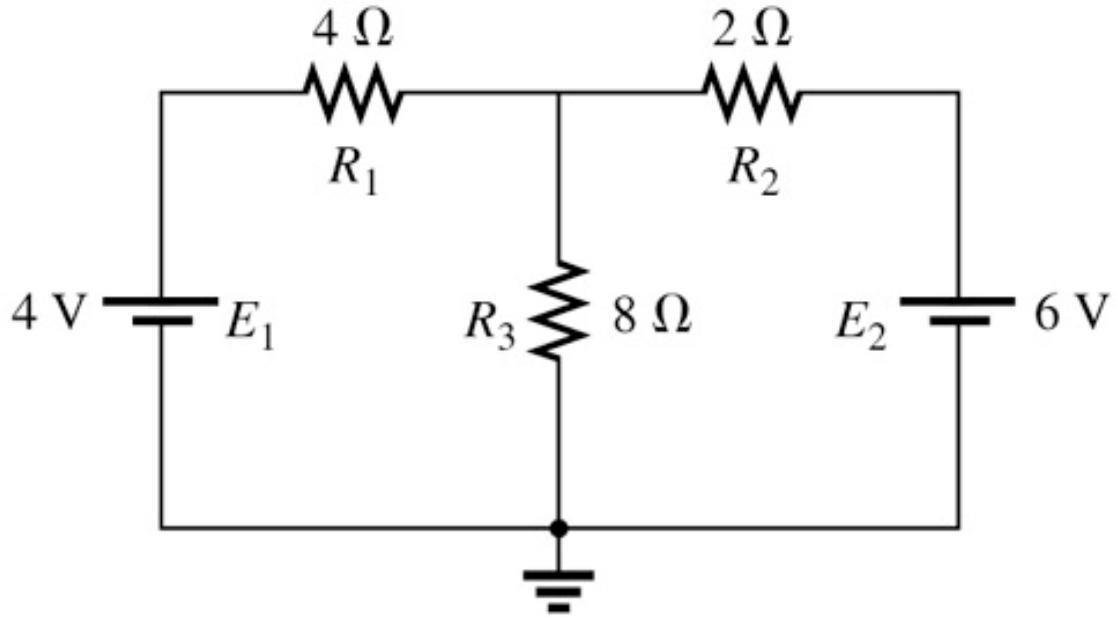
Today's Material

- Branch Current Analysis (with example)
- Breakout #1
  - Branch current analysis problem

Branch Current Analysis (by example)

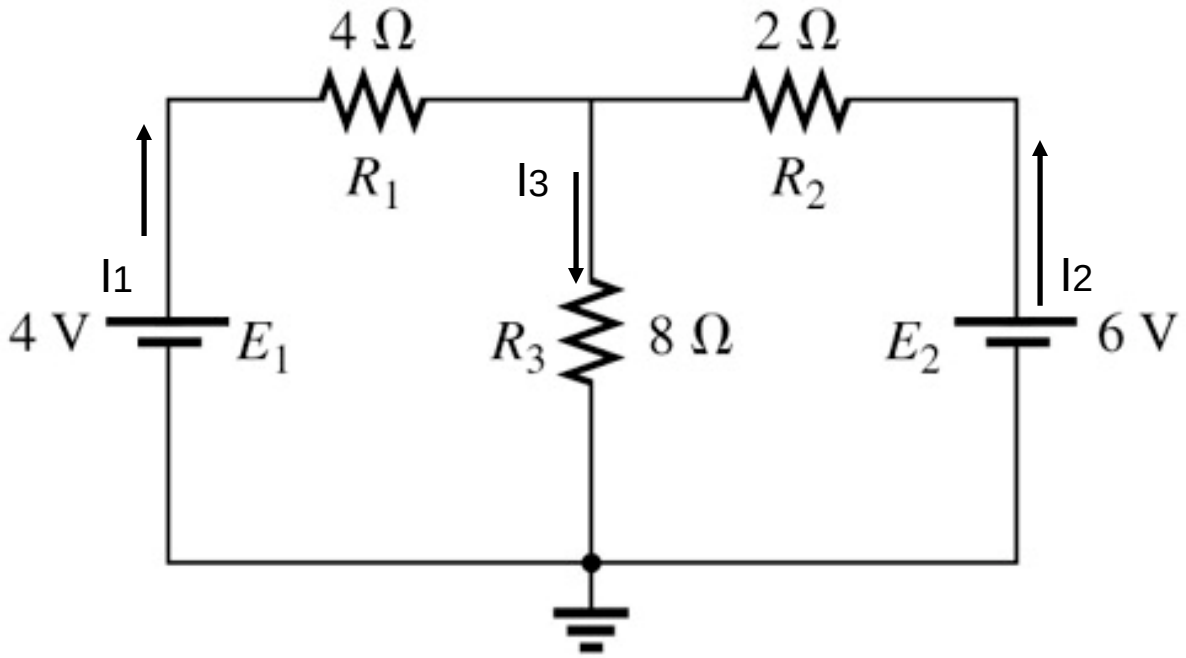
- Find V_{R3} and the power delivered by E_2
  - Any thoughts?
  - Can we combine circuit elements in series or parallel?



