USC University of Southern California

# ECE 105: Introduction to Electrical Engineering

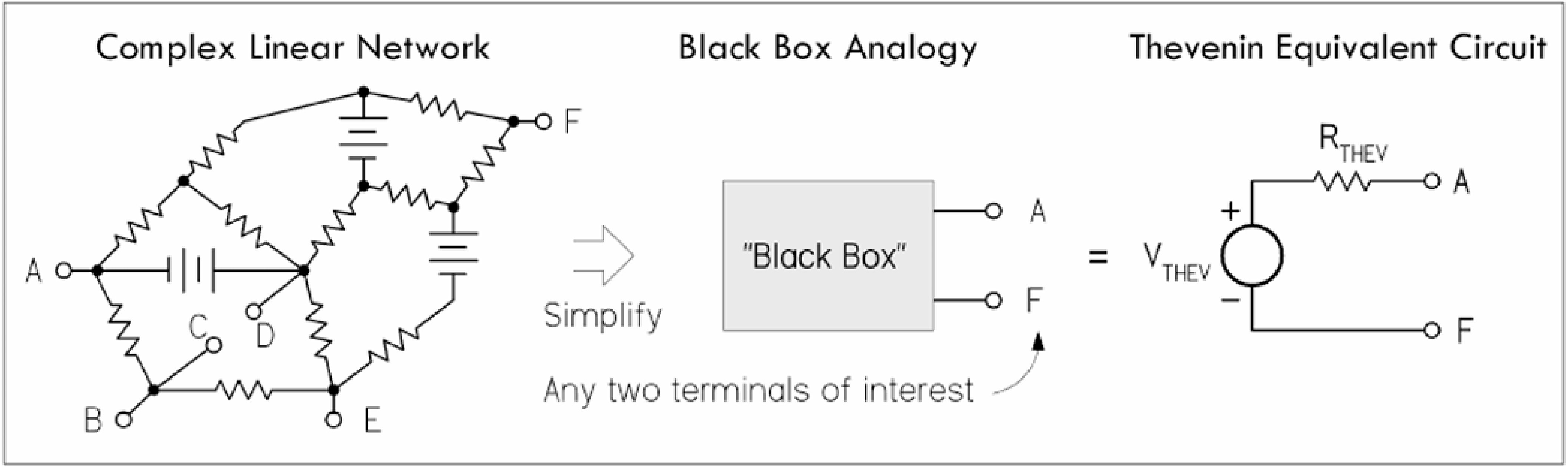
Lecture 8

Circuit Problems - Recap

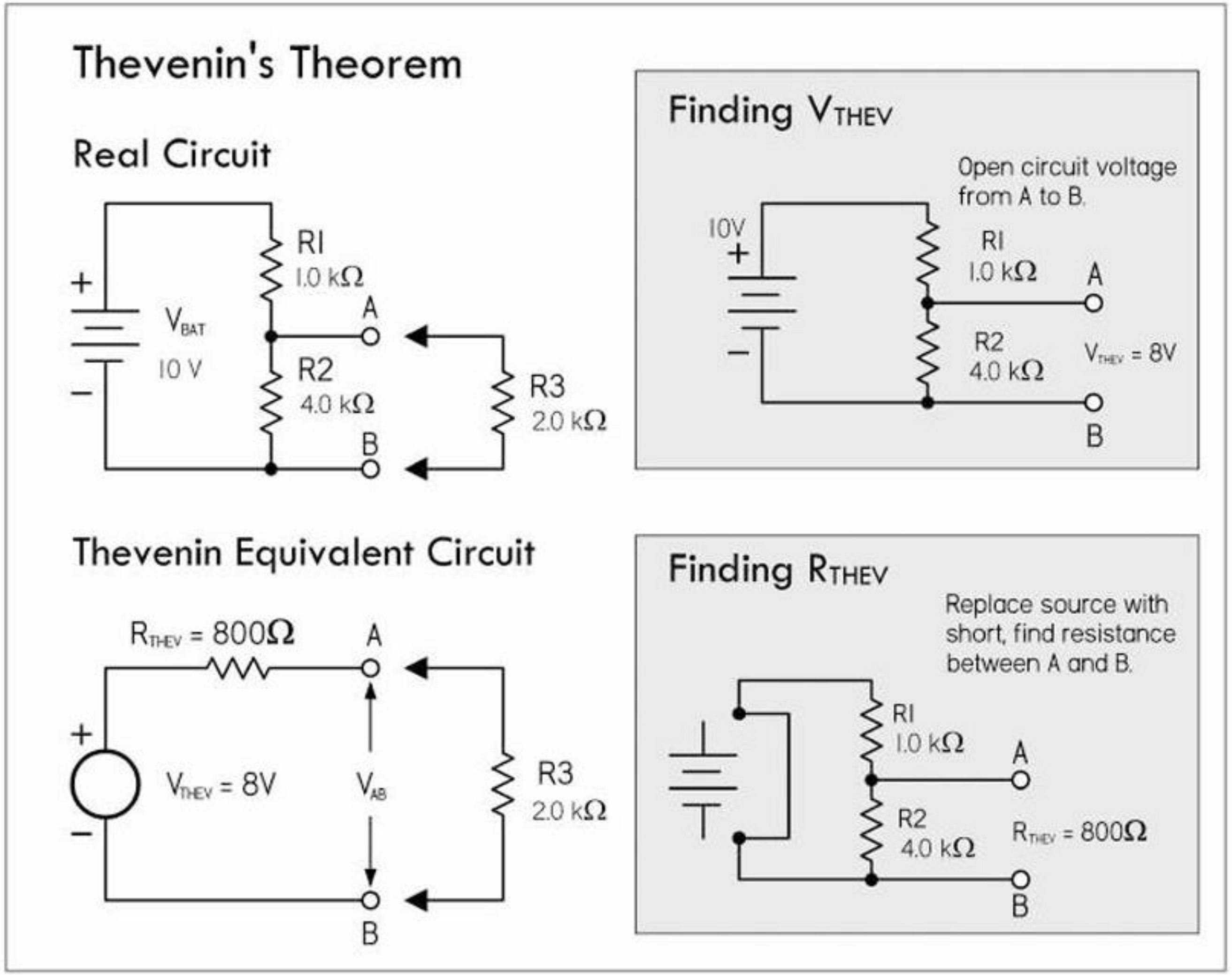
