Electricity & Magnetism

Sem-2 (Hons)

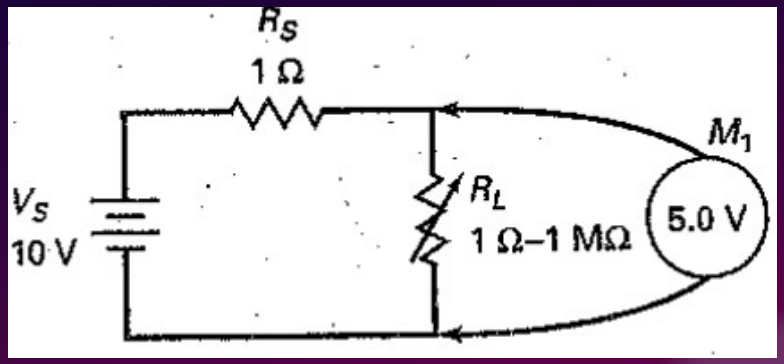
Network Theorems

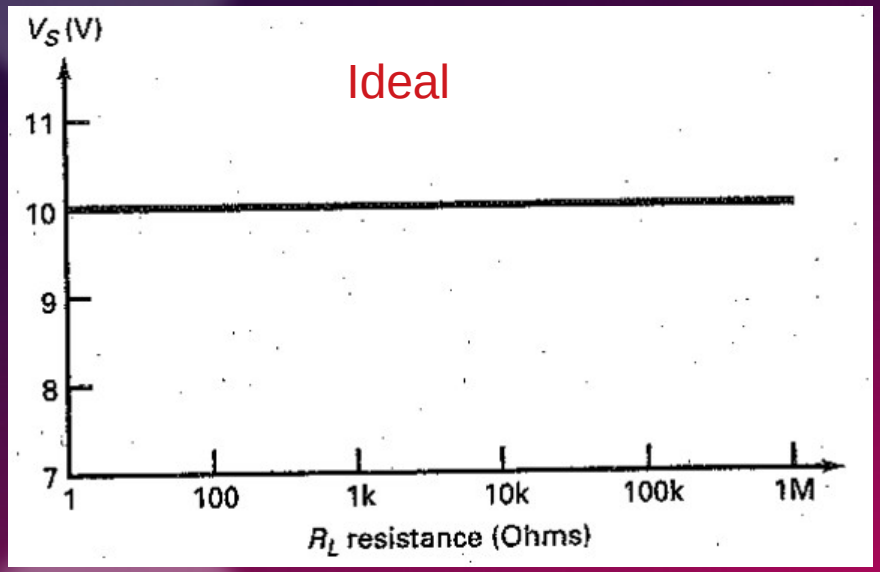
Syllabus

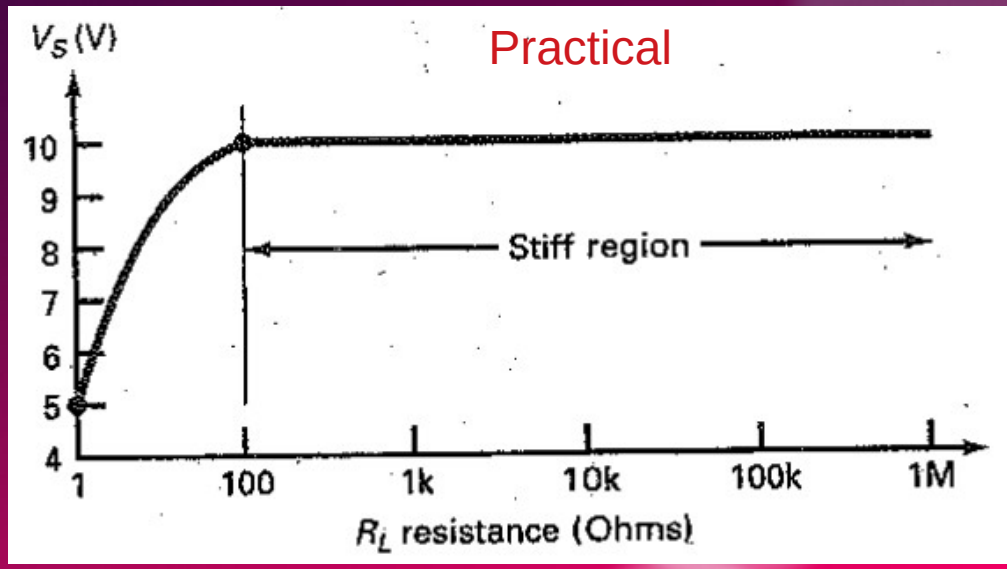
Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem.Applications to dc circuits. (4 Lectures)

