

The slide features abstract green geometric shapes. On the left, a vertical green bar is partially visible. On the right, a large, complex shape composed of several overlapping triangles in various shades of green (from light lime to dark forest green) extends from the top to the bottom. The main title is centered in a large, bold, green font.

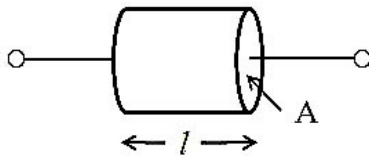
# Basic circuit analysis and simulation

EE01205479 IoT for Electrical Engineering

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# Resistance

$$R = \frac{\rho l}{A}$$



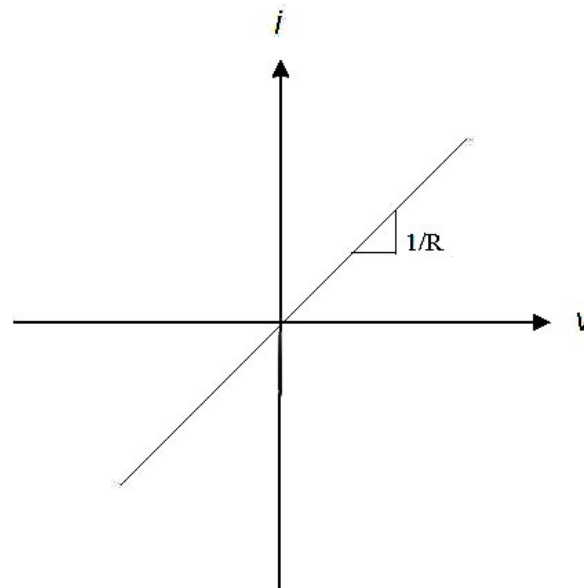
Physical



symbol



Resistors



i-v characteristics

# Basic Relationships

- Ohm's Law

$$V = IR$$

- Power

$$P = VI = \frac{V^2}{R} = I^2 R$$

# Kirchhoff's Current and Voltage Laws

## ► KCL

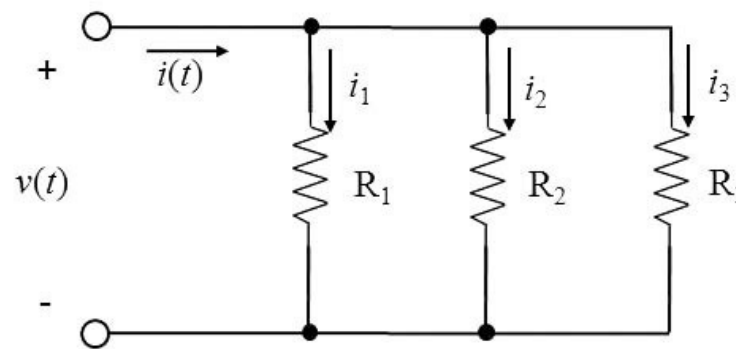
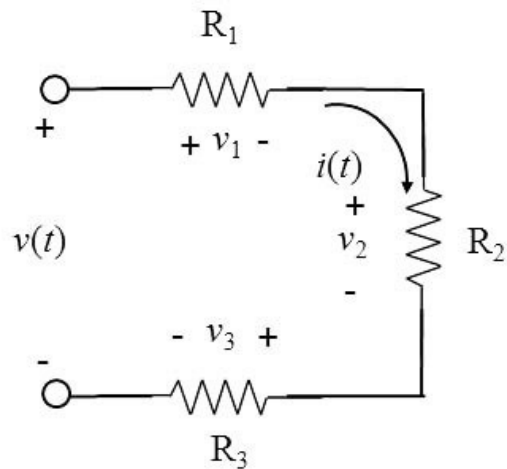
$$\sum_{n=1}^N i_n = 0$$

