P 6.1 [a] $v = L\frac{di}{dt};$

$$\frac{di}{dt} = 18[t(-10e^{-10t}) + e^{-10t}] = 18e^{-10t}(1 - 10t);$$

$$v = (50 \times 10^{-6})(18)e^{-10t}(1 - 10t)$$

$$= 0.9e^{-10t}(1 - 10t)\,\text{mV}, \quad t > 0.$$

[b] $p = vi.$

$$v(200\,\text{ms}) = 0.9e^{-2}(1 - 2) = -121.8\,\mu\text{V}.$$

$$i(200\,\text{ms}) = 18(0.2)e^{-2} = 487.2\,\text{mA}.$$

$$p(200\,\text{ms}) = (-121.8 \times 10^{-6})(487.2 \times 10^{-3}) = -59.34\,\mu\text{W}.$$

[c] delivering.

[d] $w = \frac{1}{2}Li^2 = \frac{1}{2}(50 \times 10^{-6})(487.2 \times 10^{-3})^2 = 5.93\,\mu\text{J}.$

[e] The energy is a maximum where the current is a maximum:

$$\frac{di_L}{dt} = 18[t(-10)e^{-10t} + e^{-10t}) = 18e^{-10t}(1 - 10t);$$

$$\frac{di_L}{dt} = 0 \quad \text{when} \quad t = 0.1\,\text{s}.$$

$$i_{\text{max}} = 18(0.1)e^{-1} = 662.2\,\text{mA};$$

$$w_{\text{max}} = \frac{1}{2}(50 \times 10^{-6})(662.2 \times 10^{-3})^2 = 10.96\,\mu\text{J}.$$

P 6.2 [a] $0 \le t \le 2\,\text{ms}:$

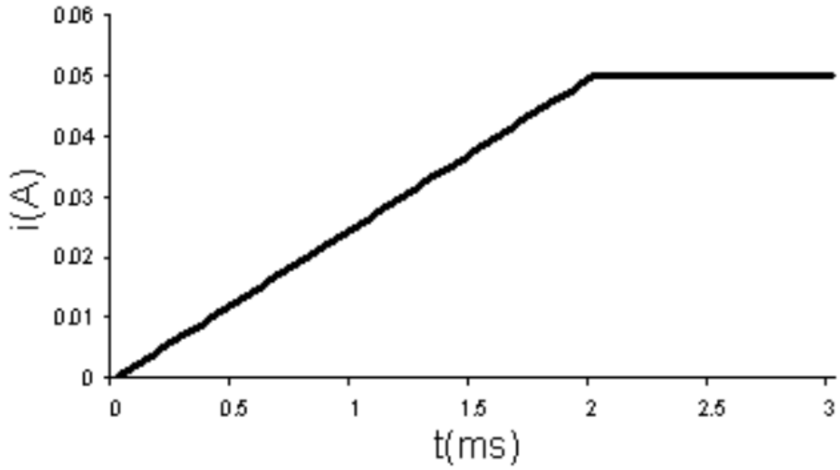
$$i = \frac{1}{L}\int_0^t v_s\,dx + i(0) = \frac{1}{200 \times 10^{-6}}\int_0^t 5 \times 10^{-3}\,dx + 0$$

$$= 25x\,\Big|_0^t = 25t\,\text{A};$$

$2\,\text{ms} \le t < \infty:$

$$i = \frac{1}{200 \times 10^{-6}}\int_{2\times10^{-3}}^t (0)\,dx + 25(2 \times 10^{-3}) = 50\,\text{mA}.$$

[b]



P 6.14 $v = -10\,\text{V}, \quad t \leq 0; \qquad C = 0.8\,\mu\text{F};$

$$v = 40 - e^{-1000t}(50\cos 500t + 20\sin 500t)\text{V}, \quad t \geq 0.$$

[a] $i = 0, \quad t < 0.$

[b]
$$\begin{aligned}
\frac{dv}{dt} &= 1000e^{-1000t}(50\cos 500t + 20\sin 500t) \\
&\quad -e^{-1000t}(-25{,}000\sin 500t + 10{,}000\cos 500t) \\
&= e^{-1000t}(50{,}000\cos 500t + 20{,}000\sin 500t \\
&\quad +25{,}000\sin 500t - 10{,}000\cos 500t) \\
&= (40{,}000\cos 500t + 45{,}000\sin 500t)e^{-1000t}; \\
i &= C\frac{dv}{dt} = (32\cos 500t + 36\sin 500t)e^{-1000t}\,\text{mA.}
\end{aligned}$$

[c] no.

