1

P6.03_6ed

The current in a 2 mH (milli Henry) inductor is $i_L = 50\,t\,e^{-10t}$ Amps for $t \geq 0$.

a) Find the voltage across the inductor for $t = 0^+$.

$v_L(t = 0^+) =$ 100 ✔ mV (milli Volt)

b) Find the power absorbed/delivered by the inductor at t = 50 ms (milli sec).

p_L (t = 50 ms) = 45.98 ✔ mW (milli Watt)

c) Find the power absorbed/delivered by the inductor at t = 200 ms (milli sec).

p_L (t = 200 ms) = -18.31 ✔ mW (milli Watt)

a.)

$i_L = 50te^{-10t}$

$V_L = L\,{}^{di}/_{dt}$

$V_L = L\frac{d}{dt}(50te^{-10t})$

$V_L = 50L\,{}^{d}/_{dt}\,(te^{-10t})$

$= 50L\left[e^{-10t} - 10te^{-10t}\right]$

$V_L(t) = 50(2\times10^{-3})\left[e^{-10t}(1-10t)\right]$

When t=0:

$V_L(t) = 0.1\left[(1-10t)e^{-10t}\right]$

$V_L(0) = 0.1(1-0)e^{0}$

$= 0.1\text{ V} \approx 100\text{mV}$

b.) $P_L = Li\frac{di}{dt}$

$P_L(t) = (2\times10^{-3})(50te^{-10t})\frac{d}{dt}(50te^{-10t})$

$= 5te^{-10t}\left[e^{-10t}(1-10t)\right]$

$= 5te^{-20t}(1-10t)$

$P_L(0.05) = 5(0.05)e^{-20(0.05)}\left[1-10(0.05)\right]$

$= 0.04598\text{ W} \approx 45.98\text{ mW}$

c.) $P_L = Li\frac{di}{dt}$

$P_L(t) = (2\times10^{-3})(50te^{-10t})\frac{d}{dt}(50te^{-10t})$

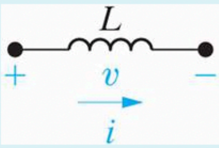
$= 5te^{-10t}\left[e^{-10t}(1-10t)\right]$

$= 5te^{-20t}(1-10t)$

$P_L(0.2) = 5(0.2)e^{-20(0.2)}\left[1-10(0.2)\right]$

$= -0.01831\text{ W} \approx -18.31\text{ mW}$

2



CQ6.09

Given:

L = 18 mH (milli Henry)

At an instant of time the inductor has a current of 4.8 Amps which is increasing by 10.4 Amps/ms.

What is the power absorbed/delivered by the inductor at that instant of time?

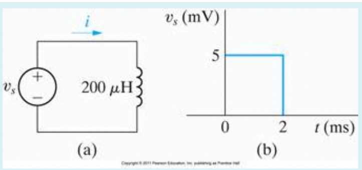
P_L = ?? Watts

Answer: 898.56 ✔

$P_L = Li\,{}^{di}/_{dt}$

$= \left(18\text{mH} \times \frac{1\text{ H}}{1000\text{ mH}}\right)(4.8\text{ A})\left(\frac{10.4\text{ A}}{\text{ms}} \times \frac{1000\text{ ms}}{1\text{ s}}\right) = 898.56\text{ W}$

3



P6.03_9ed

The voltage at the terminals of the 200 μH (micro Henry) inductor is shown in the figure.

The inductor current i is known to be zero for $t \leq 0$.

Derive an expression for i for $0 \leq t \leq 2$ms (milli sec).

Select one:

- (●) a. i = 25 t A 0 ≤ t ≤ 2ms (milli sec) ✔
- ( ) b. i = -25 t A 0 ≤ t ≤ 2ms (milli sec)
- ( ) c. i = 5 t A 0 ≤ t ≤ 2ms (milli sec)
- ( ) d. i = 25 A 0 ≤ t ≤ 2ms (milli sec)

$V_s = 5\times10^{-3}\text{ V} \quad 0 \leq t \leq 2\text{ms}$

$L = 200\times10^{-6}\text{ H}$

$i = \frac{1}{L}\int_{t_0}^{t} V_L\,dt + i_L(t_0)$

$= \frac{1}{200\times10^{-6}}\int_0^{2\times10^{-3}}(5\times10^{-3})dt + 0$

$= \frac{5\times10^{-3}}{200\times10^{-6}}\int_0^{2\times10^{-3}}dt$

$= 25\left[t\right]_0^{2\times10^{-3}} = 25(2\times10^{-3}) = 0.05\text{ A}$

for $0 \leq t \leq 2\text{ms}$: $i = 25t$

$t \geq 2\text{ms}$: $i = 0.05\text{A}$

4

P6.17_6ed

The voltage across the terminals of a 0.40 µF (micro F) capacitor is:

$V_C(t) = 25$ V for $t \le 0$;

$V_C(t) = A_1 t e^{-1,500t} + A_2 e^{-1,500t}$ V for $t \ge 0$.

