Chapter 11

1. a. $B = \dfrac{\Phi}{A} = \dfrac{4\times10^{-4}\ \text{Wb}}{0.01\ \text{m}^2} = 4 \times 10^{-2}\ \text{Wb/m}^2 = \mathbf{0.04\ Wb/m^2}$

   b. **0.04 T**

   c. $F = NI = (40\ \text{t})(2.2\ \text{A}) = \mathbf{88\ At}$

   d. $0.04\cancel{T}\left[\dfrac{10^4\ \text{gauss}}{1\cancel{T}}\right] = \mathbf{0.4 \times 10^3\ gauss}$

2. $0.2''\left[\dfrac{2.54\ \cancel{\text{cm}}}{1''}\right]\left[\dfrac{1\ \text{m}}{100\ \cancel{\text{cm}}}\right] = 5.08\ \text{mm}$

   $1''\left[\dfrac{2.54\ \cancel{\text{cm}}}{1''}\right]\left[\dfrac{1\ \text{m}}{100\ \cancel{\text{cm}}}\right] = 25.4\ \text{mm}$

   $A = \dfrac{\pi d^2}{4} = \dfrac{\pi(5.08\ \text{mm})^2}{4} = 20.27 \times 10^{-6}\ \text{m}^2$

   $L = \dfrac{N^2\mu A}{\ell} = \dfrac{(200\ \text{t})^2(4\pi\times10^{-7})(20.27\times10^{-6}\ \text{m}^2)}{25.4\ \text{mm}} = \mathbf{40.1\ \mu H}$

3. a. $L = \dfrac{N^2\mu_r\mu_o A}{\ell} = \dfrac{(200\ t)^2(500)(4\pi\times10^{-7})(20.27\times10^{-6}\ \text{m}^2)}{25.4\ \text{mm}} = \mathbf{20.06\ mH}$

   b. increase = change in μ_r
   $L_{new} = \mu_r L_o$

4. $L = N^2\dfrac{\mu_r\mu_o}{\ell} = \dfrac{(200\ \text{t})^2(1000)(4\pi\times10^{-7})(1.5\times10^{-4}\ \text{m}^2)}{0.15\ \text{m}} = \mathbf{50.27\ mH}$

5. $L = \dfrac{N^2\mu_r\mu_o A}{\ell}$

   a. $L' = (3)^2L_o = 9L_o = 9(4.7\ \text{mH}) = \mathbf{42.3\ mH}$

   b. $L' = \dfrac{1}{3}L_o = \dfrac{1}{3}(4.7\ \text{mH}) = \mathbf{1.57\ mH}$

   c. $L' = \dfrac{(2)(2)^2}{\frac{1}{2}}L_o = 16\ (4.7\ \text{mH}) = \mathbf{75.2\ mH}$

   d. $L' = \dfrac{\left(\frac{1}{2}\right)^2\frac{1}{2}(1500)\text{L}_o}{\frac{1}{2}} = 375(4.7\ \text{mH}) = \mathbf{1.76\ mH}$

6. a. $39 \times 10^2\ \mu\text{H} \pm 10\% \Rightarrow 3900\ \mu\text{H} \pm 10\% \Rightarrow \mathbf{3.9\ mH \pm 10\%}$

uH (not uF, typo)

b. $68 \times 10^0\ \mu\text{H} \pm 5\% = \mathbf{68\ \mu F \pm 5\%}$

c. $\mathbf{47\ \mu H \pm 10\%}$

d. $15 \times 10^2\ \mu\text{H} \pm 10\% = 1500\ \mu\text{H} \pm 10\% = \mathbf{15\ mH \pm 10\%}$

7. $e = N\dfrac{d\phi}{dt} = (50\text{ t})(120\text{ mWb/s}) = \mathbf{6.0\ V}$

8. $e = N\dfrac{d\phi}{dt} \Rightarrow \dfrac{d\phi}{dt} = \dfrac{e}{N} = \dfrac{20\text{ V}}{200\text{ t}} = \mathbf{100\ mWb/s}$

9. $e = N\dfrac{d\phi}{dt} \Rightarrow N = e\left(\dfrac{1}{\dfrac{d\phi}{dt}}\right) = 42\text{ mV}\left(\dfrac{1}{3\text{ m Wb/s}}\right) = \mathbf{14\ turns}$

10. a. $e = L\dfrac{di_L}{dt} = (22\text{ mH})(1\text{ A/s}) = \mathbf{22\ mV}$

b. $e = L\dfrac{di_L}{dt} = (22\text{ mH})(20\text{ mA/ms}) = \mathbf{440\ mV}$

$e = L\dfrac{di_L}{dt} = (22\text{ mH})\left(\dfrac{6\text{ mA}}{100\ \mu\text{s}}\right) = \mathbf{1.32\ V}$