[d] yes, from 0 to 32 mA.

[e] $v(\infty) = 40\,\text{V};$

$$w = \frac{1}{2}Cv^2 = \frac{1}{2}(0.8 \times 10^{-6})(40)^2 = 640\,\mu\text{J}.$$

P 6.17 $i_C = C(dv/dt)$

$0 < t < 0.5:$

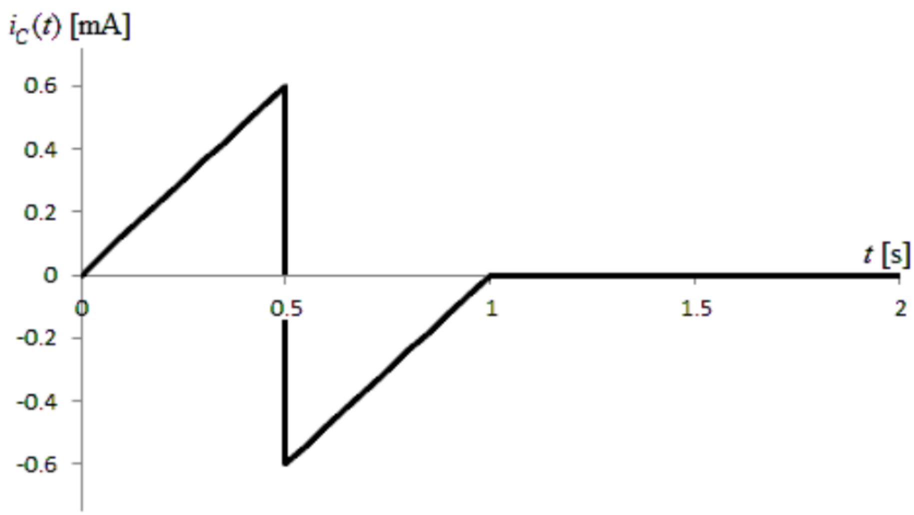
$$v_c = 30t^2\,\text{V};$$

$$i_C = 20 \times 10^{-6}(60)t = 1.2t\,\text{mA}.$$

$0.5 < t < 1:$

$$v_c = 30(t-1)^2\,\mathrm{V};$$

$$i_C = 20 \times 10^{-6}(60)(t-1) = 1.2(t-1)\,\mathrm{mA}.$$



P 6.23 **[a]** $15\|30 = 10\,\text{mH}$;

$10 + 10 = 20\,\text{mH}$;

$20\|20 = 10\,\text{mH}$;

$12\|24 = 8\,\text{mH}$;

$10 + 8 = 18\,\text{mH}$;

$18\|9 = 6\,\text{mH}$;

$L_{\text{ab}} = 6 + 8 = 14\,\text{mH}$.

[b] $12 + 18 = 30\,\mu\text{H}$;

$30\|20 = 12\,\mu\text{H}$;

$12 + 38 = 50\,\mu\text{H}$;

$30\|75\|50 = 15\,\mu\text{H}$;

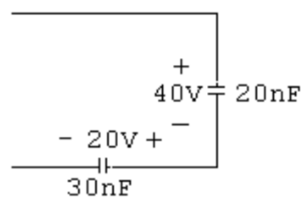
$15 + 15 = 30\,\mu\text{H}$;

$30\|60 = 20\,\mu\text{H}$;

$L_{\text{ab}} = 20 + 25 = 45\,\mu\text{H}$.

