# Basic circuit analysis and simulation

EE01205479 IoT for Electrical Engineering

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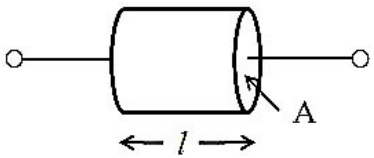
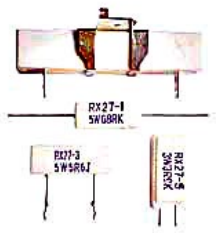
# Resistance

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

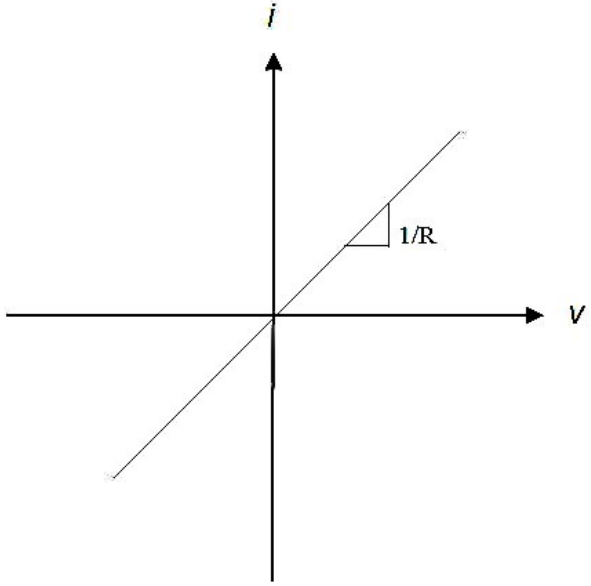



Physical


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

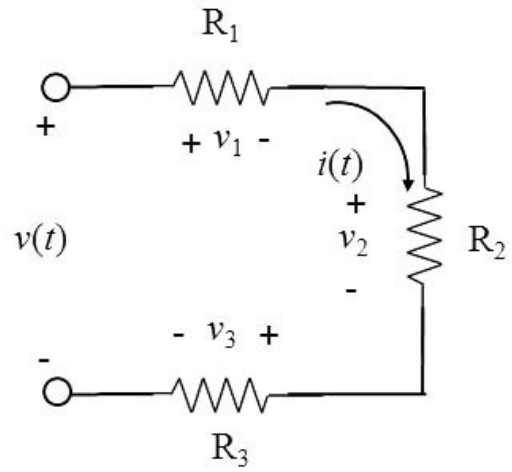