## ► KVL

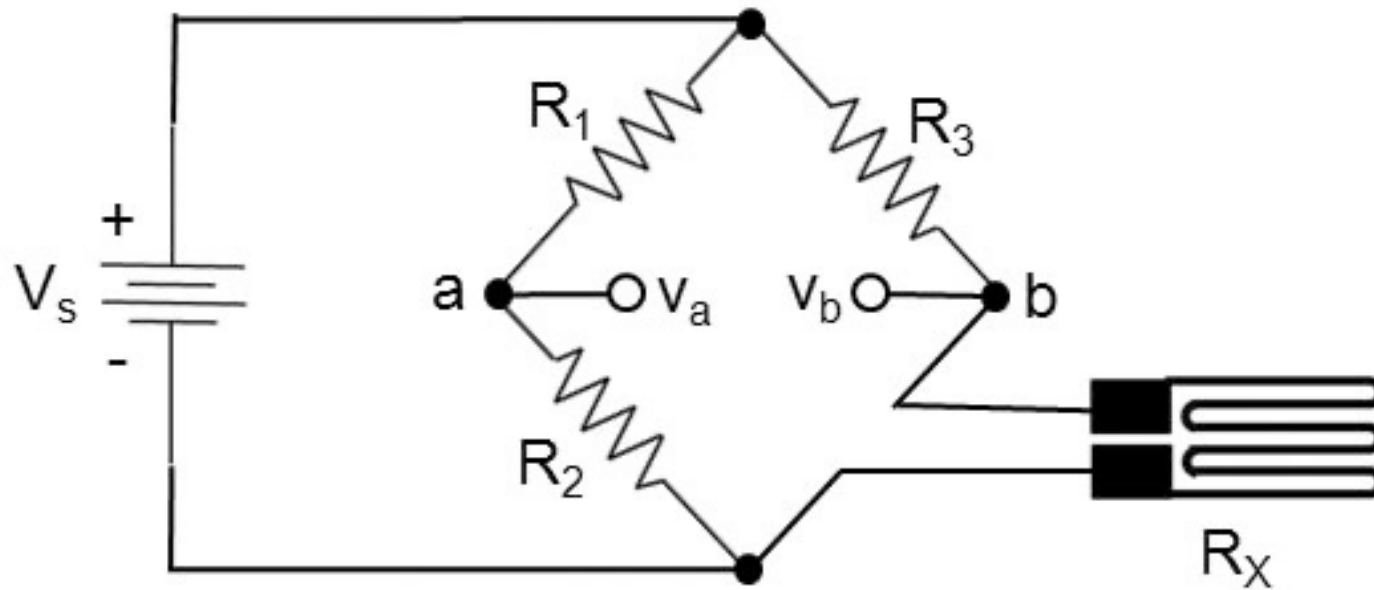
$$\sum_{n=1}^N v_n = 0$$

# KCL and KVL applications

- ▶ Total resistance
  - ▶ Series
  - ▶ Parallel
- ▶ Current and voltage divider



## Exercise1 : Wheatstone bridge



Let  $V_s = 5$  Volts.  $R_1 = R_2 = R_3 = 1000$  Ohms,  $R_x$  varies between 800 – 1200 Ohms  
Compute the corresponding voltage range for  $V_{ab}$ .

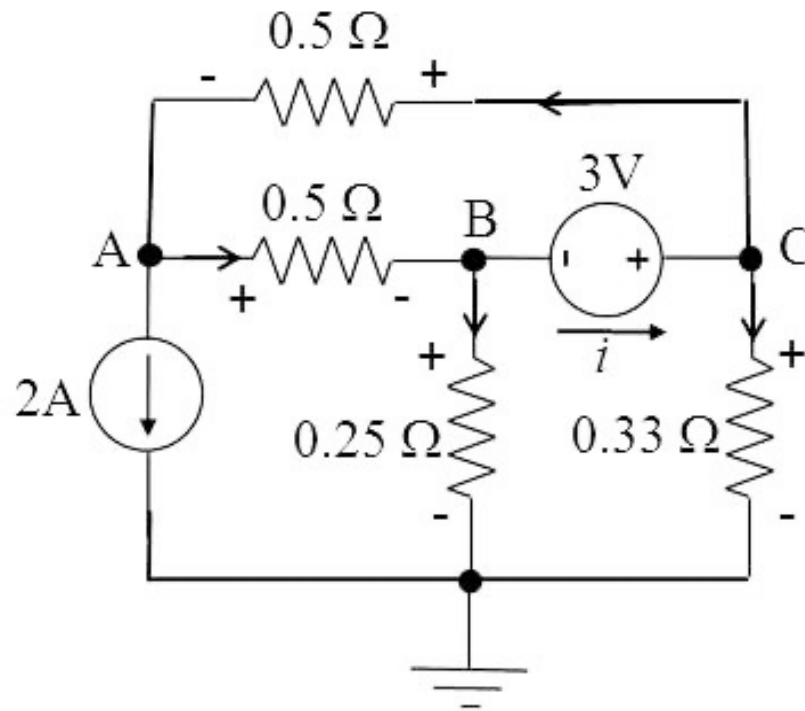
# Circuit analysis methods

- ▶ Node voltage
- ▶ Mesh current
- ▶ Superposition
- ▶ Equivalent circuit/source transformation
  - ▶ Thevenin voltage source
  - ▶ Norton current source



