Lecture 1 : Basic circuit analysis and simulation

01205479 IoT for EE

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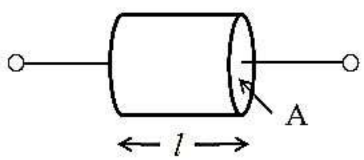
Resistance

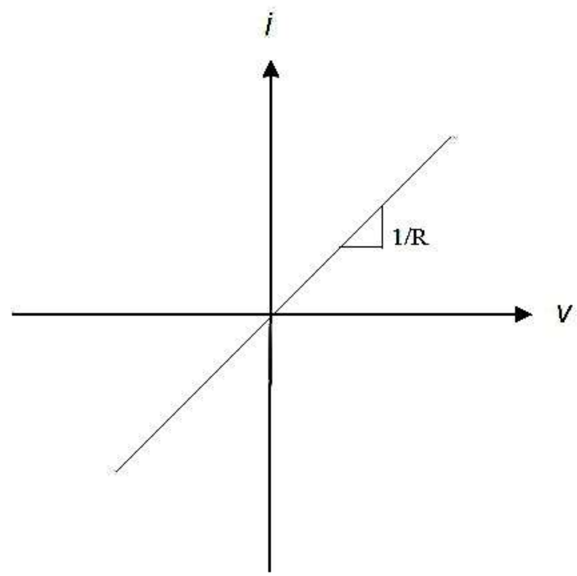
$$R = \frac{\rho l}{A}$$



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

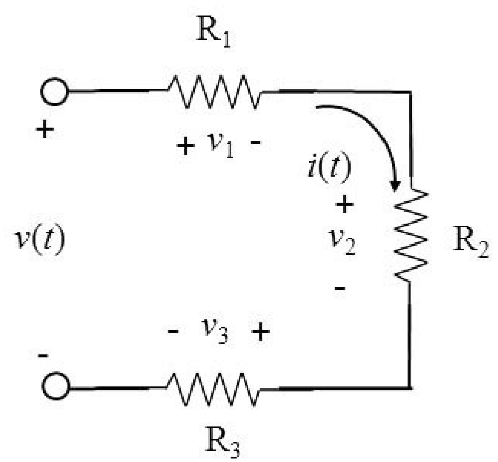
$$\sum_{n=1}^{N} i_n = 0$$