Voltage Sources

- Constant Voltage Source
- Value of the Voltage does not change with time
- Plot it V(t) vs t ?
- Draw a circuit diagram

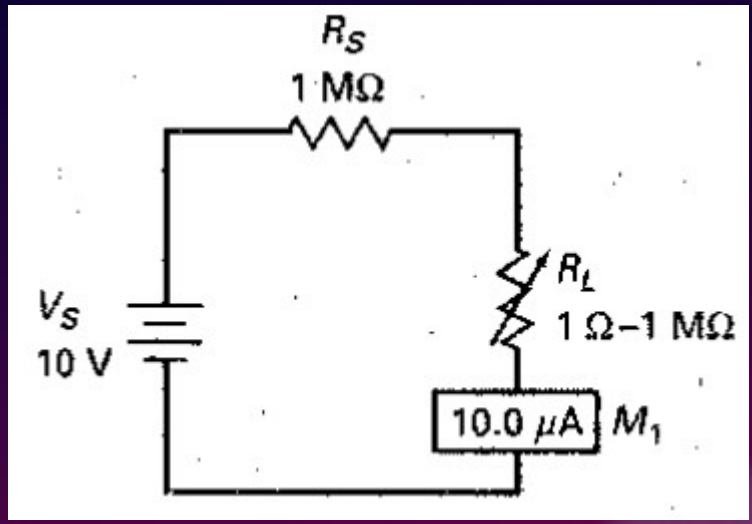


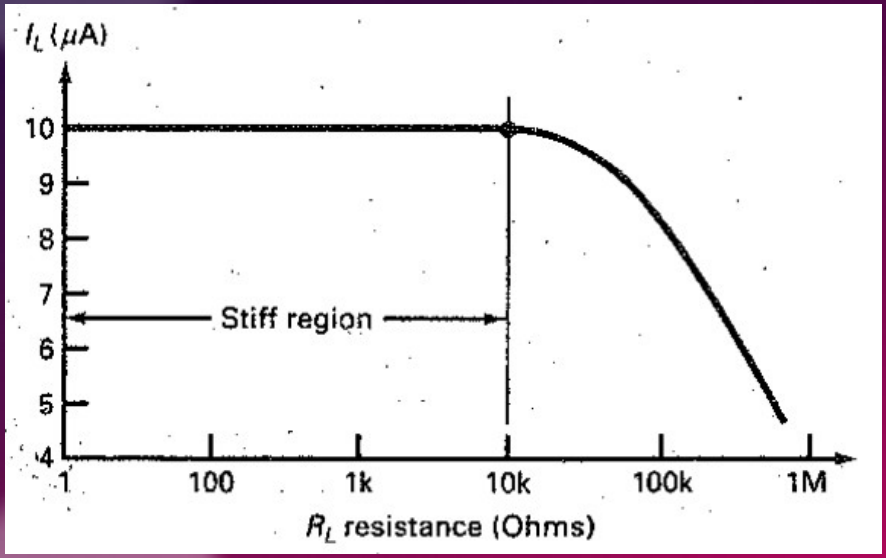




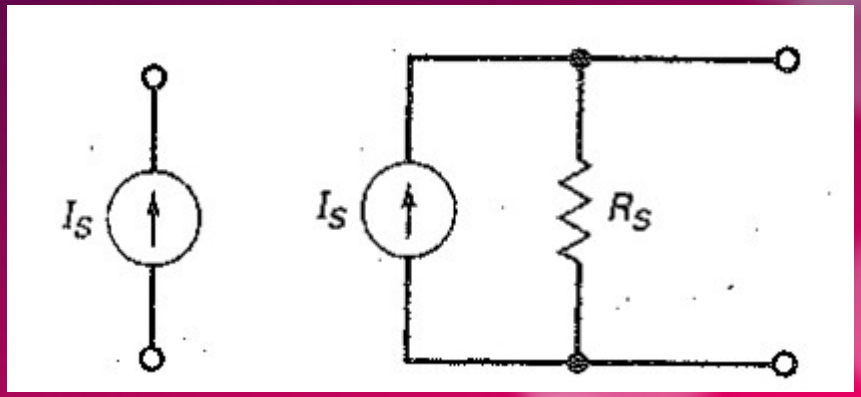
Current Sources

- Constant Current Source
- Value of current does not change with time.
- Draw a circuit ?
- Plot I(t) vs t ?





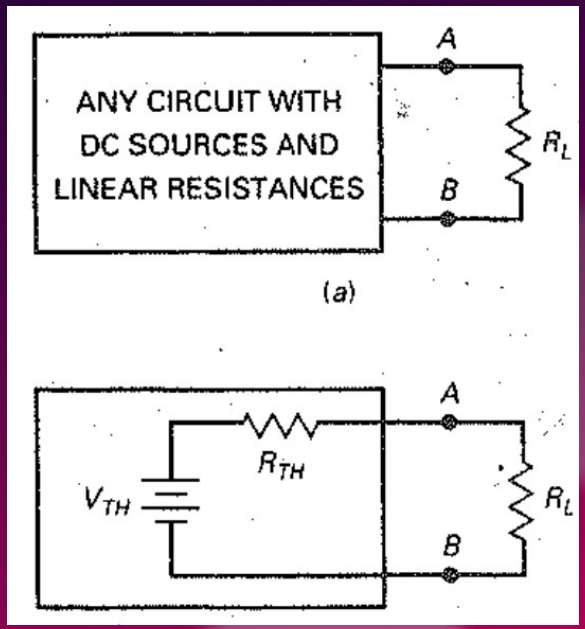
Schematic symbol of current source



Thevenin Theorem

By M L Thevenin, France