# Node voltage analysis

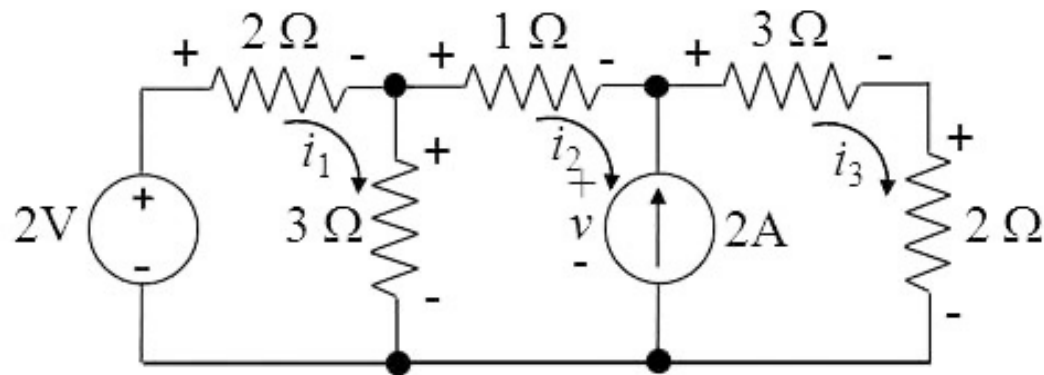
- Assign  $V_A$ ,  $V_B$ ,  $V_C$  as variables
- Use KCL to solve



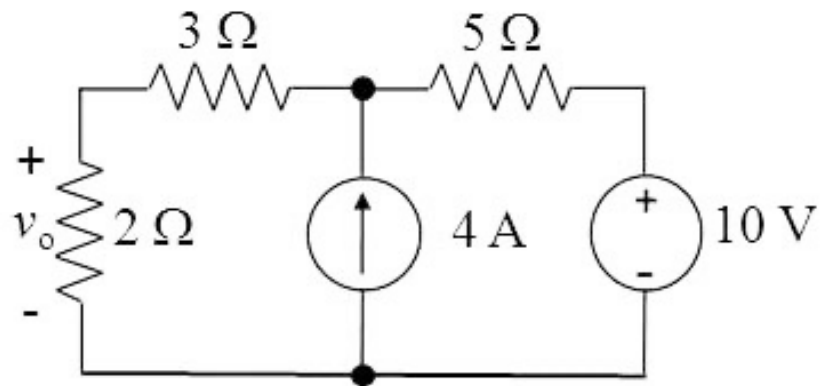


# Mesh current analysis

- Assign  $i_1$ ,  $i_2$ ,  $i_3$  as variables
- Use KVL to solve



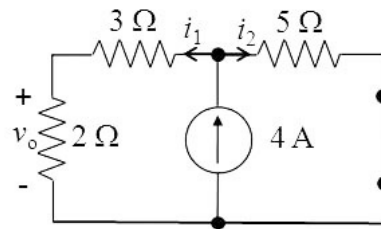
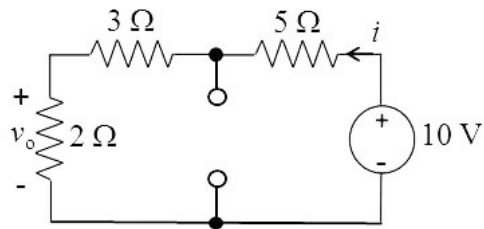
# Superposition method



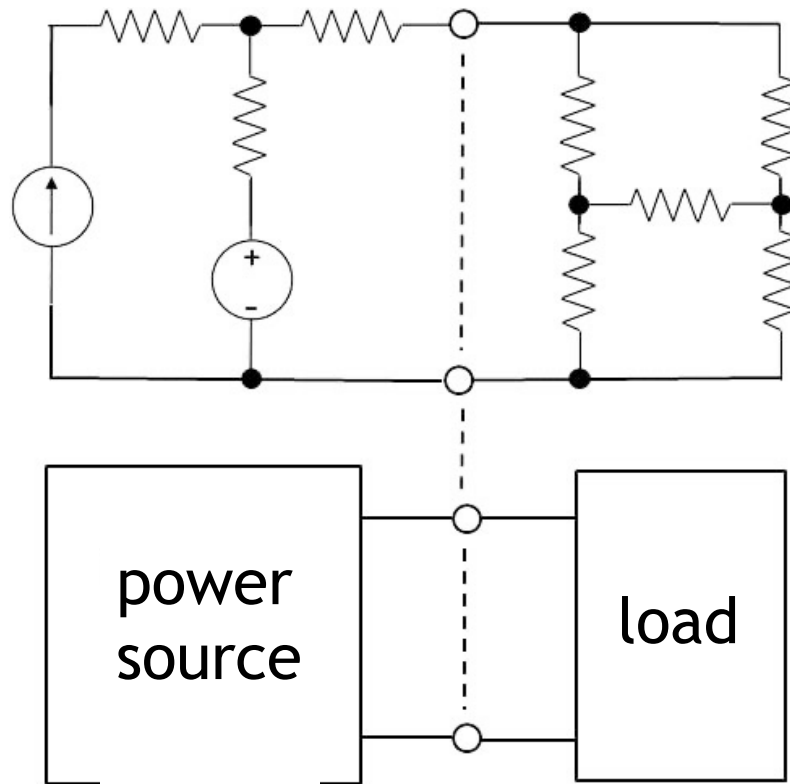
$$V_{o1} = (2/(2+3+5)) * 10 = 2\ \text{V}$$

