Topic 4

# Mesh analysis

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**DC NETWORK ANALYSIS**

What is network analysis?

Generally speaking, *network analysis* is any structured technique used to mathematically analyze a circuit (a "network" of interconnected components). Quite often the engineer will encounter circuits containing multiple sources of power or component configurations which defy simplification by series/parallel analysis techniques. In those cases, he or she will be forced to use other means. This chapter presents a few techniques useful in analyzing such complex circuits.

**Note:**
Some circuit configurations ("networks") cannot be solved by reduction according to series/parallel circuit rules, due to multiple unknown values.
Mathematical techniques to solve for multiple unknowns (called "simultaneous equations" or "systems") can be applied to basic Laws of circuits to solve networks.

# Mesh Current Method or Mesh analysis

The Mesh Current Method, also known as the Loop Current Method, is quite similar to the Branch Current method in that it uses simultaneous equations, Kirchhoff's Voltage Law, and Ohm's Law to determine unknown currents in a network. It differs from the Branch Current method in that it does not use Kirchhoff's Current Law, and it is usually able to solve a circuit with less unknown variables and less simultaneous equations.

Let's use this circuit (fig. 2.1) to illustrate the method:

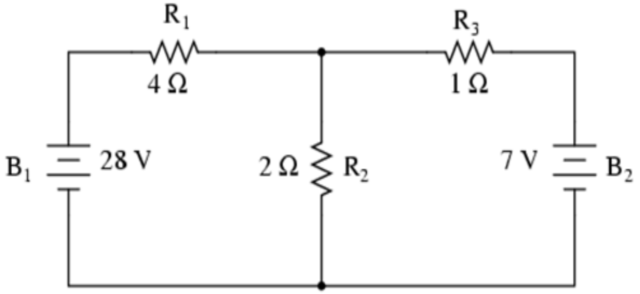


Figure: 2.1

Steps to follow for the "Mesh Current" method of analysis:

1. Draw mesh currents in loops of the circuit.
2. Label resistor voltage drop polarities based on assumed directions of mesh currents.
3. Write KVL equations for each loop of the circuit, substituting the product IR for E in each resistor term of the equation. Where two mesh currents intersect through a component, express the current as the algebraic sum of those two mesh currents (i.e. $I_1 + I_2$) if the currents go in the same direction through that component. If not, express the current as the difference (i.e. $I_1 - I_2$).
4. Solve for unknown mesh currents (simultaneous equations).
5. If any solution is negative, then the assumed current direction is wrong!
6. Algebraically add mesh currents to find current in components sharing multiple mesh currents.
7. Solve for voltage drops across all resistors (E=IR).

**Example-1:** Determine the currents through and voltages across each branch of the network using mesh current method.

Calculation:

Loop 1:

$28 - 4I_1 - 2(I_1 - I_2) = 0$ (Applying KVL)

$6I_1 - 2I_2 = 28$ ----------- Equ$^n$ (1)

Loop 2:

$-2(I_2 - I_1) - I_2 - 7 = 0$ (Applying KVL)

$2I_1 - 3I_2 = 7$ ----------- Equ$^n$ (2)

Substituting equation (1) & (2) we get

$$D = \begin{vmatrix} 6 & -2 \\ 2 & -3 \end{vmatrix} = -18 + 4 = -14$$

$$I_1 = \frac{\begin{vmatrix} 28 & -2 \\ 7 & -3 \end{vmatrix}}{-14} = \frac{-84+14}{-14} = 5A$$

$$I_2 = \frac{\begin{vmatrix} 6 & 28 \\ 2 & 7 \end{vmatrix}}{-14} = \frac{42-56}{-14} = 1A$$