$$\sum_{n=1}^{N} i_n = 0$$

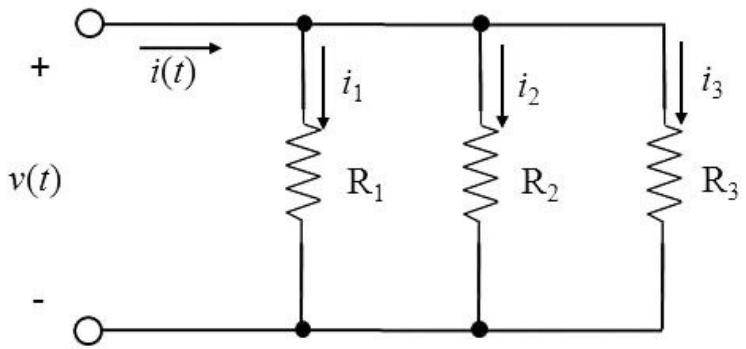
- KVL

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

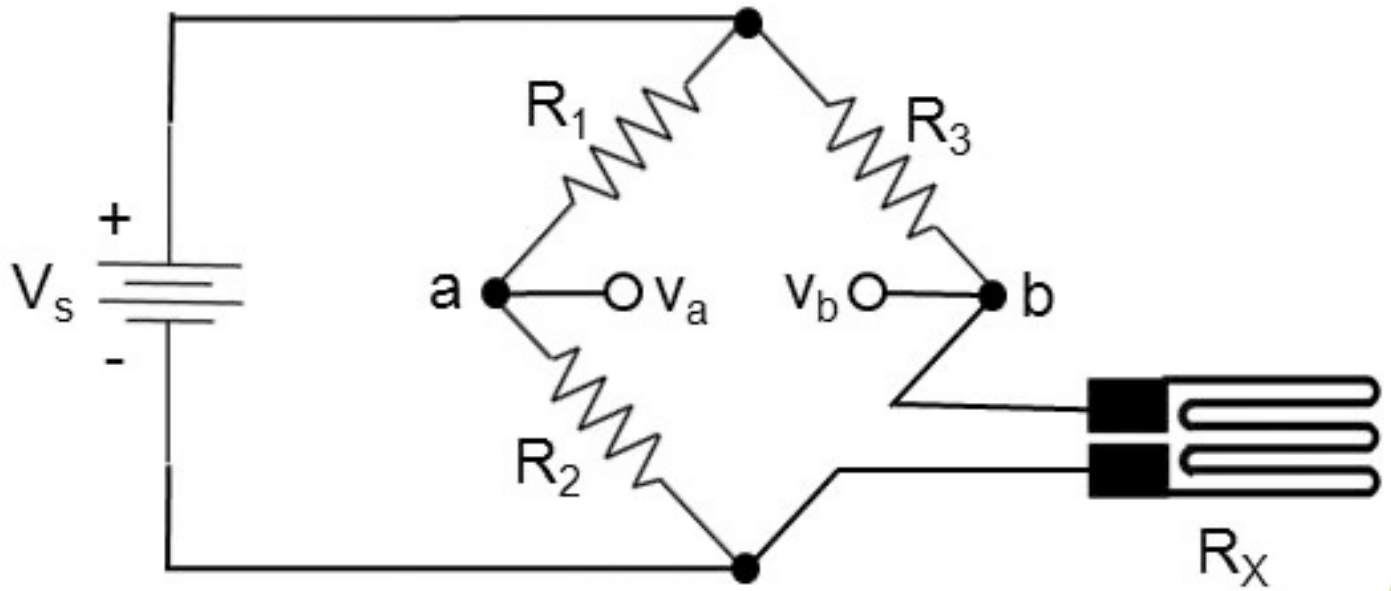
# KCL and KVL applications

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



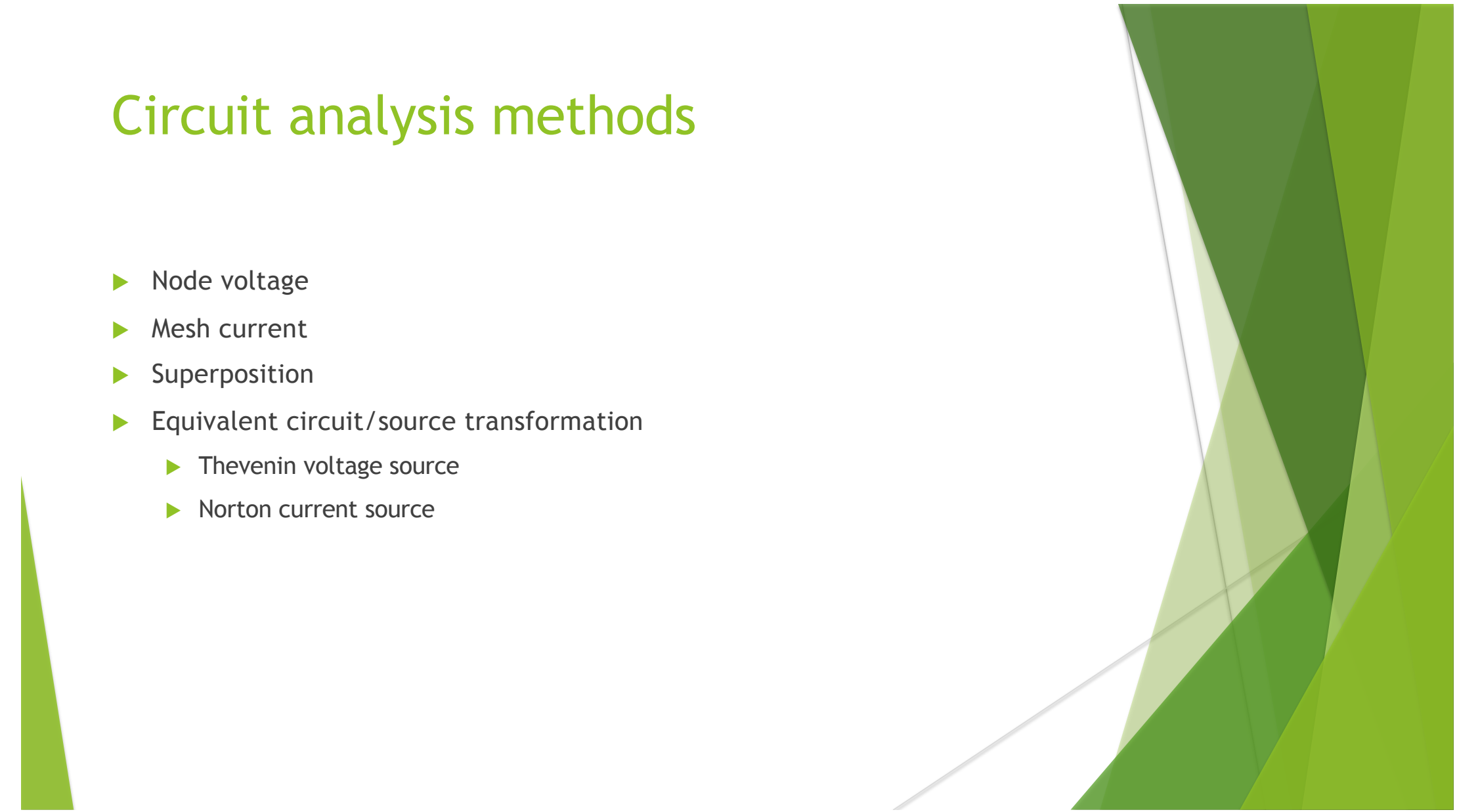
# Exercise1 : Wheatstone bridge




Let Vs = 5 Volts. R1 = R2 = R3 = 1000 Ohms, Rx varies between 800 – 1200 Ohms
Compute the corresponding voltage range for Vab.

