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# Magnetic Circuit Formulas

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# List of 23 Magnetic Circuit Formulas

## Magnetic Circuit

### Electrical Specifications

#### 1) Energy Stored in Magnetic Field

Open Calculator

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

ex $$10.20408\text{J} = \frac{0.2\text{T}}{(0.14\text{H/m})^2}$$

#### 2) Forces on Charges Moving in Magnetic Fields

Open Calculator

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

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

#### 3) Forces on Current Carrying Wires

Open Calculator

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

ex $$0.15606\text{N} = 0.2\text{T} \cdot 2.89\text{A} \cdot 270\text{mm} \cdot \sin(90^\circ)$$

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### 4) Minimum Frequency to Avoid Saturation

Open Calculator

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

ex $$15.56182\text{Hz} = \frac{440\text{V}}{2 \cdot \pi \cdot 18 \cdot 0.25\text{m}^2}$$

### 5) Percent Voltage Regulation

Open Calculator

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

ex $$22.00436 = \left(\frac{280\text{V} - 229.5\text{V}}{229.5\text{V}}\right) \cdot 100$$

### 6) Voltages Induced in Field Cutting Conductors

Open Calculator

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

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

## Magnetic Specifications

### 7) Average Hysteresis Power Loss

Open Calculator

fx $$P_{hystersis} = K_h \cdot f \cdot B^n$$

ex $$2.523697\text{W} = 2.13\text{J/m}^3 \cdot 15.56\text{Hz} \cdot (0.2\text{T})^{1.6}$$

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## 8) Flux Density in Toroidal Core

Open Calculator

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

ex $$0.229183\text{T} = \frac{1.9\text{H/m} \cdot 18 \cdot 0.012\text{A}}{\pi \cdot 570\text{mm}}$$

## 9) Intensity of Magnetization

Open Calculator

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

ex $$0.810811\text{A/m} = \frac{1.5\text{A*m}^2}{1.85\text{m}^3}$$

## 10) Magnetic Field Strength

Open Calculator

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

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

## 11) Magnetic Flux Density

Open Calculator

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

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

## 12) Magnetic Flux Density using Magnetic Field Intensity

Open Calculator

fx $$B = \mu \cdot I$$

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

## 13) Magnetic Flux in Core

Open Calculator

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

ex $$0.057377\text{Wb} = \frac{0.035\text{AT}}{0.61\text{AT/Wb}}$$

## 14) Magnetic Flux using Flux Density

Open Calculator

fx $$\Phi_m = B \cdot A$$

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

## 15) Magnetic Potential

Open Calculator

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

ex $$62492.51 = \frac{1.5\text{A*m}^2}{4 \cdot \pi \cdot [\text{Permeability-vacuum}] \cdot 1.9\text{H/m} \cdot 800\text{mm}}$$

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## 16) Magnetic Susceptibility

Open Calculator

fx $$x = \frac{I_{mag}}{I}$$

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

## 17) Mutual Inductance

Open Calculator

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

ex $$0.746128\text{H} = \frac{[\text{Permeability-vacuum}] \cdot 1.9\text{H/m} \cdot 0.25\text{m}^2 \cdot 1500 \cdot 18}{21.6\text{mm}}$$

## 18) Permeance

Open Calculator

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

ex $$1.639344\text{H} = \frac{1}{0.61\text{AT/Wb}}$$

## 19) Reluctance

Open Calculator

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

ex $$0.617143\text{AT/Wb} = \frac{21.6\text{mm}}{0.14\text{H/m} \cdot 0.25\text{m}^2}$$

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### 20) Self Inductance

Open Calculator

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

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

## Mechanical Specifications

### 21) Area of Ring

Open Calculator

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

ex $$0.255176m^2 = \frac{\pi \cdot (570mm)^2}{4}$$

### 22) Mean Diameter

Open Calculator

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

ex $$6.875494mm = \frac{21.6mm}{\pi}$$

### 23) Mean Length

Open Calculator

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

ex $$21.67699mm = \pi \cdot 6.9mm$$

# Variables Used

- **%** 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

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- $N_2$ Secondary Turns of Coil
- **P** Magnetic Permeance *(Henry)*
- $P_{hystersis}$ 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)*
- **Z** Number of Conductors
- **θ** Angle between Vectors *(Degree)*
- **μ** Magnetic Permeability of a Medium *(Henry per Meter)*
- $\mu_r$ Relative Permeability *(Henry per Meter)*
- $\Phi_m$ Magnetic Flux *(Weber)*
- **ψ** Magnetic Potential

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# Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  *Archimedes' constant*
- Constant: **[Permeability-vacuum]**, 4 * Pi * 1E-7 Henry / Meter
  *Permeability of vacuum*
- Function: **sin**, sin(Angle)
  *Trigonometric sine function*
- Measurement: **Length** in Millimeter (mm)
  *Length Unit Conversion*
- Measurement: **Electric Current** in Ampere (A)
  *Electric Current Unit Conversion*
- Measurement: **Volume** in Cubic Meter ($m^3$)
  *Volume Unit Conversion*
- Measurement: **Area** in Square Meter ($m^2$)
  *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*

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- 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*
- 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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## Check other formula lists

- **AC Circuits Formulas**
- **DC Circuits Formulas**
- **Magnetic Circuit Formulas**
- **Two-Port Network Formulas**

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