Important AC Machines Formulas PDF

Formulas
Examples
with Units

List of 28
Important AC Machines Formulas

1) Electrical Parameters Formulas

1.1) Apparent Power Formula

Evaluate Formula

Formula

$$S = \frac{P_{rated}}{PF}$$

Example with Units

$$48.0156\,\text{kVA} = \frac{21.607\,\text{kW}}{0.45}$$

1.2) Current in Conductor Formula

Evaluate Formula

Formula

$$I_z = \frac{I_{ph}}{n_{||}}$$

Example with Units

$$10\,\text{A} = \frac{20\,\text{A}}{2}$$

1.3) Current per Phase Formula

Evaluate Formula

Formula

$$I_{ph} = \frac{S \cdot 1000}{E_{ph} \cdot 3}$$

Example with Units

$$20\,\text{A} = \frac{48\,\text{kVA} \cdot 1000}{800\,\text{kV} \cdot 3}$$

1.4) Field Coil Voltage Formula

Evaluate Formula

Formula

$$E_f = I_f \cdot R_f$$

Example with Units

$$42.4983\,\text{V} = 83.33\,\text{A} \cdot 0.51\,\Omega$$

1.5) Field Current Formula

Evaluate Formula

Formula

$$I_f = \frac{E_f}{R_f}$$

Example with Units

$$83.3333\,\text{A} = \frac{42.5\,\text{V}}{0.51\,\Omega}$$

1.6) Field Resistance Formula

Evaluate Formula

Formula

$$R_f = \frac{T_c \cdot \rho \cdot L_{mt}}{A_f}$$

Example with Units

$$0.51\,\Omega = \frac{204 \cdot 2.5\text{e-}5\,\Omega\text{*m} \cdot 0.25\,\text{m}}{0.0025\,\text{m}^2}$$

1.7) Output Coefficient using Output Equation Formula

Evaluate Formula

Formula

$$C_{o(ac)} = \frac{P_o}{L_a \cdot D_a^2 \cdot N_s \cdot 1000}$$

Example with Units

$$0.8488 = \frac{600\,\text{kW}}{0.3\,\text{m} \cdot 0.5\,\text{m}^2 \cdot 1500\,\text{rev/s} \cdot 1000}$$

1.8) Output Power of Synchronous Machine Formula

Evaluate Formula

Formula

$$P_o = C_{o(ac)} \cdot 1000 \cdot D_a^2 \cdot L_a \cdot N_s$$

Example with Units

$$600.8296\,\text{kW} = 0.85 \cdot 1000 \cdot 0.5\,\text{m}^2 \cdot 0.3\,\text{m} \cdot 1500\,\text{rev/s}$$

1.9) Short Circuit Ratio Formula

Evaluate Formula

Formula

$$SCR = \frac{1}{X_s}$$

Example with Units

$$2.5 = \frac{1}{0.4\,\Omega}$$

1.10) Specific Electric Loading Formula

Evaluate Formula

Formula

$$q_{av} = \frac{I_a \cdot Z}{\pi \cdot n_{||} \cdot D_a}$$

Example with Units

$$187.4845\,\text{Ac/m} = \frac{1.178\,\text{A} \cdot 500}{3.1416 \cdot 2 \cdot 0.5\,\text{m}}$$

1.11) Specific Electric Loading using Output Coefficient AC Formula

Evaluate Formula

Formula

$$q_{av} = \frac{C_{o(ac)} \cdot 1000}{11 \cdot B_{av} \cdot K_w}$$

Example with Units

$$187.4642\,\text{Ac/m} = \frac{0.85 \cdot 1000}{11 \cdot 0.458\,\text{Wb/m}^2 \cdot 0.9}$$

1.12) Synchronous Speed using Output Equation Formula

Evaluate Formula

Formula

$$N_s = \frac{P_o}{C_{o(ac)} \cdot 1000 \cdot D_a^2 \cdot L_a}$$

Example with Units

$$1497.9289\,\text{rev/s} = \frac{600\,\text{kW}}{0.85 \cdot 1000 \cdot 0.5\,\text{m}^2 \cdot 0.3\,\text{m}}$$