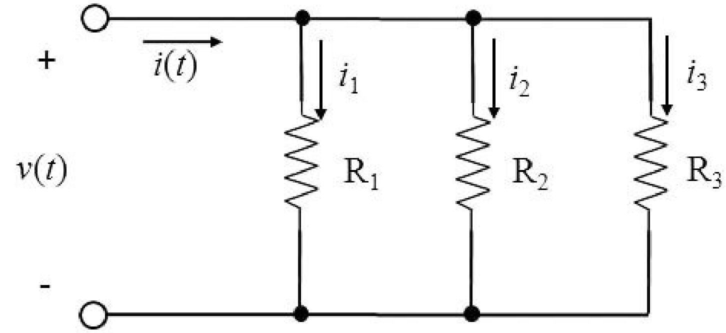
- KVL

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

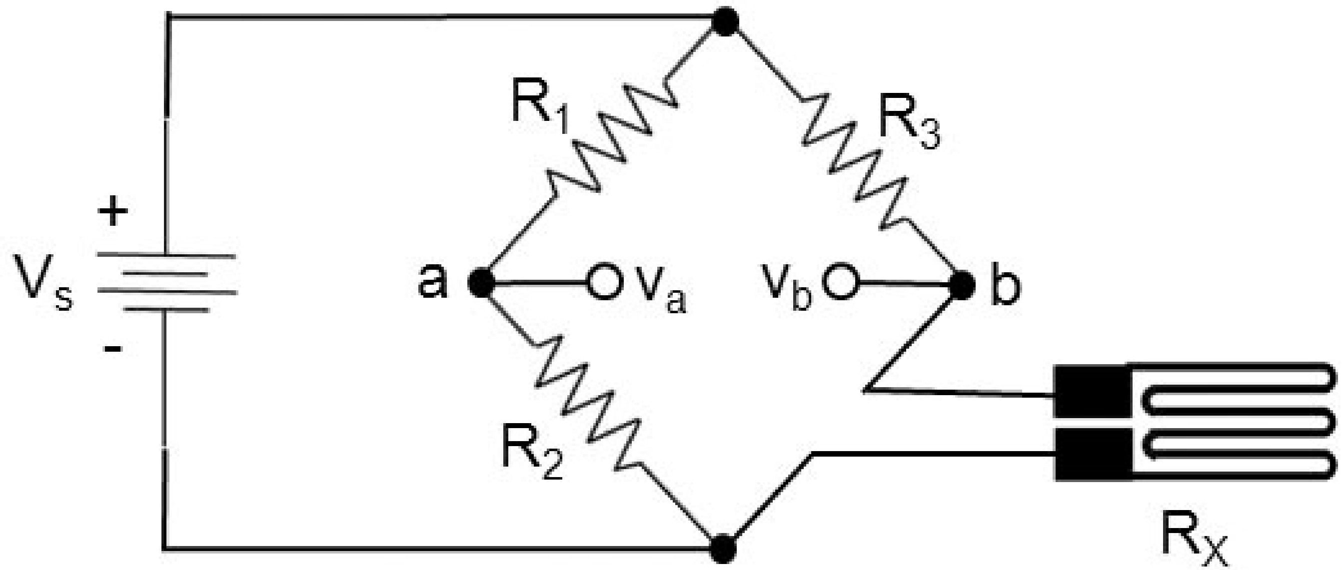
KCL and KVL applications

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



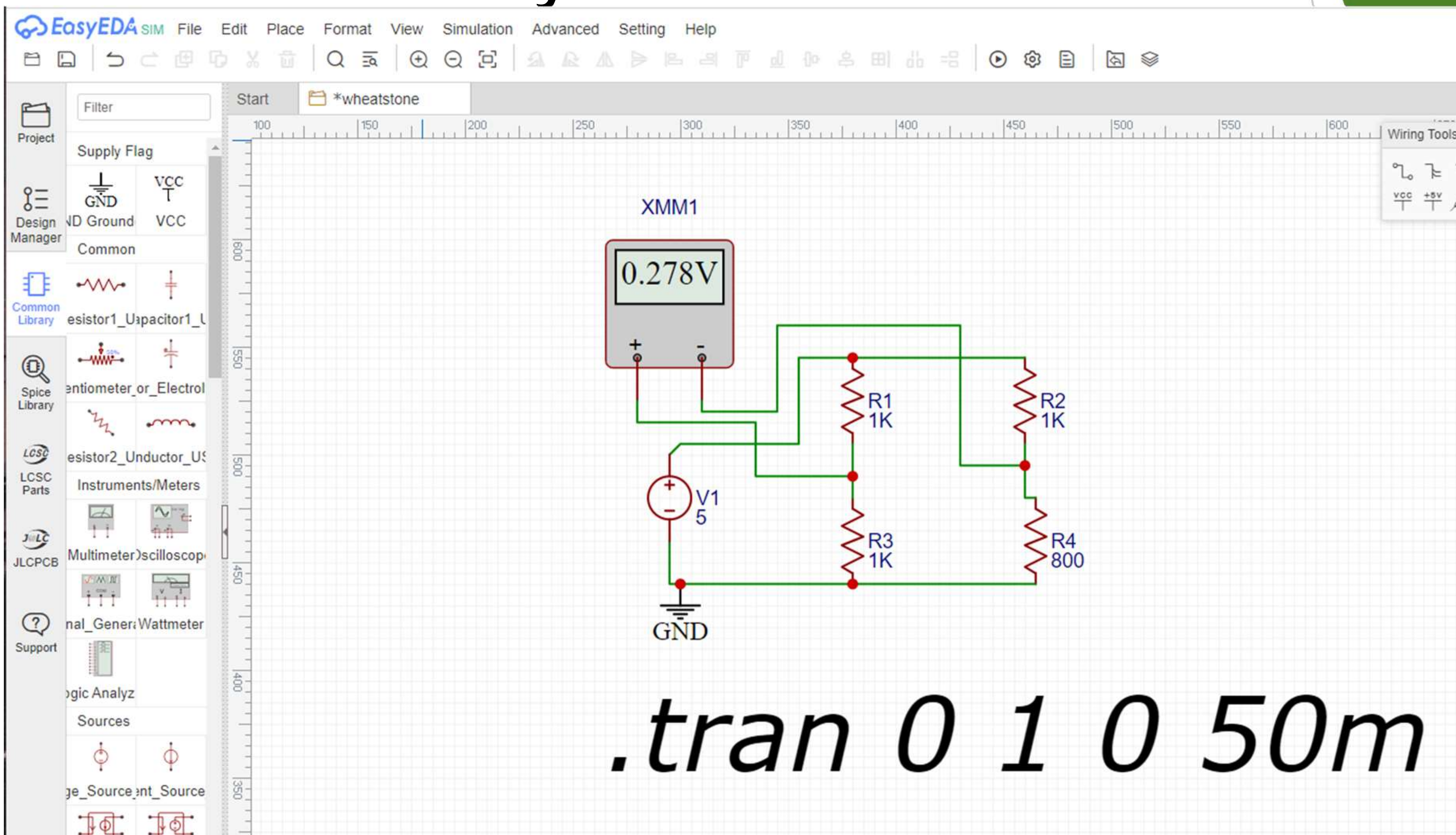


Exercise1 : Wheatstone bridge



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

Simulate on EasyEDA