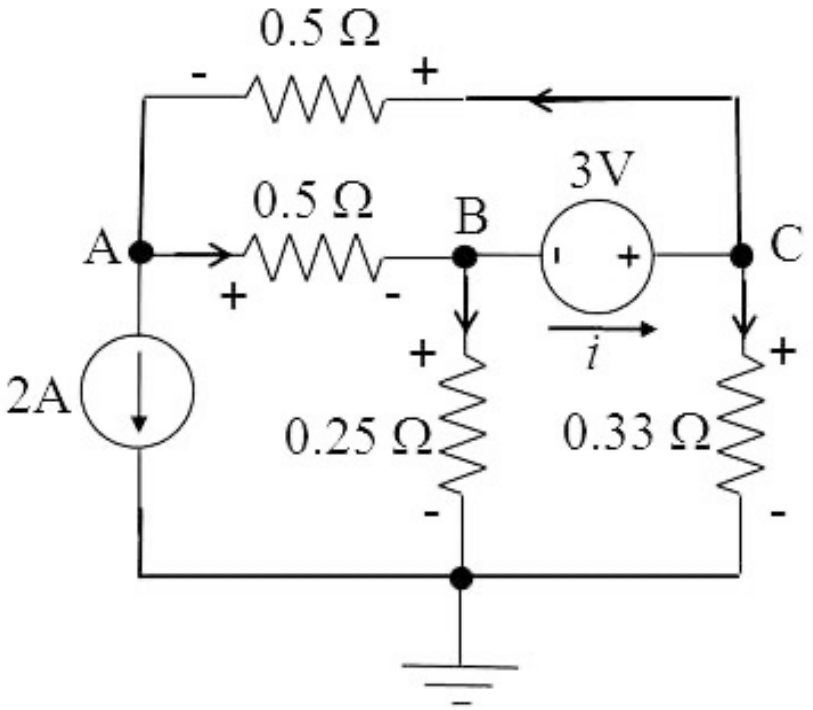
# Circuit analysis methods

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



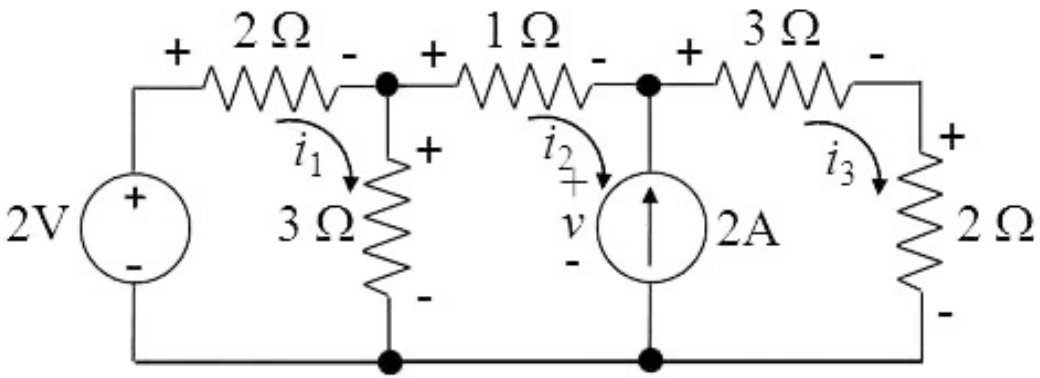
# Node voltage analysis

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

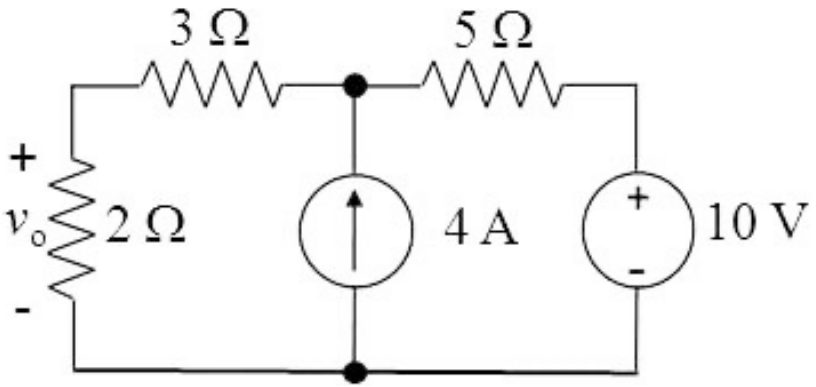


