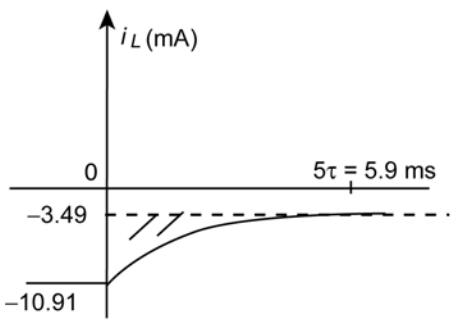
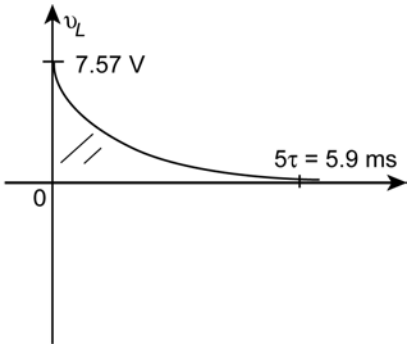
b.





31. a. $i_L = 100\text{ mA}(1 - e^{-1\text{ms}/20\text{ms}}) = 100\text{ mA}(1 - e^{-1/20})$
$= 100\text{ mA}(1 - e^{-0.05}) = 100\text{ mA}(1 - 951.23 \times 10^{-3}) = 100\text{ mA}(48.77 \times 10^{-3})$
$=$ **4.88 mA**

b. $i_L = 100\text{ mA}(1 - e^{-100\text{ms}/20\text{ms}}) = 100\text{ mA}(1 - e^{-5})$
$=$ **99.33 mA**

c. $50\text{ mA} = 100\text{ mA}(1 - e^{-t/\tau})$
$0.5 = 1 - e^{-t/\tau}$
$-0.5 = -e^{-t/\tau}$
$0.5 = e^{-t/\tau}$
$\log_e 0.5 = -t/\tau$
$t = -(\tau)(\log_e 0.5) = -(20\text{ ms})(\log_e 0.5) = -(20\text{ ms})(-693.15 \times 10^{-3})$
$=$ **13.86 ms**

d. $99\text{ mA} = 100\text{ mA}(1 - e^{-t/20\text{ ms}})$
$0.99 = 1 - e^{-t/20\text{ms}}$
$-0.01 = -e^{-t/20\text{ms}}$
$0.01 = e^{-t/20\text{ms}}$
$\log_e 0.01 = -t/20\text{ ms}$
$t = -(20\text{ ms})(\log_e 0.01) = -(20\text{ ms})(-4.605) =$ **92.1ms**

32. a. $I_L\,(1\tau) = 0.632 I_{\max} = 126.4\ \mu\text{A}$

$$I_{\max} = \frac{126.4}{0.632} = \mathbf{200\ \mu A}$$

b.
$$i_L = I_m(1 - e^{-t/\tau})$$

$$160\ \mu\text{A} = 200\ \mu\text{A}\left(1 - e^{\frac{-64.4\,\mu\text{s}}{\tau}}\right)$$

$$0.8 = 1 - e^{\frac{-64.4\,\mu\text{s}}{\tau}}$$

$$0.2 = e^{\frac{-64.4\,\mu\text{s}}{\tau}}$$

$$\log_e 0.2 = -1.61 = \frac{-64.4\ \mu\text{s}}{\tau}$$

$$\tau = \frac{64.4\ \mu\text{s}}{1.61} = \mathbf{40\ \mu s}$$

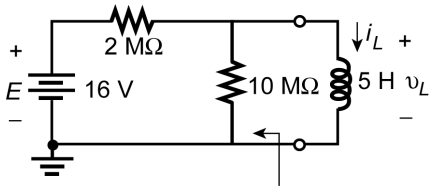
c. $\tau = \dfrac{L}{R} = 40\ \mu\text{s} = \dfrac{L}{500\ \text{k}\Omega}$, $L = (500\ \text{k}\Omega)(40\ \mu\text{s}) = \mathbf{20\ mH}$

d. $I_m = \dfrac{E}{R} \Rightarrow E = (200\ \mu\text{A})(500\ \Omega) = \mathbf{100\ mV}$