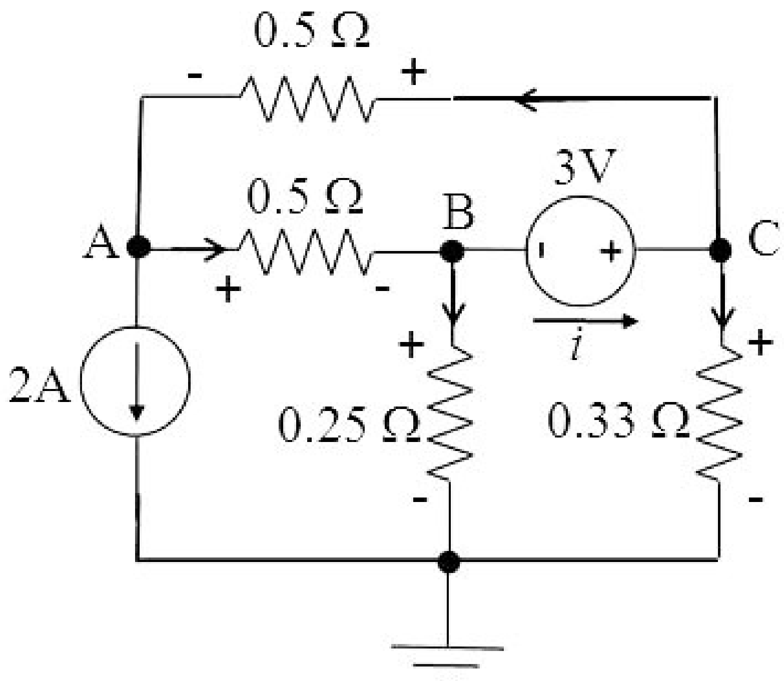


Circuit analysis methods

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

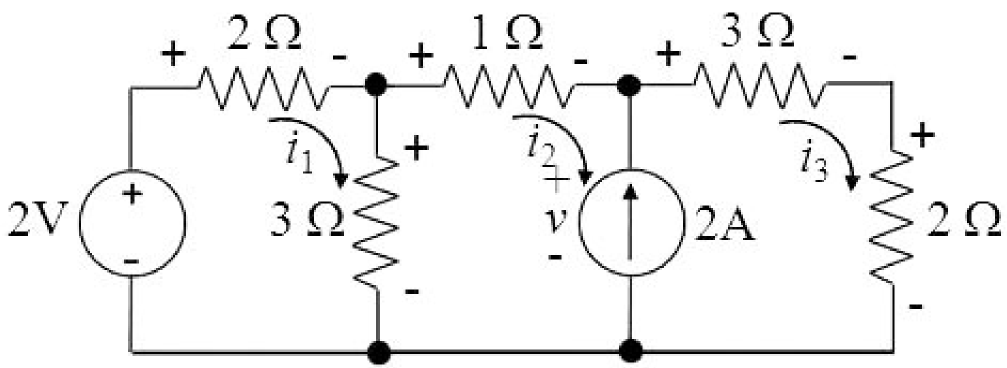
Node voltage analysis

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

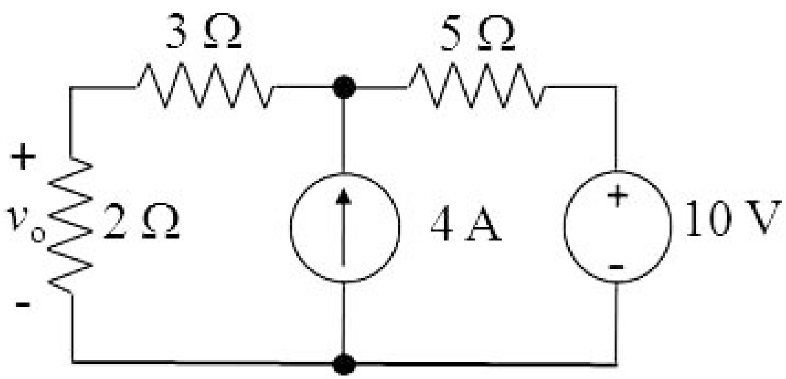


Mesh current analysis

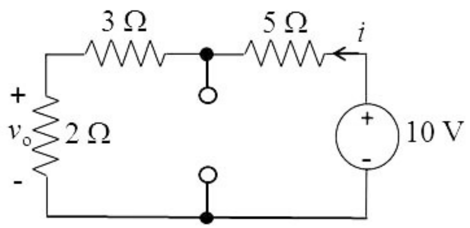
- Assign i_1, i_2, i_3 as variables
- Use KVL to solve