- The Thevenin voltage V_{TH} is defined as the voltage across the load terminals when the load resistance is open.
- Thevenin voltage is open circuit (OC) voltage $V_{TH} = V_{OC}$
- Thevenin resistance is defined as the resistance that an ohmmeter measures across the load terminals when all the sources are zero and the load resistance is open.
- To zero a voltage source, replace it by a short
- To zero a current source, replace it by an open



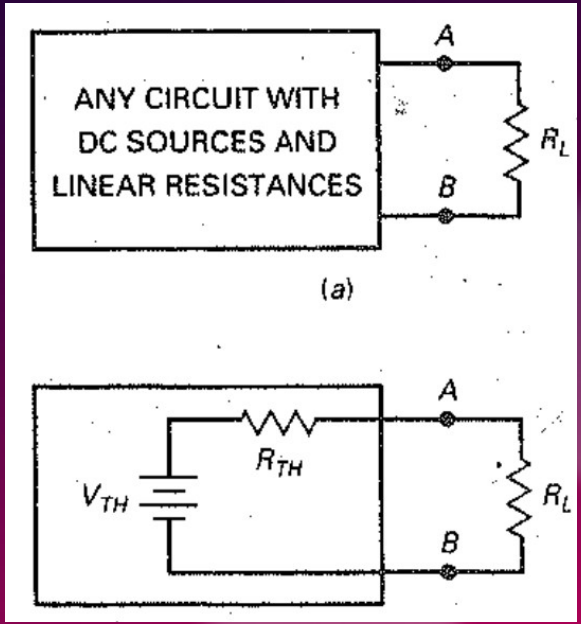
Linear resistances does not change with increase of voltages

