

Elementary Engineering Mathematics
Equation Sheet #5 – Electric Circuits

Kirchhoff's Voltage and Current Laws (DC and AC Circuits)

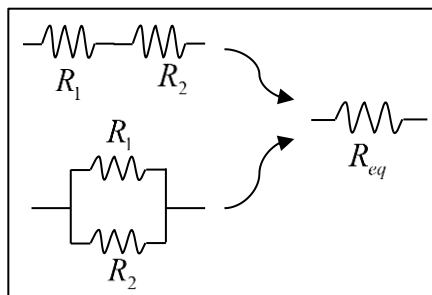
	Equation	Description
Kirchhoff's Voltage Law	$\sum(\text{voltage rises}) = \sum(\text{voltage drops})$	The sum of voltage rises must equal the sum of the voltage drops around any loop in a circuit.
Kirchhoff's Current Law	$\sum(\text{currents in}) = \sum(\text{currents out})$	The sum of the currents flowing into a node equals to the sum of the currents flowing away from a node.

DC Resistor Circuits

Ohm's Law	$V_R = R I$	The voltage drop across a resistor is the product of its resistance and the current passing through it.
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Resistors in Series/Parallel

- The **equivalent resistance** of resistors in **series** is the **sum** of the **individual resistances**.
- The **equivalent resistance** of resistors in **parallel** is the **inverse sum** of the **inverse resistances**.
- For 2 elements:



Series	Parallel
$R_{eq} = R_1 + R_2$	$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{R_1 R_2}{R_1 + R_2}$

AC Circuits

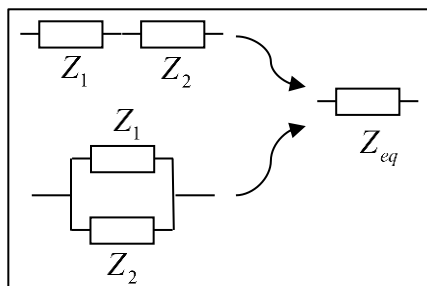
Complex form of Ohm's Law	$V = Z I$	The voltage drop across an element is the product of its impedance and the current passing through it.
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Impedances for AC circuit elements (ω is the frequency in radians/sec)

	Resistor	Capacitor	Inductor
Impedance	$Z_R = R$	$Z_C = -j/\omega C$	$Z_L = j\omega L$

Elements in Series/Parallel

- The **equivalent impedance** of elements in **series** is the **sum** of the **individual impedances**.
- The **equivalent impedance** of elements in **parallel** is the **inverse sum** of the **inverse impedances**.
- For 2 elements:



Series	Parallel
$Z_{eq} = Z_1 + Z_2$	$Z_{eq} = \frac{1}{\frac{1}{Z_1} + \frac{1}{Z_2}} = \frac{Z_1 Z_2}{Z_1 + Z_2}$