The initial current in the capacitor is 90 mA (milli Amp).

Assume the passive sign convention (current is in the direction of voltage drop).

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

w(t = 0) = 125 ✔ mJ (micro J)

b) Find the coefficients A_1 and A_2.

A_1 = 262500 ✔ Volts/Sec

A_2 = 25 ✔ Volts/Sec

c) Find the capacitor current at t = 0.4 ms (milli sec).

i(t = 0.4 ms) = 14.82 ✔ mA (milli Amp)

d) Find the capacitor current at t = 2 ms (milli sec).

i(t = 2 ms) = -11.20 ✔ mA (milli Amp)

$C = 0.40\times10^{-6}$ F

$V_c(t) = 25$ V $t \le 0$

$V_c(t) = A_1 t e^{-1500t} + A_2 e^{-1500t}$ V $t \ge 0$

$i_c(0) = 0.09$ A

(a) $W = \frac{1}{2}CV^2$

$= \frac{1}{2}(0.40\times10^{-6})(25)^2$

$= 1.25\times10^{-4}$ J $\approx$ 125 µJ

(b) $V_c(t) = A_1 t e^{-1500t} + A_2 e^{-1500t}$

@ t = 0: $V_c(t) = 25$ V

$25 = A_2$ V/s

$i_c = C\frac{dv}{dt}$

$= (0.40\times10^{-6})\frac{d}{dt}(A_1 t e^{-1500t} + A_2 e^{-1500t})$

$= 0.40\times10^{-6}\left[A_1(e^{-1500t} - 1500te^{-1500t}) - 1500A_2 e^{-1500t}\right]$

@ t = 0:

$0.09 = 0.40\times10^{-6}(A_1 - 1500A_2)$

$225000 = A_1 - 1500A_2$

$A_1 = 225000 + 1500(25) = 262500$ V/s

(c) $V_c(t) = 262500te^{-1500t} + 25e^{-1500t}$

$i_c = C\, dV/dt$

$= (0.40\times10^{-6})\frac{d}{dt}(262500te^{-1500t} + 25e^{-1500t})$

$= (0.40\times10^{-6})\left[262500(e^{-1500t} - 1500te^{-1500t}) - 37500e^{-1500t}\right]$

$(0.40\times10^{-6})\left[e^{-1500t}\left[225000 - (393.75\times10^6)t\right]\right]$

@ t = 0.4 ms $\approx 4\times10^{-4}$ s

$i_c = 0.014818$ A $\approx$ 14.82 mA

@ t = 2ms $\approx 2\times10^{-3}$ s

$i_c = -0.01120$ A $\approx$ - 11.20 mA

5

P6.13_10ed

The voltage across a 5 µF (micro F) capacitor is $v_c = 500\, t\, e^{-2,500\, t}$ V for $t \ge 0$.

Find the current "through" the capacitor for t > 0.

Find the power at the terminals of the capacitor when t = 80 µs (micro sec).

Select one:

- (selected) a. $i_c = 2.5\, e^{-2500t}$ (1-2500 t) mV (milli Volts) ✔
  p_c = 53.626 µW (micro Watts) absorbing
- b. $i_c = 2.5\, e^{-2500t}$ (1-2500 t) V
  p_c = 53.626 W absorbing
- c. $i_c = 5.3\, e^{-5000t}$ (1-2500 t) mV (milli Volts)
  p_c = -53.626 µW (micro Watts) delivering
- d. $i_c = 0.5\, e^{-2500t}$ (1-2500 t) mV (milli Volts)
  p_c = 13.626 mW (milli Watts) absorbing

$C = 5\times10^{-6}$ F

$V_c = 500te^{-2500t}$ V

$i_c = C\frac{dv}{dt}$

$i_c = (5\times10^{-6})\frac{d}{dv}(500te^{-2500t})$

$= (2.5\times10^{-3})\left[e^{-2500t} - 2500te^{-2500t}\right]$

$= (2.5\times10^{-3})e^{-2500t}(1-2500t)$ V

$i_c = 2.5e^{-2500t}(1-2500t)$ mV

$P_c = vi_c$

$= (500te^{-2500t})(2.5\times10^{-3})e^{-2500t}(1-2500t)$

$= 1.25te^{-5000t}(1-2500t)$

@ t = 80µs $\approx 80\times10^{-6}$ s

$P_c(t = 80\mu s) = 5.3626\times10^{-6}$ W $\approx$ 53.626 µW

6

P6.18_9ed

The initial current in a 0.2 μF (micro F) capacitor is 250 mA (milli Amp) with an initial voltage of 150 V.

