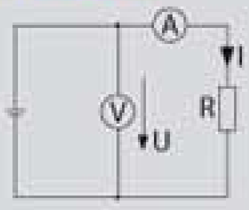
Experimenting – Learning – Understanding

Key formulae for Electrical Engineering

Ohm's law

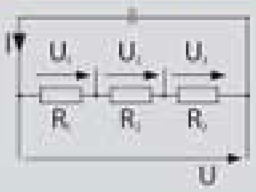


$U = IR$

I	Current in A
U	Voltage in V
R	Resistance in Ω

$1\Omega = \frac{1V}{1A}$

Resistors connected in series

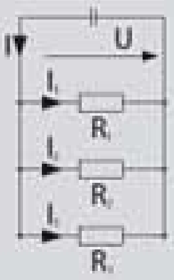


$U = U_1 + U_2 + U_3 + ...$
$R = R_1 + R_2 + R_3 + ...$

$I = \frac{U}{R} = \frac{U_1}{R_1} = \frac{U_2}{R_2} = \frac{U_3}{R_3}$

U	Total voltage in V
U_1, U_2	Voltages across individual resistors in V
R	Total resistance in Ω
R_1, R_2	Resistance of individual resistors in Ω

Resistors connected in parallel



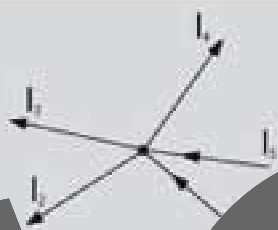
$I = I_1 + I_2 + I_3 + ...$
$G = G_1 + G_2 + G_3 + ...$

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$

$U = I \cdot R = I_1 \cdot R_1 = I_2 \cdot R_2$

I	Total current in A
I_1, I_2	Current through individual resistors …
R	Total resista…
G	Overall cond… in S
G_1, G_2	Conductance o… dual resistors in S
…	…tance of indi… …rs in Ω

Kirchhoff's first law (current law)



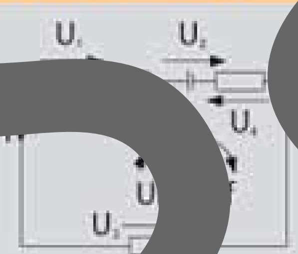
At any junctio… in … electrica… circuit, the … urrents flowing tow… t point is equal to the … currents flowing away f… at point.

… $= \Sigma I_{out}$

Example:
$I_1 = 3A$; $I_2 = 6A$, …; $I_4 = 1{,}5A$;
… $= ?A$

…**tion:**
… $= I_2 + I_3 + I_4$
… $I_2 + I_3 + I_4 - I_1$
$I_5 = 6A + 2A + 1{,}5A - 3A$
$I_5 = 9{,}5A - 3A = 6{,}5A$

Kirchhoff's second law (… law)



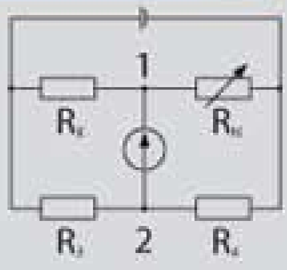
In any … current loop the direct… of the electrical pot… l differences around … op must be zero. Directed … eans that if you trace around the loop in a specific direction (either direction is just as valid) voltages in the same direction as you are tracing are considered positive and those in the opposite direction count as negative.

$\Sigma U = 0$

Example:
$U_1 = 4{,}5V$; $U_2 = 1{,}5V$; $U_4 = 1V$; $U_5 = 3V$;
$U_3 = ?V$;

Solution:
$U_1 + U_2 - U_5 - U_4 - U_3 = 0$
$U_3 = U_1 + U_2 - U_4 - U_5$
$= 4{,}5V + 1{,}5V - 3V - 1V$
$U_3 = 2V$

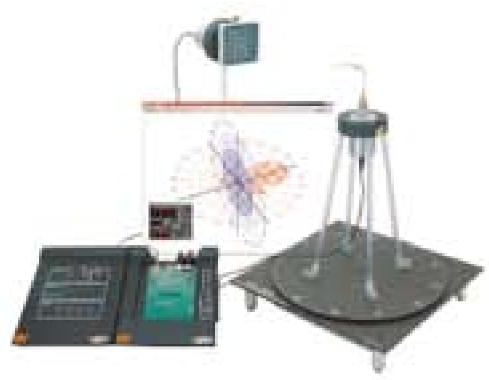
Wheatstone's bridge



To achieve balance ($I_{12} = 0$):

$\frac{R_x}{R_N} = \frac{R_3}{R_4}$

R_x	Unknown resistance in Ω
R_N	Variable resistance in V
R_3, R_4	Known bridge resistors in Ω



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