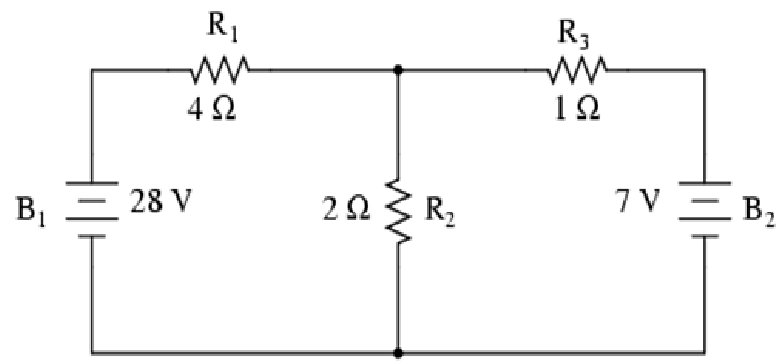



Figure: 2.1

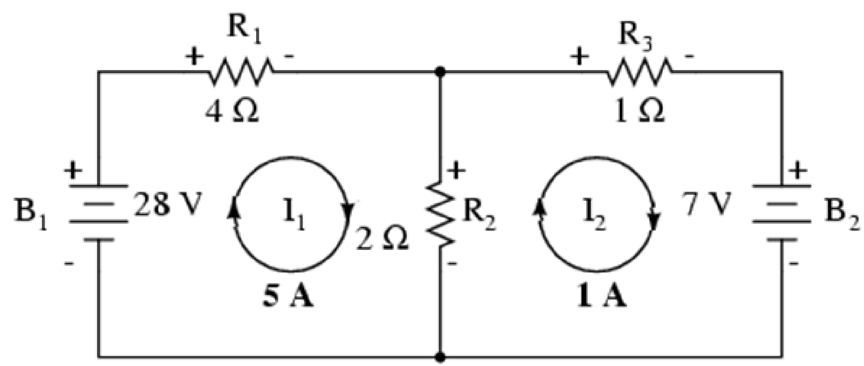



Figure: 2.2

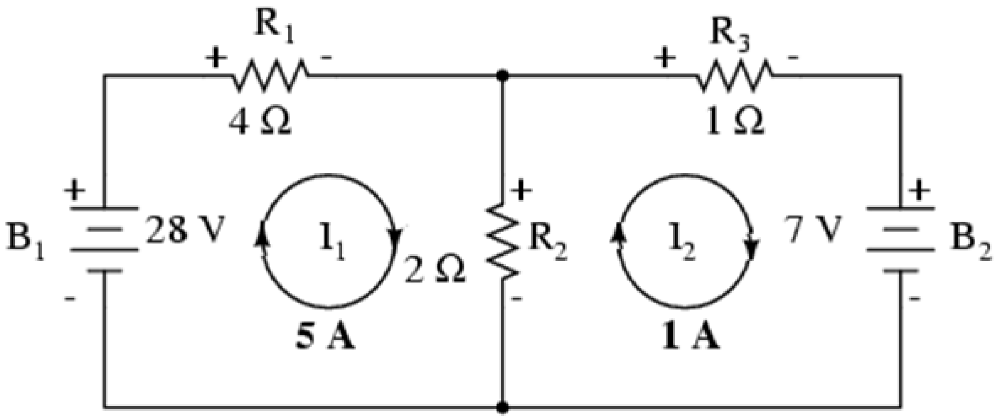



Figure: 2.2

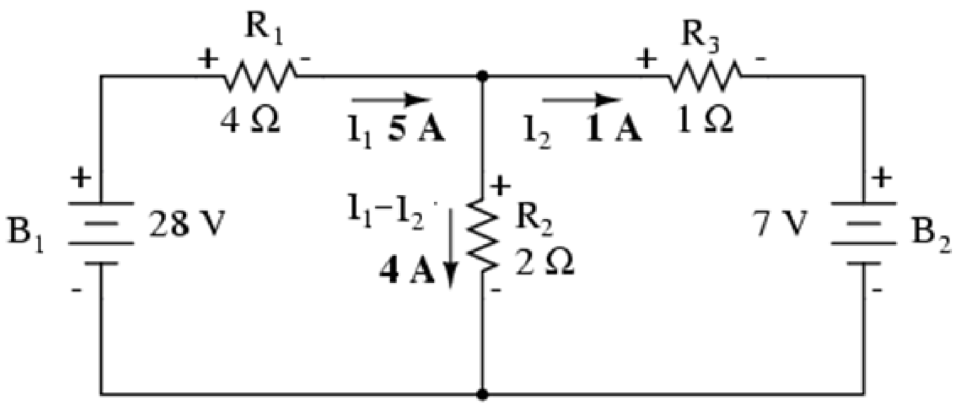