Yasser Khan

Rehan Kapadia

# Equivalent circuits



# Thevenin's equivalent circuit



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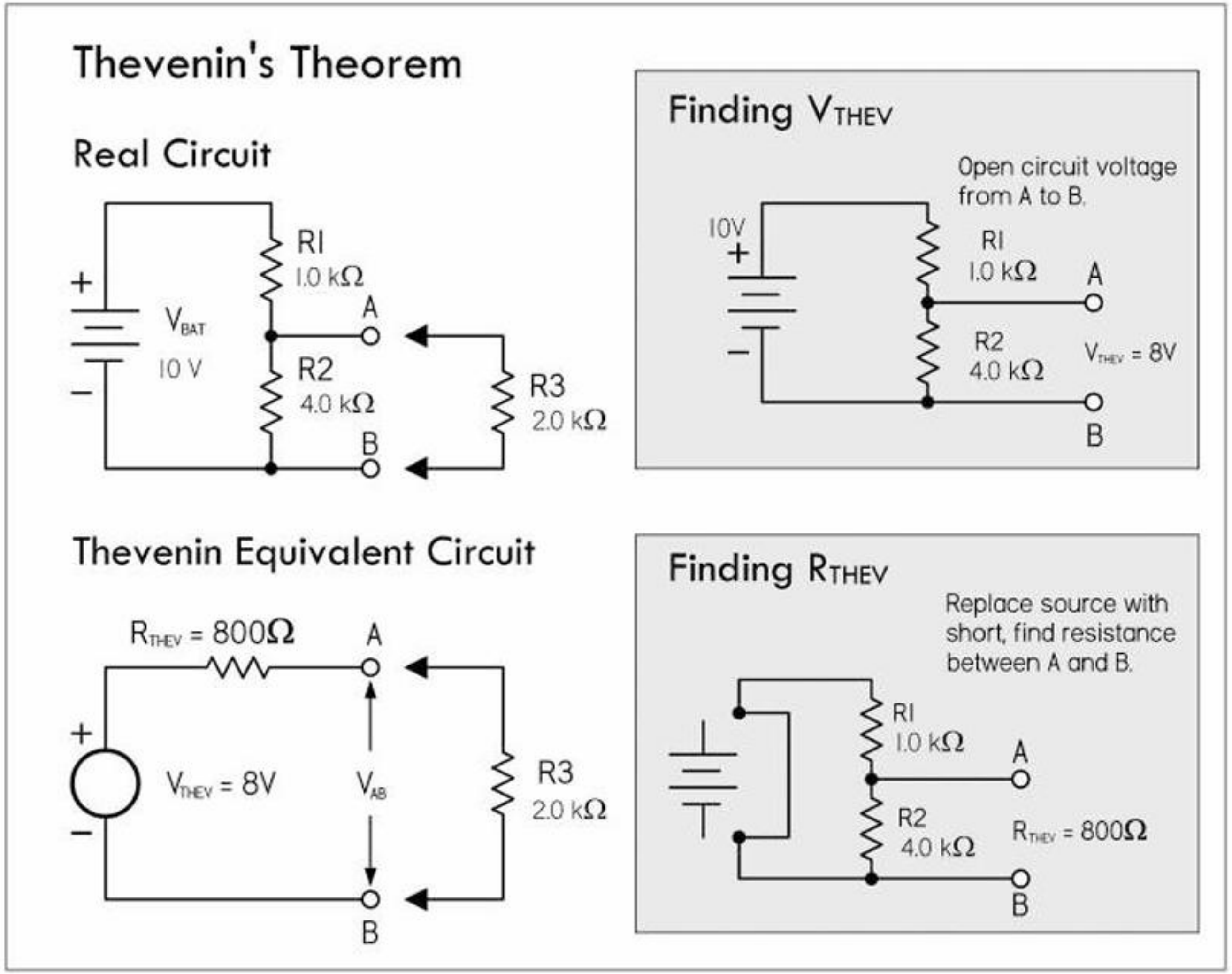


