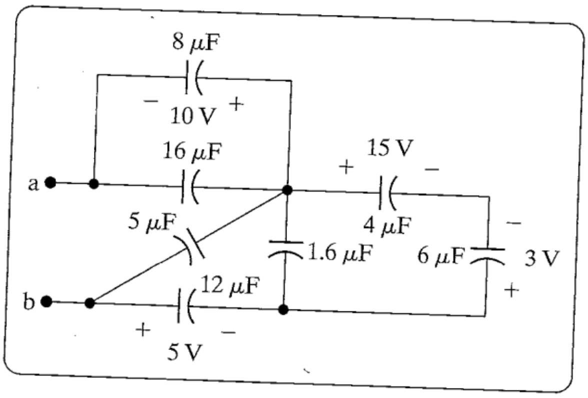
g) the energy trapped in the ideal inductors.

Figure P6.23



6.25 Find the equivalent capacitance with respect to the terminals a,b for the circuit shown in Fig. P6.25.

Figure P6.25



6.27 The two series-connected capacitors in Fig. P6.27 are connected to the terminals of a black box at $t = 0$. The resulting current $i(t)$ for $t > 0$ is known to be $20e^{-t}$ μA.

a) Replace the original capacitors with an equivalent capacitor and find $v_o(t)$ for $t \geq 0$.

b) Find $v_1(t)$ for $t \geq 0$.

c) Find $v_2(t)$ for $t \geq 0$.

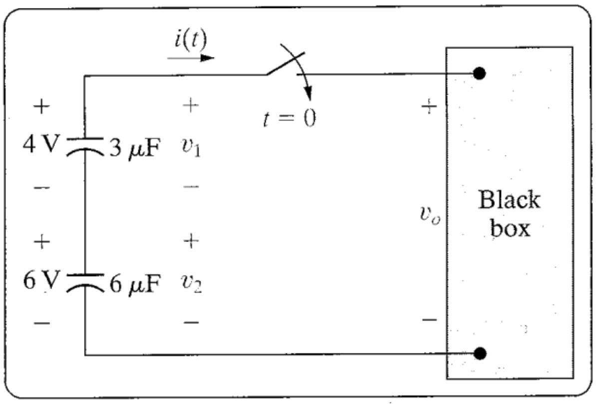
d) How much energy is delivered to the black box in the time interval $0 \leq t \leq \infty$?

e) How much energy was initially stored in the series capacitors?

f) How much energy is trapped in the ideal capacitors?

g) Do the solutions for v_1 and v_2 agree with the answer obtained in (f)?

Figure P6.27

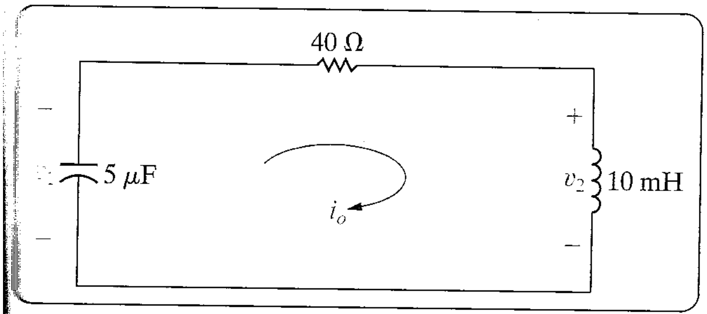


6.32 The current in the circuit in Fig. P6.32 is known t be

$$i_o = 5e^{-2000t}(2\cos 4000t + \sin 4000t)\ \text{A}$$

for $t \geq 0^+$. Find $v_1(0^+)$ and $v_2(0^+)$.

Figure P6.32



6.33 At $t = 0$, a series-connected capacitor and inductor are placed across the terminals of a black box, as shown in Fig. P6.33. For $t > 0$, it is known that

$$i_o = 1.5e^{-16{,}000t} - 0.5e^{-4000t}\ \text{A}.$$

If $v_c(0) = -50$ V find v_o for $t \geq 0$.

Figure P6.33