1.13) Winding Factor using Output Coefficient AC Formula

Evaluate Formula

Formula

$$K_w = \frac{C_{o(ac)} \cdot 1000}{11 \cdot B_{av} \cdot q_{av}}$$

Example with Units

$$0.9 = \frac{0.85 \cdot 1000}{11 \cdot 0.458\,\text{Wb/m}^2 \cdot 187.464\,\text{Ac/m}}$$

2) Magnetic Parameters Formulas

2.1) Flux per Pole using Pole Pitch Formula

Evaluate Formula

Formula

$$\Phi = B_{av} \cdot Y_p \cdot L_{limit}$$

Example with Units

$$0.054\,\text{Wb} = 0.458\,\text{Wb/m}^2 \cdot 0.392\,\text{m} \cdot 0.3008\,\text{m}$$

2.2) Full Load Field MMF Formula

Evaluate Formula

Formula

$$MMF_f = I_f \cdot T_c$$

Example with Units

$$16999.32\,\text{AT} = 83.33\,\text{A} \cdot 204$$

2.3) Magnetic Loading Formula

Evaluate Formula

Formula

$$B = n \cdot \Phi$$

Example with Units

$$0.216\,\text{Wb} = 4 \cdot 0.054\,\text{Wb}$$

2.4) MMF of Damper Winding Formula

Evaluate Formula

Formula

$$MMF_d = 0.143 \cdot q_{av} \cdot Y_p$$

Example with Units

$$10.5085\,\text{AT} = 0.143 \cdot 187.464\,\text{Ac/m} \cdot 0.392\,\text{m}$$

2.5) Pole Arc Formula

Evaluate Formula

Formula

$$\theta = n_d \cdot 0.8 \cdot Y_s$$

Example with Units

$$257.6\,\text{m} = 10 \cdot 0.8 \cdot 32.2\,\text{m}$$

2.6) Pole Pitch Formula

Evaluate Formula

Formula

$$Y_p = \frac{\pi \cdot D_a}{n}$$

Example with Units

$$0.3927\,\text{m} = \frac{3.1416 \cdot 0.5\,\text{m}}{4}$$

2.7) Specific Magnetic Loading Formula

Evaluate Formula

Formula

$$B_{av} = \frac{n \cdot \Phi}{\pi \cdot D_a \cdot L_a}$$

Example with Units

$$0.4584\,\text{Wb/m}^2 = \frac{4 \cdot 0.054\,\text{Wb}}{3.1416 \cdot 0.5\,\text{m} \cdot 0.3\,\text{m}}$$

2.8) Specific Magnetic Loading using Output Coefficient AC Formula

Evaluate Formula

Formula

$$B_{av} = \frac{C_{o(ac)} \cdot 1000}{11 \cdot q_{av} \cdot K_w}$$

Example with Units

$$0.458\,\text{Wb/m}^2 = \frac{0.85 \cdot 1000}{11 \cdot 187.464\,\text{Ac/m} \cdot 0.9}$$

3) Mechanical Parameters Formulas

3.1) Area of Field Conductor Formula

Evaluate Formula

Formula

$$A_f = \frac{MMF_f \cdot \rho \cdot L_{mt}}{E_f}$$

Example with Units

$$0.0025\,\text{m}^2 = \frac{17000\,\text{AT} \cdot 2.5\text{e-}5\,\Omega\text{*m} \cdot 0.25\,\text{m}}{42.5\,\text{V}}$$

3.2) Armature Core Length using Output Equation Formula

Evaluate Formula

Formula

$$L_a = \frac{P_o}{C_{o(ac)} \cdot 1000 \cdot D_a^2 \cdot N_s}$$

Example with Units

$$0.2996\,\text{m} = \frac{600\,\text{kW}}{0.85 \cdot 1000 \cdot 0.5\,\text{m}^2 \cdot 1500\,\text{rev/s}}$$

3.3) Armature Diameter using Output Equation Formula

Evaluate Formula

Formula

$$D_a = \sqrt{\frac{P_o}{C_{o(ac)} \cdot 1000 \cdot N_s \cdot L_a}}$$

Example with Units

$$0.4997\,\text{m} = \sqrt{\frac{600\,\text{kW}}{0.85 \cdot 1000 \cdot 1500\,\text{rev/s} \cdot 0.3\,\text{m}}}$$