$$V_{o2} = 2 * 2 = 4\ \text{V}$$

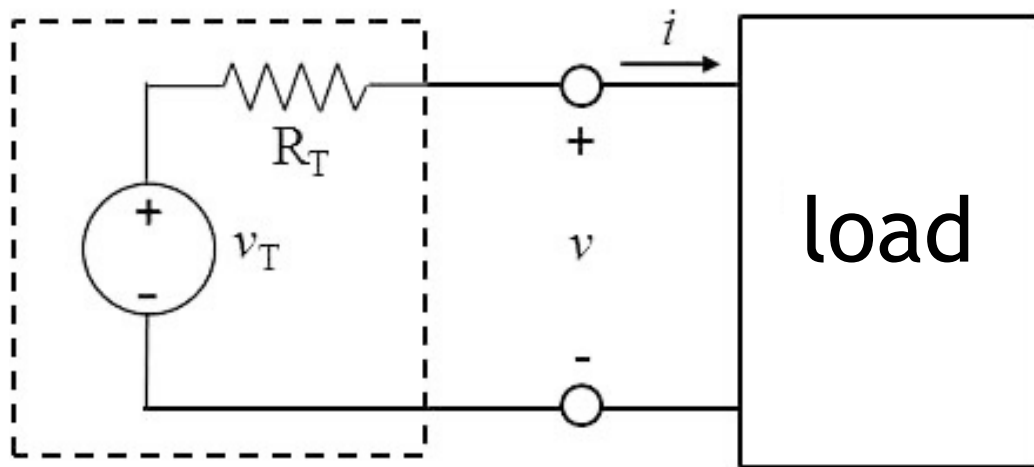
$$V_o = 2 + 4 = 6\ \text{V}$$



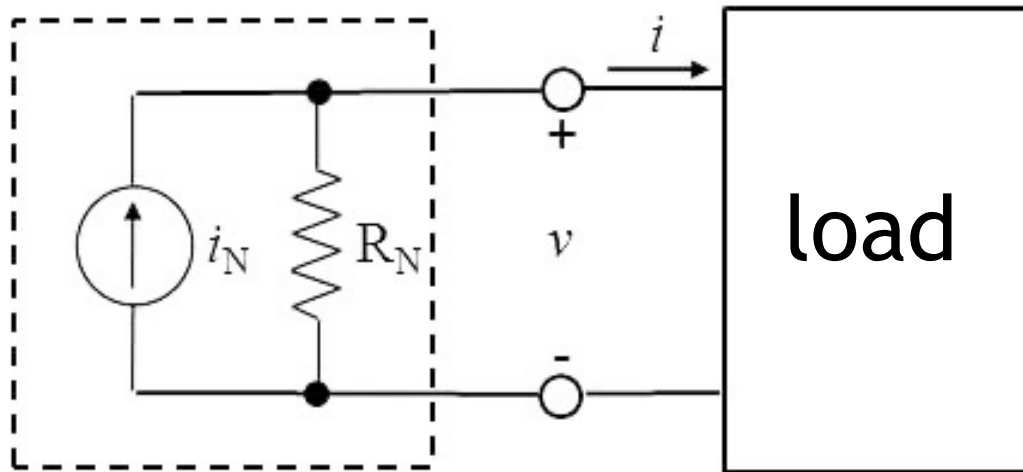
## Equivalent circuit concept