What is the initial energy stored in the capacitor?

w(t= 0) = 2.25 ✔ mJ (milli J)

$C = 0.2\times10^{-6}$ F

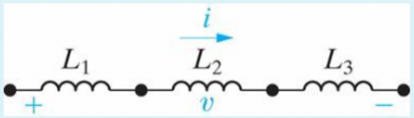
@t=0: $i = 0.25$ A

$V = 150$ V

$w = \frac{1}{2}CV^2 = \frac{1}{2}(0.2\times10^{-6})(150)^2$

$= 2.25\times10^{-3}$ J $\approx$ 2.25 mJ

7



CQ6.04

Given:

L_1 = 1.8 mH (milli Henry) L_2 = 6.7 mH (milli Henry) L_3 = 4.4 mH (milli Henry)

Find the equivalent inductance L_{Eq}.

L_{Eq} = ?? mH (milli Henry)

Answer:

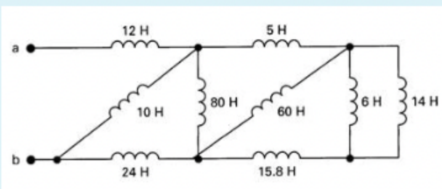
12.9 ✔

$L_{eq} = L_1 + L_2 + L_3$

$= 1.8\text{ mH} + 6.7\text{ mH} + 4.4\text{ mH}$

$= 12.9$ mH

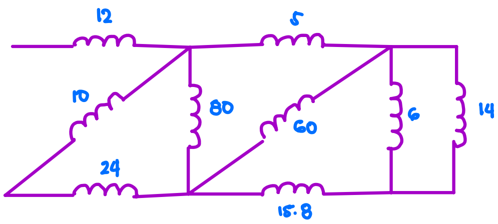
8.



P6.21_6ed

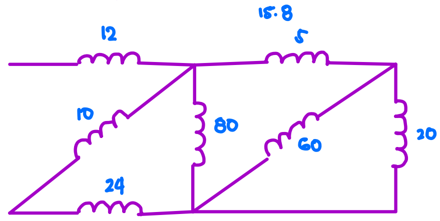
Find the equivalent inductance with respect to the terminals a,b.

L_{Eq} = 20 ✔ H

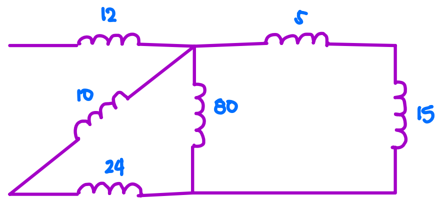


$L_{parallel} = \frac{(6)(14)}{6+14} = 4.2$ H

$L_{series} = 4.2 + 15.8 = 20$ H

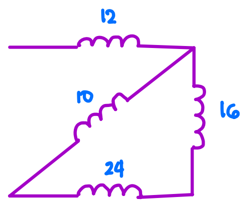


$L_{parallel} = \frac{(60)(20)}{60+20} = 15$ H



$L_{series} = 5 + 15 = 20$ H

$L_{parallel} = \frac{(80)(20)}{80+20} = 16$ H

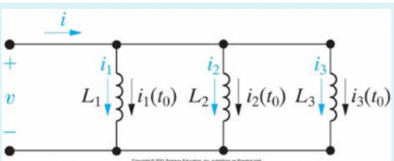


$L_{series} = 16 + 24 = 40$ H

$L_{parallel} = \frac{(10)(40)}{10+40} = 8$ H

$L_{series} = 12 + 8 = 20$ H

9



CQ6.05

Given:

L_1 = 2.7 mH (milli Henry) L_2 = 7.5 mH (milli Henry) L_3 = 8.0 mH (milli Henry)

Find the equivalent inductance L_{Eq}.

L_{Eq} = ?? mH (milli Henry)

Answer:

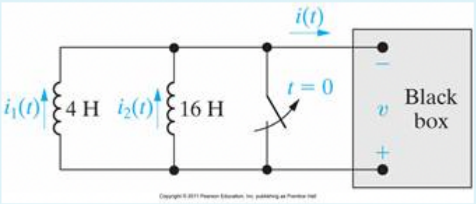
1.5906 ✔

$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$

$= \frac{1}{2.7} + \frac{1}{7.5} + \frac{1}{8.0}$

$L_{eq} = \frac{1}{\frac{1}{2.7} + \frac{1}{7.5} + \frac{1}{8.0}} = 1.5906$ mH

10



P6.25_9ed

Given: The voltage v (acoss all the parallel elements) is 64 e^{-4t} Volts for t > 0.

And at t = 0^- i_1 = -10A and i_2 = 5A

a) Find the equivalent inductance of the two inductors in the figure.