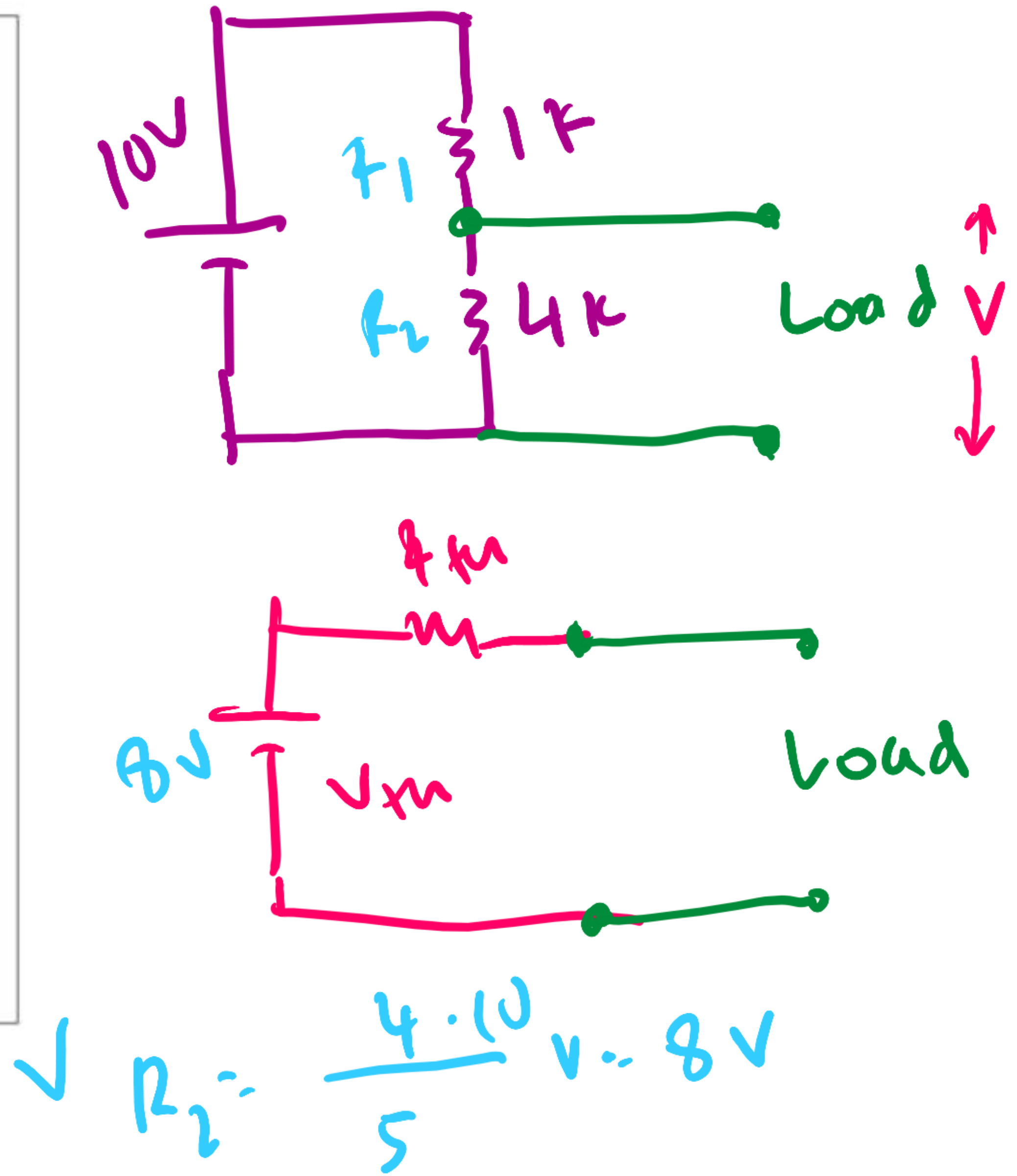

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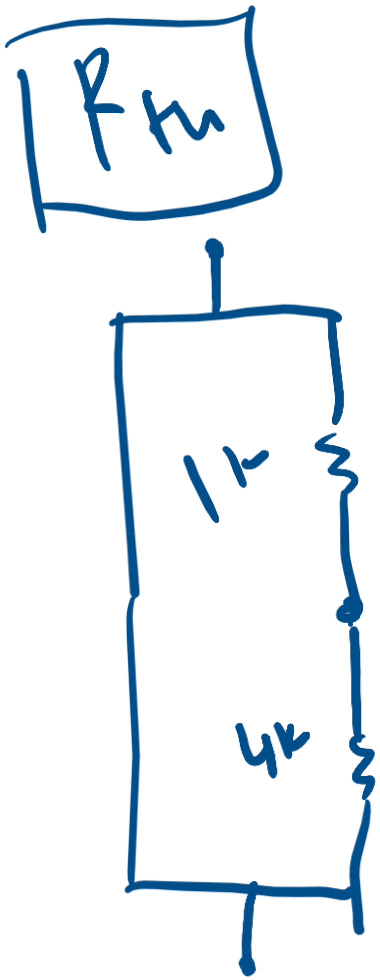
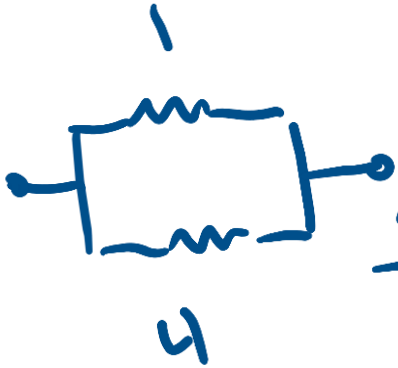