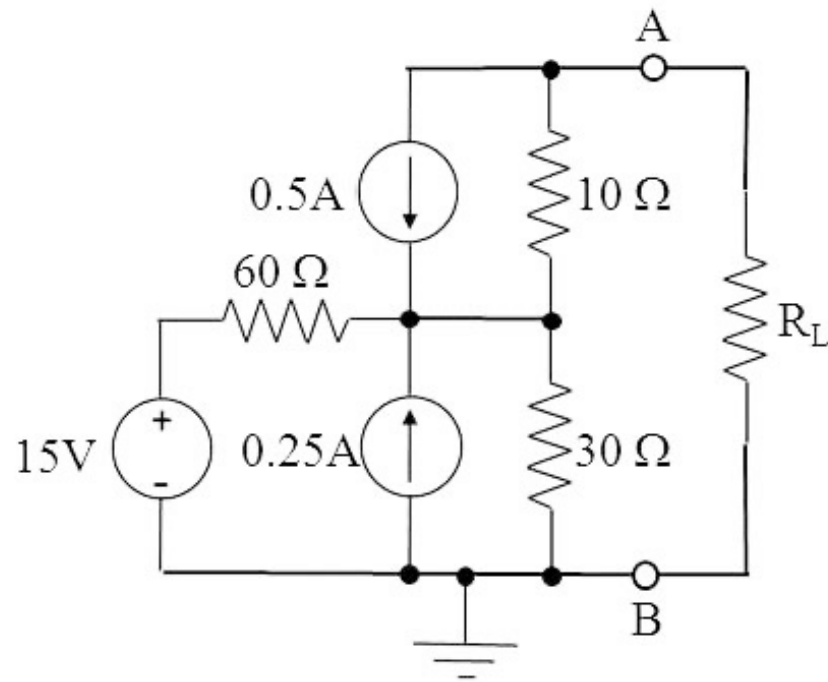
## Thevenin source



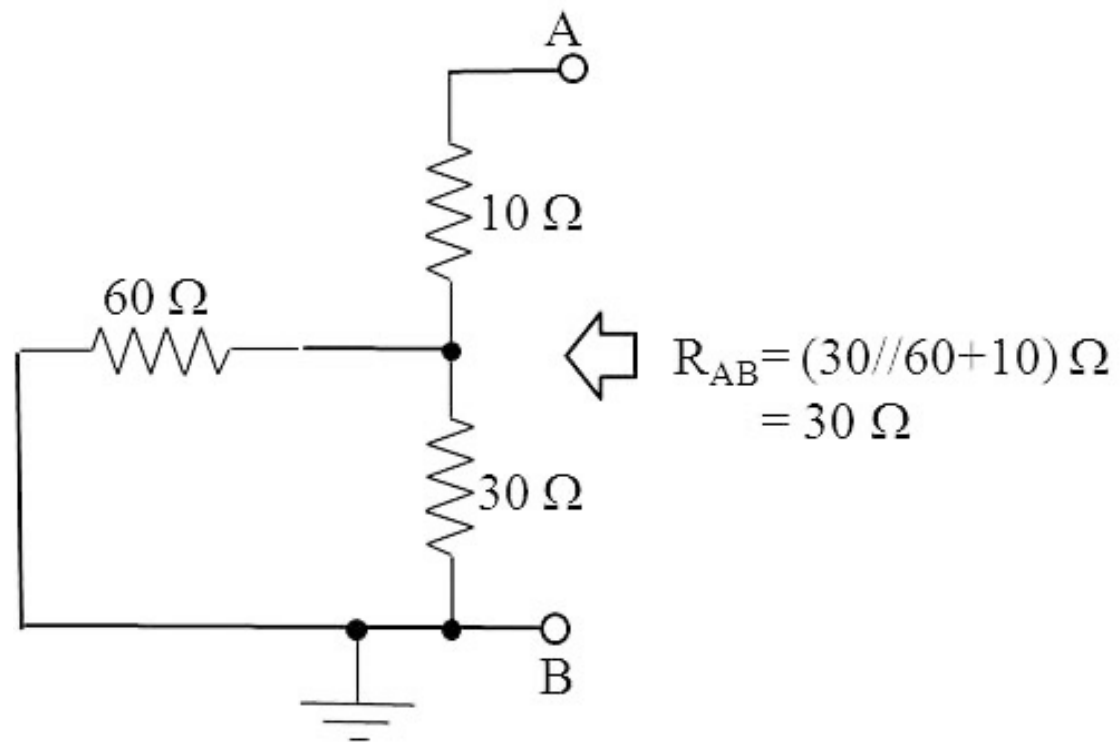
## Norton source

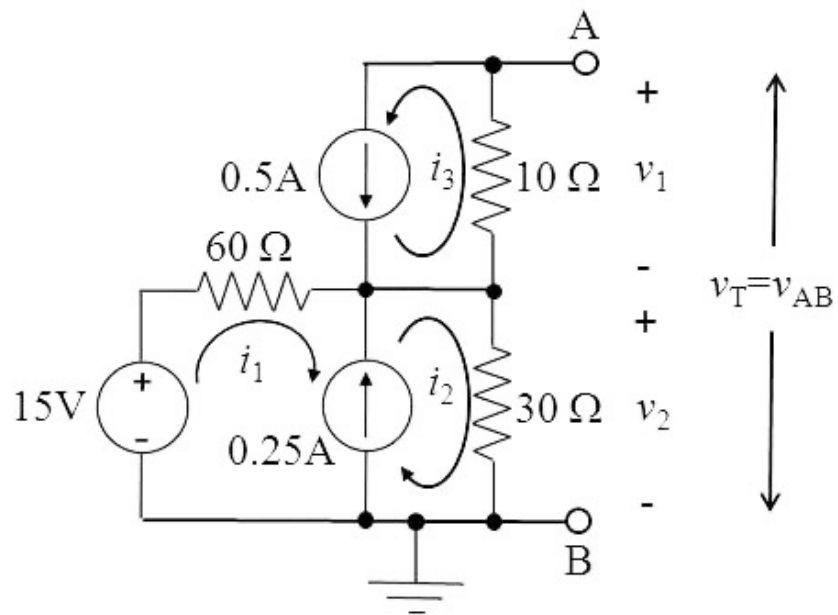


## Example : Thevenin equivalent source