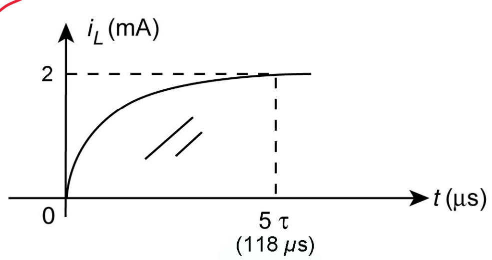
11. a. $\tau = \dfrac{L}{R} = \dfrac{470\text{ mH}}{20\text{ k}\Omega} = \mathbf{23.5\ \mu s}$

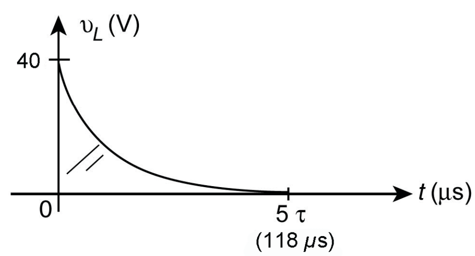
b. $i_L = \dfrac{E}{R}(1 - e^{-t/\tau}) = \dfrac{40\text{ V}}{20\text{ k}\Omega}(1 - e^{-t/\tau})$
$= \mathbf{2\ mA(1 - e^{-t/23.5\ \mu s})}$

c. $\upsilon_L = Ee^{-t/\tau} = \mathbf{40\ V}\boldsymbol{e^{-t/23.5\ \mu s}}$
$\upsilon_R = i_R R = i_L R = E(1 - e^{-t/\tau}) = \mathbf{40\ V(1 - e^{-t/23.5\ \mu s})}$

d. i_L: $1\tau = \mathbf{1.264\ mA}$, , $3\tau = \mathbf{1.9\ mA}$, $5\tau = \mathbf{1.986\ mA}$
υ_L: $1\tau = \mathbf{14.72\ V}$, $3\tau = \mathbf{1.96\ V}$, $5\tau = \mathbf{280\ mV}$

e.





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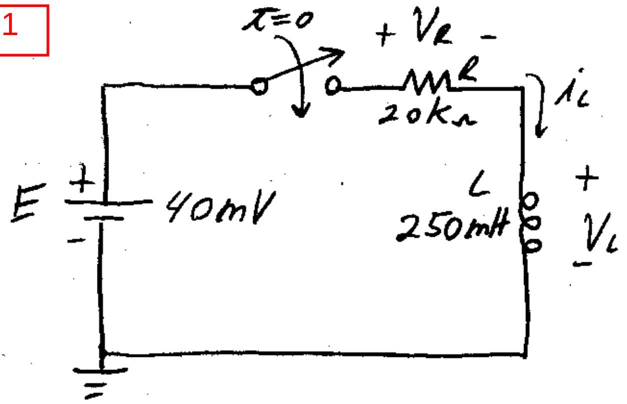

a. FIND τ

$$\tau = \frac{L}{R} = \frac{250\,mH}{20k\Omega} = \boxed{12.5\,\mu Sec}$$

b. FIND $i_L(t)$ FOR $t>0$

$$i_L(t) = i_{L\,MAX}\left(1 - e^{-t/\tau}\right)$$

$$i_{L\,MAX} = \frac{40\,mV}{20k\Omega} = 2\,\mu A$$

$$\therefore \boxed{i_L(t) = 2\,\mu A\left(1 - e^{-t/12.5\times10^{-6}}\right)}$$

c. FIND $V_L(t)$ & $V_R(t)$ FOR $t>0$

$$V_R(t) = i_L(t)\cdot R = \boxed{40\,mV\left(1 - e^{-t/12.5\times10^{-6}}\right)}$$

$V_L(t)$: $E - V_R(t) - V_L(t) = 0$, KVL

$$\therefore V_L(t) = E - V_R(t)$$

$$= 40\,mV - 40\,mV\left(1 - e^{-t/12.5\times10^{-6}}\right)$$

$$\boxed{V_L(t) = 40\,mV\,e^{-t/12.5\times10^{-6}}}$$

d. FIND $i_L(t)$ & $V_L(t)$ AT $t = \tau, 3\tau, 5\tau$.