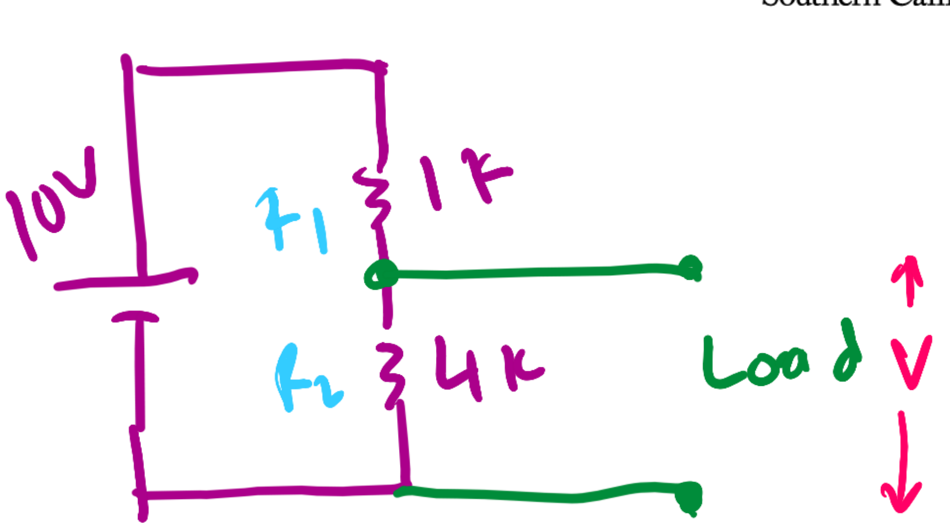

$$\frac{1}{R_{eq}} = \frac{1}{1k} + \frac{1}{4k}$$

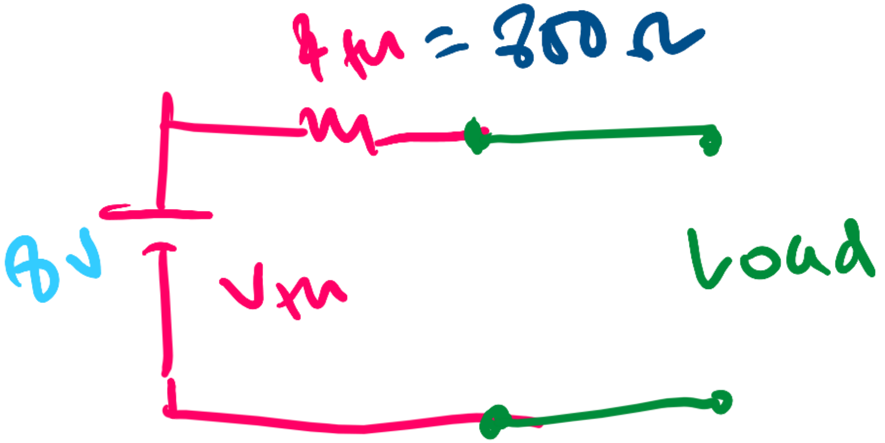
$$= \frac{5}{1.4}$$




$$\frac{1}{R_{eq}} = \frac{5}{4}$$

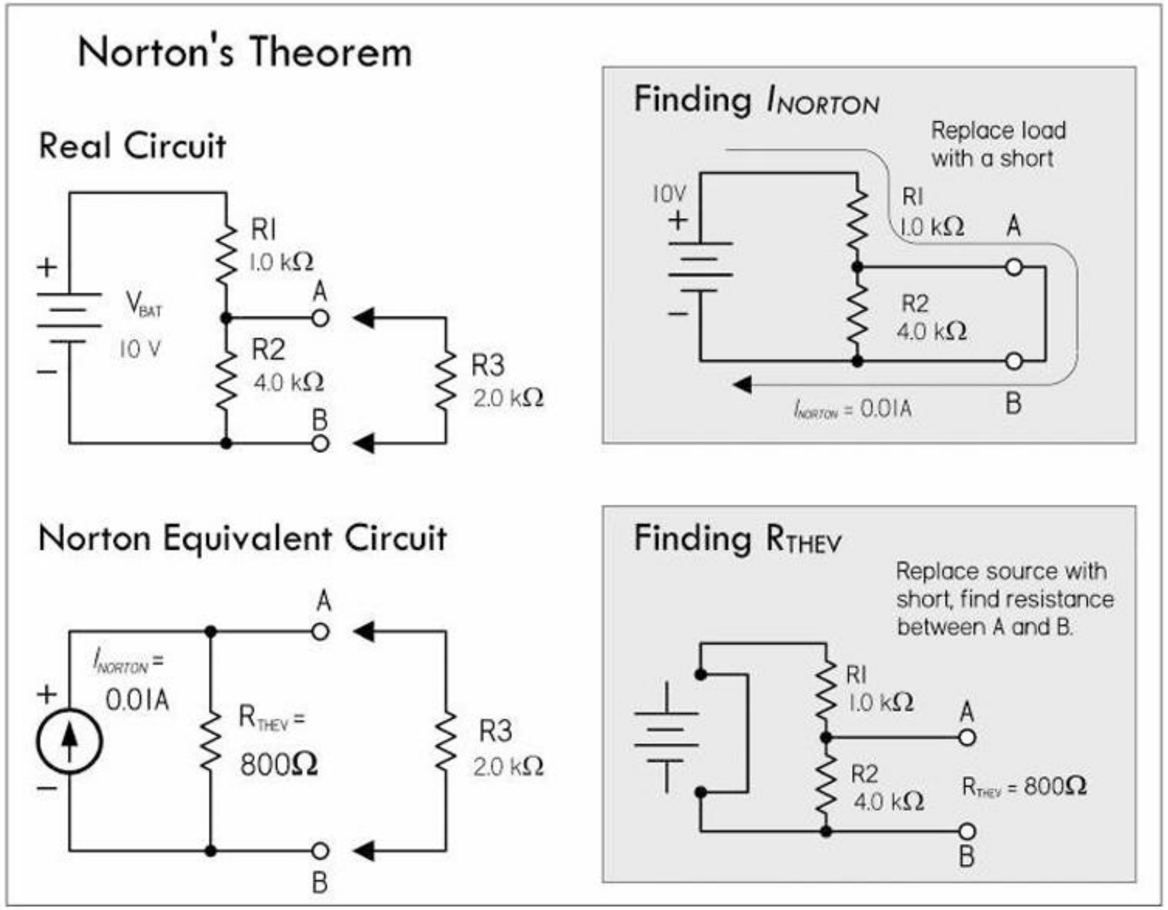
$$R_{eq} = 800\ \Omega$$

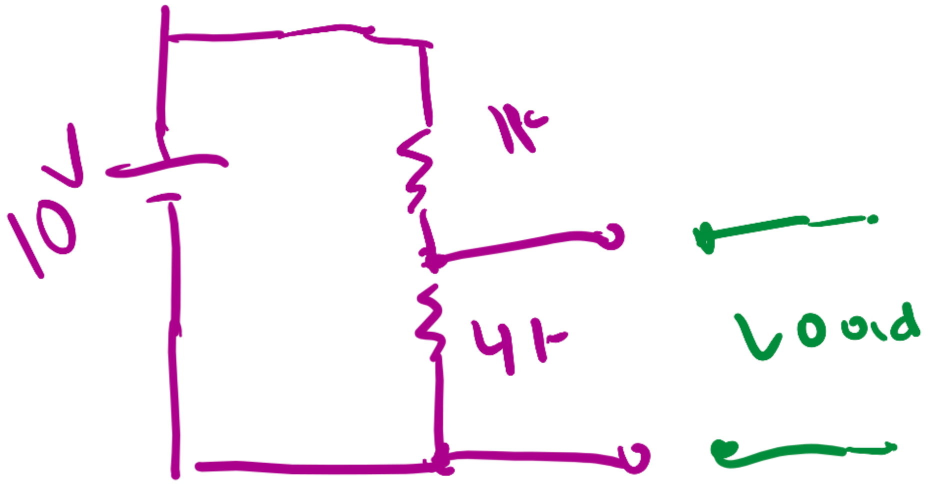