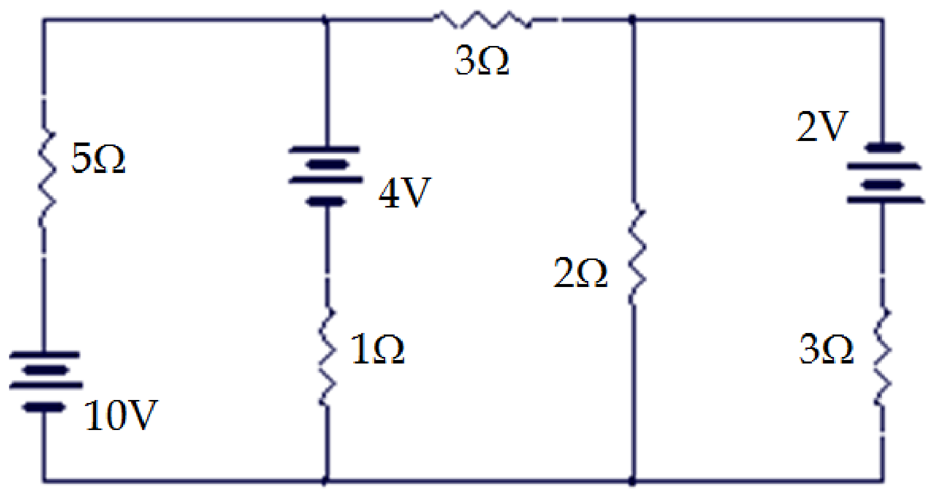
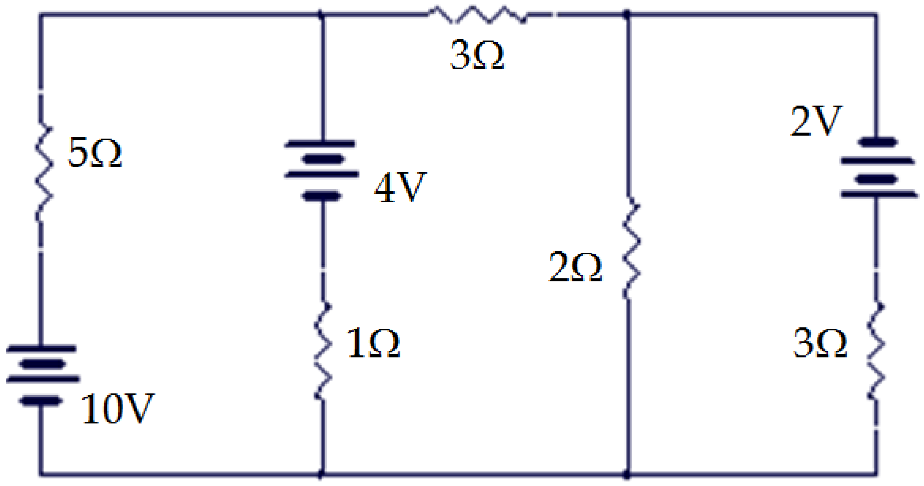



Figure: 2.3

**Problem-1:** Determine the currents through and voltages across each branch of the network using mesh current method.





3Ω
5Ω
4V
2V
2Ω
1Ω
3Ω
10V