

Important Magnetic Circuit Formulas PDF



Formulas Examples with Units

List of 23 Important Magnetic Circuit Formulas

1) Electrical Specifications Formulas

1.1) Energy Stored in Magnetic Field Formula

Formula

$$E = \frac{B^2}{\mu}$$

Example with Units

$$10.2041 \text{ J} = \frac{0.2 \text{ T}^2}{0.14 \text{ H/m}}$$

Evaluate Formula

1.2) Forces on Charges Moving in Magnetic Fields Formula

Formula

$$F = q \cdot u \cdot B \cdot \sin(\theta)$$

Example with Units

$$0.153 \text{ N} = 0.18 \text{ mC} \cdot 4250 \text{ m/s} \cdot 0.2 \text{ T} \cdot \sin(90^\circ)$$

Evaluate Formula

1.3) Forces on Current Carrying Wires Formula

Formula

$$F = B \cdot i \cdot l \cdot \sin(\theta)$$

Example with Units

$$0.1561 \text{ N} = 0.2 \text{ T} \cdot 2.89 \text{ A} \cdot 270 \text{ mm} \cdot \sin(90^\circ)$$

Evaluate Formula

1.4) Minimum Frequency to Avoid Saturation Formula

Formula

$$f = \frac{V_m}{2 \cdot \pi \cdot N_2 \cdot A}$$

Example with Units

$$15.5618 \text{ Hz} = \frac{440 \text{ V}}{2 \cdot 3.1416 \cdot 18 \cdot 0.25 \text{ m}^2}$$

Evaluate Formula

1.5) Percent Voltage Regulation Formula

Formula

$$\% = \left(\frac{V_{nl} - e}{e} \right) \cdot 100$$

Example with Units

$$22.0044 = \left(\frac{280 \text{ V} - 229.5 \text{ V}}{229.5 \text{ V}} \right) \cdot 100$$

Evaluate Formula

1.6) Voltages Induced in Field Cutting Conductors Formula

Formula

$$e = B \cdot l \cdot u$$

Example with Units

$$229.5 \text{ V} = 0.2 \text{ T} \cdot 270 \text{ mm} \cdot 4250 \text{ m/s}$$

Evaluate Formula



2) Magnetic Specifications Formulas

2.1) Average Hysteresis Power Loss Formula

Formula

$$P_{\text{hysteresis}} = K_h \cdot f \cdot B^n$$

Example with Units

$$2.5237 \text{ W} = 2.13 \text{ J/m}^3 \cdot 15.56 \text{ Hz} \cdot 0.2 \text{ T}^{1.6}$$

Evaluate Formula 

2.2) Flux Density in Toroidal Core Formula

Formula

$$B = \frac{\mu_r \cdot N_2 \cdot i_{\text{coil}}}{\pi \cdot D_{\text{in}}}$$

Example with Units

$$0.2292 \text{ T} = \frac{1.9 \text{ H/m} \cdot 18 \cdot 0.012 \text{ A}}{3.1416 \cdot 570 \text{ mm}}$$

