NODE-VOLTAGE ANALYSIS

- A **principal node** is a point where three or more currents divide or combine, other than ground.
- The method of **node voltage analysis** uses algebraic equations for the node currents to determine each node voltage.
  - Use KCL to determine node currents
  - Use Ohm’s Law to calculate the voltages.
- The number of current equations required to solve a circuit is one less than the number of principal nodes.
- One node must be the reference point for specifying the voltage at any other node.

NODE-VOLTAGE ANALYSIS

- Finding the voltage at a node presents an advantage: A node voltage must be common to two loops, so that voltage can be used for calculating all voltages in the loops.

NODE-VOLTAGE ANALYSIS

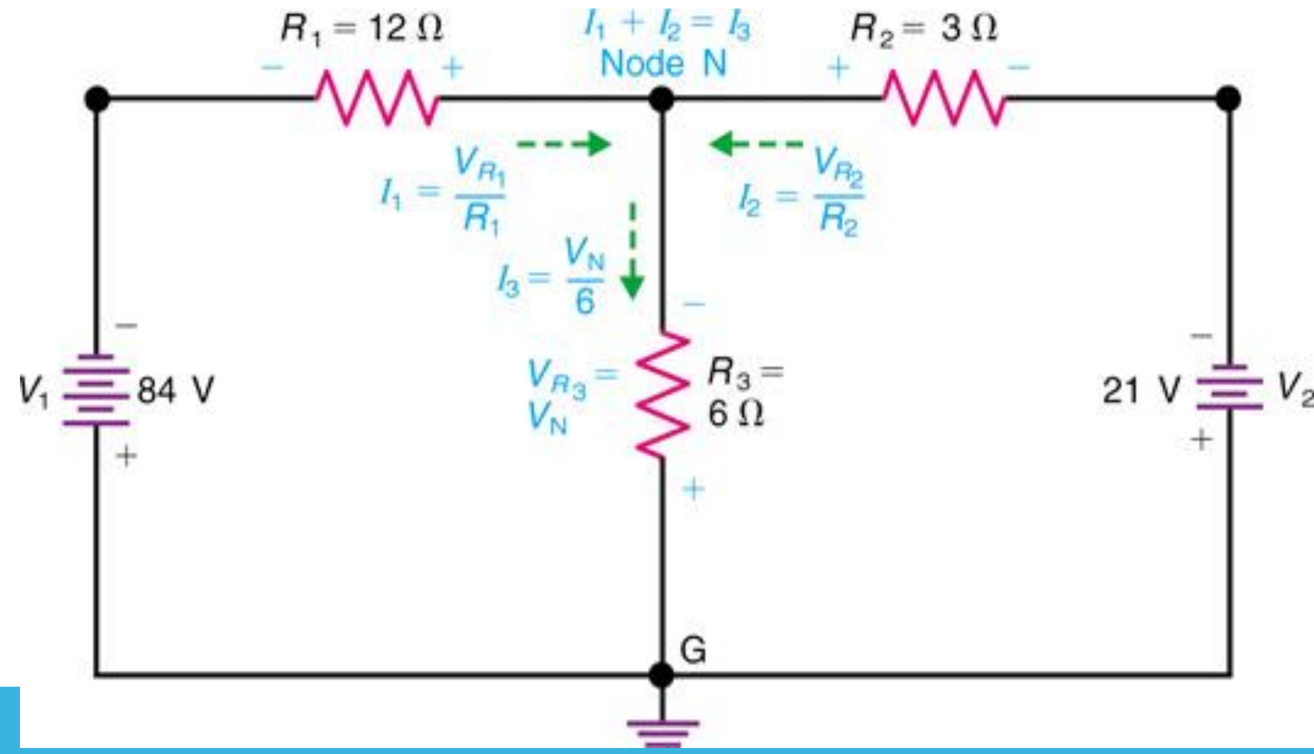
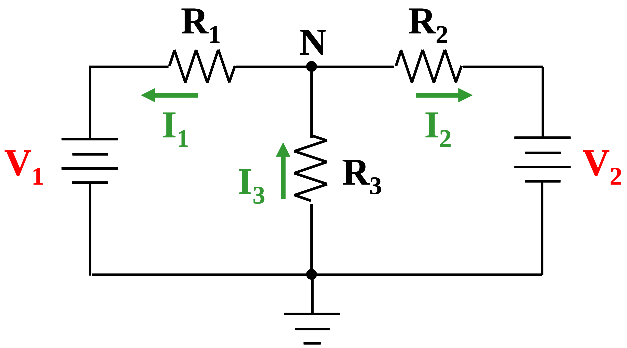


Fig. 9-7: Method of node-voltage analysis for the same circuit as in Fig. 9-5.