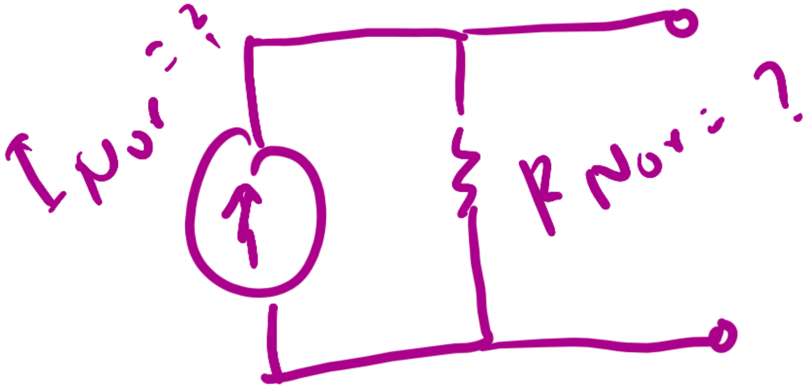




$$\checkmark\ R_2 = \frac{4 \cdot 10}{5} V = 8V$$

# Norton's equivalent circuit



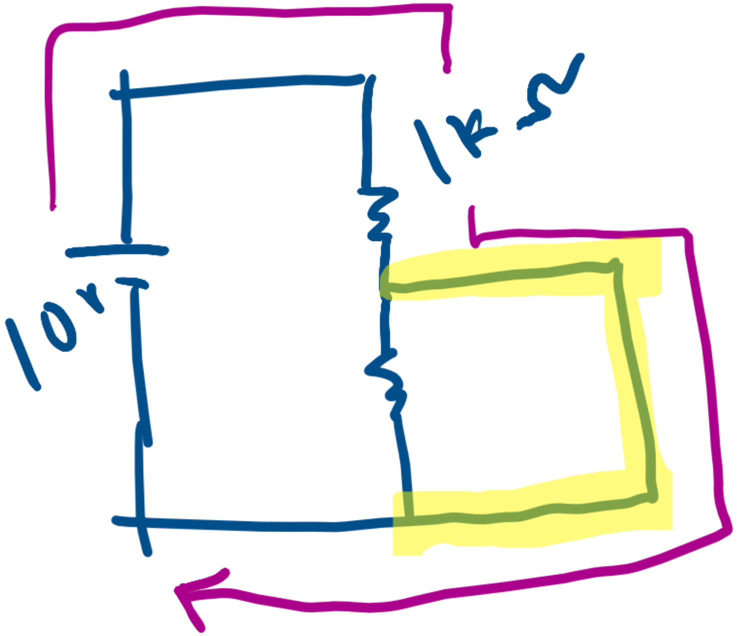




$R_{Nor} = R_{Th} = 800\ \Omega$

# Norton's equivalent circuit

Replace load with a short.