(a)

Branch Current Analysis (by example)

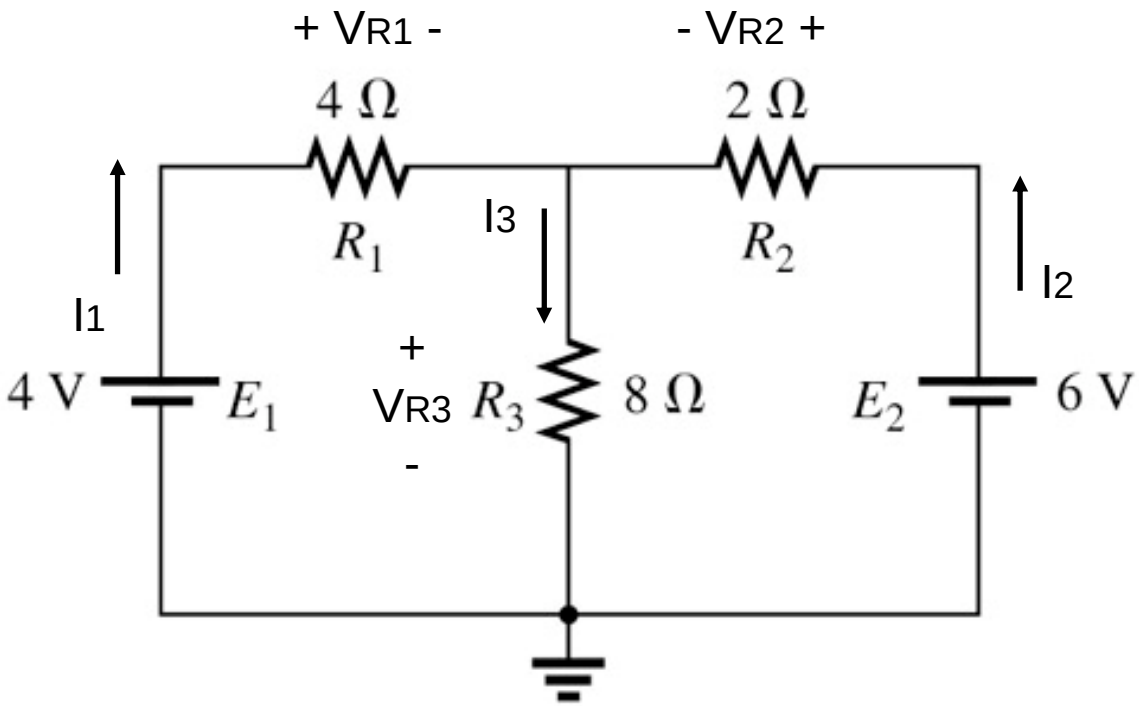
- Method
  1. Assign an arbitrary current to each branch of the network



(a)

Branch Current Analysis (by example)

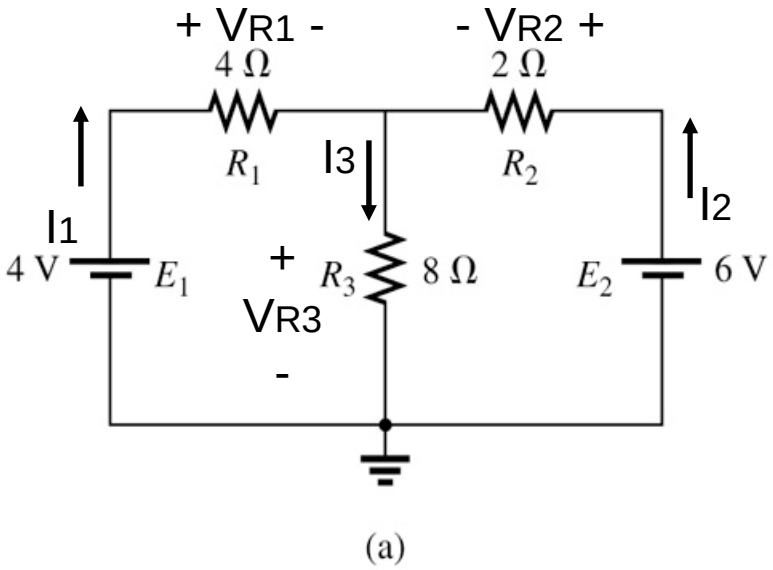
- Method
  2. Label the voltage drops for each resistor, determined by the appropriate branch current direction