# Mesh current analysis

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



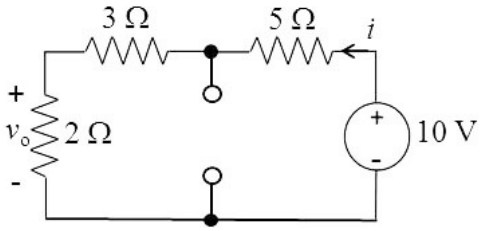
# Superposition method

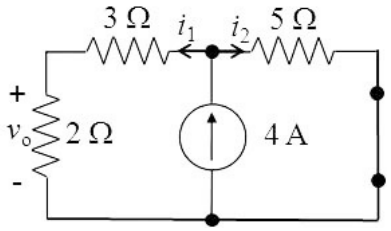



$V_{o1} = (2/(2+3+5))*10 = 2$ V

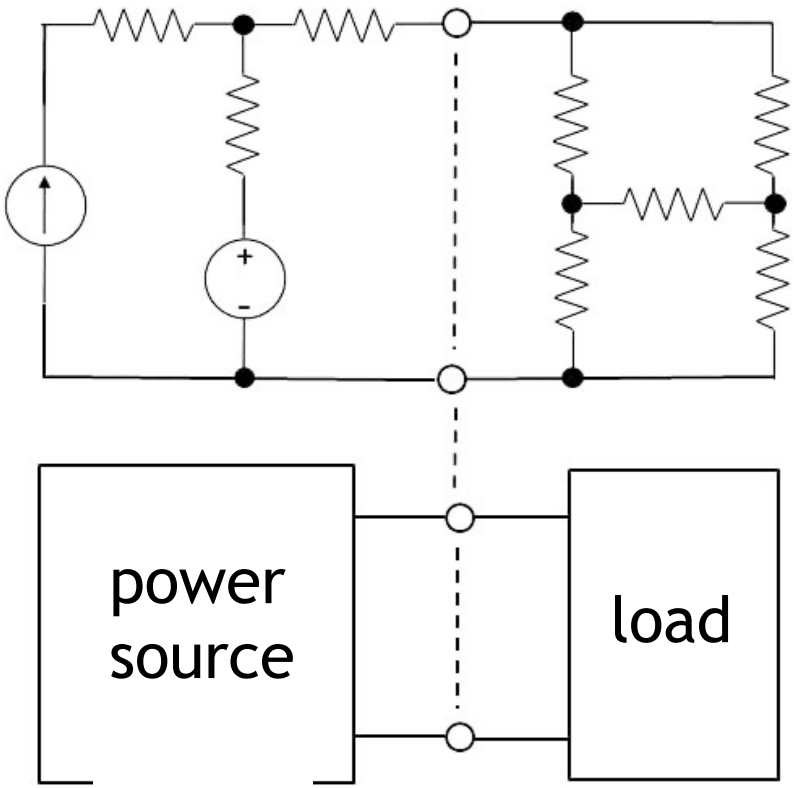