33. a. $L \Rightarrow$ open circuit equivalent

$$V_L = \frac{10\ \text{M}\Omega(16\ \text{V})}{10\ \text{M}\Omega + 2\ \text{M}\Omega} = \mathbf{13.33\ V}$$

b.



$$R_{Th} = 2\ \text{M}\Omega \parallel 10\ \text{M}\Omega = 1.67\ \text{M}\Omega$$

$$E_{Th} = \frac{10\ \text{M}\Omega(16\ \text{V})}{10\ \text{M}\Omega + 2\ \text{M}\Omega} = 13.33\ \text{V}$$

$$I_{L_{\text{final}}} = \frac{E_{Th}}{R_{Th}} = \frac{13.33\ \text{V}}{1.67\ \text{M}\Omega} = \mathbf{7.98\ \mu A}$$

c. $i_L = 7.98\ \mu\text{A}(1 - e^{-t/3\,\mu\text{s}})$ $\qquad \tau = \dfrac{L}{R} = \dfrac{5\ \text{H}}{1.67\ \text{M}\Omega} = 3\ \mu\text{s}$

$$10\ \mu\text{A} = 7.98\ \mu\text{A}(1 - e^{-t/3\,\mu\text{s}})$$

$$1.253 = 1 - e^{-t/3\,\mu\text{s}}$$

$$0.253 = e^{-t/3\,\mu\text{s}}$$

$$\log_e(0.253) = -t/3\mu\text{s}$$

$$1.374 = t/3\mu\text{s}$$

$$t = 1.374(3\ \mu\text{s}) = \mathbf{4.12\ \mu s}$$

d. $v_L = 13.33\text{ V}\, e^{-t/3\,\mu s} = 13.33\text{ V}\, e^{-12\,\mu s/3\,\mu s} = 13.33\text{ V}\, e^{-4}$
$= 13.33\text{ V}(0.0183) = \mathbf{0.244\ V}$

34. $e_L = L\dfrac{\Delta i}{\Delta t}$: 0 – 4 ms, $e_L = (200\text{mH})\left[\dfrac{15\text{ mA}}{4\text{ ms}}\right] = \mathbf{750\ mV}$

4 – 10 ms, $e_L = (200\text{ mH})\left[\dfrac{0\text{ mA}}{6\text{ ms}}\right] = \mathbf{0\ V}$

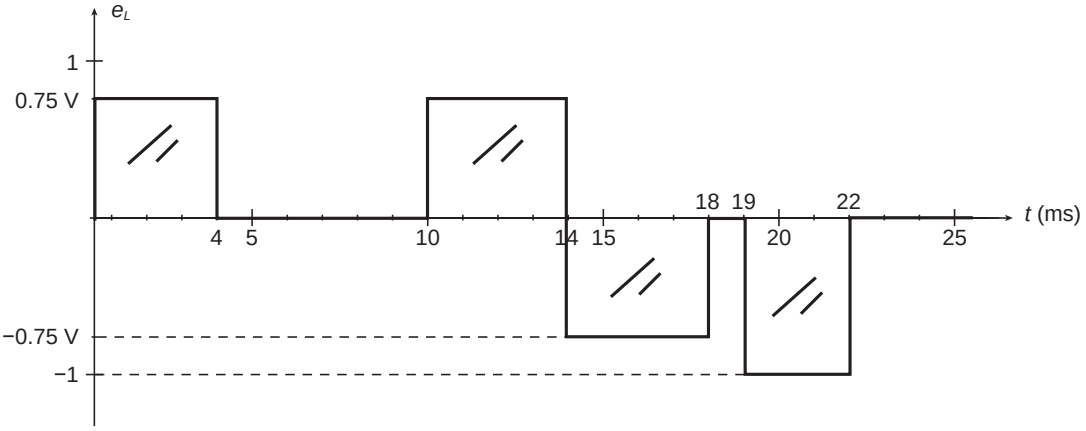
10 – 14 ms, $e_L = (200\text{ mH})\left[\dfrac{15\text{ mA}}{4\text{ ms}}\right] = \mathbf{750\ mV}$

