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Electromagnetic Induction Formulas

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List of 25 Electromagnetic Induction Formulas

Electromagnetic Induction

Basics of Electromagentic Induction

1) Capacitive Reactance

Open Calculator

fx $$X_c = \frac{1}{\omega \cdot C}$$

ex $$0.1\Omega = \frac{1}{2\text{rad/s} \cdot 5\text{F}}$$

2) Current Value for Alternating Current

Open Calculator

fx $$i_p = I_o \cdot \sin(\omega_f \cdot t + \angle A)$$

ex $$22.45734\text{A} = 60\text{A} \cdot \sin(10.28\text{Hz} \cdot 32\text{s} + 30^\circ)$$

3) Decay of Current in LR circuit

Open Calculator

fx $$I_{decay} = i_p \cdot e^{-\frac{T_w}{\frac{L}{R}}}$$

ex $$0.021959\text{A} = 2.2\text{A} \cdot e^{-\frac{2.6\text{s}}{\frac{5.7\text{H}}{10.1\Omega}}}$$

4) EMF Induced in Rotating Coil

Open Calculator

$$\mathrm{e} = \mathrm{n} \cdot \mathrm{A} \cdot \mathrm{B} \cdot \omega \cdot \sin(\omega \cdot \mathrm{t})$$

$$21850.62\mathrm{V} = 95 \cdot 50\mathrm{m^2} \cdot 2.5\mathrm{Wb/m^2} \cdot 2\mathrm{rad/s} \cdot \sin(2\mathrm{rad/s} \cdot 32\mathrm{s})$$

5) Growth of Current in LR Circuit

Open Calculator

$$\mathrm{i} = \frac{e}{\mathrm{R}} \cdot \left(1 - e^{-\frac{\mathrm{t}}{\frac{\mathrm{L}}{\mathrm{R}}}}\right)$$

$$0.269137\mathrm{A} = \frac{e}{10.1\Omega} \cdot \left(1 - e^{-\frac{32\mathrm{s}}{\frac{5.7\mathrm{H}}{10.1\Omega}}}\right)$$

6) Inductive Reactance

Open Calculator

$$\mathrm{X_L} = \omega \cdot \mathrm{L}$$

$$11.4\Omega = 2\mathrm{rad/s} \cdot 5.7\mathrm{H}$$

7) Motional EMF

Open Calculator

$$\varepsilon = \mathrm{B} \cdot \mathrm{L_{emf}} \cdot \mathrm{v}$$

$$45\mathrm{V} = 2.5\mathrm{Wb/m^2} \cdot 3\mathrm{m} \cdot 6\mathrm{m/s}$$

8) Power Factor

Open Calculator

$$\mathrm{PF} = \mathrm{V_{rms}} \cdot \mathrm{I_{rms}} \cdot \cos(\varphi)$$

$$18.80904 = 7\mathrm{V} \cdot 3.8\mathrm{A} \cdot \cos(45^\circ)$$

9) Resonant Frequency for LCR Circuit

Open Calculator

fx $$\omega_r = \frac{1}{2 \cdot \pi \cdot \sqrt{Z \cdot C}}$$

ex $$0.091888\text{Hz} = \frac{1}{2 \cdot \pi \cdot \sqrt{0.6\Omega \cdot 5\text{F}}}$$

10) RMS Current given Peak Current

Open Calculator

fx $$I_{rms} = \frac{i_p}{\sqrt{2}}$$

ex $$1.555635\text{A} = \frac{2.2\text{A}}{\sqrt{2}}$$

11) Self Inductance of Solenoid

Open Calculator

fx $$L_{in} = \pi \cdot [\text{Permeability-vacuum}] \cdot n_{turns}^2 \cdot r^2 \cdot L_{solenoid}$$

ex $$0.019538\text{H} = \pi \cdot [\text{Permeability-vacuum}] \cdot (18)^2 \cdot (1.15\text{m})^2 \cdot 11.55\text{m}$$

12) Time Constant of LR Circuit

Open Calculator

fx $$\tau = \frac{L}{R}$$

ex $$0.564356\text{s} = \frac{5.7\text{H}}{10.1\Omega}$$

13) Time Period for Alternating Current

Open Calculator

fx $$T_w = \frac{2 \cdot \pi}{\omega}$$

ex $$3.141593\text{s} = \frac{2 \cdot \pi}{2\text{rad/s}}$$

14) Total Flux in Mutual Inductance

Open Calculator

fx $$\Phi = M \cdot i_p$$

ex $$44\text{Wb} = 20\text{H} \cdot 2.2\text{A}$$

15) Total Flux in Self Inductance

Open Calculator

fx $$L_{in} = \pi \cdot \Phi_m \cdot r^2$$

ex $$955.5939\text{H} = \pi \cdot 230\text{Wb} \cdot (1.15\text{m})^2$$

Energy

16) Energy Density of Magnetic Field

Open Calculator

fx $$U = \frac{B^2}{2 \cdot \mu}$$

ex $$156.25\text{J} = \frac{(2.5\text{Wb/m}^2)^2}{2 \cdot 0.02\text{H/m}}$$

17) Energy of RMS Current

Open Calculator

$$E_{rms} = i_p^2 \cdot R \cdot t$$

$$1564.288\text{J} = (2.2\text{A})^2 \cdot 10.1\Omega \cdot 32\text{s}$$

18) Energy Stored in Inductor

Open Calculator

$$U_{inductor} = 0.5 \cdot L \cdot i_p^2$$

$$13.794\text{J} = 0.5 \cdot 5.7\text{H} \cdot (2.2\text{A})^2$$

Impedance

19) Impedance for LCR Circuit

Open Calculator

$$Z = \sqrt{R^2 + \left(\frac{1}{\omega_f \cdot C} - (\omega_f \cdot L)\right)^2}$$

$$59.44091\Omega = \sqrt{(10.1\Omega)^2 + \left(\frac{1}{10.28\text{Hz} \cdot 5\text{F}} - (10.28\text{Hz} \cdot 5.7\text{H})\right)^2}$$

