Elementary Engineering Mathematics
Equation Sheet #5 – Electric Circuits

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

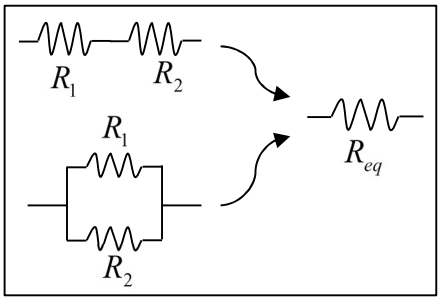
	Equation	Description
Kirchhoff's Voltage Law	$\sum(\text{voltage rises}) = \sum(\text{voltage drops})$	The ***sum*** of ***voltage rises*** must equal the ***sum*** of the ***voltage drops*** around any loop in a circuit.
Kirchhoff's Current Law	$\sum(\text{currents in}) = \sum(\text{currents out})$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

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
$R_{eq} = R_1 + R_2$	$R_{eq} = \dfrac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_2}} = \dfrac{R_1 R_2}{R_1 + R_2}$

AC Circuits

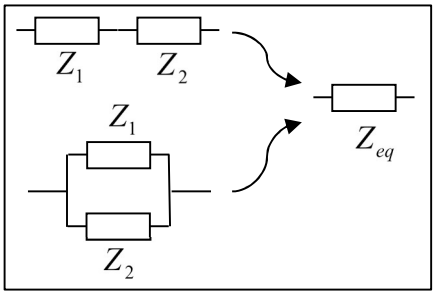
Complex form of Ohm's Law	$V = Z\,I$	The ***voltage drop across an element*** is the product of its impedance and the current passing through it.

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
$Z_{eq} = Z_1 + Z_2$	$Z_{eq} = \dfrac{1}{\dfrac{1}{Z_1} + \dfrac{1}{Z_2}} = \dfrac{Z_1 Z_2}{Z_1 + Z_2}$