## Compute Thevenin resistance

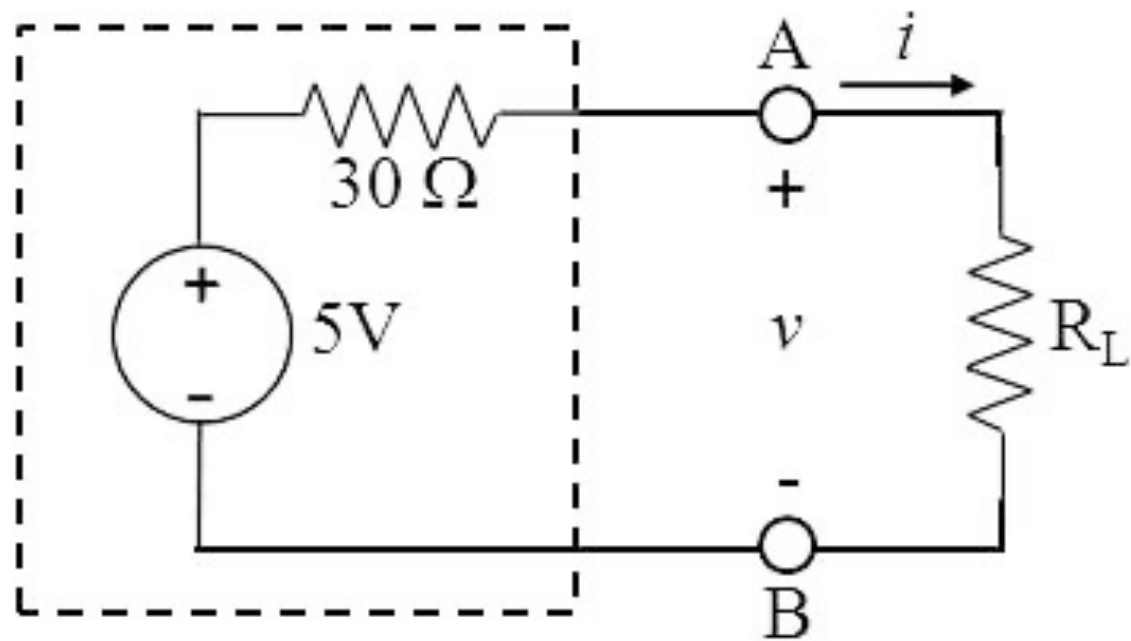




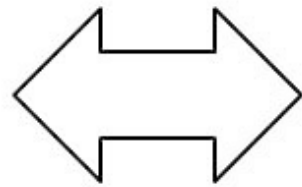
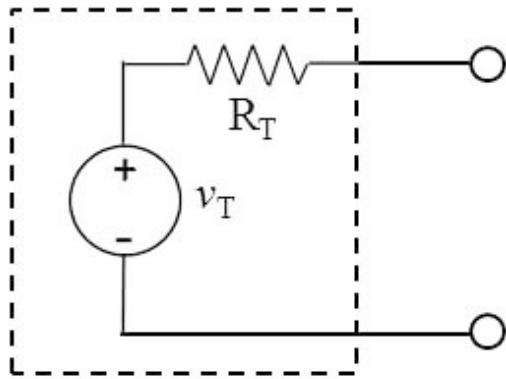
Compute  
Thevenin  
voltage