NODE-VOLTAGE ANALYSIS

Node Voltage Method



At node N: $I_1 + I_2 = I_3$

or

$$\frac{V_{R_1}}{R_1} + \frac{V_{R_2}}{R_2} = \frac{V_N}{R_3}$$

NODE-VOLTAGE ANALYSIS

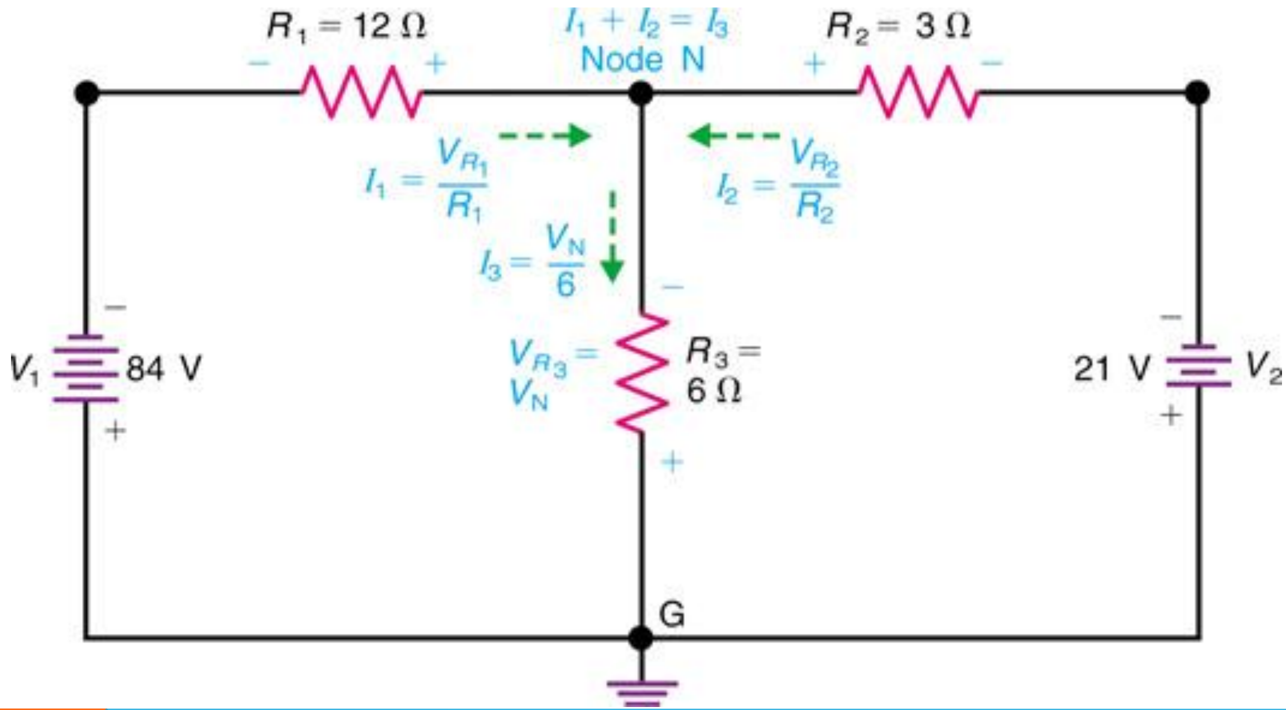


Fig. 9-7

$$V_{R1}/R_1 + V_{R2}/R_2 = V_N/R_3$$

$$V_{R1}/12 + V_{R2}/3 = V_N/6$$

NODE-VOLTAGE ANALYSIS

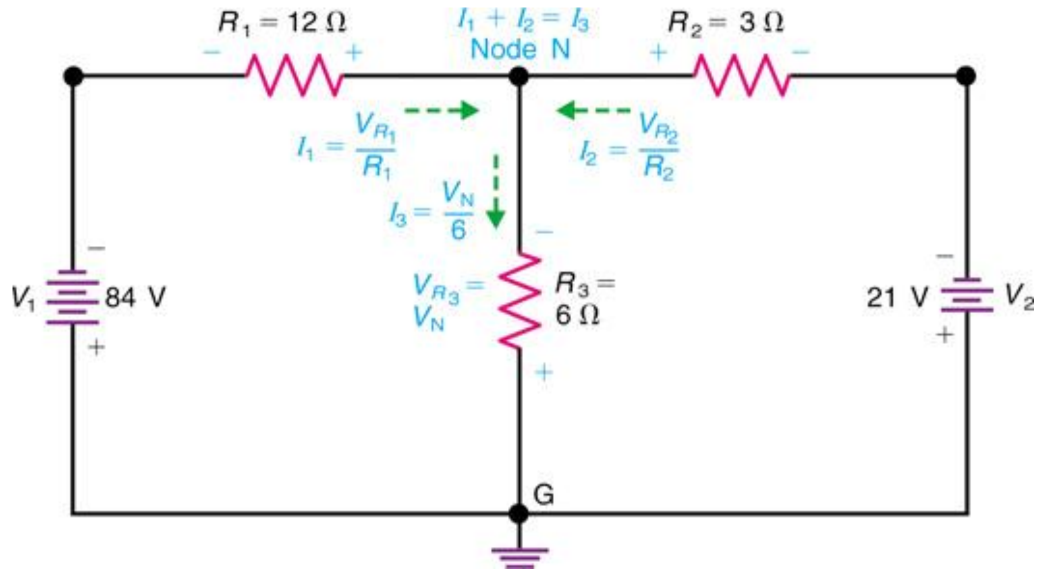


Fig. 9-7

$V_{R1} + V_N = 84$ or $V_{R1} = 84 - V_N$

For the loop with V_2 of 21V,

$V_{R2} + V_N = 21$ or $V_{R2} = 21 - V_N$

Substituting values

$I_1 + I_2 = I_3$

Using the value of each V in terms of V_N