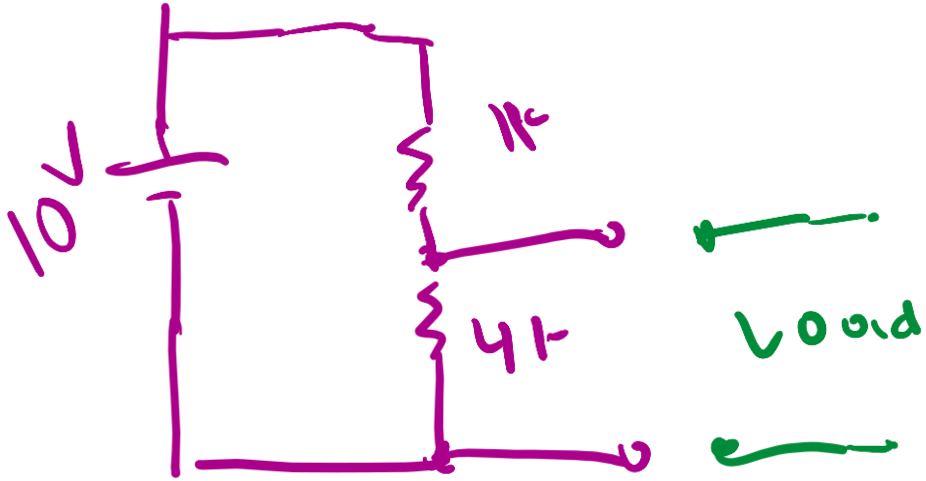


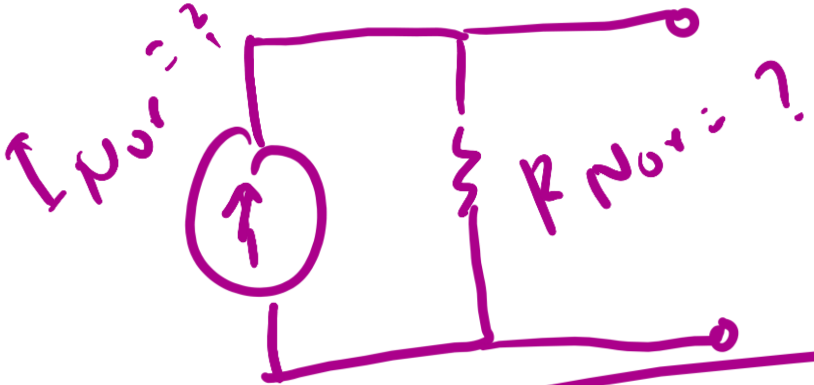

$V = IR$

$I = \frac{V}{R} = \frac{10V}{1K}$

$= .01A$

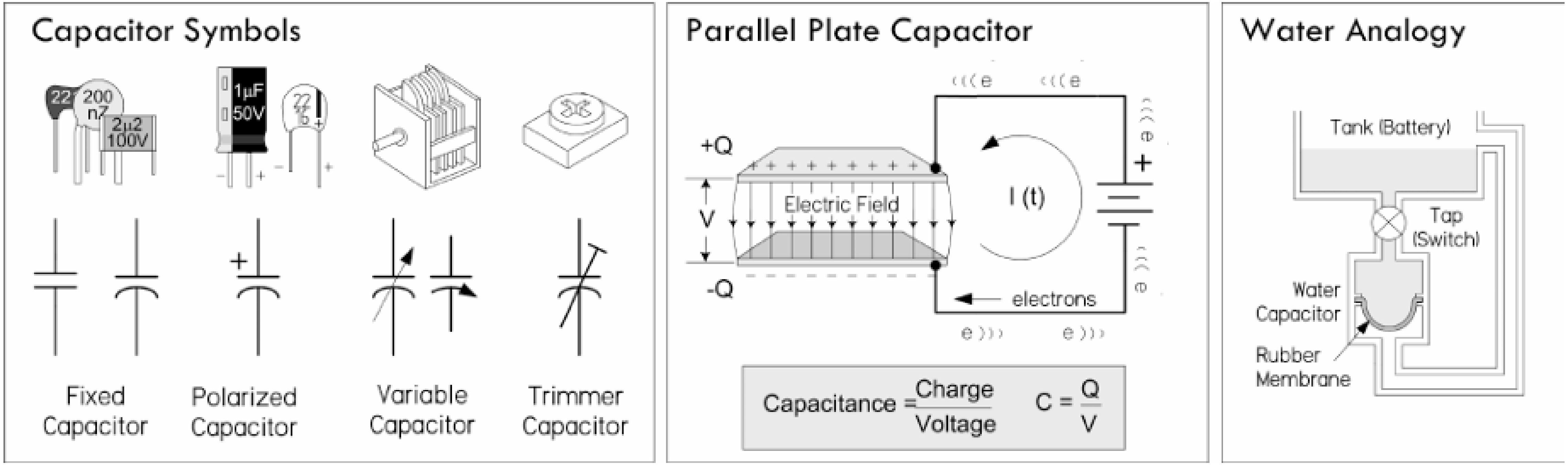
$I_{Nor} = .01A$



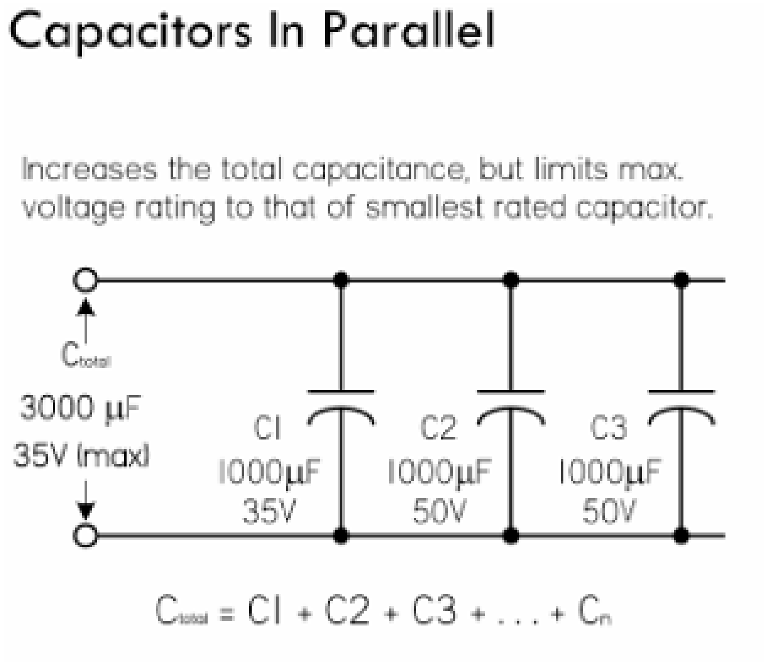




$R_{Nor} = R_{Th} = 800\,\Omega$

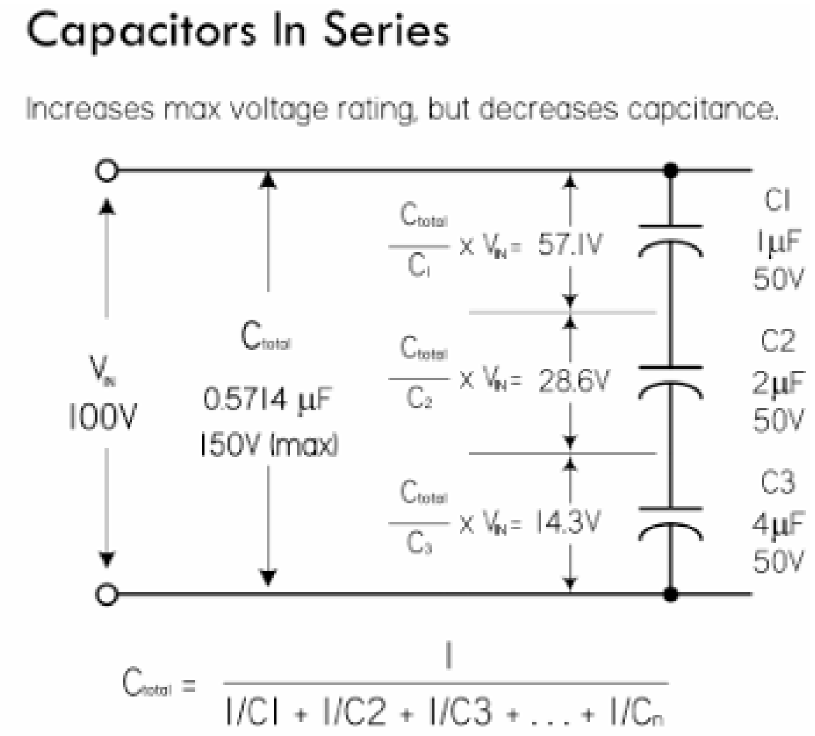
# Capacitors


Capacitor Symbols
1μF
50V
Fixed Capacitor
Polarized Capacitor
Variable Capacitor
Trimmer Capacitor
Parallel Plate Capacitor
+Q
-Q
V
Electric Field
I (t)
electrons
Capacitance = Charge / Voltage
C = Q / V
Water Analogy
Tank (Battery)
Tap (Switch)
Water Capacitor
Rubber Membrane