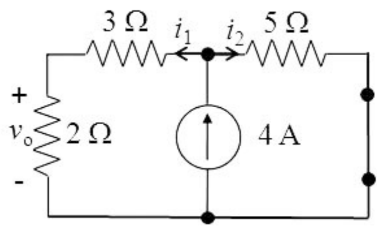


Superposition method



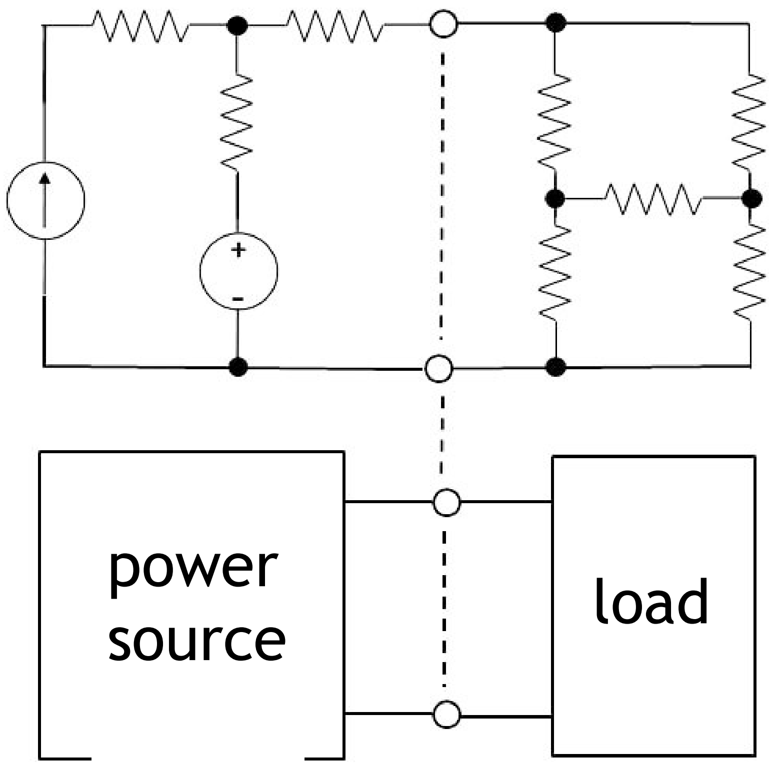
V_{o1} = (2/(2+3+5))*10 = 2 V
V_{o2} = 2*2 = 4 V
V_o = 2 + 4 = 6 V