(a)

Branch Current Analysis (by example)

- Method
  3. Apply KVL around each closed, independent loop of the network



(a)

$$+E_1 - V_{R1} - V_{R3} = 0$$

$$+4 - 4 \cdot I_1 - 8 \cdot I_3 = 0, \quad (1)$$

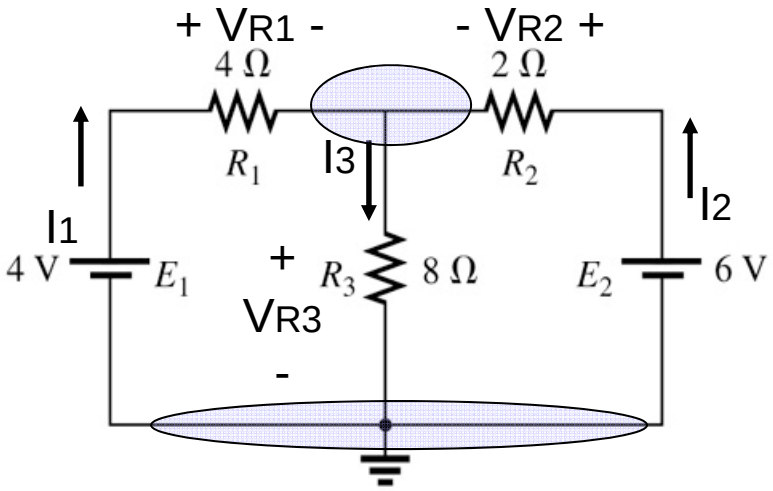
$$+V_{R3} + V_{R2} - E_2 = 0$$

$$+8 \cdot I_3 + 2 \cdot I_2 - 6 = 0, \quad (2)$$

Note: We have 2 equations and 3 unknowns at this point

Branch Current Analysis (by example)

- Method
  4. Apply KCL at the minimum number of nodes that will include all the network's branch currents



(a)

Note: Only 2 independent NODES here

Note: Only 1 NODE needed to include all three branch currents

$$I_1 + I_2 - I_3 = 0, \quad (3)$$

Branch Current Analysis (by example)

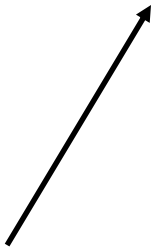
- Method
  5. Solve the simultaneous linear equations for the branch currents and then relate the solution to the unknown(s)

We have:

$$+4-4\cdot I_1-8\cdot I_3=0, \quad (1)$$
$$+8\cdot I_3+2\cdot I_2-6=0, \quad (2)$$
$$I_1+I_2-I_3=0, \quad (3)$$

Rewritten:

$$-4\cdot I_1+0\cdot I_2-8\cdot I_3=-4, \quad (1)$$
$$0\cdot I_1+2\cdot I_2+8\cdot I_3=6, \quad (2)$$
$$I_1+I_2-I_3=0, \quad (3)$$



Note: 3 equations and 3 unknowns

Branch Current Analysis (by example)

- Solving the equations
  - Method of determinants (review) - See Appendix **B**
  - Use your calculator for 3x3 or smaller (manual excerpt below and on the next page)

Rewritten:

$$-4 \cdot I_1 + 0 \cdot I_2 - 8 \cdot I_3 = -4, \quad (1)$$

$$0 \cdot I_1 + 2 \cdot I_2 + 8 \cdot I_3 = 6, \quad (2)$$

$$I_1 + I_2 - I_3 = 0, \quad (3)$$

- For the EL-W516T
  - MODE **4 0** (2 eqs)
  - MODE **4 1** (3 eqs)

Simultaneous Linear Equations

Simultaneous linear equations with two unknowns (2-VLE) or with three unknowns (3-VLE) may be solved using the following functions.

