5.1

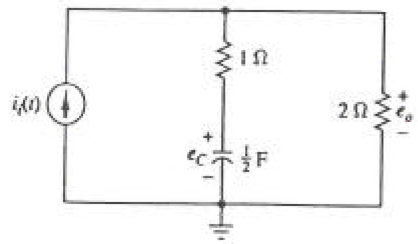
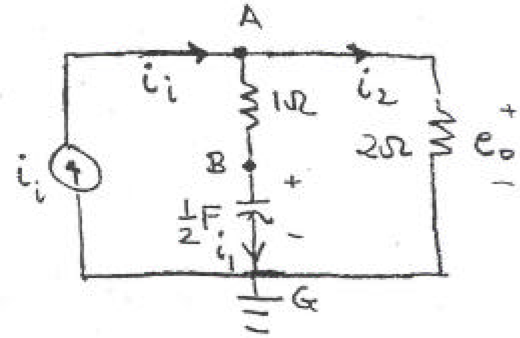


FIGURE P5.1



$$i_i = i_1 + i_2 \qquad (1)$$

$$\frac{e_A - e_B}{1\Omega} = i_1 \qquad (2)$$

$$i_1 = \frac{1}{2}F \cdot \frac{d(e_B - 0)}{dt} \qquad (3)$$

$$i_2 = \frac{e_A - 0}{2\Omega} \qquad (4)$$

4 unknowns: i_1, i_2, e_A, e_B & 4 equations

This is OK at this point. # unknowns: i_1, i_2, e_A, e_B

equations: 4

Further simplification (not required)

5.7

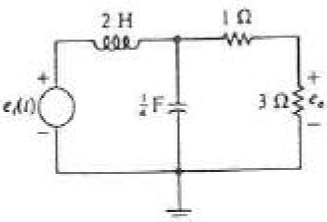
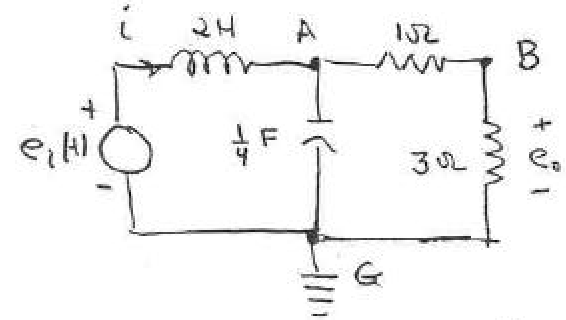


FIGURE P5.7



Node A $\quad i(t_0) + \frac{1}{2}\int_{t_0}^{t}(e_i - e_A)\,dt = \frac{e_A - e_B}{1} + \frac{1}{4}\dot{e}_A \quad (1)$

Node B: $\quad \frac{e_A - e_B}{1} = \frac{e_B}{3} \quad (2)$ Note $e_B = e_o$

Node G: $\quad \frac{e_B}{3} + \frac{1}{4}\dot{e}_A = i \quad (3)$ (Do not need to write this equati-

Unknowns: i, e_A, e_B (3)

Equations: 3.

Not Required

Note: could simplify (2) $\Rightarrow e_A = \frac{4}{3}e_B$

Differentiate (1) & substitute

$$\frac{1}{2}\left[e_i(t) - \frac{4}{3}e_B(t)\right] = \frac{1}{3}\dot{e}_B + \frac{1}{3}\ddot{e}_B$$

Since $e_B = e_o \Rightarrow -e_i(t) = -\frac{8}{3}e_o(t) + \frac{2}{3}\dot{e}_0 + \frac{2}{3}\ddot{e}_o(t)$

5.11

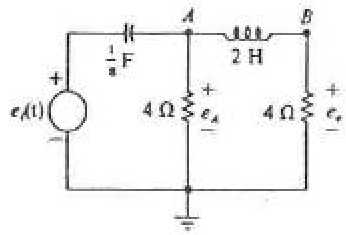
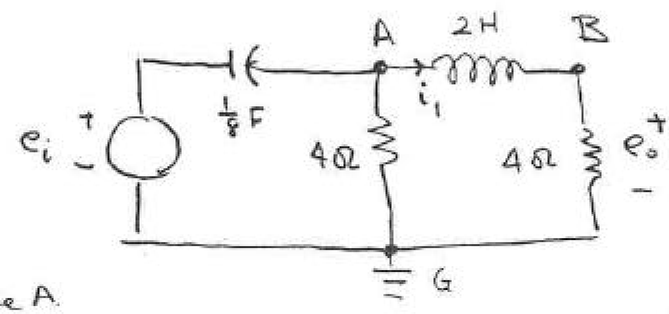


FIGURE P5.11



Node A

$$\frac{1}{8}\frac{d(e_i - e_A)}{dt} = i_1(t_0) + \frac{1}{2}\int_{t_0}^{t}(e_A - e_B)\,d\tau + \frac{e_A - 0}{4} \qquad (1)$$

Node B: $$i_1(t_0) + \frac{1}{2}\int_0^t (e_A - e_B)\,d\tau = \frac{e_B}{4} \qquad (2)$$

Node G: $$\frac{e_B}{4} + \frac{e_A}{4} = i \qquad (3)$$ (Do not need to write this equation) if we are not interested in i.