Evaluate Formula 

2.3) Intensity of Magnetization Formula

Formula

$$I_{\text{mag}} = \frac{m}{V}$$

Example with Units

$$0.8108 \text{ A/m} = \frac{1.5 \text{ A}^2\text{m}^2}{1.85 \text{ m}^3}$$

Evaluate Formula 

2.4) Magnetic Field Strength Formula

Formula

$$H = \frac{F}{m}$$

Example with Units

$$0.1 \text{ A/m} = \frac{0.15 \text{ N}}{1.5 \text{ A}^2\text{m}^2}$$

Evaluate Formula 

2.5) Magnetic Flux Density Formula

Formula

$$B = \frac{\Phi_m}{A}$$

Example with Units

$$0.2 \text{ T} = \frac{0.05 \text{ Wb}}{0.25 \text{ m}^2}$$

Evaluate Formula 

2.6) Magnetic Flux Density using Magnetic Field Intensity Formula

Formula

$$B = \mu \cdot I$$

Example with Units

$$0.252 \text{ T} = 0.14 \text{ H/m} \cdot 1.8 \text{ A/m}$$

Evaluate Formula 

2.7) Magnetic Flux in Core Formula

Formula

$$\Phi_m = \frac{\text{mmf}}{S}$$

Example with Units

$$0.0574 \text{ Wb} = \frac{0.035 \text{ AT}}{0.61 \text{ AT/Wb}}$$

Evaluate Formula 

2.8) Magnetic Flux using Flux Density Formula

Formula

$$\Phi_m = B \cdot A$$

Example with Units

$$0.05 \text{ Wb} = 0.2 \text{ T} \cdot 0.25 \text{ m}^2$$

Evaluate Formula 



2.9) Magnetic Potential Formula

Formula

Evaluate Formula 

$$\psi = \frac{m}{4 \cdot \pi \cdot [\text{Permeability-vacuum}] \cdot \mu_r \cdot D_{\text{poles}}}$$

Example with Units

$$62492.5064 = \frac{1.5 \text{ A} \cdot \text{m}^2}{4 \cdot 3.1416 \cdot 1.3\text{E}-6 \cdot 1.9 \text{ H/m} \cdot 800 \text{ mm}}$$

2.10) Magnetic Susceptibility Formula

Formula

Example with Units

Evaluate Formula 

$$\chi = \frac{I_{\text{mag}}}{I}$$

$$0.45 \text{ H/m} = \frac{0.81 \text{ A/m}}{1.8 \text{ A/m}}$$

2.11) Mutual Inductance Formula

Formula

Evaluate Formula 

$$M = \frac{[\text{Permeability-vacuum}] \cdot \mu_r \cdot A \cdot Z \cdot N_2}{L_{\text{mean}}}$$

Example with Units

$$0.7461 \text{ H} = \frac{1.3\text{E}-6 \cdot 1.9 \text{ H/m} \cdot 0.25 \text{ m}^2 \cdot 1500 \cdot 18}{21.6 \text{ mm}}$$

2.12) Permeance Formula

Formula

Example with Units

Evaluate Formula 

$$P = \frac{1}{S}$$

$$1.6393 \text{ H} = \frac{1}{0.61 \text{ AT/Wb}}$$

2.13) Reluctance Formula

Formula

Example with Units

Evaluate Formula 

$$S = \frac{L_{\text{mean}}}{\mu \cdot A}$$

$$0.6171 \text{ AT/Wb} = \frac{21.6 \text{ mm}}{0.14 \text{ H/m} \cdot 0.25 \text{ m}^2}$$