## Thevenin equivalent circuit

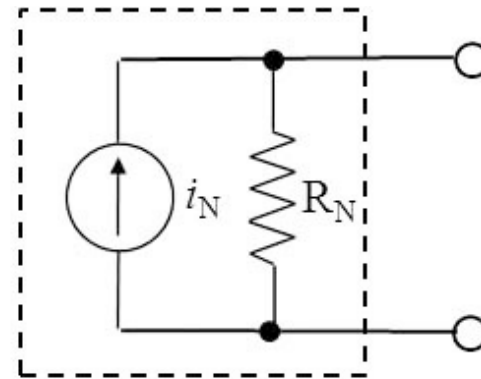


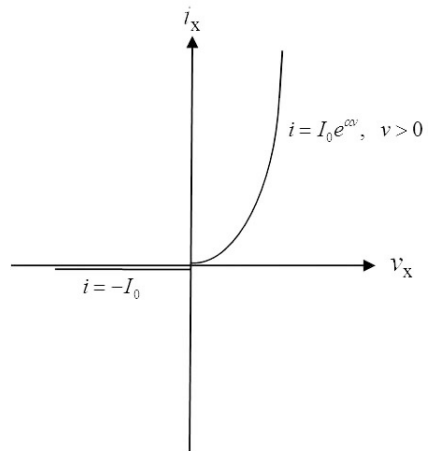
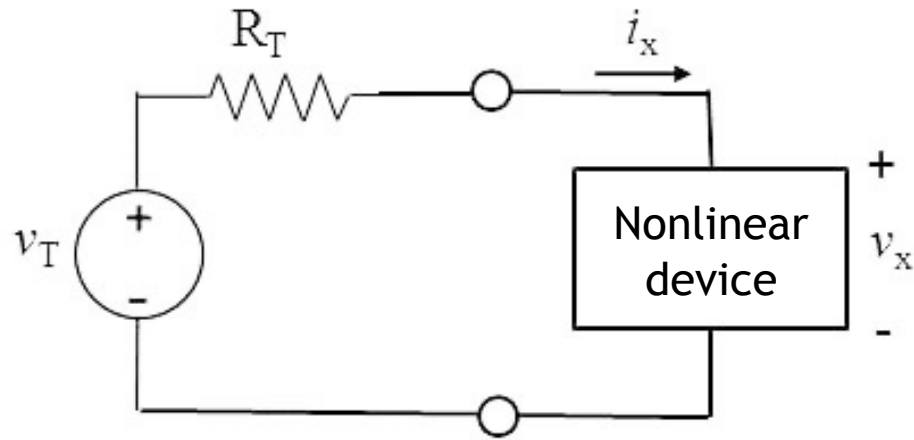
# Source transformation