$84 - V_N/12 + 21 - V_N/3 = V_N/6$

NODE-VOLTAGE ANALYSIS

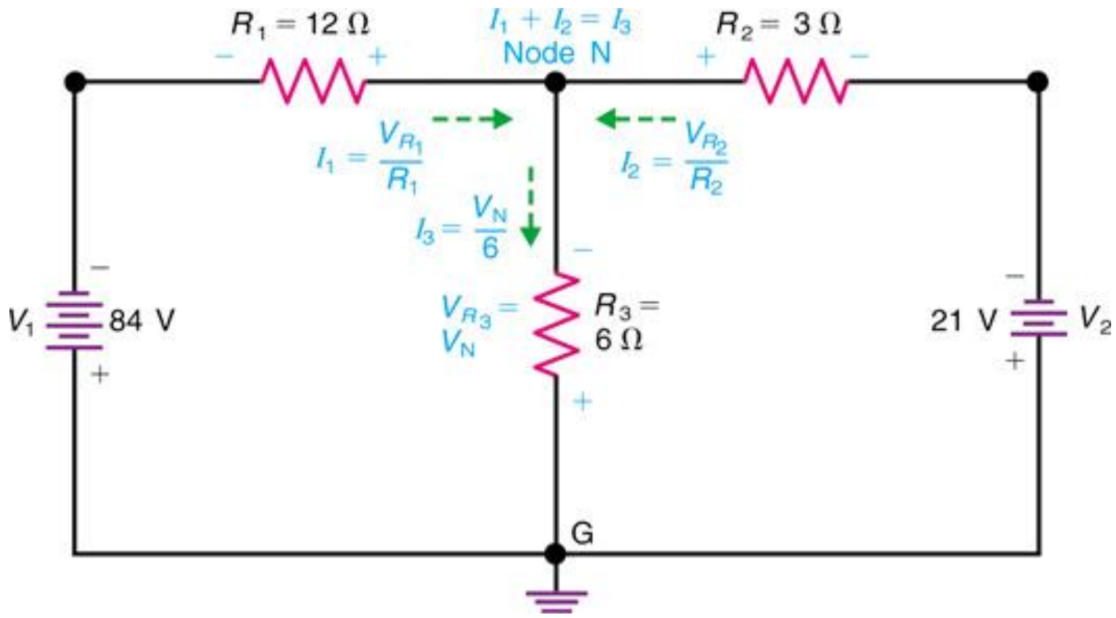


Fig. 9-7

This equation has only one unknown, V_N. Clearing fractions by multiplying each term by 12, the equation is

$(84 - V_N) + 4(21 - V_N) = 2V_N$

$84 - V_N + 84 - 4V_N = 2V_N$

$-7V_N = -168$

$V_N = 24V$

NODE-VOLTAGE ANALYSIS

Calculating All Voltages and Currents

Node Equations

- Applies KCL to currents in and out of a node point.
- Currents are specified as *V/R* so the equation of currents can be solved to find a node voltage.