$V_{o2} = 2*2 = 4$ V

$V_o = 2 + 4 = 6$ V

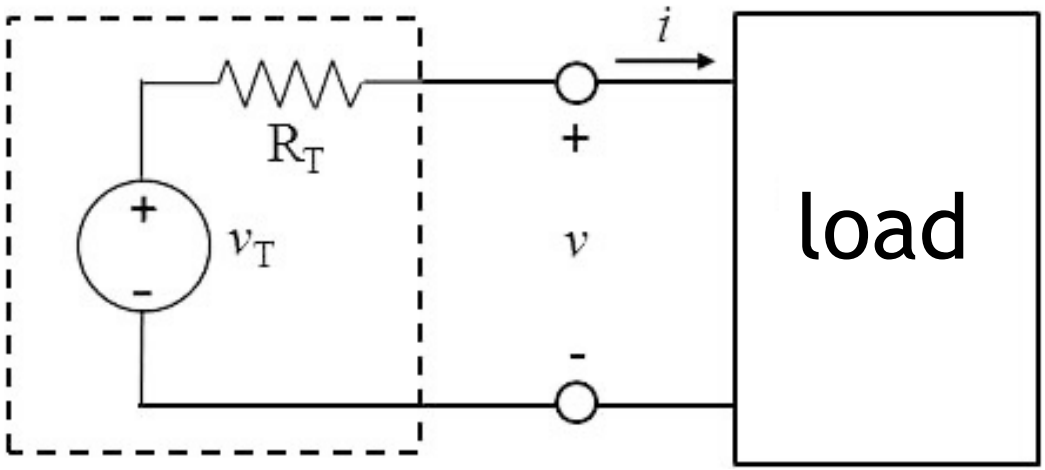


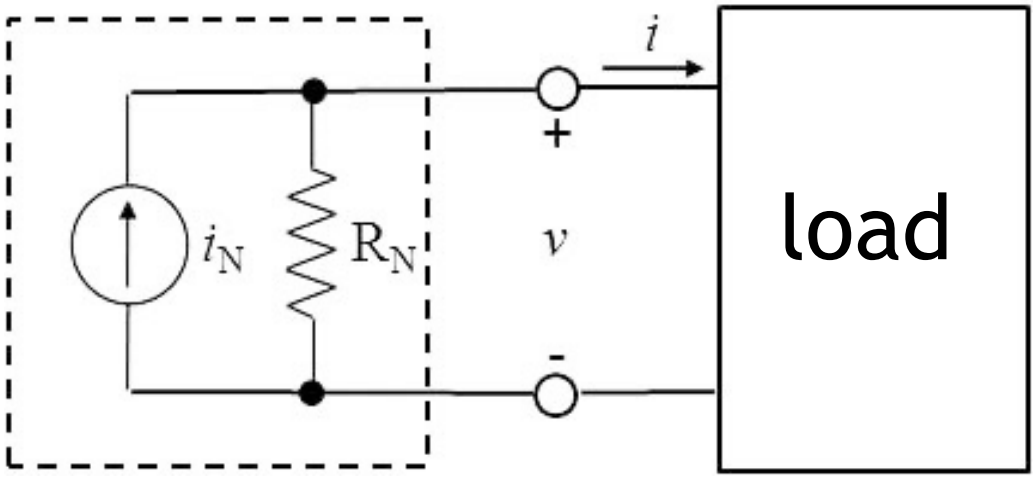
# Equivalent circuit concept



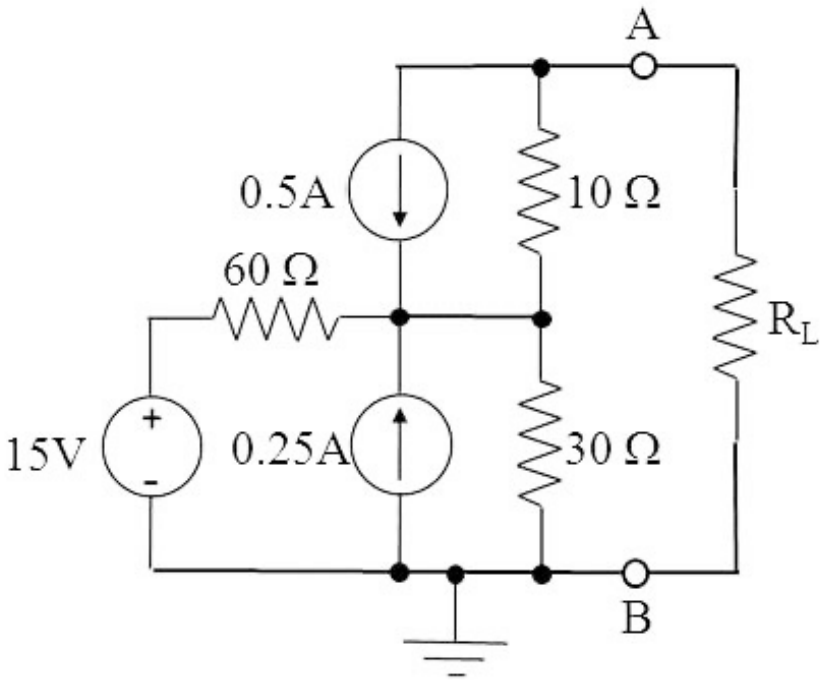
# Thevenin source



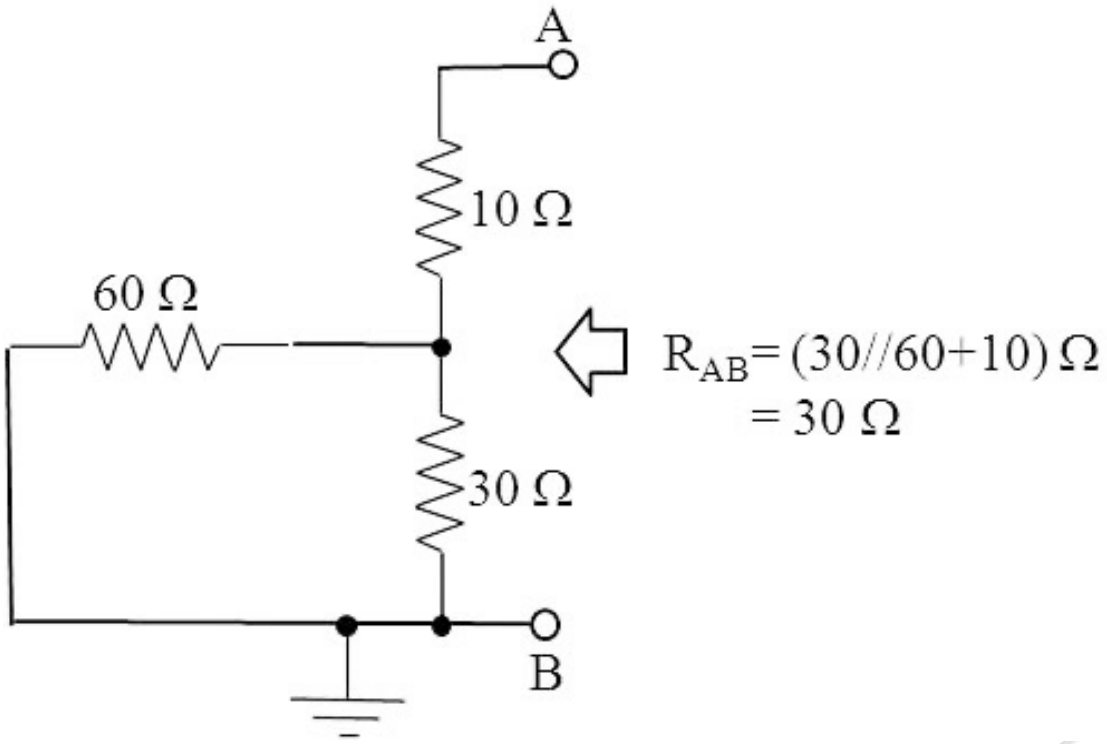
