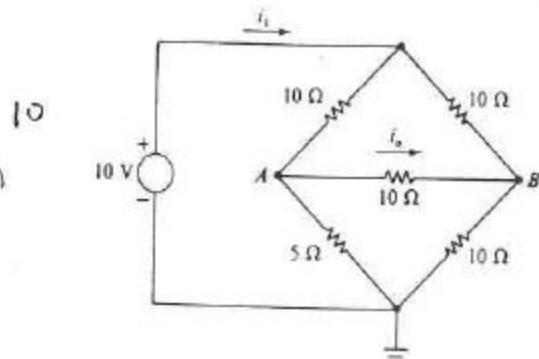


- 5.16 a) Explain why the rules for series and parallel resistors cannot be used for the circuit shown in Figure P5.16.
 b) Use the node-equation method to find the voltages of nodes A and B with respect to the ground node.
 c) Find the currents i_o and i_1 and the equivalent resistance connected across the source.

b).

Current Equation for node A

$$\frac{10 - e_A}{10} = \frac{e_A - e_B}{10} + \frac{e_A - 0}{5} \quad (1)$$



Node B

$$\frac{10 - e_B}{10} = \frac{e_B - e_A}{10} + \frac{e_B - 0}{10} \quad (2)$$

FIGURE P5.16

Simplify (1)

$$10 - e_A = 3e_A - e_B$$

$$\text{or } 4e_A - e_B = 10$$

Simplify (2)

$$10 - e_B = 2e_B - e_A$$

$$\text{or } 3e_B - e_A = 10$$

In matrix form $\begin{bmatrix} 4 & -1 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} e_A \\ e_B \end{bmatrix} = \begin{bmatrix} 10 \\ 10 \end{bmatrix}$

Cramer's Rule

$$e_A = \frac{\begin{vmatrix} 10 & -1 \\ 10 & 3 \end{vmatrix}}{\begin{vmatrix} 4 & -1 \\ -1 & 3 \end{vmatrix}} = \frac{40}{11}$$

$$e_B = \frac{\begin{vmatrix} 4 & 10 \\ -1 & 10 \end{vmatrix}}{\begin{vmatrix} 4 & -1 \\ -1 & 3 \end{vmatrix}} = \frac{50}{11}$$

c) Find i_o and i_1 and the equivalent resistance.

$$\text{Note } i_1 = i_2 + i_3$$

$$i_2 = \frac{10 - e_A}{10} = 1 - \frac{e_A}{10} = 1 - \frac{40}{110}$$

$$i_3 = \frac{10 - e_B}{10} = 1 - \frac{50}{110}$$

$$i_1 = i_2 + i_3 = 1 - \frac{40}{110} + 1 - \frac{50}{110} = 2 - \frac{90}{110} = 1 \frac{2}{11} = \frac{13}{11}$$

$$i_o = \frac{e_B - e_A}{10} = \frac{\frac{50}{11} - \frac{40}{11}}{10} = \frac{10}{10 \cdot 11} = \frac{1}{11}$$

Equivalent Resistance

$$10V = R_E \cdot i_1 \Rightarrow R_E = \frac{10}{\frac{13}{11}} = \frac{110}{13}$$

8.34 Find the transfer function for the circuit shown in Figure 8.12 by characterizing the passive elements by their impedances.

$$\begin{aligned} Z_{e_1} &= \frac{1}{3s} + 2s \quad (\text{series 1}) \\ &= \frac{1 + 6s^2}{3s} \end{aligned}$$

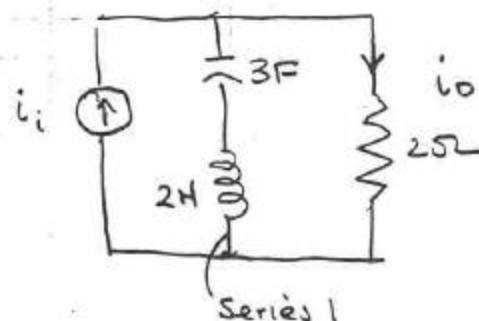


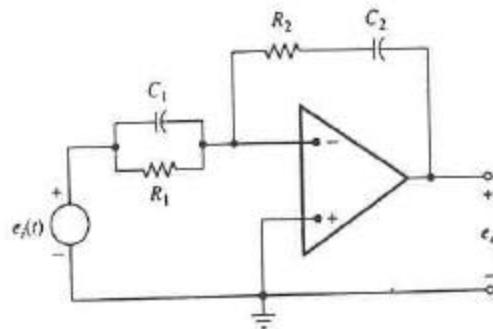
Fig 8.12

Current sharing rule:

