

Ohm's law and power

Ohm's law	$V = I \times R$
Power	$P = V \times I = I^2 \times R = V^2 \div R$
Series	$R = R_1 + R_2 + \dots$
Parallel	$1/R = 1/R_1 + 1/R_2 + \dots$

AC power

Single phase	$P = V \times I \times \cos \phi$
Three phase	$P = \sqrt{3} \times V_L \times I_L \times \cos \phi$
Apparent power	$S = \sqrt{3} \times V_L \times I_L$ (kVA)
Power triangle	$S^2 = P^2 + Q^2$
RMS	$V_{rms} = V_{peak} \div \sqrt{2}$

Star and delta

	Star (Y)	Delta (Δ)
Line voltage	$\sqrt{3} \times V_{ph}$	V_{ph}
Line current	I_{ph}	$\sqrt{3} \times I_{ph}$
Star delta starting	Current and torque $\div 3$	

Motors

Full load current	$I = P \div (\sqrt{3} \times V \times \eta \times \cos \phi)$
Synchronous speed	$N_s = 120 \times f \div \text{poles}$
Slip	$s = (N_s - N) \div N_s$
Torque	$T \text{ (N·m)} = 9549 \times P \text{ (kW)} \div N \text{ (rpm)}$
Rule of thumb	415 V motor: about 1.8 A per kW

Voltage drop

Single phase	$\Delta V = 2 \times I \times L \times (R \cos \phi + X \sin \phi)$
Three phase	$\Delta V = \sqrt{3} \times I \times L \times (R \cos \phi + X \sin \phi)$
Limits (typical)	3 % lighting, 5 % power

Power factor correction

Capacitor	$Q_c = P \times (\tan \phi_1 - \tan \phi_2)$ kVAR
Example	100 kW from 0.8 to 0.95: 42 kVAR

Copper and cables

Item	Value
Copper resistivity (20 °C)	0.0172 $\Omega \cdot \text{mm}^2/\text{m}$
Aluminium resistivity	0.0282 $\Omega \cdot \text{mm}^2/\text{m}$
Copper temperature coefficient	0.00393 per °C
1.5 mm ² copper	about 12.1 Ω/km (IEC 60228 class 2)
2.5 mm ² copper	about 7.41 Ω/km

Reactance and resonance

Inductive	$X_L = 2\pi f L$
Capacitive	$X_C = 1 \div (2\pi f C)$
Resonance	$f_0 = 1 \div (2\pi \sqrt{L C})$
Time constant	$\tau = R C$ or $L \div R$

Energy

Energy	$E \text{ (kWh)} = P \text{ (kW)} \times t \text{ (h)}$
Battery	Backup (h) $\approx Ah \times V \div \text{load (W)}$