L_{Eq} = 3.2 ✔ H

b) Find i(t) at t = 1sec.

i(t = 1s) = -91.58 ✔ mA (milli Amp)

(a) $L_{eq} = \dfrac{(4)(16)}{4+16} = 3.2\ H$

(b) $i_1(t) = \frac{1}{L}\int_{t_0}^{t} V_L\,dt + i_L(t_0)$

$= \frac{1}{4}\int_0^1 64e^{-4t}\,dt + (-10)$

$= 16\left[-\frac{1}{4}e^{-4t}\right]_0^1 - 10$

$= 16\left[-\frac{1}{4}e^{-4} + \frac{1}{4}\right] - 10$

$= -4e^{-4} + 4 - 10 = -4e^{-4} - 6$

$i_2(t) = \frac{1}{16}\int_0^1 64e^{-4t}\,dt + 5$

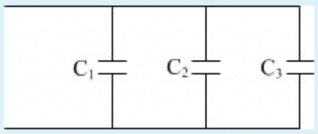
$= 4\left[-\frac{1}{4}e^{-4t}\right]_0^1 + 5$

$= -e^{-4} + 1 + 5 = -e^{-4} + 6$

$i = i_1 + i_2 = -4e^{-4} - 6 - e^{-4} + 6 = -5e^{-4}$

$= -0.09158\ A \approx -91.58\ mA$

11



Given:

C_1 = 1.7 μF (micro F) C_2 = 7.7 μF (micro F)

C_3 = 1.2 μF (micro F)

Find the equivalent capacitance C_{Eq}.

C_{Eq} = ?? μF (micro F)

Answer:

10.6 ✔

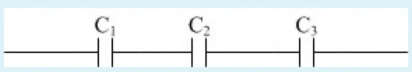
PARALLEL:

$C_{eq} = C_1 + C_2 + C_3$

$= 1.7 + 7.7 + 1.2$

$= 10.6\ \mu F$

12



CQ6.01

Given:

C_1 = 2.6 μF (micro Farad) C_2 = 7.2 μF (micro Farad) C_3 = 7.1 μF (micro Farad)

Find the equivalent capacitance C_{Eq}.

C_{Eq} = ?? μF (micro Farad)

Answer:

1.505 ✔

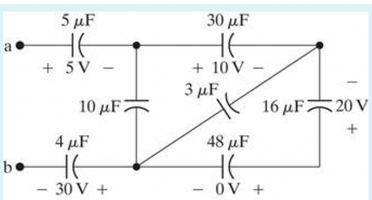
SERIES:

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$\frac{1}{C_{eq}} = \frac{1}{2.6} + \frac{1}{7.2} + \frac{1}{7.1}$

$C_{eq} = 1.505\ \mu F$

13



P6.26_9ed

Find the equivalent capacitance with respect to the terminals a,b.

C_{Eq} = 2 ✔ μF (micro F)

And find the initial voltage across the equivalent capacitance.

V_{Ceq} = 25 ✔ V

C_{series}: $\dfrac{(48)(16)}{48+16} = 12\ \mu F$

$C_{parallel}$: $12 + 3 = 15\ \mu F$

C_{series}: $\dfrac{(30)(15)}{30+15} = 10\ \mu F$

$C_{parallel}$: $10 + 10 = 20\ \mu F$

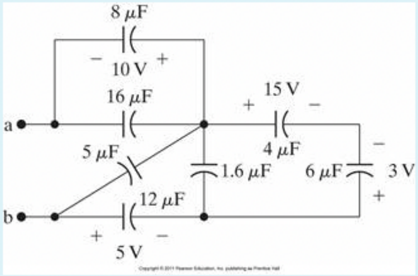
C_{series}: $\frac{1}{C_{eq}} = \frac{1}{5} + \frac{1}{20} + \frac{1}{4}$

$C_{eq} = 2\ \mu F$

$-V + 5 + 10 - 20 + 30 = 0$

$V = 25\ V$

19



P6.27_9ed

Find the equivalent capacitance with respect to the terminals a,b.

C_{Eq} = 6.03 μF (micro F)

Find the initial voltage across the equivalent capacitance.

V_{Ceq} = -3 V

$C_{series}: \dfrac{(15)(3)}{15+3} = 2.5\ \mu F$

$C_{parallel}: 8 + 16 = 24\ \mu F$

$C_{parallel}: 1.6 + 2.5 = 4.1\ \mu F$

$C_{series}: \dfrac{(12)(4.1)}{12+4.1} = \dfrac{492}{161}$

$-V - 10 + 15 - 3 - 5 = 0$

$V = -3\ V$

$C_{parallel}: 5 + \dfrac{492}{161} = \dfrac{1297}{161}$

$C_{series}\ \dfrac{(24)\left(\frac{1297}{161}\right)}{24 + \frac{1297}{161}} = 6.03\ \mu F$