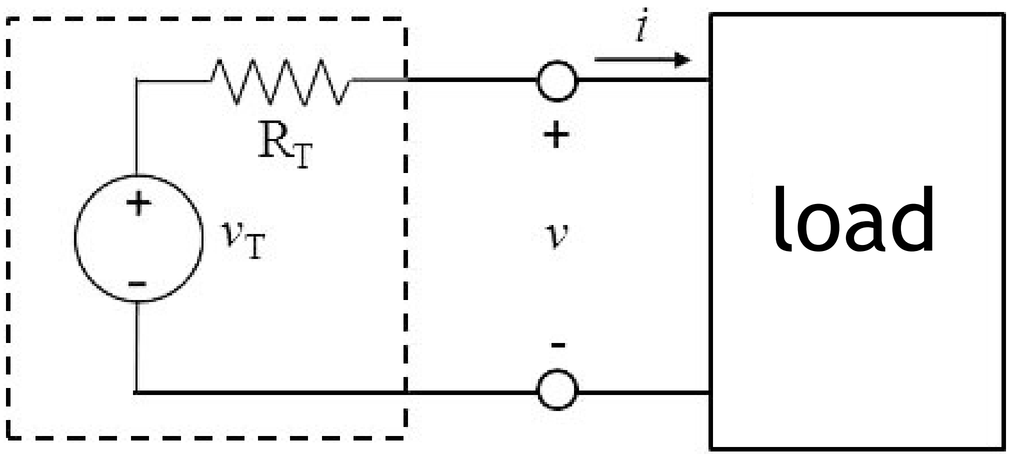


Exercise : simulate on EasyEDA

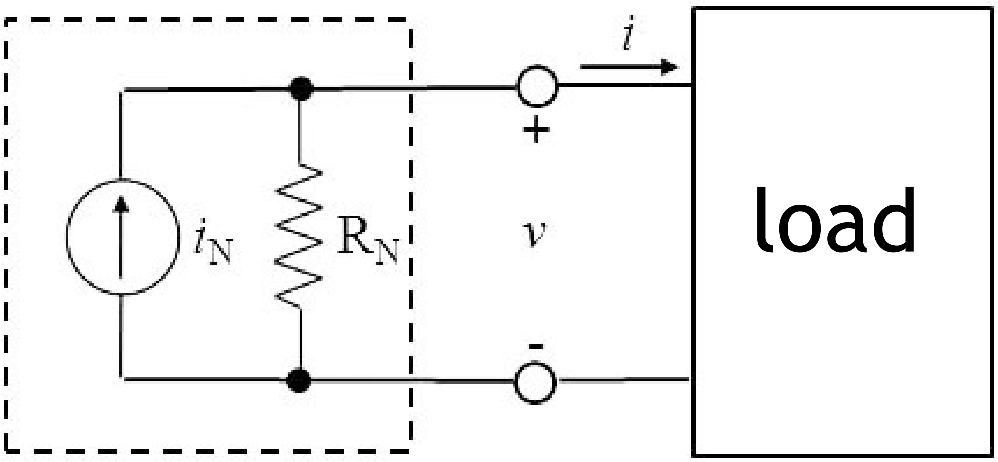
Equivalent circuit concept



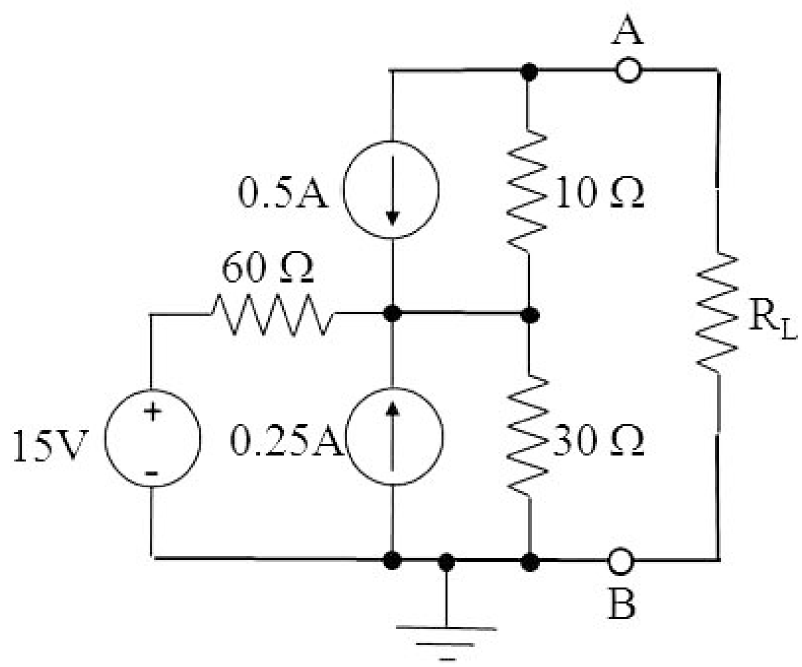
Thevenin source



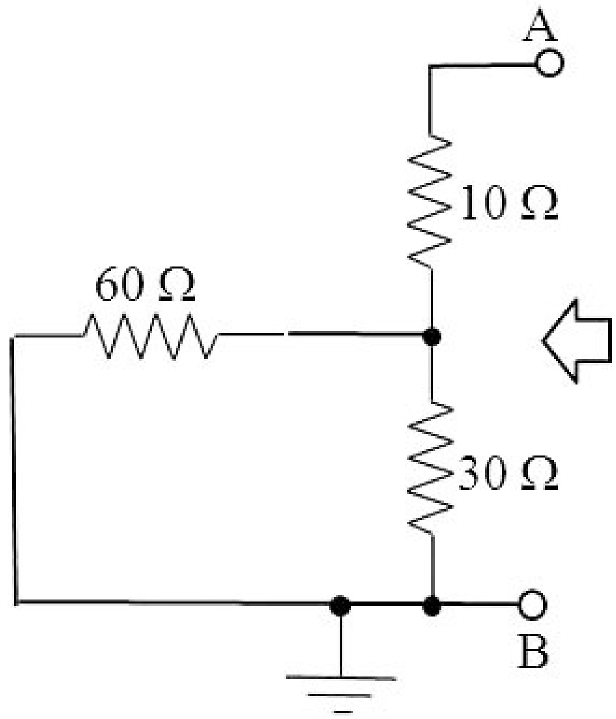
Norton source