# Capacitors



Capacitors In Parallel
Increases the total capacitance, but limits max. voltage rating to that of smallest rated capacitor.
Ctotal
3000 µF
35V (max)
C1
1000µF
35V
C2
1000µF
50V
C3
1000µF
50V
Ctotal = C1 + C2 + C3 + . . . + Cn

Capacitors In Series
Increases max voltage rating, but decreases capcitance.
VIN
100V
Ctotal
0.5714 µF
150V (max)
Ctotal / C1 x VIN = 57.1V
Ctotal / C2 x VIN = 28.6V
Ctotal / C3 x VIN = 14.3V
C1
1µF
50V
C2
2µF
50V
C3
4µF
50V
Ctotal = 1 / (1/C1 + 1/C2 + 1/C3 + . . . + 1/Cn)

# Inductors

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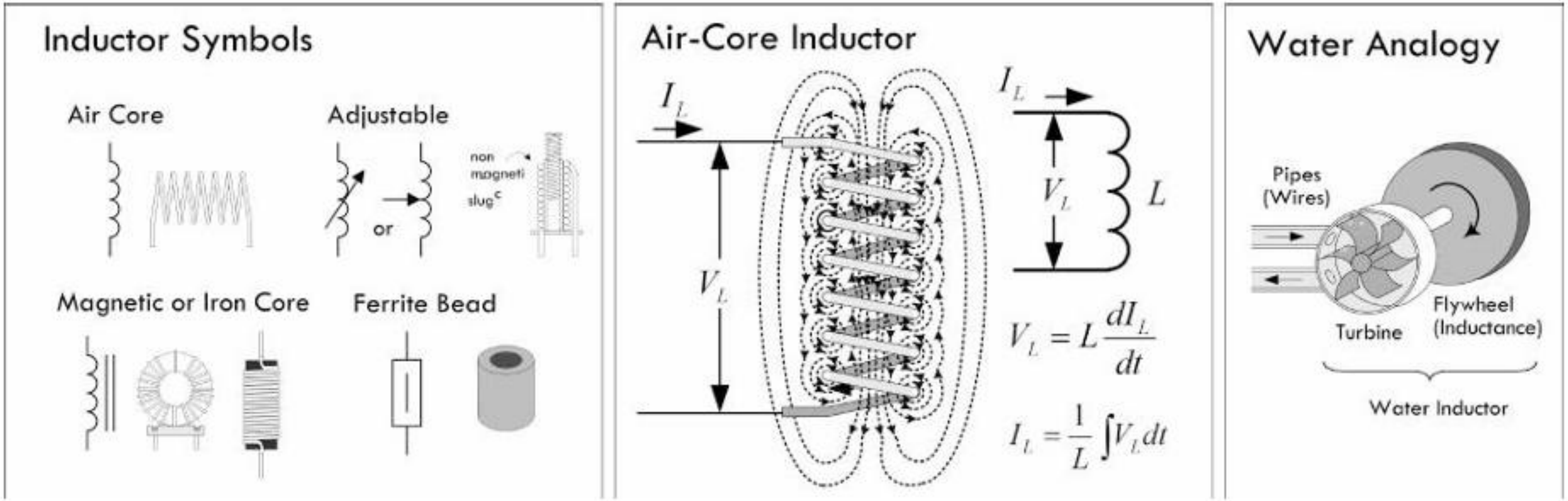

# Inductors

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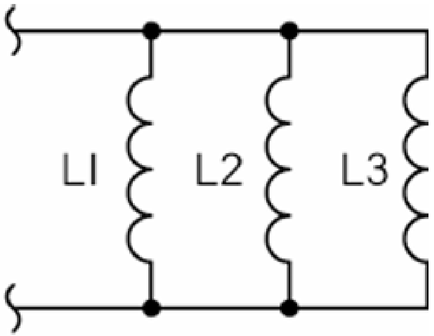
Inductors in Series



Inductors in parallel

$$L_{eq} = L_1 + L_2 + L_3$$

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

# Problem 1

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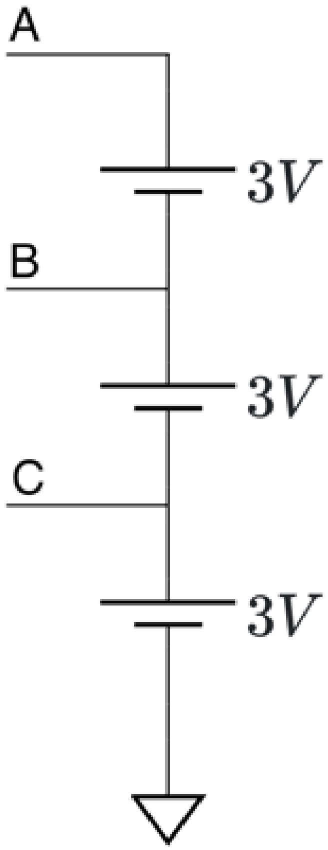
Given the circuit diagram with nodes **A, B,** and **C**, each connected to **3V** sources as shown. Determine the voltages $\mathbf{V_A}$, $\mathbf{V_B}$, and $\mathbf{V_C}$ at the respective nodes with respect to the ground.