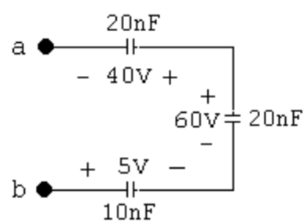
P 6.30 **[a]** $\frac{1}{C_1} = \frac{1}{48} + \frac{1}{24} = \frac{1}{16}; \qquad C_1 = 16\,\text{nF};$

$C_2 = 4 + 16 = 20\,\text{nF}.$



$$\frac{1}{C_3} = \frac{1}{20} + \frac{1}{30} = \frac{1}{12}; \qquad C_3 = 12\,\text{nF};$$

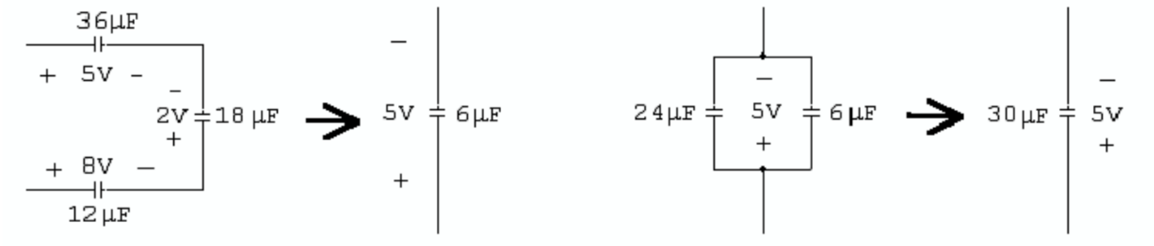
$C_4 = 12 + 8 = 20\,\text{nF}.$



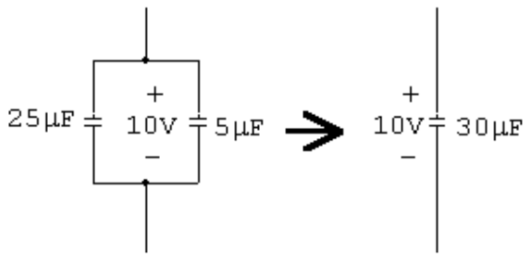
$$\frac{1}{C_5} = \frac{1}{20} + \frac{1}{20} + \frac{1}{10} = \frac{1}{5}; \qquad C_5 = 5\,\text{nF}.$$

Equivalent capacitance is $5\,\text{nF}$ with an initial voltage drop of $+15$ V.

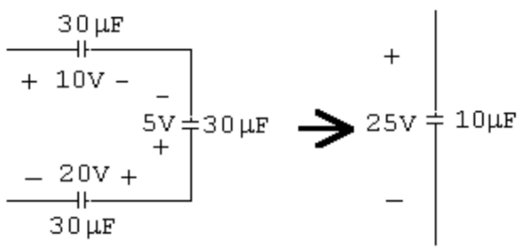
[b] $\dfrac{1}{36} + \dfrac{1}{18} + \dfrac{1}{12} = \dfrac{1}{6} \quad \therefore \quad C_{\text{eq}} = 6\,\mu\text{F}$ $\qquad 24 + 6 = 30\,\mu\text{F}.$



$25 + 5 = 30\,\mu\text{F}.$



$$\frac{1}{30} + \frac{1}{30} + \frac{1}{30} = \frac{3}{30} \quad \therefore \quad C_{\text{eq}} = 10\,\mu\text{F}.$$



Equivalent capacitance is $10\,\mu$F with an initial voltage drop of +25 V.

P 6.35

$$\begin{aligned}
\frac{di_o}{dt} &= 5\{e^{-2000t}[-8000\sin 4000t + 4000\cos 4000t] \\
&\quad -2000e^{-2000t}[2\cos 4000t + \sin 4000t]\}; \\
\frac{di_o}{dt}(0^+) &= 5[1(4000) + (-2000)(2)] = 0; \\
v_2(0^+) &= 10 \times 10^{-3}\frac{di_o}{dt}(0^+) = 0; \\
v_1(0^+) &= 40i_o(0^+) + v_2(0^+) = 40(10) + 0 = 400\text{V}.
\end{aligned}$$