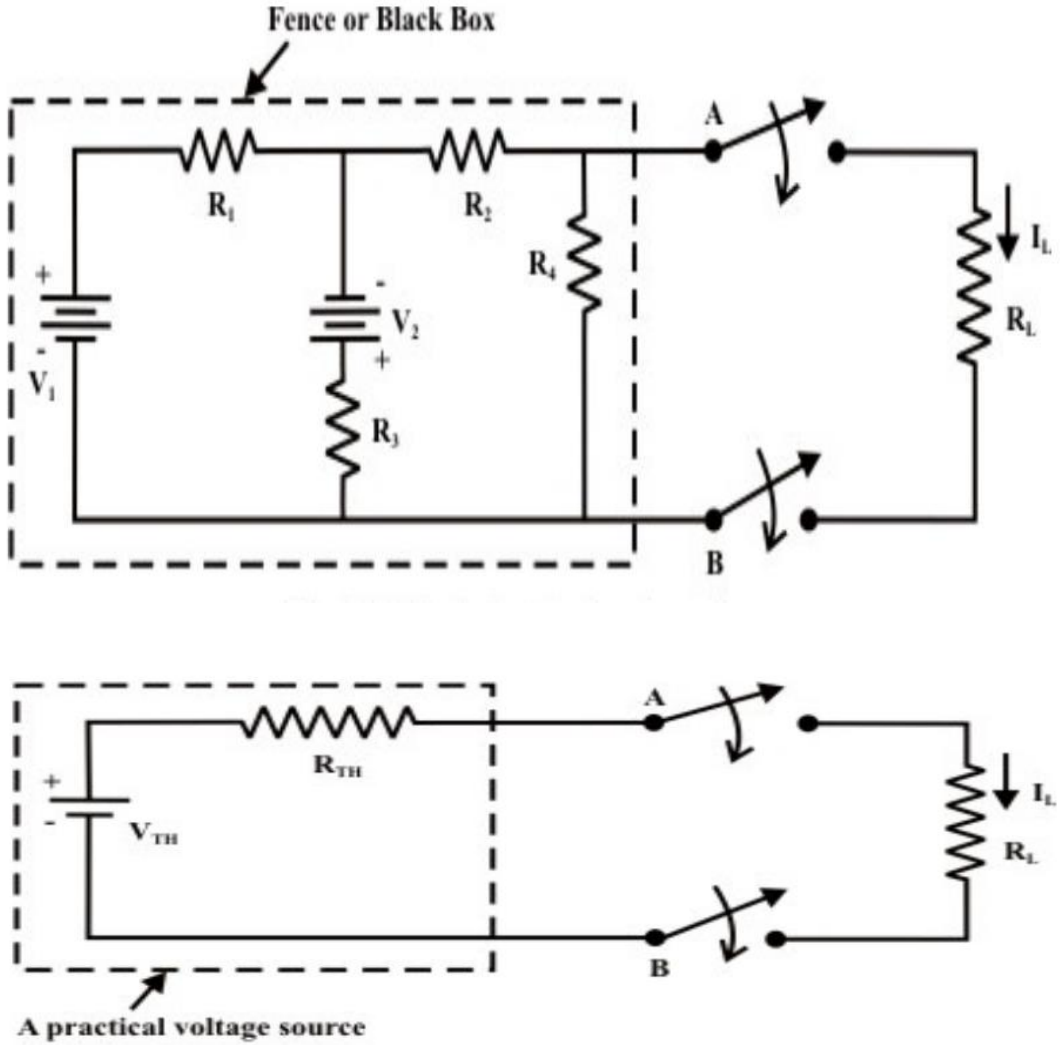
Basic Electrical Technology

Thevenin's Theorem

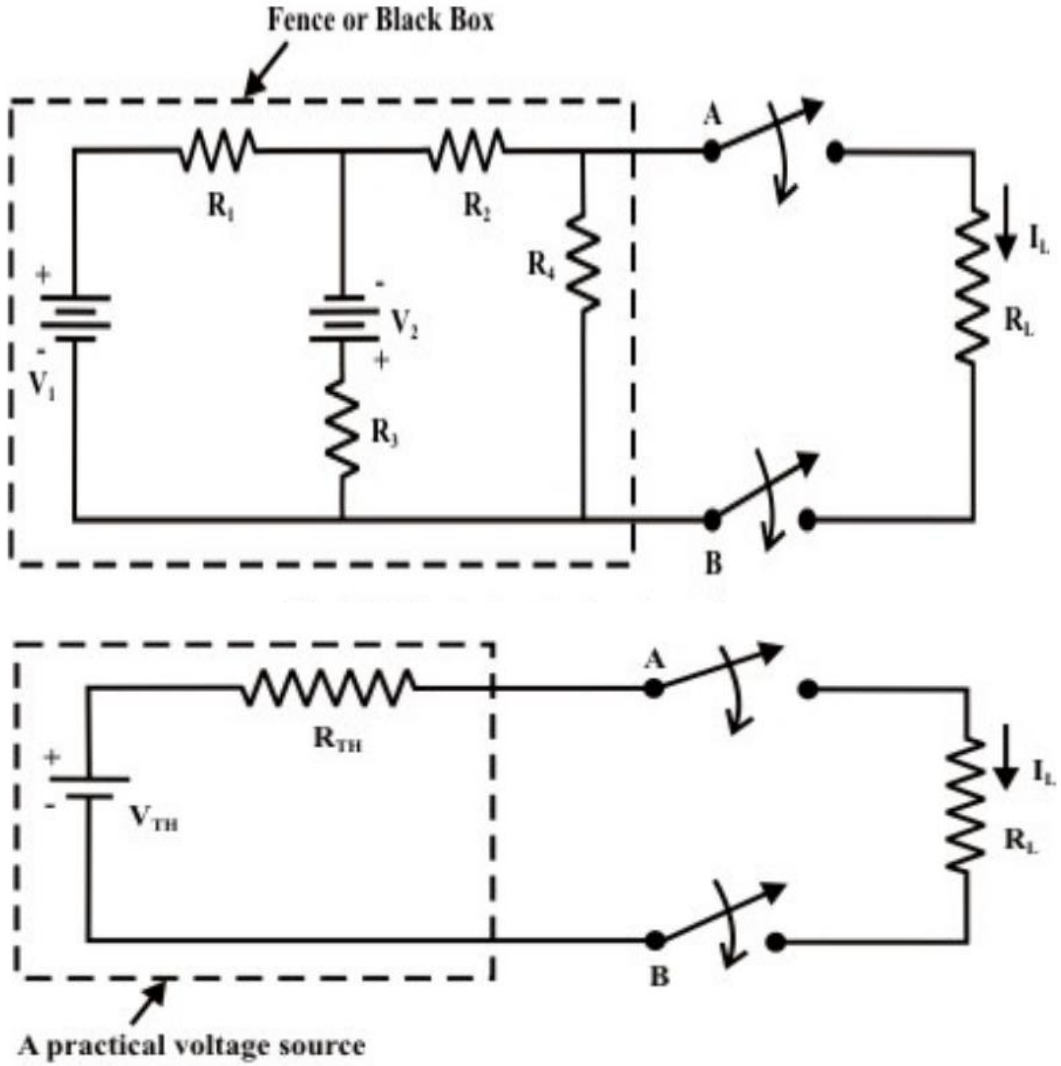
Why Thevenin's Theorem

- In many applications, a network may contain a variable component or element while other elements in the circuit are kept constant.
- If the solution for current or voltage or power in any component of network is desired, in such cases the whole circuit need to be analyzed each time with the change in component value.
- In order to avoid such repeated computation, it is desirable to introduce a method that will not have to be repeated for each value of variable component.
- For the circuit shown,
  - Find
    - Mesh current method needs 3 equations to be solved
    - Node voltage method requires 2 equations to be solved