$$\begin{aligned} I_o(s) &= I_i(s) \cdot \frac{Z_{e_1}}{Z_{e_1} + 2} = I_i(s) \cdot \frac{\frac{1+6s^2}{3s}}{\left(\frac{1+6s^2}{3s}\right) + 2} \\ &= I_i(s) \cdot \frac{1+6s^2}{6s^2+6s+1} \quad T(s) = \frac{1+6s^2}{6s^2+6s+1} \end{aligned}$$

- 8.39 a) Use impedances and the results of Example 8.16 to find the transfer function for the op-amp circuit shown in Figure P8.39.
 b) Plot the pole-zero pattern.

National Brand
 Model No. 54
 1000 SPOTS 15 FALCON 5 SQUARE
 42-301 500 SPOTS 15 FALCON 5 SQUARE
 42-302 1000 SPOTS 15 FALCON 5 SQUARE
 42-303 1000 SPOTS 15 FALCON 5 SQUARE
 42-304 1000 SPOTS 15 FALCON 5 SQUARE
 42-305 1000 SPOTS 15 FALCON 5 SQUARE
 42-306 1000 SPOTS 15 FALCON 5 SQUARE
 42-307 1000 SPOTS 15 FALCON 5 SQUARE
 42-308 1000 SPOTS 15 FALCON 5 SQUARE
 42-309 1000 SPOTS 15 FALCON 5 SQUARE



(a) From Example 8.16.

$$\frac{E_o(s)}{E_i(s)} = - \frac{Z_L(s)}{Z_1(s)}$$

Z_1 : Elements in parallel.

$$\Rightarrow Z_1 = \frac{\frac{R_1}{C_1 s}}{\frac{1}{C_1 s} + R_1} = \frac{R_1}{1 + R_1 C_1 s}$$

Z_2 : Elements in series

$$Z_2 = R_2 + \frac{1}{C_2 s} = \frac{R_2 C_2 s + 1}{C_2 s}$$

Then $\frac{E_o(s)}{E_i(s)} = - \frac{R_2 C_2 s + 1}{C_2 s \cdot R_1}$

$$= - \frac{(R_2 C_2 s + 1)(R_1 C_1 s + 1)}{C_2 s R_1}$$

$$\frac{E_o(s)}{E_i(s)} = - \frac{(R_1 R_2 C_1 C_2 s^2 + (R_1 C_1 + R_2 C_2)s + 1)}{C_2 s R_1} = T(s)$$

Grader:
 This step
 not necessary.