Number of unknowns: e_A, e_B, i $\qquad (e_B = e_o)$

Number of equations: 3 ✓

Not Required: Simplification

(2) ⇒ $$e_A = e_B + \frac{\dot{e}_B}{2} \qquad (4)$$

(1), (2) ⇒ $$\dot{e}_i = \dot{e}_A + 2e_B + 2e_A \qquad (5)$$

(5), (4) ⇒

$$\dot{e}_i = \dot{e}_B + \frac{\ddot{e}_B}{2} + 2e_B + 2\left(e_B + \frac{\dot{e}_B}{2}\right)$$

$$\dot{e}_i = 4e_B + 2\dot{e}_B + \frac{\ddot{e}_B}{2}$$

5.12

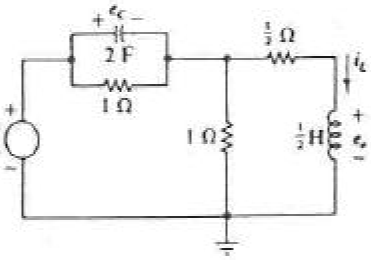
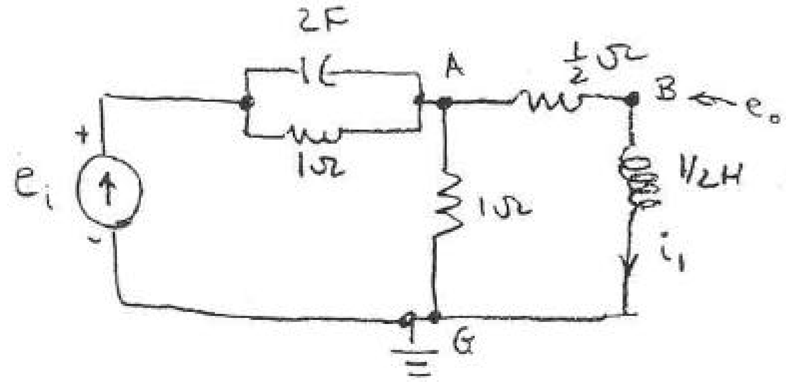


FIGURE P5.12



Node A: $\quad 2(\dot{e}_i - \dot{e}_A) + \dfrac{e_i - e_A}{1\Omega} = \dfrac{e_A - e_B}{\frac{1}{2}\Omega} + \dfrac{e_A}{1\Omega} \quad$ (1)

Node B: $\quad \dfrac{e_A - e_B}{\frac{1}{2}\Omega} = i_1(t_0) + \dfrac{1}{1/2}\displaystyle\int_{t_0}^{t} e_B(\tau)\,d\tau \quad$ (2)

Unknowns: e_A, e_B

\# of equations: 2

Not Required

From (2) $\quad e_A = \frac{1}{2} i_1(t_0) + \int_{t_0}^{t} e_B(\tau)\,d\tau + e_B \quad$ (3)

or $\quad \dot{e}_A = e_B + \dot{e}_B \quad$ (4)

(1) $\Rightarrow \quad 2\dot{e}_i + e_i = 2\dot{e}_A + 4e_A - 2e_B \quad$ (5)

Differentiate (5) & divide by 2. $\Rightarrow$ (Use (4))

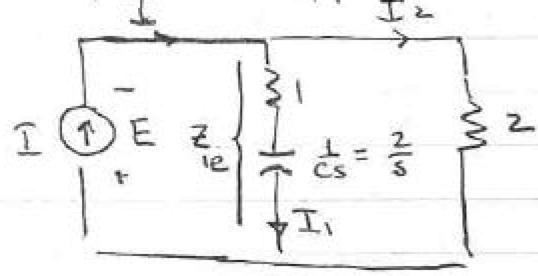
$$\ddot{e}_i + \tfrac{1}{2}\dot{e}_i = \cancel{\dot{e}_B} + \ddot{e}_B + 2(e_B + \dot{e}_B) - \cancel{\dot{e}_B}$$

$$\Rightarrow \quad \ddot{e}_i + \tfrac{1}{2}\dot{e}_i = \ddot{e}_B + 2\dot{e}_B + 2e_B$$