14 – 18 ms, $e_L = -(200\text{ mH})\left[\dfrac{15\text{ mA}}{4\text{ ms}}\right] = \mathbf{-750\ mV}$

18 – 19 ms, $e_L = \mathbf{0\ V}$

19 – 22 ms, $e_L = -(200\text{ mH})\left[\dfrac{15\text{ mA}}{3\text{ ms}}\right] = \mathbf{-1\ V}$

22 ms →, $e_L = \mathbf{0\ V}$



35. $v_L = L\dfrac{\Delta i_L}{\Delta t}$

0 → 2 ms: $v_L = \mathbf{0\ V}$

2 → 6 ms: $v_L = -(5\text{ mH})\left(\dfrac{30\text{ mA}}{4\text{ ms}}\right) = \mathbf{-37.5\ mV}$

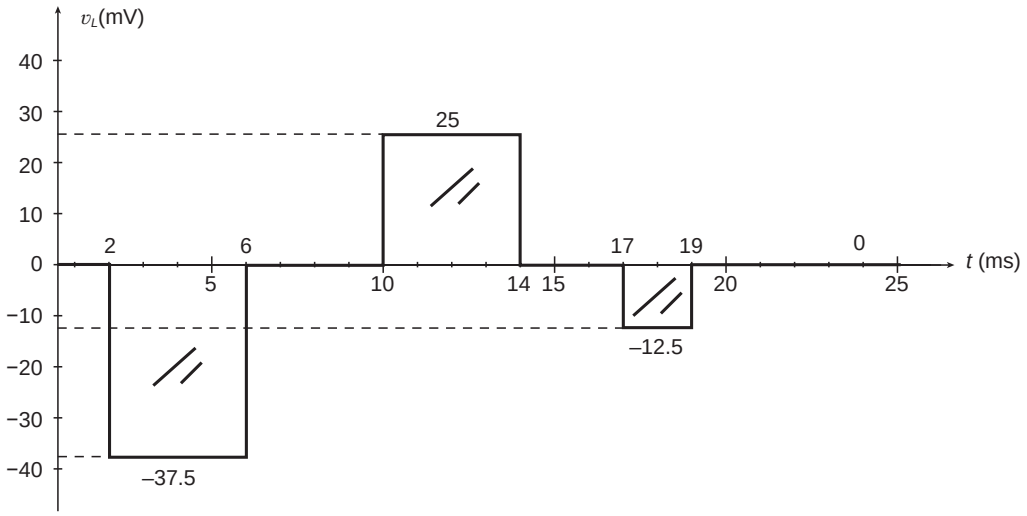
6 → 10 ms: $v_L = \mathbf{0\ V}$

10 → 14 ms: $v_L = (5\text{ mH})\left(\dfrac{20\text{ mA}}{4\text{ ms}}\right) = \mathbf{25\ mV}$

14 → 17 ms: $v_L = \mathbf{0\ V}$

17 → 19 ms: $v_L = -(5\text{ mH})\left(\dfrac{5\text{ mA}}{2\text{ ms}}\right) = \mathbf{-12.5\ mV}$

19 →, $v_L = \mathbf{0\ V}$



36. L = 10 mH, 4 mA at t = 0 s

$$v_L = L\frac{\Delta i}{\Delta t} \Rightarrow \Delta i = \frac{\Delta t}{L} v_L$$

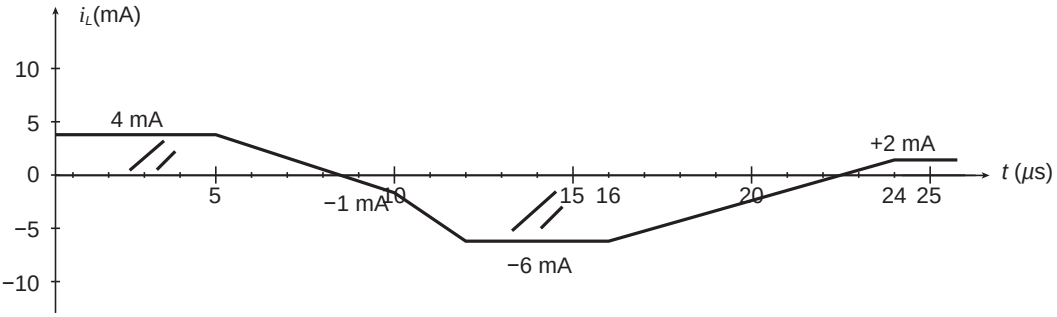
0 – 5 μs: v_L = 0 V, Δi_L = 0 mA and i_L = **4 mA**