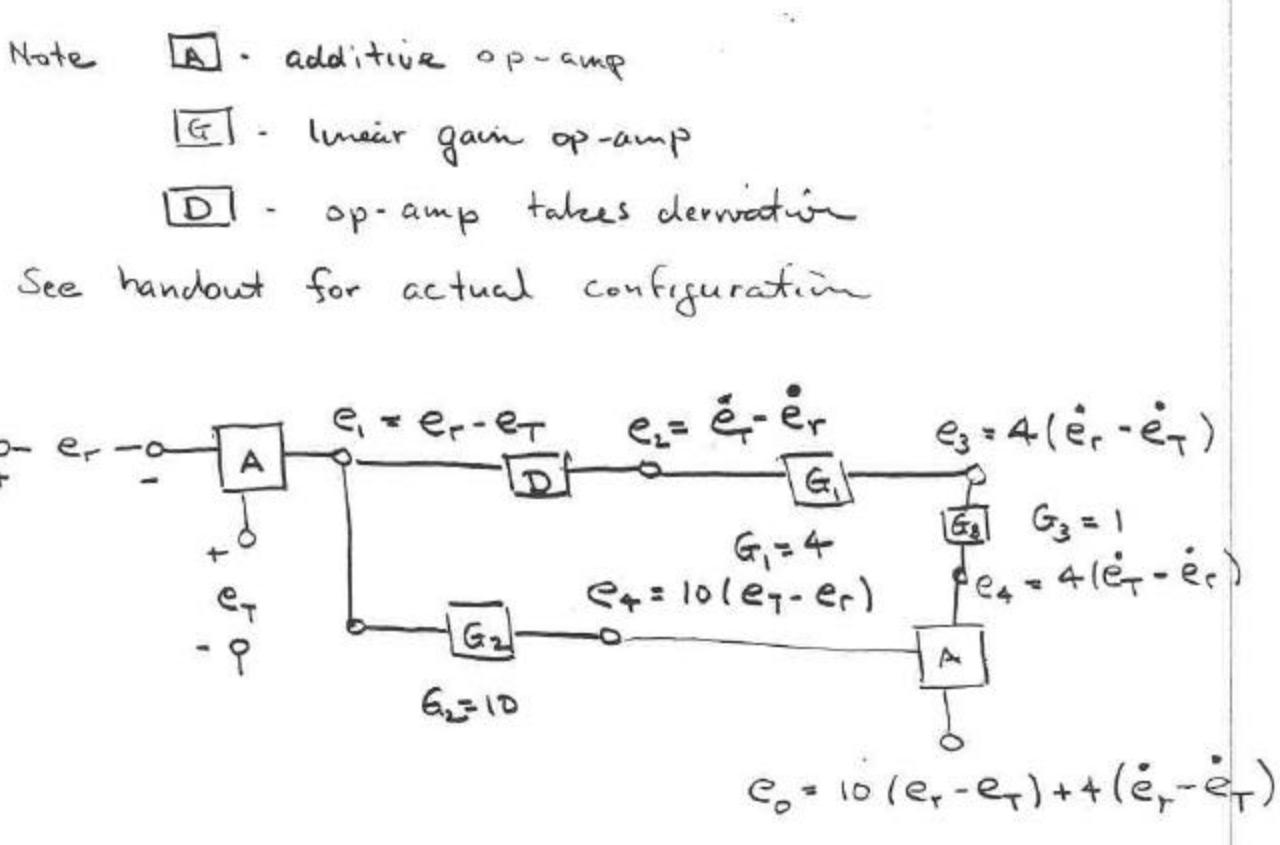
$$= - \left(R_2 C_1 s + \frac{(R_1 C_1 + R_2 C_2)}{C_2 R_1} + \frac{1}{C_2 R_1 s} \right)$$

↓ ↓ ↓
 Takes derivative Gain integrates

ADDITIONAL PROBLEMS

- See problem sheet.

National® Brand
Model No. 1450
13-182
1000 SHOTGUN RESISTORS
40-381 50-5401 500-5501 5500-5501
40-382 100-741 11-381 110-381
40-383 200-111 200-112 200-113
40-384 400-111 400-112 400-113
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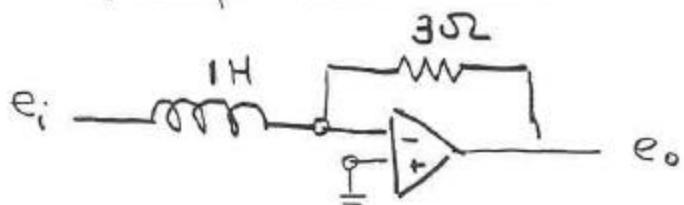
Integration: want $-\frac{z_2}{e_1} = -\frac{3}{s} \Rightarrow z_2 = 3$
<

$$\Rightarrow Z_2 = 3\Omega \text{ (Resistor)}$$

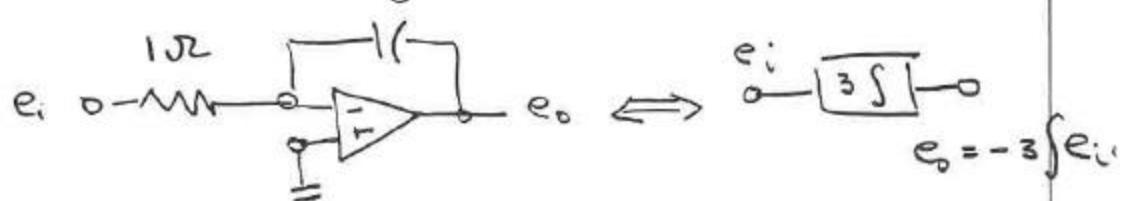
$$Z_1 = 5 \text{ (inductor)}$$

(Could use capacitor
for Z_2 and
resistor for Z_1)

i.e. Op-Amp looks like



Alternatively, it could look like.



Then full circuit