2.14) Self Inductance Formula

Formula

Example with Units

Evaluate Formula 

$$L = \frac{Z \cdot \Phi_m}{i_{\text{coil}}}$$

$$6250 \text{ H} = \frac{1500 \cdot 0.05 \text{ Wb}}{0.012 \text{ A}}$$



3) Mechanical Specifications Formulas

3.1) Area of Ring Formula

Formula

$$A = \frac{\pi \cdot D_{in}^2}{4}$$

Example with Units

$$0.2552 \text{ m}^2 = \frac{3.1416 \cdot 570 \text{ mm}^2}{4}$$

Evaluate Formula 

3.2) Mean Diameter Formula

Formula

$$D_{mean} = \frac{L_{mean}}{\pi}$$

Example with Units

$$6.8755 \text{ mm} = \frac{21.6 \text{ mm}}{3.1416}$$

Evaluate Formula 

3.3) Mean Length Formula

Formula

$$L_{mean} = \pi \cdot D_{mean}$$

Example with Units

$$21.677 \text{ mm} = 3.1416 \cdot 6.9 \text{ mm}$$

Evaluate Formula 



Variables used in list of Magnetic Circuit Formulas above

- % Percentage Regulation
- **A** Area of Coil (Square Meter)
- **B** Magnetic Flux Density (Tesla)
- **D_{in}** Coil Inner Diameter (Millimeter)
- **D_{mean}** Mean Diameter (Millimeter)
- **D_{poles}** Pole Distance (Millimeter)
- **e** Voltage (Volt)
- **E** Energy (Joule)
- **f** Frequency (Hertz)
- **F** Force (Newton)
- **H** Magnetic Field Strength (Ampere per Meter)
- **i** Electric Current (Ampere)
- **I** Magnetic Field Intensity (Ampere per Meter)
- **i_{coil}** Coil Current (Ampere)
- **I_{mag}** Intensity of Magnetization (Ampere per Meter)
- **K_h** Hysteresis Constant (Joule per Cubic Meter)
- **l** Length of Conductor (Millimeter)
- **L** Self Inductance (Henry)
- **L_{mean}** Mean Length (Millimeter)
- **m** Magnetic Moment (Ampere Square Meter)
- **M** Mutual Inductance (Henry)
- **mmf** Magnetomotive Force (Ampere-Turn)
- **n** Steinmetz Coefficient
- **N₂** Secondary Turns of Coil
- **P** Magnetic Permeance (Henry)
- **P_{hysteresis}** Hysteresis Loss (Watt)
- **q** Electric Charge (Millicoulomb)
- **S** Reluctance (Ampere-Turn per Weber)
- **u** Charge Velocity (Meter per Second)
- **V** Volume (Cubic Meter)
- **V_m** Peak Voltage (Volt)
- **V_{nl}** No Load Voltage (Volt)
- **x** Magnetic Susceptibility (Henry per Meter)

Constants, Functions, Measurements used in list of Magnetic Circuit Formulas above

- **constant(s):** pi, 3.14159265358979323846264338327950288
Archimedes' constant
- **constant(s):** [Permeability-vacuum], 1.2566E-6
Permeability of vacuum
- **Functions:** sin, sin(Angle)
Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- **Measurement: Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement: Electric Current** in Ampere (A)
Electric Current Unit Conversion 
- **Measurement: Volume** in Cubic Meter (m³)
Volume Unit Conversion 
- **Measurement: Area** in Square Meter (m²)
Area Unit Conversion 
- **Measurement: Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Energy** in Joule (J)
Energy Unit Conversion 
- **Measurement: Electric Charge** in Millicoulomb (mC)
Electric Charge Unit Conversion 
- **Measurement: Power** in Watt (W)
Power Unit Conversion 
- **Measurement: Force** in Newton (N)
Force Unit Conversion 
- **Measurement: Angle** in Degree (°)
Angle Unit Conversion 
- **Measurement: Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement: Magnetic Flux** in Weber (Wb)
Magnetic Flux Unit Conversion 
- **Measurement: Inductance** in Henry (H)
Inductance Unit Conversion 
- **Measurement: Magnetic Flux Density** in Tesla (T)
Magnetic Flux Density Unit Conversion 



- **Z** Number of Conductors
 - **θ** Angle between Vectors (Degree)
 - **μ** Magnetic Permeability of a Medium (Henry per Meter)
 - **μ_r** Relative Permeability (Henry per Meter)
 - **Φ_m** Magnetic Flux (Weber)
 - **ψ** Magnetic Potential
- **Measurement: Magnetomotive Force** in Ampere-Turn (AT)
Magnetomotive Force Unit Conversion 
 - **Measurement: Magnetic Field Strength** in Ampere per Meter (A/m)
Magnetic Field Strength Unit Conversion 
 - **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
 - **Measurement: Magnetic Permeability** in Henry per Meter (H/m)
Magnetic Permeability Unit Conversion 
 - **Measurement: Magnetic Moment** in Ampere Square Meter (A*m²)
Magnetic Moment Unit Conversion 
 - **Measurement: Energy Density** in Joule per Cubic Meter (J/m³)
Energy Density Unit Conversion 
 - **Measurement: Reluctance** in Ampere-Turn per Weber (AT/Wb)
Reluctance Unit Conversion 



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7/8/2024 | 1:03:23 PM UTC