5 – 10 μs: $\Delta i_L = \dfrac{5\ \mu\text{s}}{10\ \text{mH}}(-10\ \text{V})$ = **−5 mA**

10 – 12 μs: $\Delta i_L = \dfrac{2\ \mu\text{s}}{10\ \text{mH}}(-25\ \text{V})$ = **−5 mA**

12 – 16 μs: v_L = 0 V, Δi_L = 0 mA and i_L = **−6 mA**

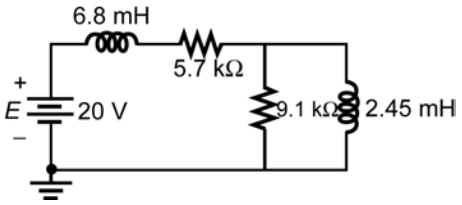
16 – 24 μs: $\Delta i_L = \dfrac{8\ \mu\text{s}}{10\ \text{mH}}10\ \text{V}$ = **8 mA**



37. a. $L_4 + L_5$ = 5.6 mH + 2 mH = 7.6 mH
$L_3 \parallel 7.6$ mH = 3 mH || 7.6 mH = 2.15 mH
L_2 + 2.18 mH = 3.3 mH + 2.15 mH = 5.45 mH
$L_1 \parallel 5.45$ mH = 2.4 mH || 5.45 mH = 1.67 mH
$L_T = L_6$ + 1.67 mH = 9.1 mH + 1.67 mH = **10.77 mH**

38. $L_2 \parallel L_4$ = 10 mH ‖ 30 mH = 7.5 mH
$L_3 + L_2 \parallel L_4$ = 47 mH + 7.5 mH = 54.5 mH
54.5 mH ‖ 22 mH = 15.67 mH
$L_T = L_1$ + 15.67 mH = 18 mH + 15.67 mH = **33.67 mH**

39. 33 mH + 1.8 mH = 5.1 mH
4.7 mH || 5.1 mH = **2.45 mH**



40. L'_T = 6.2 mH + 12 mH || 36 mH + 24 mH = **39.2 mH**
C'_T = 9.1 μ F + 10 μF || 91 μF = 9.1 μF + 9.01 μF = 18.11 μF
C_T = C'_T || 3.3 μF = 18.11 μF || 3.3 μF = 2.79 μF
39.2 mH in series with 2.79 μF

41. 7 μF || 42 μF = 6 μF
12 μF + 6 μF = **18 μF**
5 mH + 20 mH = **25 mH**
Series combination of 2.2 kΩ resistor, 25 mH coil, 18 μF capacitor

42. a. R'_T = 2 kΩ || 8.2 kΩ = 1.61 kΩ, L'_T = 3 mH || 2 mH = 1.2 mH

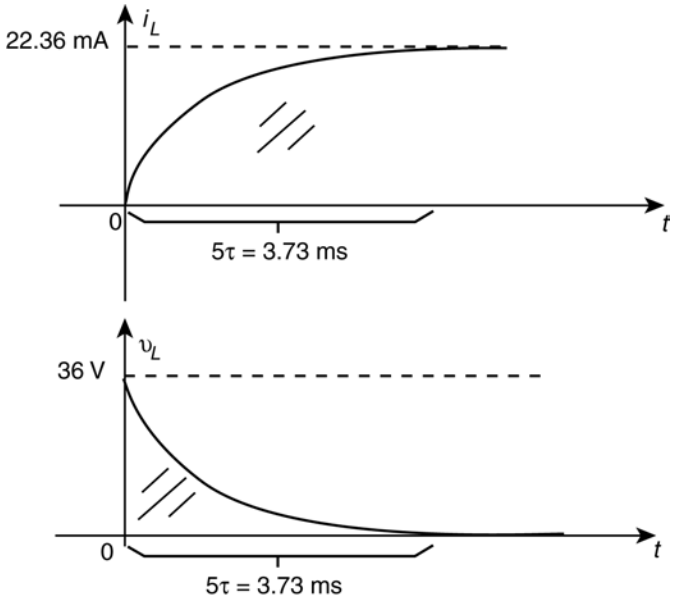
$$\tau = \frac{L'_T}{R'_T} = \frac{1.2\text{ mH}}{1.61\text{ k}\Omega} = 745.3\ \mu\text{s}$$