20) Impedance for LR Circuit

Open Calculator

$$Z = \sqrt{R^2 + (\omega_f \cdot L)^2}$$

$$59.46008\Omega = \sqrt{(10.1\Omega)^2 + (10.28\text{Hz} \cdot 5.7\text{H})^2}$$

21) Impedance for RC Circuit

Open Calculator

fx $$Z = \sqrt{R^2 + \frac{1}{(\omega_f \cdot C)^2}}$$

ex $$10.10002\Omega = \sqrt{(10.1\Omega)^2 + \frac{1}{(10.28\text{Hz} \cdot 5\text{F})^2}}$$

22) Impedance given Energy and Current

Open Calculator

fx $$Z = \frac{E}{i_p}$$

ex $$68.18182\Omega = \frac{150\text{J}}{2.2\text{A}}$$

Phase Shift

23) Phase Shift for LCR Circuit

Open Calculator

fx $$\varphi_{RC} = \frac{\frac{1}{\omega \cdot C} - \omega \cdot Z}{R}$$

ex $$-6.240134^\circ = \frac{\frac{1}{2\text{rad/s} \cdot 5\text{F}} - 2\text{rad/s} \cdot 0.6\Omega}{10.1\Omega}$$

24) Phase Shift for LR Circuit

Open Calculator

fx $$\varphi_{RC} = \arctan\left(\omega \cdot \frac{Z}{R}\right)$$

ex $$6.775656^\circ = \arctan\left(2\text{rad/s} \cdot \frac{0.6\Omega}{10.1\Omega}\right)$$

25) Phase Shift for RC Circuit

Open Calculator

fx $$\varphi_{RC} = \arctan\left(\frac{1}{\omega \cdot C \cdot R}\right)$$

ex $$0.567266^\circ = \arctan\left(\frac{1}{2\text{rad/s} \cdot 5\text{F} \cdot 10.1\Omega}\right)$$

Variables Used

- $\angle A$ Angle A *(Degree)*
- A Area of Loop *(Square Meter)*
- B Magnetic Field *(Weber per Square Meter)*
- C Capacitance *(Farad)*
- e EMF Induced in a Rotating Coil *(Volt)*
- E Electric Energy *(Joule)*
- E_{rms} RMS Energy *(Joule)*
- i Growth of Current in LR Circuit *(Ampere)*
- I_{decay} Decay of Current in L-R Circuit *(Ampere)*
- I_o Peak Current *(Ampere)*
- i_p Electric Current *(Ampere)*
- I_{rms} Root Mean Square Current *(Ampere)*
- L Inductance *(Henry)*
- L_{emf} Length *(Meter)*
- L_{in} Self Inductance of Solenoid *(Henry)*
- $L_{solenoid}$ Length of Solenoid *(Meter)*
- M Mutual Inductance *(Henry)*
- n Number of Turns of Coil
- n_{turns} Number of Turns of Solenoid
- PF Power Factor
- r Radius *(Meter)*
- R Resistance *(Ohm)*

- t Time *(Second)*
- T_w Time Period of Progressive Wave *(Second)*
- U Energy Density *(Joule)*
- $U_{inductor}$ Energy Stored in Inductor *(Joule)*
- v Velocity *(Meter per Second)*
- V_{rms} Root Mean Square Voltage *(Volt)*
- X_C Capacitive Reactance *(Ohm)*
- X_L Inductive Reactance *(Ohm)*
- Z Impedance *(Ohm)*
- ε Electromotive Force *(Volt)*
- μ Magnetic Permeability of Medium *(Henry per Meter)*
- τ Time Constant of L-R Circuit *(Second)*
- φ Phase Difference *(Degree)*
- Φ Total Flux in Mutual Inductance *(Weber)*
- Φ_m Magnetic Flux *(Weber)*
- φ_{RC} Phase Shift RC *(Degree)*
- ω Angular Velocity *(Radian per Second)*
- ω_f Angular Frequency *(Hertz)*
- ω_r Resonant Frequency *(Hertz)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Constant: **[Permeability-vacuum]**, 4 * Pi * 1E-7 Henry / Meter
  Permeability of vacuum
- Function: **arctan**, arctan(Number)
  Inverse trigonometric tangent function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **ctan**, ctan(Angle)
  Trigonometric cotangent function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Ampere (A)
  Electric Current 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: **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: **Capacitance** in Farad (F)
  Capacitance Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Inductance** in Henry (H)
  Inductance Unit Conversion
- Measurement: **Magnetic Field** in Weber per Square Meter (Wb/m²)
  Magnetic Field Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Magnetic Permeability** in Henry per Meter (H/m)
  Magnetic Permeability Unit Conversion

Check other formula lists

- **Capacitor Formulas**
- **Electromagnetic Induction Formulas**
- **Electrostatics Formulas**
- **Magnetic Field due to Current Formulas**

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