① 2-VLE: MODE 6 0

$$\begin{cases} a_1x + b_1y = c_1 \\ a_2x + b_2y = c_2 \end{cases} \qquad |D| = \begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}$$

② 3-VLE: MODE 6 1

$$\begin{cases} a_1x + b_1y + c_1z = d_1 \\ a_2x + b_2y + c_2z = d_2 \\ a_3x + b_3y + c_3z = d_3 \end{cases} \qquad |D| = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

- If the determinant D = 0, an error occurs.
- If the absolute value of an intermediate result or calculation result is 1×10^{100} or more, an error occurs.

Solving simultaneous linear equations

1. Press MODE 6 0 or MODE 6 1.
2. Enter the value for each coefficient (a_1, etc.).
   - Coefficients can be entered using ordinary arithmetic operations.
   - To clear the entered coefficient, press ON/C.
   - Press ▲ or ▼ to move the cursor up or down through the coefficients. Press 2ndF ▲ or 2ndF ▼ to jump to the first or last coefficient.
3. When all coefficients have been entered, press ENTER to solve the equation.
   - While the solution is displayed, press ENTER or ON/C to return to the coefficient entry display. To clear all the coefficients, press 2ndF CA.

Branch Current Analysis (by example)

- Solving the equations using your calculator:

Work this example first:

$\begin{cases} x+y-z=9 \\ 6x+6y-z=17 \\ 14x-7y+2z=42 \end{cases}$	MODE 6 1 1 ENTER 1 ENTER (—) 1 ENTER 9 ENTER 6 ENTER 6 ENTER (—) 1 ENTER 17 ENTER 14 ENTER (—) 7 ENTER 2 ENTER 42		
$x=?$	ENTER	X:	3.238095238
$y=?$		Y:	-1.638095238
$z=?$		Z:	-7.4
$\det(D)=?$		D:	105.

- For the EL-W516T
  - MODE **4 0** (2 eqs)
  - MODE **4 1** (3 eqs)

Now find I_1, I_2, I_3:

$$-4 \cdot I_1 + 0 \cdot I_2 - 8 \cdot I_3 = -4, \quad (1)$$

$$0 \cdot I_1 + 2 \cdot I_2 + 8 \cdot I_3 = 6, \quad (2)$$

$$I_1 + I_2 - I_3 = 0, \quad (3)$$

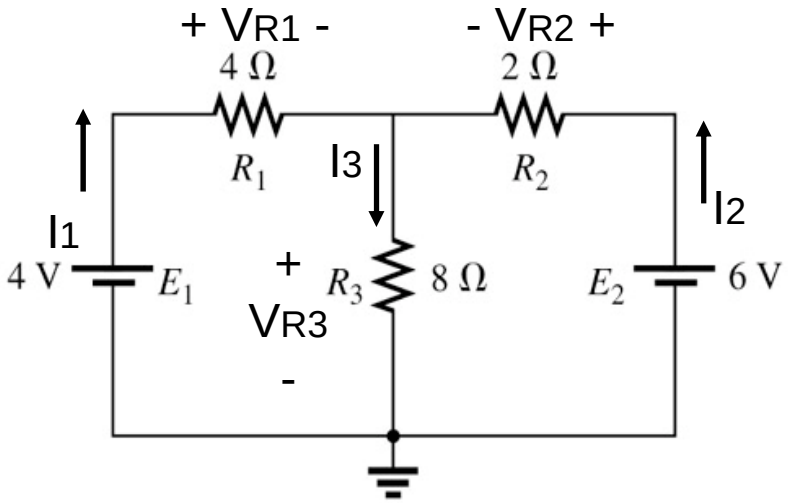
I_1 = -0.1429 A

I_2 = 0.7143 A

I_3 = 0.5714 A

Branch Current Analysis (by example)

- What were we looking for?
  - V_{R3} and P_{E2}



(a)

$$V_{R3} = I_3 \cdot R_3$$
$$= 571.4\,\text{mA} \cdot 8\,\Omega = 4.57\,\text{V}$$

$$P_{E2} = E_2 \cdot I_2$$
$$= 6\,\text{V} \cdot 714.3\,\text{mA} = 4.29\,\text{W}$$

I_1 = -0.1429 A

I_2 = 0.7143 A

I_3 = 0.5714 A

Breakout #1

- Find P_{E1}, P_{R2} and the current through R_3