$$i_L = \frac{E}{R'_T}(1 - e^{-t/\tau})$$

$$= \frac{36\text{ V}}{1.61\text{ k}\Omega}(1 - e^{-t/745.3\mu\text{s}}) = \mathbf{22.36\ mA(1 - e^{-t/745.3\mu s})}$$

$$v_L = Ee^{-t/\tau} = \mathbf{36\ V}e^{-t/745.3\mu\text{s}}$$

b.



43. a. Source conversion: $E = 16$ V, $R_s = 2$ kΩ

$R_{Th} = 2\ \text{k}\Omega + 2\ \text{k}\Omega \parallel 8.2\ \text{k}\Omega = 2\ \text{k}\Omega + 1.61\ \text{k}\Omega = 3.61\ \text{k}\Omega$

$$E_{Th} = \frac{8.2\ \text{k}\Omega(16\ \text{V})}{8.2\ \text{k}\Omega + 2\ \text{k}\Omega} = 12.86\ \text{V}$$

$$I_m = \frac{E_{Th}}{R_{Th}} = \frac{12.86\ \text{V}}{3.61\ \text{k}\Omega} = 3.56\ \text{mA}, \quad \tau = \frac{L}{R} = \frac{30\ \text{mH}}{3.61\ \text{k}\Omega} = 8.31\ \mu\text{s}$$

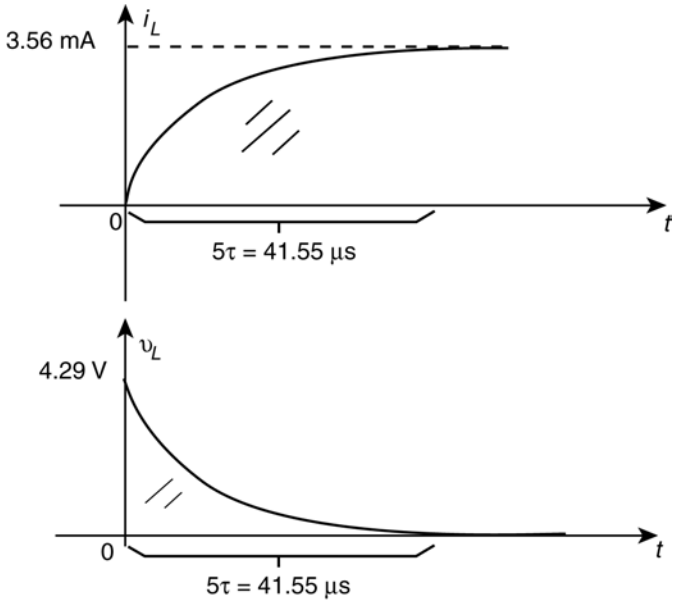
$i_L = \mathbf{3.56\ mA(1 - e^{-t/8.31\mu s})}$

$\upsilon_{L_1} + \upsilon_{L_2} = 12.86$ V initially ($t = 0+$)

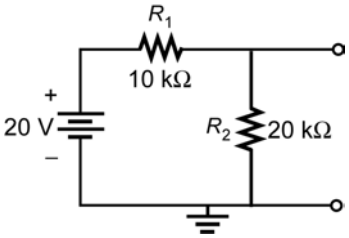
$$\upsilon_L = \frac{10\ \text{mH}}{10\ \text{mH} + 20\ \text{mH}} \text{ of total} = \frac{1}{3}(12.86\ \text{V}) = 4.29\ \text{V}$$

$\upsilon_L = \mathbf{4.29\ V}e^{-t/8.31\mu s}$

b.



44. a.