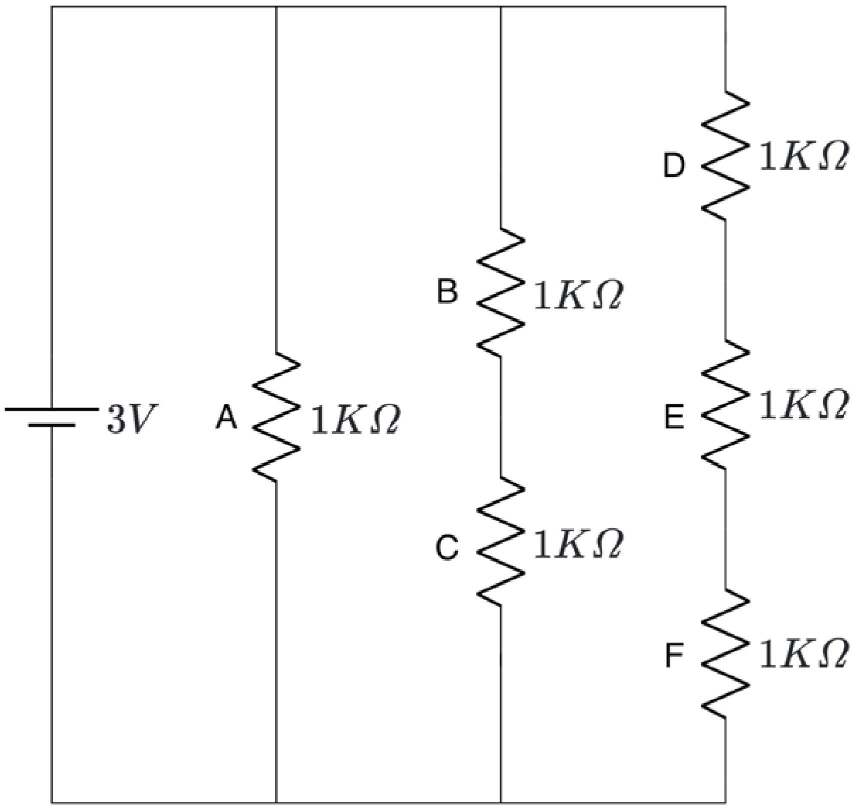
# KCL

# Voltage divider

# Current divider

# Problem 2

Given the circuit with six resistors connected to a **3V** voltage source as shown. Find voltages across the resistors (**$V_A$, $V_B$, $V_C$, $V_D$, $V_E$,** and **$V_F$**) and current through resistors (**$I_A$, $I_B$, $I_C$, $I_D$, $I_E$,** and **$I_F$**).



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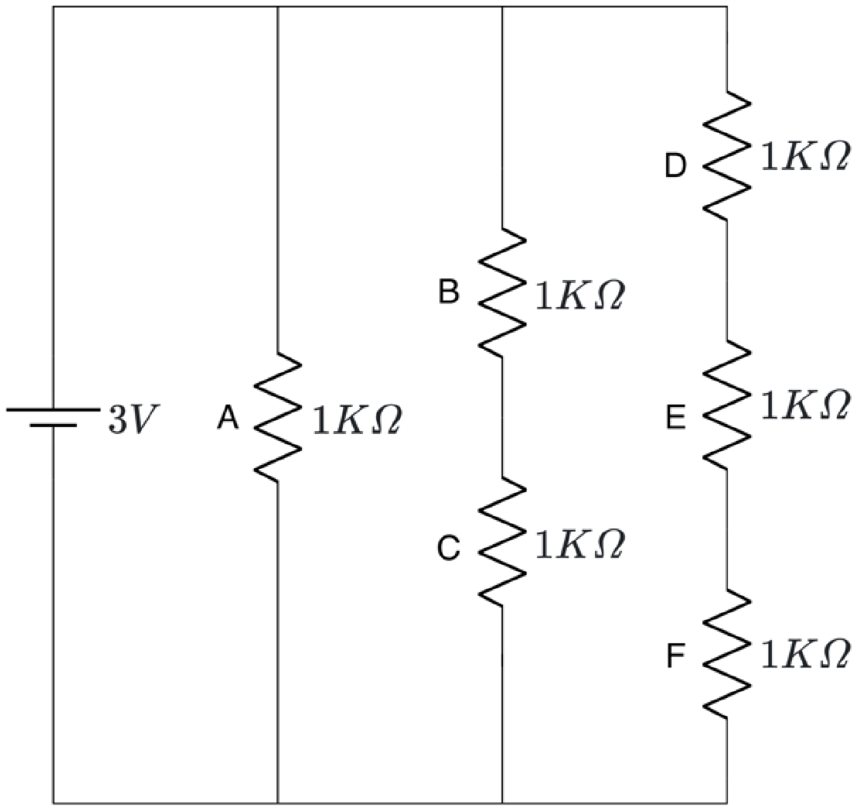
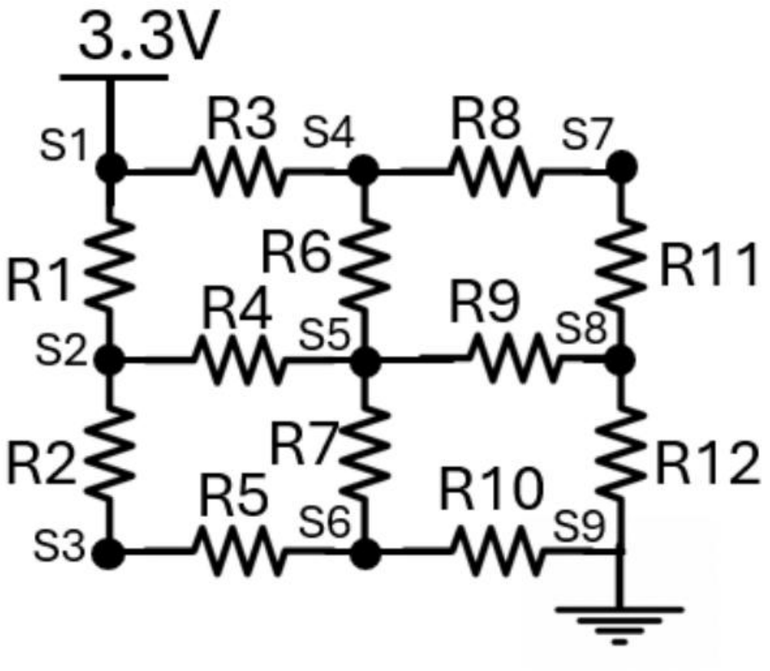


# Problem 3

Given the circuit diagram with nodes **$S_1$ to $S_9$**, **$S_1$** is connected to **3.3V** and GND (0V). Determine the voltages **$S_1$ to $S_9$** at the respective nodes with respect to the ground if **$R_1$ to $R_{12}$** = R



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