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DC Machines Formulas

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List of 19 DC Machines Formulas

DC Machines

1) Area of Damper Winding

$$\text{fx } A_d = \frac{0.2 \cdot q_{av} \cdot Y_p}{\delta_s}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 5.652761\text{m}^2 = \frac{0.2 \cdot 187.464\text{Ac/m} \cdot 0.392\text{m}}{2.6\text{A/m}^2}$$

2) Armature Core Length using Specific Magnetic Loading

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

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 0.30024\text{m} = \frac{4 \cdot 0.054\text{Wb}}{\pi \cdot 0.5\text{m} \cdot 0.458\text{Wb/m}^2}$$

3) Armature Diameter using Specific Magnetic Loading

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

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 0.5004\text{m} = \frac{4 \cdot 0.054\text{Wb}}{\pi \cdot 0.458\text{Wb/m}^2 \cdot 0.3\text{m}}$$



4) Average Gap Density using Limiting Value of Core Length

$$\text{fx } B_{\text{av}} = \frac{7.5}{L_{\text{limit}} \cdot V_a \cdot T_c \cdot n_c}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 0.457764 \text{Wb/m}^2 = \frac{7.5}{0.3008\text{m} \cdot 0.0445\text{m/s} \cdot 204 \cdot 6}$$

5) Efficiency of DC Machine

$$\text{fx } \eta = \frac{P_{\text{gen}}}{P_o}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 0.666667 = \frac{400\text{kW}}{600\text{kW}}$$

6) Flux per Pole using Magnetic Loading

$$\text{fx } \Phi = \frac{B}{n}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 0.054 \text{Wb} = \frac{0.216 \text{Wb}}{4}$$

7) Flux per Pole using Pole Pitch

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

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$\text{ex } 0.054004 \text{Wb} = 0.458 \text{Wb/m}^2 \cdot 0.392\text{m} \cdot 0.3008\text{m}$$



8) Flux per Pole using Specific Magnetic Loading

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

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 0.053957Wb = \frac{0.458Wb/m^2 \cdot \pi \cdot 0.5m \cdot 0.3m}{4}$$

9) Limiting Value of Core Length

$$fx \quad L_{limit} = \frac{7.5}{B_{av} \cdot V_a \cdot T_c \cdot n_c}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 0.300645m = \frac{7.5}{0.458Wb/m^2 \cdot 0.0445m/s \cdot 204 \cdot 6}$$

10) Number of Poles using Magnetic Loading

$$fx \quad n = \frac{B}{\Phi}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 4 = \frac{0.216Wb}{0.054Wb}$$

11) Number of Poles using Pole Pitch

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

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 4 = \frac{\pi \cdot 0.5m}{0.392m}$$



12) Number of Poles using Specific Magnetic Loading

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

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 4 = \frac{0.458 \text{Wb/m}^2 \cdot \pi \cdot 0.5 \text{m} \cdot 0.3 \text{m}}{0.054 \text{Wb}}$$

13) Output Coefficient DC

$$\text{fx } C_{o(dc)} = \frac{\pi^2 \cdot B_{av} \cdot q_{av}}{1000}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$\text{ex } 0.84739 = \frac{\pi^2 \cdot 0.458 \text{Wb/m}^2 \cdot 187.464 \text{Ac/m}}{1000}$$

14) Output Power of DC Machines

$$\text{fx } P_o = \frac{P_{gen}}{\eta}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$\text{ex } 600.6006 \text{kW} = \frac{400 \text{kW}}{0.666}$$

15) Peripheral Speed of Armature using Limiting Value of Core Length

$$\text{fx } V_a = \frac{7.5}{B_{av} \cdot L_{limit} \cdot T_c \cdot n_c}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$\text{ex } 0.044477 \text{m/s} = \frac{7.5}{0.458 \text{Wb/m}^2 \cdot 0.3008 \text{m} \cdot 204 \cdot 6}$$




16) Pole Pitch 

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

Open Calculator 

$$ex \quad 0.392699m = \frac{\pi \cdot 0.5m}{4}$$

17) Specific Magnetic Loading using Output Coefficient DC 

$$fx \quad B_{av} = \frac{C_{o(dc)} \cdot 1000}{\pi^2 \cdot q_{av}}$$

Open Calculator 


$$ex \quad 0.457789Wb/m^2 = \frac{0.847 \cdot 1000}{\pi^2 \cdot 187.464Ac/m}$$

18) Stator Conductor Cross Section Area 

$$fx \quad \sigma_z = \frac{I_z}{\delta_s}$$

Open Calculator 

$$ex \quad 3.845769m^2 = \frac{9.999A}{2.6A/m^2}$$

19) Stator Conductors per Slot 

$$fx \quad Z_{ss} = \frac{Z}{n_s}$$

Open Calculator 

$$ex \quad 14 = \frac{500}{36}$$



Variables Used










- A_d Area of Damper Winding (*Square Meter*)
- B Magnetic Loading (*Weber*)
- B_{av} Specific Magnetic Loading (*Weber per Square Meter*)
- $C_{o(dc)}$ Output Coefficient DC
- D_a Armature Diameter (*Meter*)
- I_z Current in Conductor (*Ampere*)
- L_a Armature Core Length (*Meter*)
- L_{limit} Limiting Value of Core Length (*Meter*)
- n Number of Poles
- n_c Number of Coils between Adjacent Segments
- n_s Number of Stator Slots
- P_{gen} Generated Power (*Kilowatt*)
- P_o Output Power (*Kilowatt*)
- q_{av} Specific Electric Loading (*Ampere Conductor per Meter*)
- T_c Turns per Coil
- V_a Peripheral Speed of Armature (*Meter per Second*)
- Y_p Pole Pitch (*Meter*)
- Z Number of Conductors
- Z_{ss} Conductors per Slot
- δ_s Current Density in Stator Conductor (*Ampere per Square Meter*)
- η Efficiency



- σ_z Stator Conductor Cross Section Area (Square Meter)
- Φ Flux per Pole (Weber)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **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:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Power** in Kilowatt (kW)
Power Unit Conversion 
- **Measurement:** **Magnetic Flux** in Weber (Wb)
Magnetic Flux Unit Conversion 
- **Measurement:** **Magnetic Flux Density** in Weber per Square Meter (Wb/m²)
Magnetic Flux Density Unit Conversion 
- **Measurement:** **Surface Current Density** in Ampere per Square Meter (A/m²)
Surface Current Density Unit Conversion 
- **Measurement:** **Specific Electrical Loading** in Ampere Conductor per Meter (Ac/m)
Specific Electrical Loading Unit Conversion 



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- [DC Machines Formulas](#) 

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