$\leftarrow R_{Th} = 10\ \text{k}\Omega \parallel 20\ \text{k}\Omega = 6.67\ \text{k}\Omega$

$$E_{Th} = \frac{20\ \text{k}\Omega(20\ \text{V})}{20\ \text{k}\Omega + 10\ \text{k}} = 13.33\ \text{V}$$

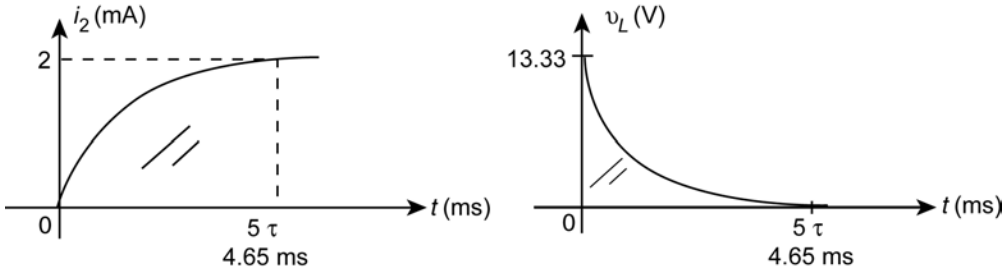
$L_T = 3\ \text{H} + 4.7\ \text{H} \parallel 10\ \text{H} = 3\ \text{H} + 3.197\ \text{H} = \mathbf{6.197\ H}$

$$\tau = \frac{L_T}{R} = \frac{6.197\ \text{H}}{6.67\ \text{k}\Omega} = 0.93\ \text{ms}$$

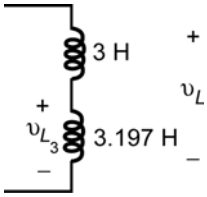
$\upsilon_L = \mathbf{13.33V}e^{-t/0.93\ \text{ms}}$

$$i_L = \frac{13.33\ \text{V}}{6.67\ \text{k}\Omega}(1 - e^{-t/\tau}) = \mathbf{2\ mA(1 - e^{-t/0.93\ ms})}$$

b.



c.



$$\upsilon_{L_3} = \frac{3.197\ \text{H}}{3\ \text{H} + 3.197\ \text{H}} = 0.52\ \upsilon_L$$

$$\upsilon_{L_3} = (0.52)(13.33e^{-t/0.93\ \text{ms}}) = \mathbf{6.93\ V}e^{\mathbf{-t/0.93\ ms}}$$

45. $$I_{R_1} = \frac{E}{R_1} = \frac{20\ \text{V}}{4\ \Omega} = 5\ \text{A}$$

$I_2 = \mathbf{0\ A}$

$I_1 = I_{R_1} + I_2 = 5\ \text{A} + 0\ \text{A} = \mathbf{5\ A}$

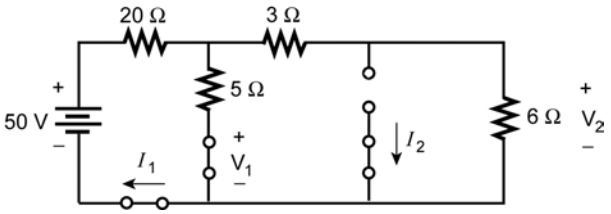
46. $I_1 = I_2 = \mathbf{0\ A}$

$V_1 = V_2 = E = \mathbf{60\ V}$

47. $$I_1 = \frac{12\ \text{V}}{4\ \Omega} = \mathbf{3\ A},\ I_2 = \mathbf{0\ A}$$

$V_1 = \mathbf{12\ V},\ V_2 = \mathbf{0\ V}$

48.



$$V_2 = \frac{6\ \Omega(50\ \text{V})}{6\ \Omega + 20\ \Omega + 3\ \Omega} = \mathbf{10.34\ V}$$

$$V_1 = \frac{(3\ \Omega + 6\ \Omega)(50\ \text{V})}{29\ \Omega} = \mathbf{15.52\ V}$$

$$I_1 = \frac{50\ \text{V}}{20\ \Omega + 3\ \Omega + 6\ \Omega} = \mathbf{1.72\ A}$$

$I_2 = \mathbf{0\ A}$