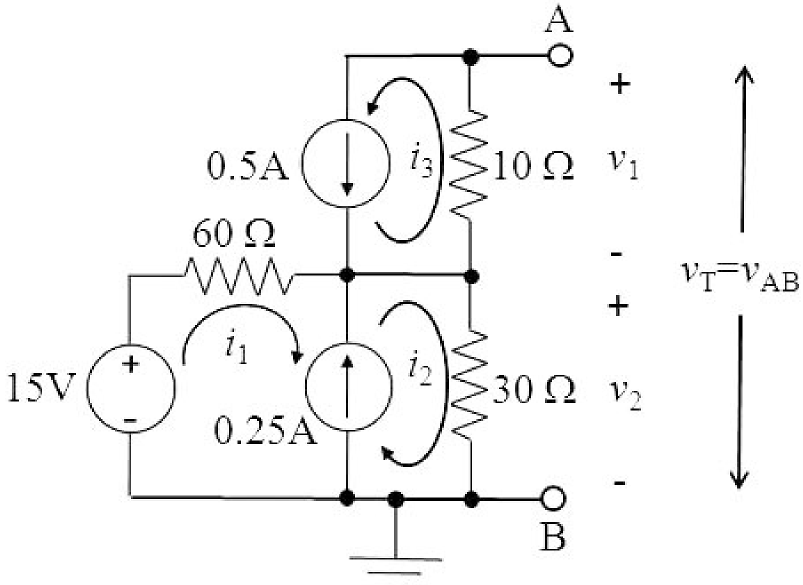
Example : Thevenin equivalent source



Compute Thevenin resistance

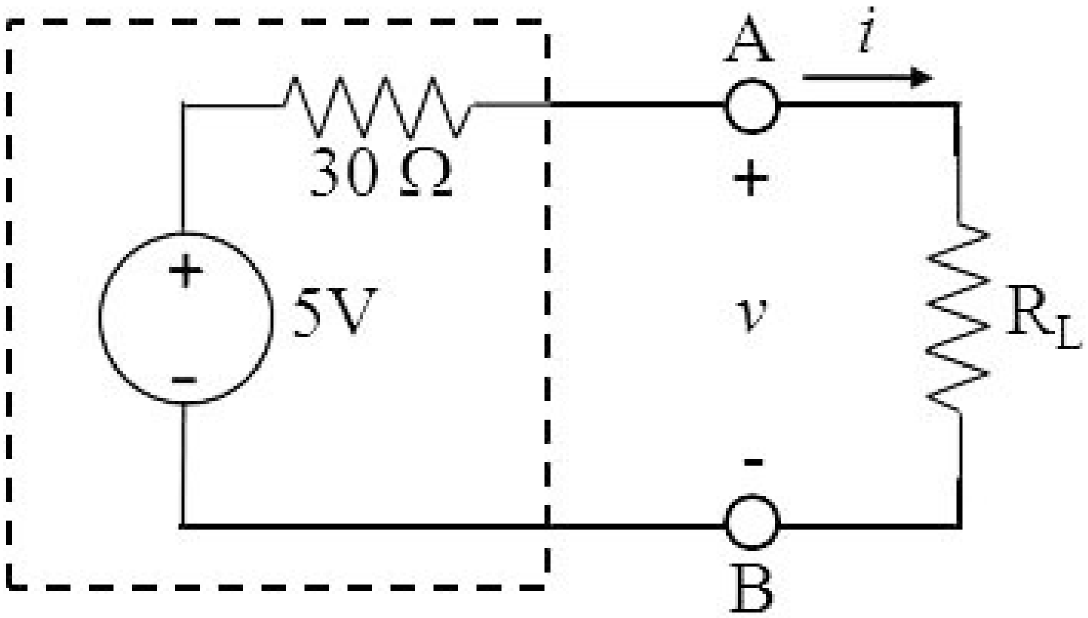


$R_{AB} = (30//60+10)\ \Omega$
$= 30\ \Omega$

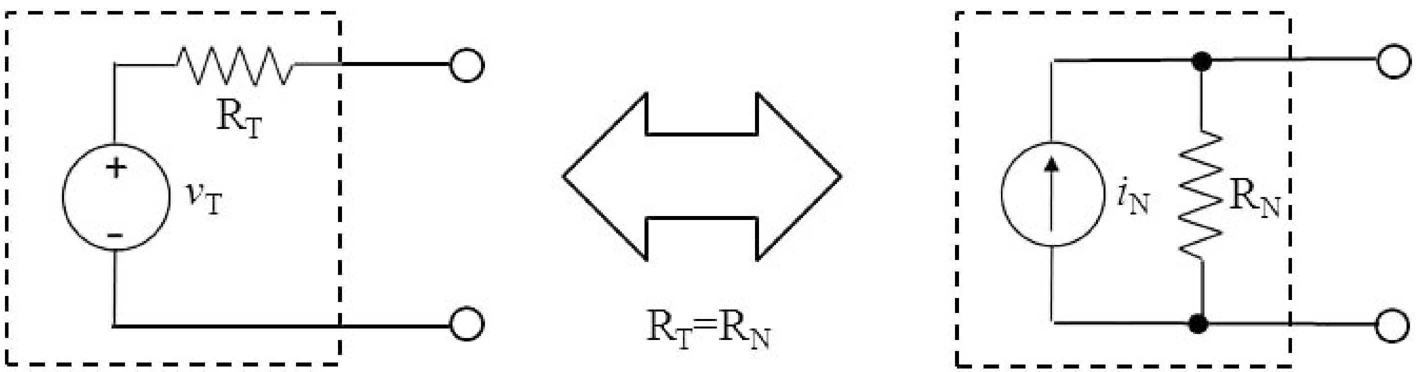


Compute Thevenin voltage

Thevenin equivalent circuit