Thevenin Theorem

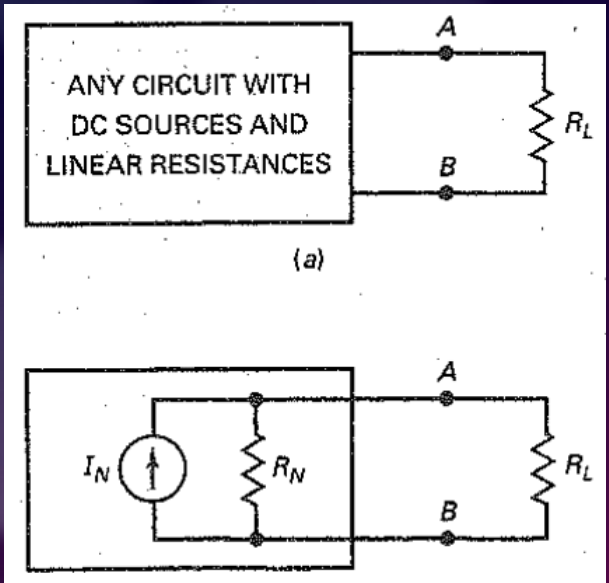
By M L Thevenin, France

$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

In your experiments, plot I_L vs R_L You shall get R_{TH} and V_{TH} from slope and intercept



Norton Theorem



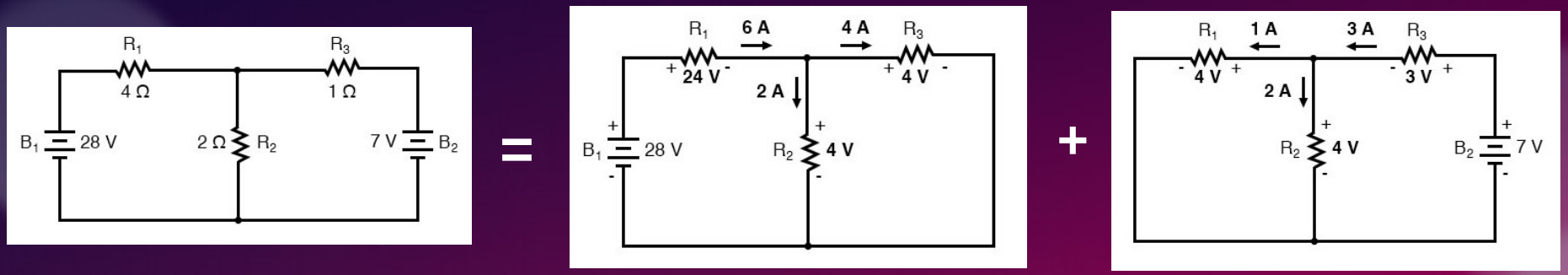
- The Norton resistance is the resistance that on ohmmeter measures across the load terminal when all sources are reduced to zero and the load resistance is open (OC).
- $R_N = R_{OC}$
- Norton current I_N is defined as the load current when the load resistor is shorted (SC).
- $I_N = I_{SC}$

$$I_L = \frac{R_N}{R_N + R_L} I_N$$

Experimentally, plot I_L vs R_L to get I_N and R_N

Superposition theorem

- The superposition theorem for electrical circuits states that for a linear system the response (voltage or current) in any branch of a bilateral linear circuit having more than one independent source equals the algebraic sum of the responses caused by each independent source acting alone, where all the other independent sources are replaced by their internal impedances



