7.1 (p220)

(a) -20 V is a dc voltage, therefore no current flows through the capacitor.

(b) $i = C\dfrac{dv}{dt} = (0.005)\dfrac{d}{dt}\left(2e^{-5t}\right) = 0.005(-10)e^{-5t}\text{ A} = \underline{-50e^{-5t}\text{ mA}}$

7.2 (p222)

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

$$= \begin{cases} 100\times10^{-12}\times0 = \underline{0}, & t<1\text{ ms} \\ 100\times10^{-12}\times\dfrac{2-0}{1\times10^{-3}} = \underline{200\,\text{nA}}, & 1\le t\le 2\text{ ms} \\ 100\times10^{-12}\times0 = \underline{0}, & t>2\text{ ms} \end{cases}$$

7.3 (p224)

$$v(50\mu s) = 1.5\cos(10^5\times50\times10^{-6})\text{ V} = 0.4255\text{ V}$$

$$w = \frac{1}{2}CV^2 = 0.5\times1000\times10^{-6}\times0.4255^2 = \underline{90.53\ \mu\text{J}}$$

7.4 (p228)

$$v_L = L\frac{di}{dt} = \begin{cases} 0.2\times\dfrac{2\times10^{-3}}{1\times10^{-3}} = 0.4\text{ V}, & t<1\text{ ms} \\ 0.2\times\dfrac{4-2}{3-1} = 0.2\text{ V}, & 1\le t\le 3\text{ ms} \\ 0.2\times\dfrac{0-4}{6-3} = -0.2667\text{ V}, & t>3\text{ ms} \end{cases}$$

Thus,

(a) $v_L = \underline{0.4\text{ V}}$ @ $t = 0$
(b) $v_L = \underline{0.2\text{ V}}$ @ $t = 2$ ms
(c) $v_L = \underline{-0.2667\text{ V}}$ @ $t = 6$ ms

7.5 (p229)

$v = L\dfrac{di}{dt}$ so

(a) $v = \pm(3)(1)/10^{-3} = \pm 3$ kV

(b) $v_{hi} = (3)(1)/12\times10^{-6} = 250$ kV; $v_{lo} = -(3)(1)/64\times10^{-6} = 46.88$ kV

(c) $v_{hi} = (3)(1)/1 = 3$ V; $v_{lo} = -(3)(1)/1\times10^{-9} = -3$ GV

7.6 (p231)

$$i_L = \frac{1}{L}\int v\,dt = \frac{1}{0.1}\int 2e^{-3t}dt = -\frac{20}{3}e^{-3t} + K$$

$$i_L(-0.5) = -1 = -\frac{20}{3}e^{1.5} + K \qquad \therefore\ K = 30.88\text{ A and } i_L = -\frac{20}{3}e^{-3t} + 30.88\text{ A}$$

7.7 (p233)

(a) $$v = L\frac{di}{dt} = 25\times10^{-3}(10e^{-100t} - 1000t\,e^{-100t})$$

so v (12 ms) = – 15.06 mV

(b) $$i(0.1) = \frac{1}{L}\int_0^{0.1} 6e^{-12t}dt + 10 = \frac{6}{0.025}\left(\frac{-1}{12}\right)e^{-12t}\Big|_0^{0.1} + 10 \quad = 23.98\text{ A}$$

(c) $$p(t) = Li\frac{di}{dt} = 0.025\left[8(1-e^{-40t})\times10^{-3}\right]\left[8\times10^{-3}(40)e^{-40t}\right]$$

so p(50 ms) = 7.489 μW

(d) $$w_L(t) = \frac{1}{2}(0.025)\left[8\times10^{-3}(1-e^{-40t})\right]^2$$

so w_L (40 ms) = 509.6 nJ

7.8 (p237)

Viewing the circuit right to left, we see that

$$\begin{aligned}C_{eq} &= \{[(1//5//2)+12]//0.4//0.8\} + (7//5)\\ &= \{[0.5882+12]//0.2667\} + 2.917\\ &= 3.178\ \mu\text{F}\end{aligned}$$

7.9 (p239)

- define a clockwise current $i(t)$

KVL yields $-v_S + 0.002\dfrac{di}{dt} + v_C = 0$ [1]

$$v_C = \frac{1}{C}\int_{-\infty}^{t} i\ dt' = 4\cos 10^5 t \text{ V} \qquad [2]$$

Thus, $i(t) = -4(80\times10^{-9})(10^5)\sin 10^5 t = -32\times10^{-3}\sin 10^5 t$

and $\dfrac{di}{dt} = -32\times10^{-3}(10^5)\cos 10^5 t = -3200\cos 10^5 t$

Substituting this into Eq. [1],

$$v_s = -0.002\times3200\cos 10^5 t + 4\cos 10^5 t$$
$$= \underline{-2.4\cos 10^5\, t \text{ V}}$$

7.10 (p241)

Recalling op amp Rule #1, that no current flows into either input terminal, we may write

$$-v_S + R_1 i + v_{L_f} + v_{out} = 0 \qquad [1]$$

or $\quad -v_S + R_1 i + L_f\dfrac{di}{dt} + v_{out} = 0 \qquad [1]$

Op Amp Rule #2 states that $v_a = v_b$. Thus,

$$-v_S + R_1 i + v_a = 0 \qquad [2]$$

may be written as

$$-v_S + R_1 i + v_b = 0 \qquad [2]$$

or $\quad -v_S + R_1 i = 0 \qquad [2]$

Thus, $i = \dfrac{v_S}{R_1}$ and $\dfrac{di}{dt} = \dfrac{1}{R_1}\dfrac{dv_s}{dt}$. Substituting into Eq. [1],

$$v_{out} = v_S - \frac{R_1 v_s}{R_1} - L_f\left(\frac{1}{R_1}\right)\frac{dv_s}{dt}$$

or $\quad \underline{v_{out} = -\dfrac{L_f}{R_1}\dfrac{dv_s}{dt}}$

7.11 (p245)

- define i_C flowing downward through the capacitor

$$8\times10^{-3}e^{-10^6 t}=\frac{v}{10}+i_C \qquad [1]$$

where $i_C=0.2\times10^{-6}\frac{dv}{dt}$

Thus, Eq. [1] becomes

$$8\times10^{-3}e^{-10^6 t}=0.1v+0.2\times10^{-6}\frac{dv}{dt} \qquad [1]$$

Substituting $v=-80\times10^{-3}e^{-10^6 t}$,

$$(0.1)(-80\times10^{-3}e^{-10^6 t})+(0.2\times10^{-6})(-80\times10^{-3})(-10^6)e^{-10^6 t}$$

$$=(-8\times10^{-3}+16\times10^{-3})e^{-10^6 t}=8\times10^{-3}e^{-10^6 t}$$

which verifies that $v=-80e^{-10^6 t}$ mV is indeed a solution to Eq. [1].

(a) Invoking duality, $v_1=0.1v=\underline{-8e^{-10^6 t}\text{ mV}}$

(b) by KVL, $v_2=8\times10^{-3}e^{-10^6 t}-v_1=\underline{16e^{-10^6 t}\text{ mV}}$

(c) by duality, $i=\underline{-80e^{-10^6 t}\text{ mA}}$