t	$i_L(t)$	$V_L(t)$
τ	1.26 μA	14.72 mV
3τ	1.90 μA	1.99 mV
5τ	1.99 μA	269.5 μV

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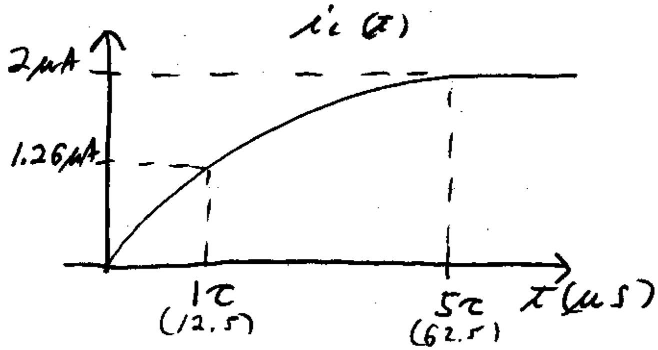
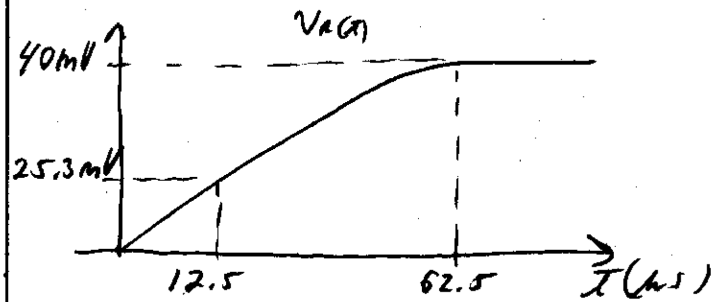
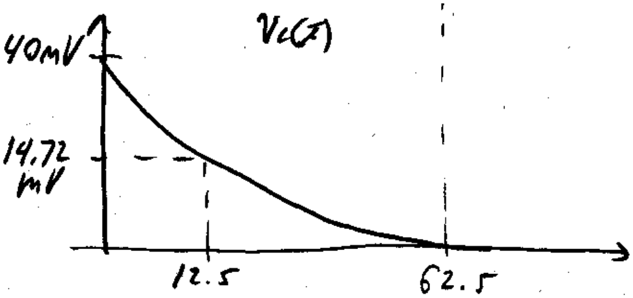
e. SKETCH $i_c(t)$, $V_c(t)$ & $V_R(t)$







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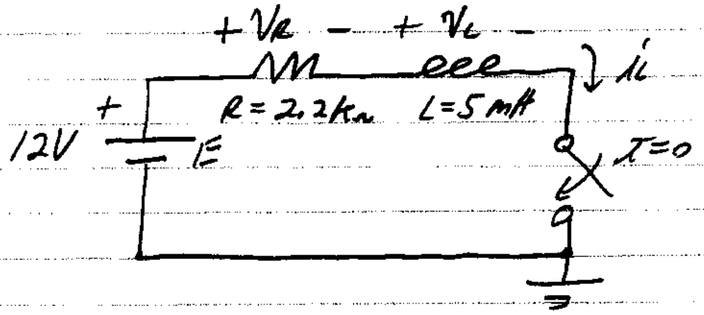
FOR THE CIRCUIT SHOWN



*(FIGURE 11.79 REDRAWN)

a) FIND τ

$$\tau = L/R = 5\,mH / 2.2k\Omega = \boxed{2.27\,\mu Sec}$$

b) FIND $i_L(t)$ | $t \geq 0$

$$i_L(t) = i_{L_{MAX}}\left(1 - e^{-t/\tau}\right)\ A$$

$$i_{L_{MAX}} = 12V/2.2k\Omega = 5.45\,mA$$

$$\therefore \boxed{i_L(t) = 5.45\,mA\left(1 - e^{-t/2.27\mu s}\right)}$$

c) FIND $V_L(t)$ + $V_R(t)$ FOR $t \geq 0$

$$V_R(t) = i_L(t) \cdot R = \boxed{12V\left(1 - e^{-t/2.27\mu s}\right)}$$

$V_L(t) \Rightarrow E - V_R - V_L = 0$, KVL

$$\therefore V_L = E - V_R = 12 - 12\left(1 - e^{-t/2.27\mu s}\right)\ V$$

$$\boxed{V_L(t) = 12\,e^{-t/2.27\mu s}\ V}$$

d) FIND $i_L(t)$ + $V_L(t)$ AT $t = \tau, 3\tau, 5\tau$

USING THE EQUATIONS ABOVE:

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CONTINUED

t	$i_L(t)$	$V_L(t)$
τ	3.45 mA	4.41 V
3τ	5.18 mA	0.597 V
5τ	5.42 mA	0.081 V

e) SKETCH $i_L(t)$, $V_L(t)$, $V_R(t)$ FOR $t \geq 0$

$\tau = 2.27\,\mu s$
$3\tau = 6.82\,\mu s$
$5\tau = 11.36\,\mu s$