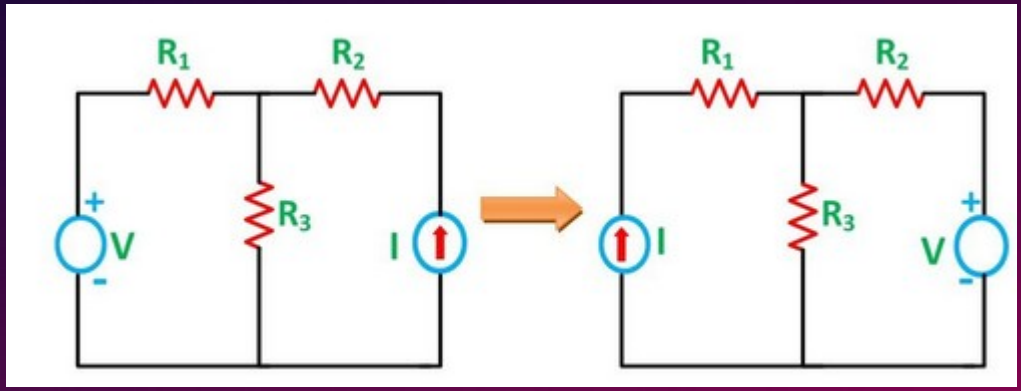
Prerequisite: All components must be “bilateral,” , The circuit must be linear.

Bilateral meaning that they behave the same with electrons flowing in either direction through them. Resistors have no polarity-specific behavior.

Theorem cannot be applied in circuits where the resistance of a component changes with voltage or current.

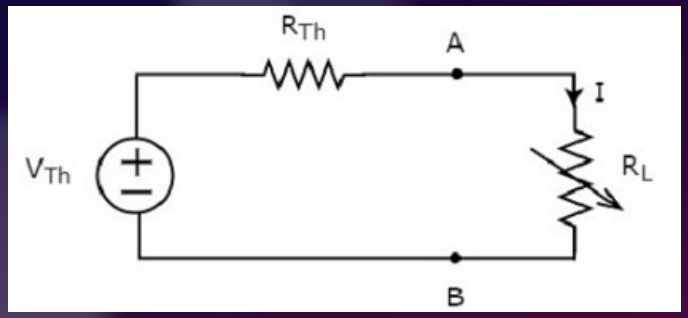
Reciprocity theorem

- Write the statement yourself:



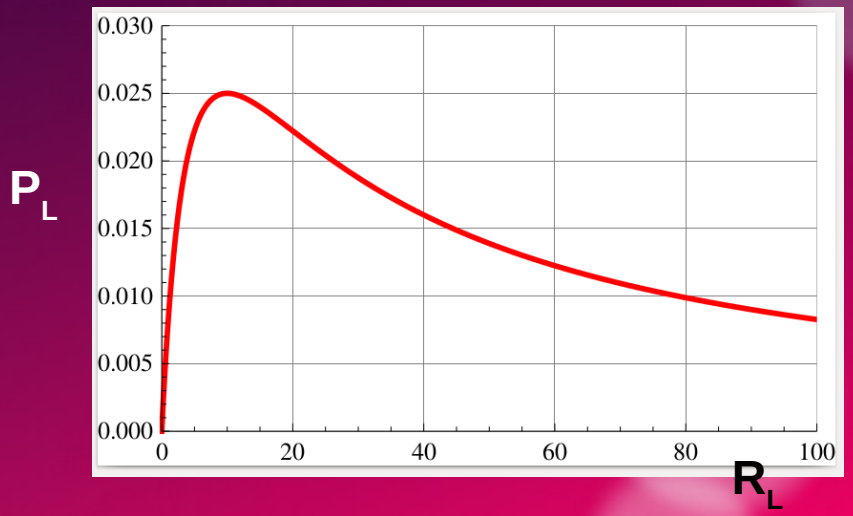
Maximum Power transfer theorem

- Maximum power transfer theorem states that the DC voltage source will deliver maximum power to the variable load resistor only when the load resistance is equal to the source resistance



$$P_L = V_{Th}^{\,2}\left\{\frac{R_L}{(R_{Th}+R_L)^2}\right\}$$

As we change the load resistance, we see the power is increasing and rises to max value at $R_L=R_{TH}$, the power decreses..



Ask questions and Solve problems