Definition

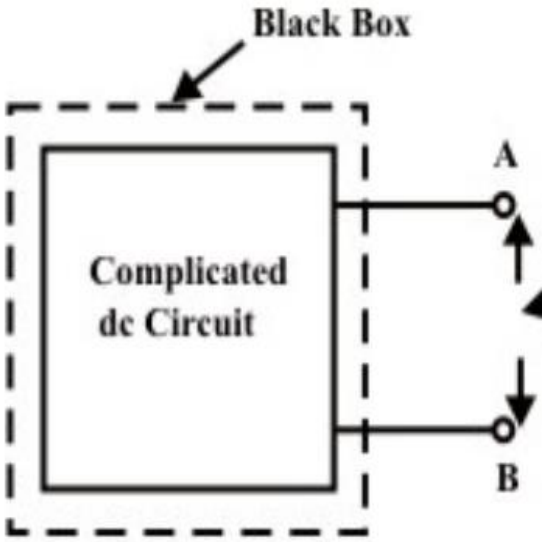
- Any **linear, bilateral** network may be replaced by a single voltage source (called Thevenin's equivalent voltage, $\mathbf{V_{Th}}$) in series with one resistance (called Thevenin's equivalent resistance, $\mathbf{R_{Th}}$) across the load terminals.
- Thevenin's equivalent voltage, $\mathbf{V_{Th}}$, is the open circuit voltage at the load terminals.
- Thevenin's equivalent resistance, $\mathbf{R_{Th}}$, is the equivalent resistance at the load terminals, after replacing the sources by their internal resistances.

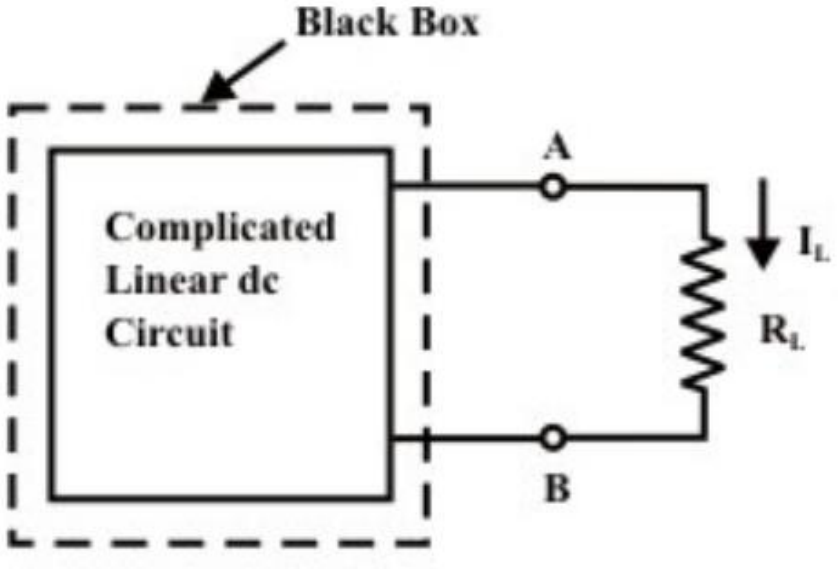


Procedure

Suppose: Find I_L through R_L.

- **Step-1: Disconnect R_L**
  - Remove the load
  - Keep the terminals open circuited as shown in 2nd figure below.