# Norton source

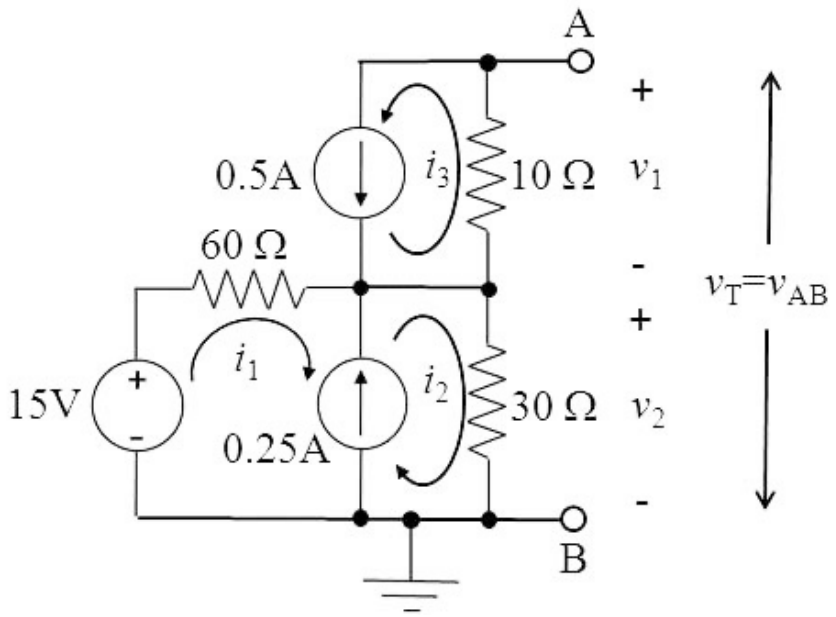


# Example : Thevenin equivalent source



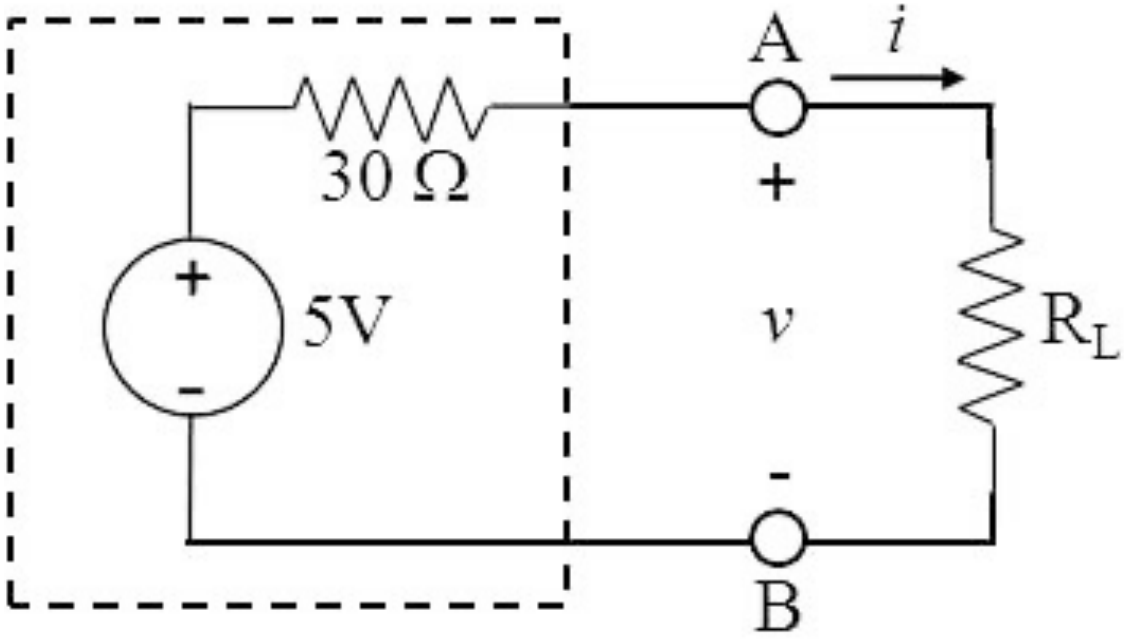
# Compute Thevenin resistance



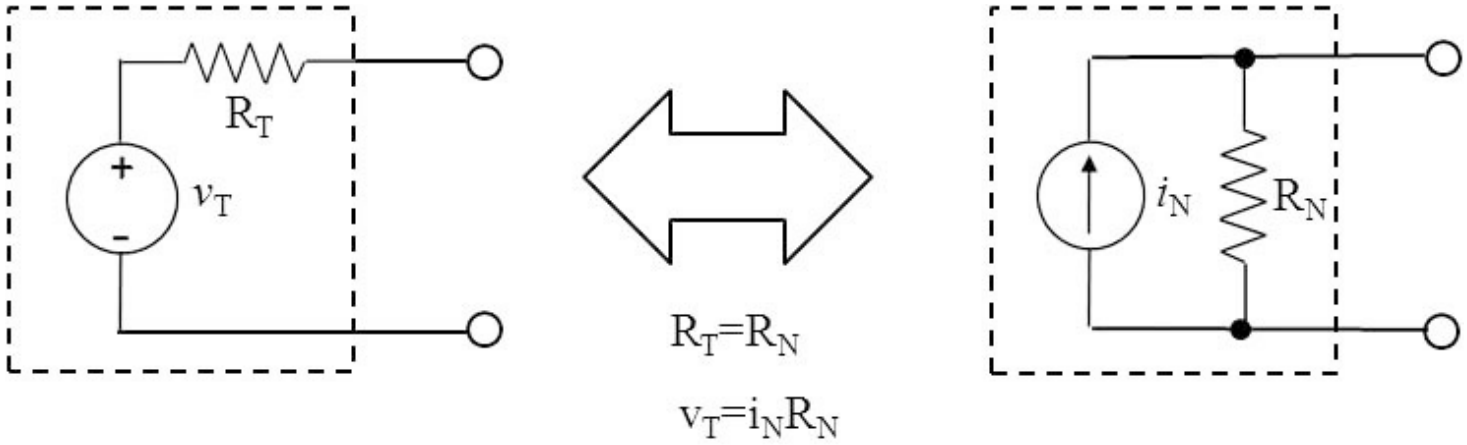



# Compute Thevenin voltage

# Thevenin equivalent circuit

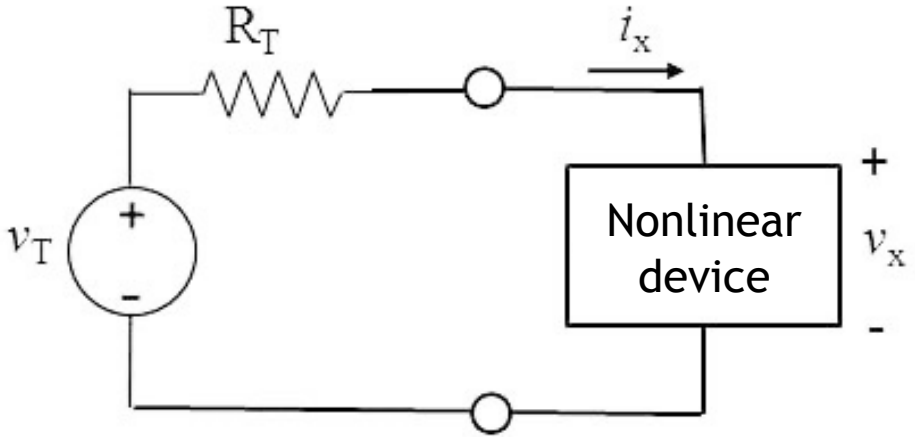