where $e_B = e_o$

1. Use impedance approach.

5.1



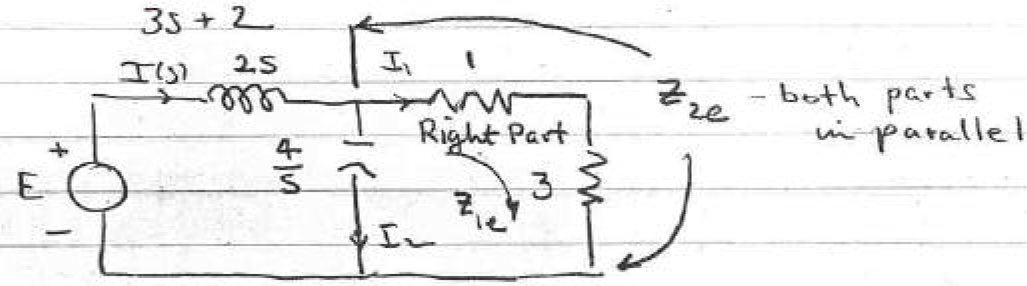
$$Z_{1e} = 1 + \frac{2}{s} = \frac{s+2}{s}$$

For two parts in parallel $Z_e = \dfrac{Z_{1e}\cdot 2}{2 + Z_{1e}}$

$$Z_e = \frac{\frac{s+2}{\cancel{s}}\cdot 2}{2 + \frac{s+2}{s}} \cdot \frac{\cancel{s}}{s} = \frac{2s+4}{2s+s+2} = \frac{2s+4}{3s+2}$$

$$\therefore \quad E(s) = \frac{2s+4}{3s+2}\, I(s).$$

5.7



Elements in series $\Rightarrow$ $Z_{1e} = 4$

Elements in parallel $\Rightarrow$ $Z_{2e} = \dfrac{\frac{4}{s}\cdot 4}{4 + \frac{4}{s}} = \dfrac{4/s}{1+1/s}\cdot\dfrac{s}{s} = \dfrac{4}{s+1}$

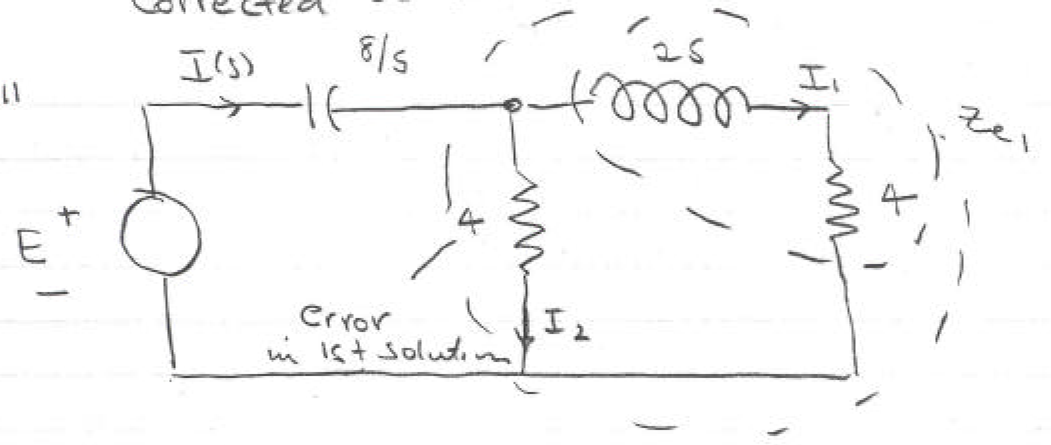
$Z_{Total} = Z_T = 2s + Z_{2e}$

$$Z_T = \frac{2s\,(s+1) + 4}{s+1} = \frac{2s^2+2s+4}{s+1} = 2\,\frac{(s^2+s+2)}{s+1}$$

$$\therefore \quad E(s) = \frac{2\,(s^2+s+2)}{s+1}\, I(s)$$

Corrected Solution

5.11



Series: $Z_{e_1} = 2s + 4$

Parallel: $Z_{e_2} = \dfrac{4 Z_{e_1}}{4 + Z_{e_1}} = \dfrac{8s+16}{2s+8} = \dfrac{4(s+2)}{s+4}$

