Important DC Machines Formulas PDF

Formulas
Examples
with Units

List of 19
Important DC Machines Formulas

1) Area of Damper Winding Formula

Evaluate Formula

Formula

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

Example with Units

$$5.6528\,\text{m}^2 = \frac{0.2 \cdot 187.464\,\text{Ac/m} \cdot 0.392\,\text{m}}{2.6\,\text{A/m}^2}$$

2) Armature Core Length using Specific Magnetic Loading Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3002\,\text{m} = \frac{4 \cdot 0.054\,\text{Wb}}{3.1416 \cdot 0.5\,\text{m} \cdot 0.458\,\text{Wb/m}^2}$$

3) Armature Diameter using Specific Magnetic Loading Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5004\,\text{m} = \frac{4 \cdot 0.054\,\text{Wb}}{3.1416 \cdot 0.458\,\text{Wb/m}^2 \cdot 0.3\,\text{m}}$$

4) Average Gap Density using Limiting Value of Core Length Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4578\,\text{Wb/m}^2 = \frac{7.5}{0.3008\,\text{m} \cdot 0.0445\,\text{m/s} \cdot 204 \cdot 6}$$

5) Efficiency of DC Machine Formula

Evaluate Formula

Formula

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

Example with Units

$$0.6667 = \frac{400\,\text{kW}}{600\,\text{kW}}$$

6) Flux per Pole using Magnetic Loading Formula

Evaluate Formula

Formula

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

Example with Units

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

7) Flux per Pole using Pole Pitch Formula

Evaluate Formula

Formula

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

Example with Units

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

8) Flux per Pole using Specific Magnetic Loading Formula

Evaluate Formula

Formula

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

Example with Units

$$0.054\,\text{Wb} = \frac{0.458\,\text{Wb/m}^2 \cdot 3.1416 \cdot 0.5\,\text{m} \cdot 0.3\,\text{m}}{4}$$

9) Limiting Value of Core Length Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3006\,\text{m} = \frac{7.5}{0.458\,\text{Wb/m}^2 \cdot 0.0445\,\text{m/s} \cdot 204 \cdot 6}$$

10) Number of Poles using Magnetic Loading Formula

Evaluate Formula

Formula

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

Example with Units

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

11) Number of Poles using Pole Pitch Formula

Evaluate Formula

Formula

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

Example with Units

$$4 = \frac{3.1416 \cdot 0.5\,\text{m}}{0.392\,\text{m}}$$

12) Number of Poles using Specific Magnetic Loading Formula

Evaluate Formula

Formula

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

Example with Units

$$4 = \frac{0.458\,\text{Wb/m}^2 \cdot 3.1416 \cdot 0.5\,\text{m} \cdot 0.3\,\text{m}}{0.054\,\text{Wb}}$$

13) Output Coefficient DC Formula

Evaluate Formula

Formula

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

Example with Units

$$0.8474 = \frac{3.1416^2 \cdot 0.458\,\text{Wb/m}^2 \cdot 187.464\,\text{Ac/m}}{1000}$$

14) Output Power of DC Machines Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$0.0445\,\text{m/s} = \frac{7.5}{0.458\,\text{Wb/m}^2 \cdot 0.3008\,\text{m} \cdot 204 \cdot 6}$$

16) Pole Pitch Formula

Evaluate Formula

Formula

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

Example with Units

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

17) Specific Magnetic Loading using Output Coefficient DC Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4578\,\text{Wb/m}^2 = \frac{0.847 \cdot 1000}{3.1416^2 \cdot 187.464\,\text{Ac/m}}$$

18) Stator Conductor Cross Section Area Formula

Evaluate Formula

Formula

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

Example with Units

$$3.8458\,\text{m}^2 = \frac{9.999\,\text{A}}{2.6\,\text{A/m}^2}$$

19) Stator Conductors per Slot Formula

Evaluate Formula

Formula

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

Example

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

Variables used in list of DC Machines Formulas above

- 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 in list of DC Machines Formulas above

- constant(s): **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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