Loop Equations

Applies KVL to the voltages in a closed path.

Voltages are specified as *IR* so the equation of voltages can be solved to find a loop current.

METHOD OF MESH CURRENTS

- A **mesh** is the simplest possible loop.
- **Mesh currents** flow around each mesh without branching.
- The difference between a mesh current and a branch current is that a mesh current does not divide at a branch point.
- A mesh current is an assumed current; a branch current is the actual current.
- *IR* drops and KVL are used for determining mesh currents.

METHOD OF MESH CURRENTS

- The number of meshes is the number of mesh currents. This is also the number of equations required to solve the circuit.

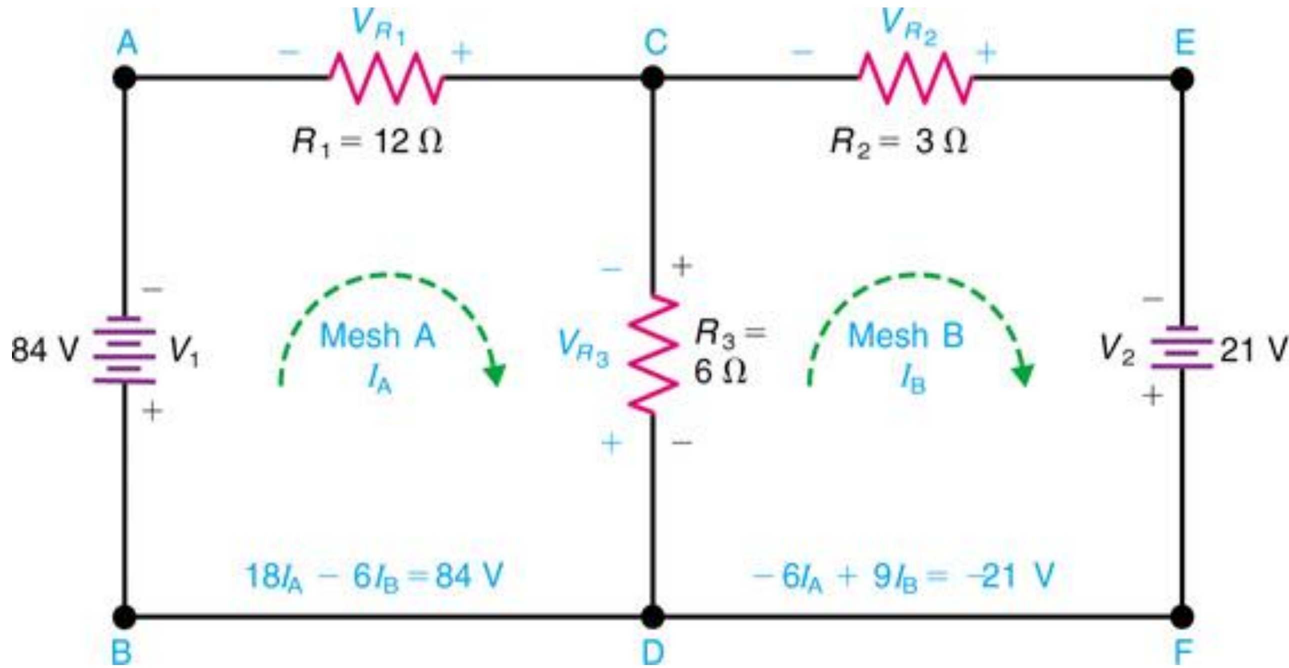


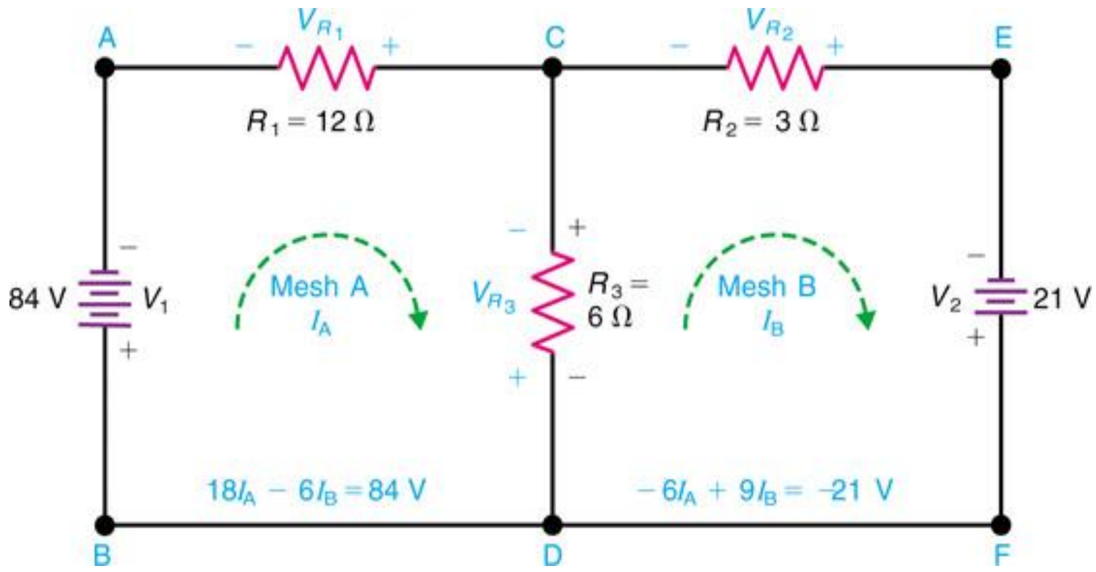
Fig. 9-8: The same circuit as Fig. 9-5 analyzed as two meshes.

METHOD OF MESH CURRENTS

- A clockwise assumption is standard. Any drop in a mesh produced by its own mesh current is considered positive because it is added in the direction of the current.