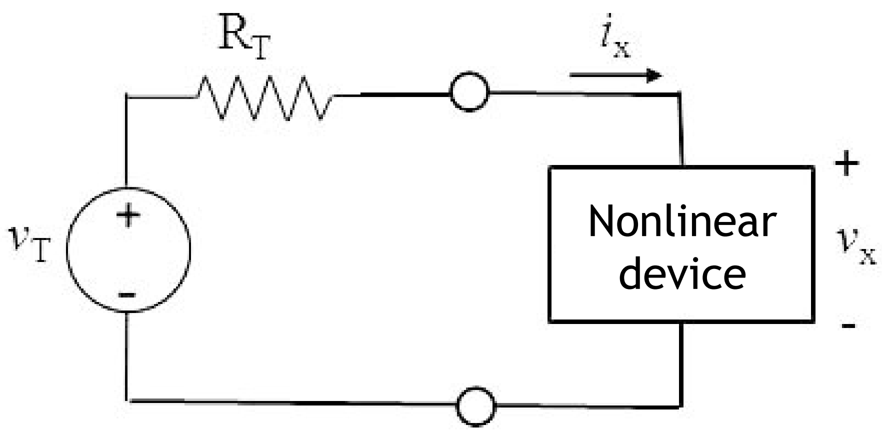


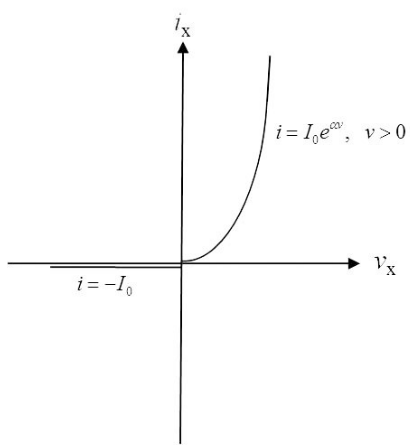
Source transformation



$R_T = R_N$

$v_T = i_N R_N$

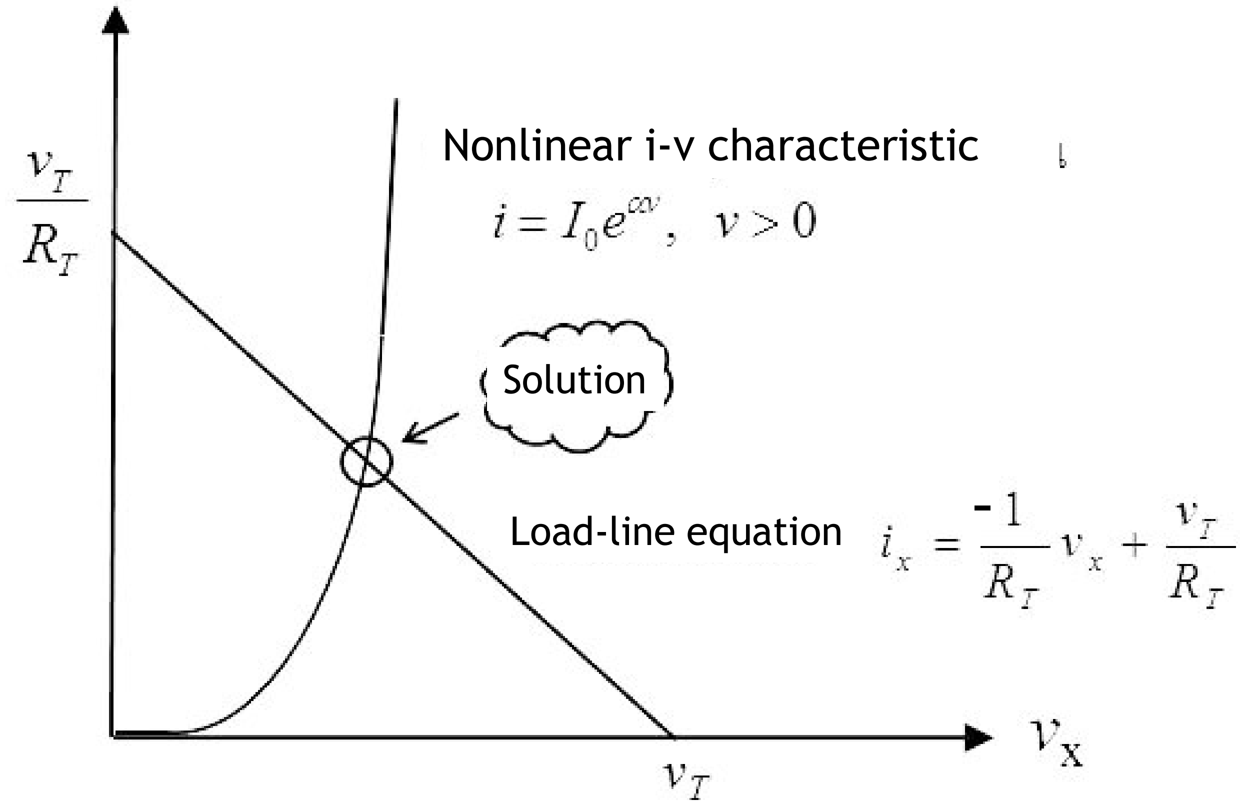




Nonlinear load

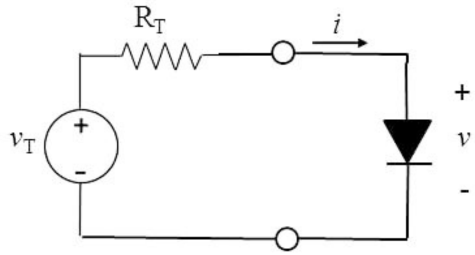
- Load-line analysis
- Numerical method