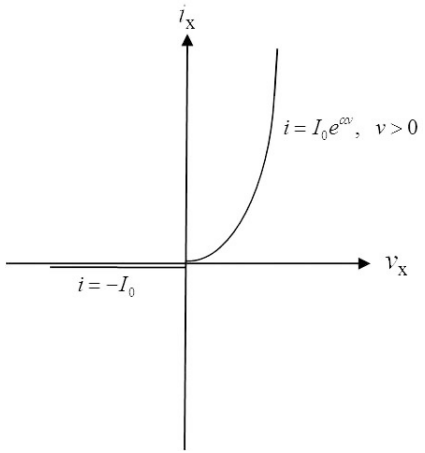
# Source transformation




$R_T = R_N$

$v_T = i_N R_N$

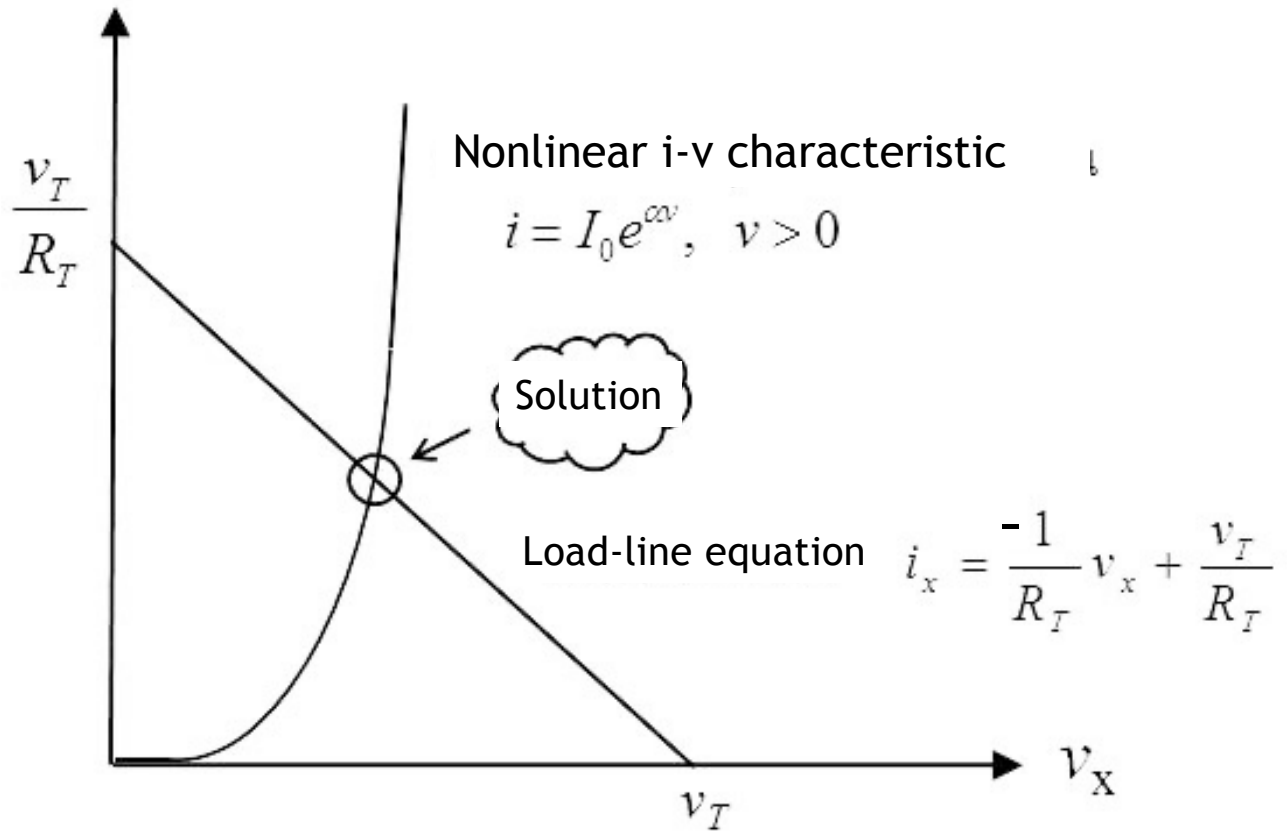



# Nonlinear load

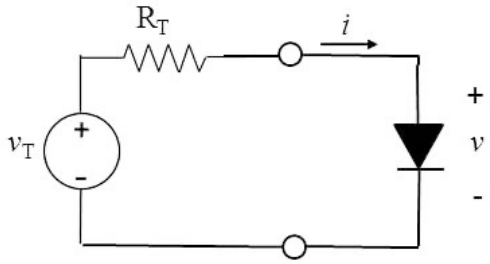
- Load-line analysis
- Numerical method