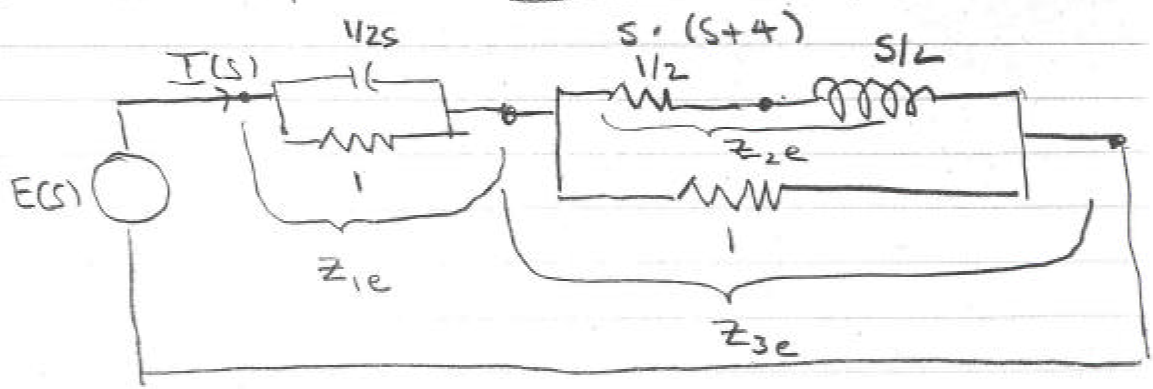
$Z_{TOTAL} = Z_T = \dfrac{8}{s} + Z_{e_2}$ (Elements in series)

$$Z_T = \frac{8(s+4) + s(4s+8)}{s\cdot(s+4)}$$

$$Z_T = \frac{4s^2+16s+32}{s(s+4)} = \frac{4(s^2+4s+8)}{s(s+4)}$$

Then $E(s) = Z_T I(s) = \dfrac{4s^2+16s+32}{s\cdot(s+4)} \cdot I(s)$

5.12



Parallel: $Z_{e_1} = \dfrac{1 \cdot 1/2s}{\frac{1}{2s} + 1} = \dfrac{1}{1+2s}$

Series: $Z_{e2} = \frac{1}{2} + \frac{s}{2} = \frac{1+s}{2}$

Parallel: $Z_{e3} = \frac{1 \cdot Z_{2e}}{1 + Z_{2e}} = \frac{(1+s)/2}{1 + \frac{(1+s)}{2}} = \frac{1+s}{s+3}$

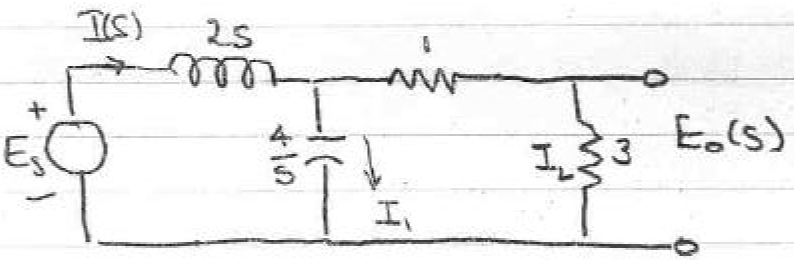
Total Impedance (series): $Z_T = Z_{e1} + Z_{e3}$

$$Z_T = \frac{1}{1+2s} + \frac{1+s}{s+3} = \frac{s+3 + (s+1)\cdot(1+2s)}{(1+2s)(s+3)}$$

$$Z_T = \frac{2s^2 + 4s + 4}{(1+2s)(s+3)}$$

$$\therefore\ E(s) = \frac{2s^2+4s+4}{(1+2s)(s+3)}$$

3. a).



From class $I_2 = I \cdot \frac{Z_1}{Z_1 + Z_2} = I(s) \cdot \frac{4/s}{4 + 4/s} \cdot \frac{s}{s}$

$\Rightarrow I_2(s) = I(s) \cdot \frac{1}{s+1}$

$$E_o(s) = 3 \cdot I_2(s) = \frac{3}{s+1} \cdot I(s) = \frac{3}{\cancel{s+1}} \cdot \frac{\cancel{s+1}}{2(s^2+s+2)}\ E(s)$$

$$E_o(s) = \frac{3}{2\cdot(s^2+s+2)} \cdot E(s)$$

If $e_i(t) = 3 \cdot H(t) \xrightarrow{L.T} E(s) = \frac{3}{s}$

$$\therefore E_o(s) = \frac{9}{2 \cdot s \cdot (s^2 + s + 2)}$$

b). Poles

$s = 0$

$s^2 + s + 2 = 0 \Rightarrow s_j = \frac{-1 \pm \sqrt{1-8}}{2}$

$$s_j = \frac{-1 \pm j\sqrt{7}}{2}$$

c). Single pole at $s = 0$. Other poles in Left-hand plane. Yes

Then

$$e_o(\infty) = \lim_{s \to 0} s \cdot E_o(s) = \left. \frac{\cancel{s} \cdot 9}{2 \cdot \cancel{s} (s^2 + s + 2)} \right|_{s=0}$$

$$e_o(\infty) = \frac{9}{4}$$