$$R_T = R_N$$

$$v_T = i_N R_N$$

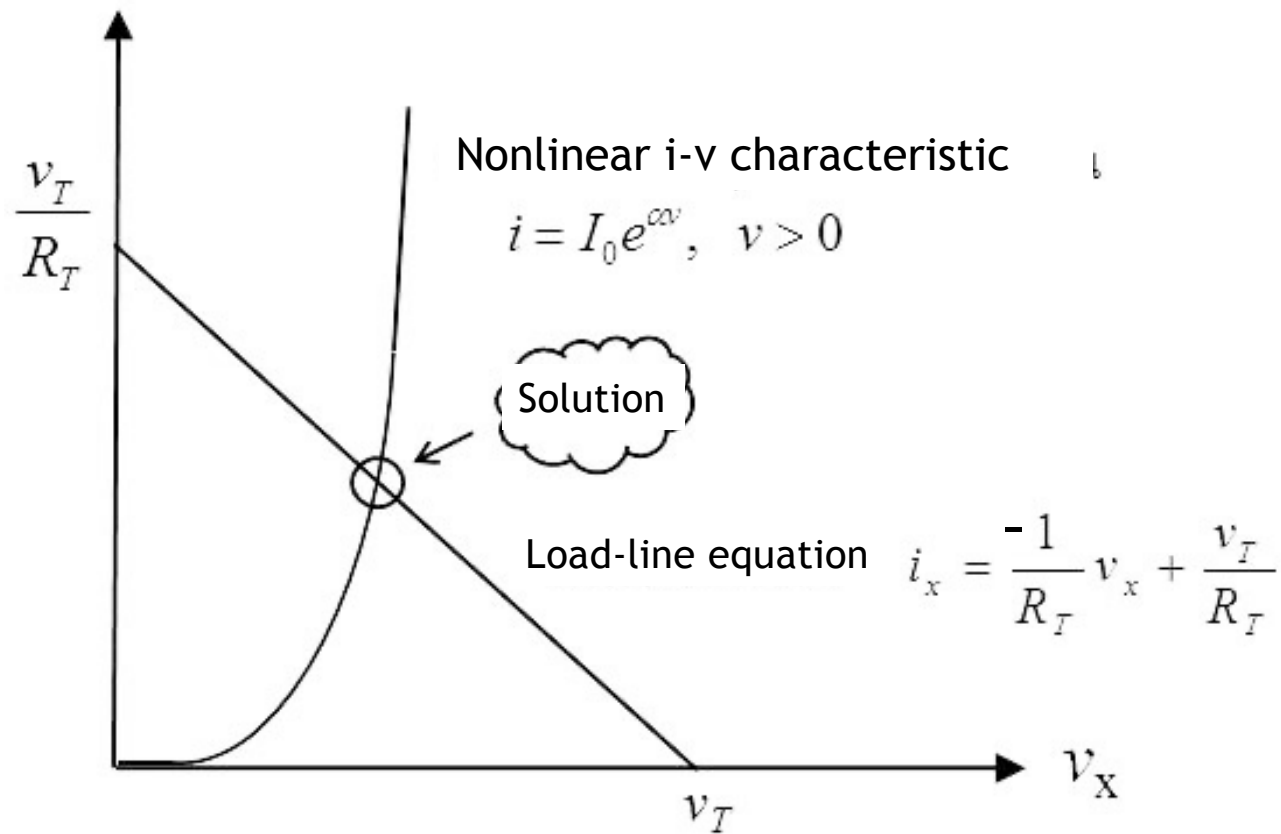




## Nonlinear load

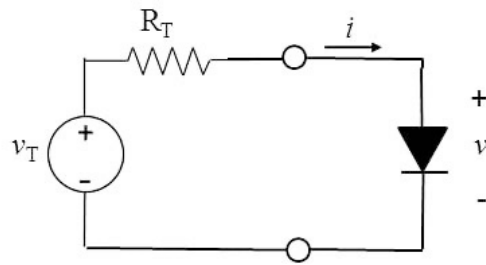
- Load-line analysis
- Numerical method

# Load-line analysis



## Exercise 2: Find current and voltage at diode by load-line and numerical methods

$$R_T = 22\Omega, \quad V_T = 12\text{ V}$$



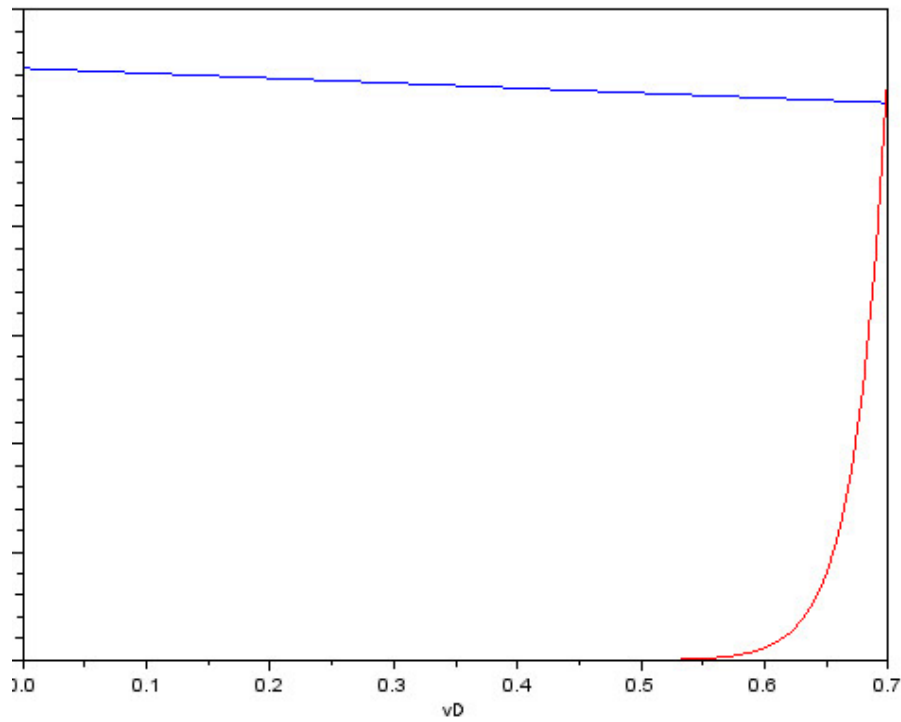
Diode i-v characteristic

$$i_D = I_{SAT} \left( \exp \left\{ \frac{v_D}{kT/q} \right\} - 1 \right)$$

at room temperature

$$I_{SAT} = 10^{-12} \text{ A}$$

$$\frac{kT}{q} = 0.0259 \text{ V}$$



Load-line  
analysis using  
Scilab plot

# Flowchart of numerical method