# Load-line analysis



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

$R_T$=22Ω, $V_T$ = 12 V



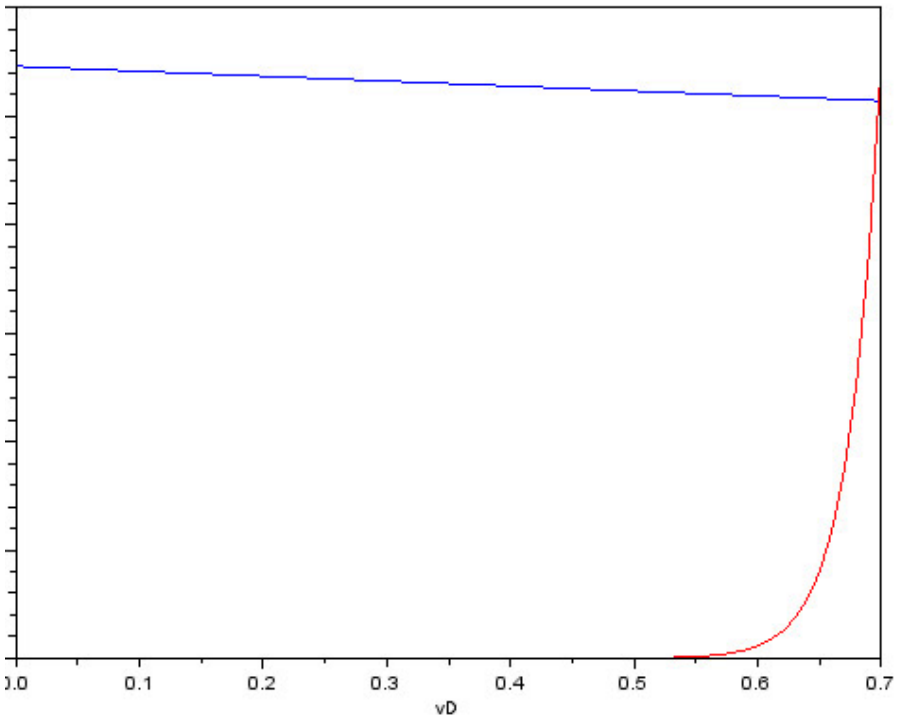

Diode i-v characteristic

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

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