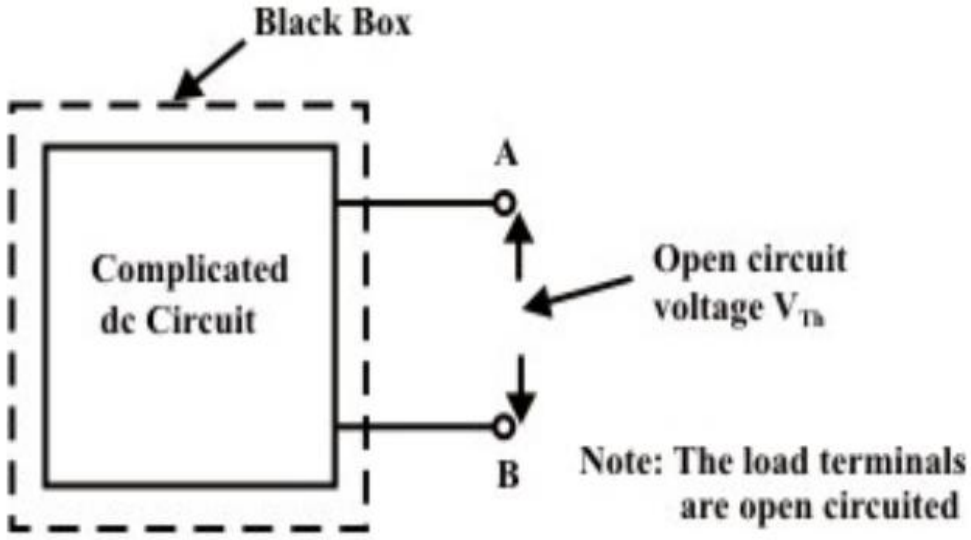




Procedure

➢ **Step-2: Find V_{Th}**

- Apply mesh current / node voltage method
- Find the voltage across the open circuited terminals.

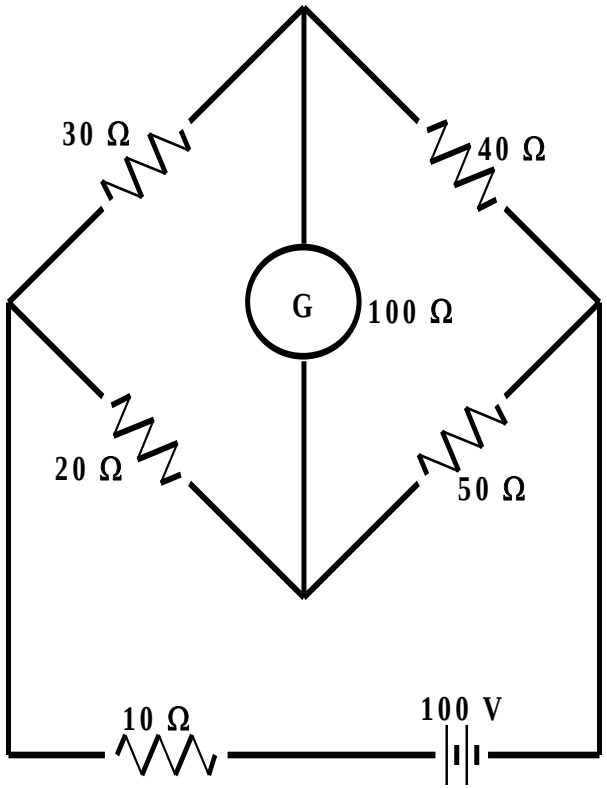


Procedure contd…

- **To find R_{Th} :**
  - Keep the load terminals open.
  - Replace all the sources by their internal resistances.
  - **Voltage sources** should be **short-circuited (just remove them and replace with plain wire)**
  - **Current sources** should be **open-circuited (just remove them)**
  - Find the equivalent resistance with respect to open circuited load terminals.