3.4) Cross Sectional Area of Damper Winding Formula

Evaluate Formula

Formula

$$\sigma_d = \frac{A_d}{n_d}$$

Example with Units

$$0.565\,\text{m}^2 = \frac{5.65\,\text{m}^2}{10}$$

3.5) Diameter of Damper Bar Formula

Evaluate Formula

Formula

$$D_d = \sqrt{\frac{4 \cdot A_d}{\pi}}$$

Example with Units

$$2.6821\,\text{m} = \sqrt{\frac{4 \cdot 5.65\,\text{m}^2}{3.1416}}$$

3.6) Length of Damper Bar Formula

Evaluate Formula

Formula

$$L_d = 1.1 \cdot L_a$$

Example with Units

$$0.33\,\text{m} = 1.1 \cdot 0.3\,\text{m}$$

3.7) Number of Damper Bars Formula

Evaluate Formula

Formula

$$n_d = \frac{\theta}{0.8 \cdot Y_s}$$

Example with Units

$$10 = \frac{257.6\,\text{m}}{0.8 \cdot 32.2\,\text{m}}$$

Variables used in list of AC Machines Formulas above

- A_d Area of Damper Winding *(Square Meter)*
- A_f Area of Field Conductor *(Square Meter)*
- **B** Magnetic Loading *(Weber)*
- B_{av} Specific Magnetic Loading *(Weber per Square Meter)*
- $C_{o(ac)}$ Output Coefficient AC
- D_a Armature Diameter *(Meter)*
- D_d Diameter of Damper Bar *(Meter)*
- E_f Field Coil Voltage *(Volt)*
- E_{ph} Induced Emf per Phase *(Kilovolt)*
- I_a Armature Current *(Ampere)*
- I_f Field Current *(Ampere)*
- I_{ph} Current per Phase *(Ampere)*
- I_z Current in Conductor *(Ampere)*
- K_w Winding Factor
- L_a Armature Core Length *(Meter)*
- L_d Length of Damper Bar *(Meter)*
- L_{limit} Limiting Value of Core Length *(Meter)*
- L_{mt} Length of Mean Turn *(Meter)*
- MMF_d MMF of Damper Winding *(Ampere-Turn)*
- MMF_f Full Load Field MMF *(Ampere-Turn)*
- **n** Number of Poles
- $n_{||}$ Number of Parallel Paths
- n_d Number of Damper Bar
- N_s Synchronous Speed *(Revolution per Second)*
- P_o Output Power *(Kilowatt)*
- P_{rated} Rated Real Power *(Kilowatt)*
- **PF** Power Factor
- q_{av} Specific Electric Loading *(Ampere Conductor per Meter)*
- R_f Field Resistance *(Ohm)*

Constants, Functions, Measurements used in list of AC Machines Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Electric Current** in Ampere (A) *Electric Current Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Power** in Kilovolt Ampere (kVA), Kilowatt (kW) *Power Unit Conversion*
- Measurement: **Magnetic Flux** in Weber (Wb) *Magnetic Flux Unit Conversion*
- Measurement: **Electric Resistance** in Ohm (Ω) *Electric Resistance Unit Conversion*
- Measurement: **Magnetic Flux Density** in Weber per Square Meter (Wb/m²) *Magnetic Flux Density Unit Conversion*
- Measurement: **Magnetomotive Force** in Ampere-Turn (AT) *Magnetomotive Force Unit Conversion*
- Measurement: **Electric Potential** in Kilovolt (kV), Volt (V) *Electric Potential Unit Conversion*
- Measurement: **Electric Resistivity** in Ohm Meter (Ω*m) *Electric Resistivity Unit Conversion*
- Measurement: **Angular Velocity** in Revolution per Second (rev/s) *Angular Velocity Unit Conversion*
- Measurement: **Specific Electrical Loading** in Ampere Conductor per Meter (Ac/m) *Specific Electrical Loading Unit Conversion*

- **S** Apparent Power *(Kilovolt Ampere)*
- **SCR** Short Circuit Ratio
- T_c Turns per Coil
- X_s Synchronous Reactance *(Ohm)*
- Y_p Pole Pitch *(Meter)*
- Y_s Slot Pitch *(Meter)*
- **Z** Number of Conductors
- **θ** Pole Arc *(Meter)*
- **ρ** Resistivity *(Ohm Meter)*
- σ_d Cross-Sectional Area of Damper Winding *(Square Meter)*
- **Φ** Flux per Pole *(Weber)*

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