Load-line analysis



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

$R_T = 22\Omega$, V_T = 12 V



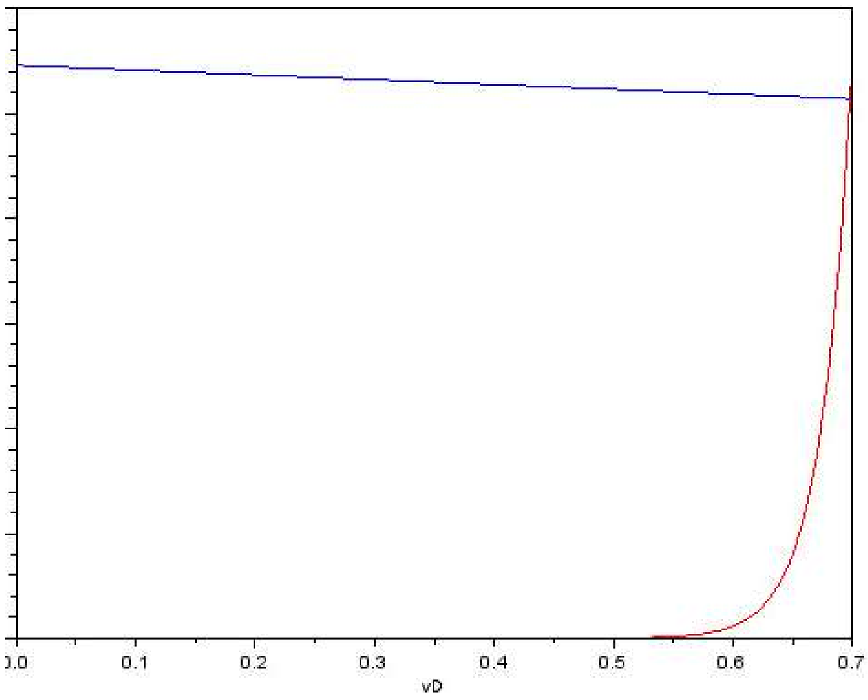
Diode i-v characteristic

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

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