Illustration 1

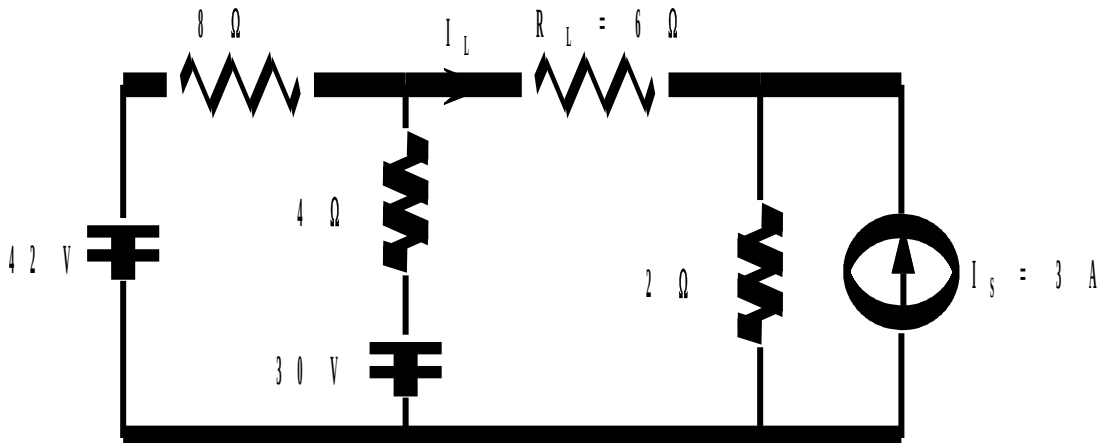
Determine the current through the galvanometer using Thevenin's Theorem



Answer : 84 mA

Illustration 2

For the circuit shown find the current $\mathbf{I_L}$ through 6 Ω resistor using Thevenin's theorem



Ans: I_L = 2.625 A

Illustration 3

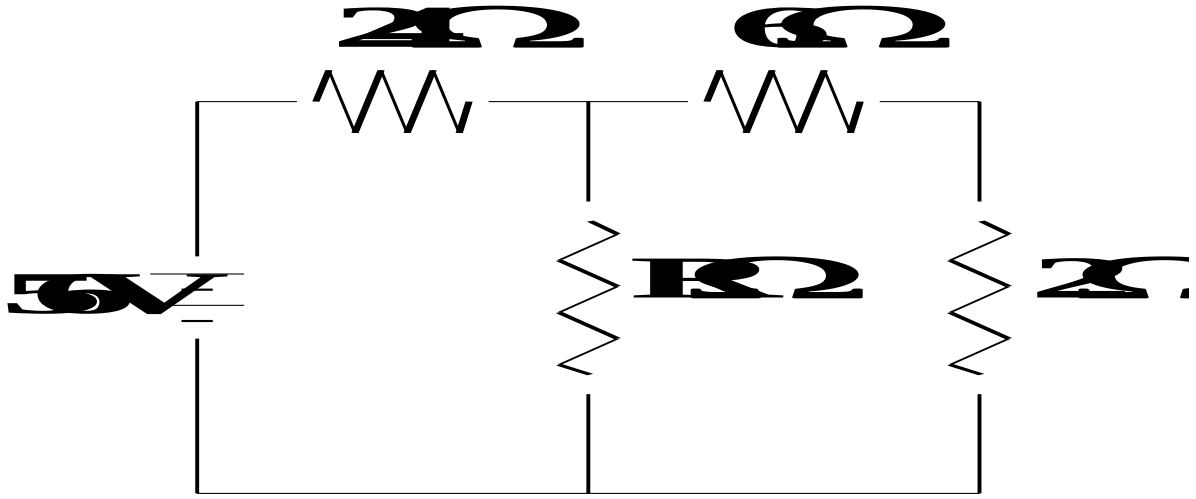
The box shown in the adjacent figure consists of independent dc sources and resistances. Measurements are taken by connecting an ammeter in series with the resistor R_L and the results are shown in the table below. Find the value of R_L for which the current is 0.6 A

R_L	I
10 Ω	2.0 A
20 Ω	1.5 A
?	0.6 A

Ans: R_L = 80 Ω

Homework 1

Using Thevenin's theorem, find the value of **R** such that the current through 2 Ω resistor is 1 A



Ans: 8 Ω