- Mesh A: $18I_A - 6I_B = 84V$
- Mesh B: $6I_A + 9I_B = -21V$

METHOD OF MESH CURRENTS

The mesh drops are written collectively here:



Mesh A: $18I_A - 6I_B = 84$

Mesh B: $-6I_A + 9I_B = -21$

Fig. 9-8: The same circuit as Fig. 9-5 analyzed as two meshes.

METHOD OF MESH CURRENTS

Use either the rules for meshes with mesh currents or the rules for loops with branch currents, but do not mix the two methods.

To eliminate I_B and solve for I_A, divide the first equation by 2 and the second by 3. then

$$9I_A - 3I_B = 42$$

$$-2I_A + 3I_B = -7$$

Add the equations, term by term, to eliminate I_B. Then

$$7I_A = 35$$

$$I_A = 5A$$

METHOD OF MESH CURRENTS

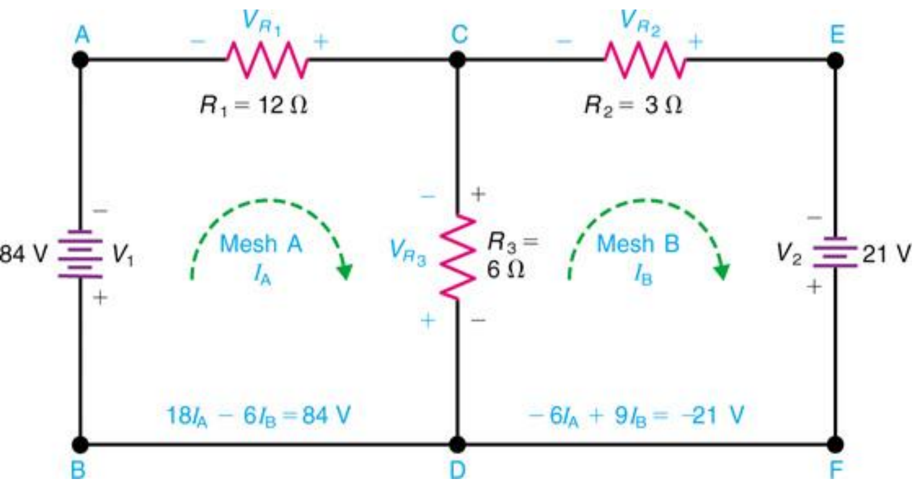


Fig. 9-8: The same circuit as Fig. 9-5 analyzed as two meshes.

To calculate I_B, substitute 5 for I_A in the second equation:

$$-2(5) + 3I_B = -7$$
$$3I_B = -7 + 10 = 3$$
$$I_B = 1A$$

The positive solutions mean that the electron flow for both I_A and I_B is actually clockwise, as assumed.