Important DC Motor Characteristics Formulas PDF

Formulas
Examples
with Units

List of 26
Important DC Motor Characteristics Formulas

1) Angular Speed given Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\omega_s = \frac{\eta_e \cdot V_s \cdot I_a}{\tau_a}$$

Example with Units

$$52.1788\,\text{rev/s} = \frac{0.8 \cdot 240\,\text{V} \cdot 0.724\,\text{A}}{0.424\,\text{N*m}}$$

2) Armature Current given Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$I_a = \frac{\omega_s \cdot \tau_a}{V_s \cdot \eta_e}$$

Example with Units

$$0.724\,\text{A} = \frac{52.178\,\text{rev/s} \cdot 0.424\,\text{N*m}}{240\,\text{V} \cdot 0.8}$$

3) Armature Current of DC Motor Formula

Evaluate Formula

Formula

$$I_a = \frac{V_a}{K_f \cdot \Phi \cdot \omega_s}$$

Example with Units

$$0.7245\,\text{A} = \frac{320\,\text{V}}{1.135 \cdot 1.187\,\text{Wb} \cdot 52.178\,\text{rev/s}}$$

4) Armature Torque given Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\tau_a = \frac{I_a \cdot V_s \cdot \eta_e}{\omega_s}$$

Example with Units

$$0.424\,\text{N*m} = \frac{0.724\,\text{A} \cdot 240\,\text{V} \cdot 0.8}{52.178\,\text{rev/s}}$$

5) Armature Torque given Mechanical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\tau_a = \eta_m \cdot \tau$$

Example with Units

$$0.4236\,\text{N*m} = 0.60 \cdot 0.706\,\text{N*m}$$

6) Back EMF Equation of DC Motor Formula

Evaluate Formula

Formula

$$E_b = \frac{n \cdot \Phi \cdot Z \cdot N}{60 \cdot n_{||}}$$

Example with Units

$$24.9433\,\text{V} = \frac{4 \cdot 1.187\,\text{Wb} \cdot 14 \cdot 1290\,\text{rev/min}}{60 \cdot 6}$$

7) Constant Losses given Mechanical Loss Formula

Evaluate Formula

Formula

$$C_{loss} = P_{core} + L_m$$

Example with Units

$$15.9\,\text{W} = 6.8\,\text{W} + 9.1\,\text{W}$$

8) Converted Power given Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$P_{conv} = \eta_e \cdot P_{in}$$

Example with Units

$$62.4\,\text{W} = 0.8 \cdot 78\,\text{W}$$

9) Core Loss given Mechanical Loss of DC Motor Formula

Evaluate Formula

Formula

$$P_{core} = C_{loss} - L_m$$

Example with Units

$$6.8\,\text{W} = 15.9\,\text{W} - 9.1\,\text{W}$$

10) DC Motor Frequency given Speed Formula

Evaluate Formula

Formula

$$f = \frac{n \cdot N}{120}$$

Example with Units

$$4.5029\,\text{Hz} = \frac{4 \cdot 1290\,\text{rev/min}}{120}$$

11) Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\eta_e = \frac{\tau_a \cdot \omega_s}{V_s \cdot I_a}$$

Example with Units

$$0.8 = \frac{0.424\,\text{N*m} \cdot 52.178\,\text{rev/s}}{240\,\text{V} \cdot 0.724\,\text{A}}$$

12) Input Power given Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$P_{in} = \frac{P_{conv}}{\eta_e}$$

Example with Units

$$78\,\text{W} = \frac{62.4\,\text{W}}{0.8}$$

13) Machine Construction Constant of DC Motor Formula

Evaluate Formula

Formula

$$K_f = \frac{V_s - I_a \cdot R_a}{\Phi \cdot N}$$

Example with Units

$$1.1355 = \frac{240\,\text{V} - 0.724\,\text{A} \cdot 80\,\Omega}{1.187\,\text{Wb} \cdot 1290\,\text{rev/min}}$$

14) Magnetic Flux of DC Motor Formula

Evaluate Formula

Formula

$$\Phi = \frac{V_s - I_a \cdot R_a}{K_f \cdot N}$$

Example with Units

$$1.1875\,\text{Wb} = \frac{240\,\text{V} - 0.724\,\text{A} \cdot 80\,\Omega}{1.135 \cdot 1290\,\text{rev/min}}$$

15) Mechanical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\eta_m = \frac{\tau_a}{\tau}$$

Example with Units

$$0.6006 = \frac{0.424\,\text{N*m}}{0.706\,\text{N*m}}$$

16) Mechanical Power Developed in DC Motor given Input Power Formula

Evaluate Formula

Formula

$$P_m = P_{in} - \left(I_a^2 \cdot R_a\right)$$

Example with Units

$$36.0659\,\text{W} = 78\,\text{W} - \left(0.724\,\text{A}^2 \cdot 80\,\Omega\right)$$

17) Motor Speed of DC Motor Formula

Evaluate Formula

Formula

$$N = \frac{60 \cdot n_{||} \cdot E_b}{Z \cdot n \cdot \Phi}$$

Example with Units

$$1289.9825\,\text{rev/min} = \frac{60 \cdot 6 \cdot 24.943\,\text{V}}{14 \cdot 4 \cdot 1.187\,\text{Wb}}$$

18) Motor Speed of DC Motor given Flux Formula

Evaluate Formula

Formula

$$N = \frac{V_s - I_a \cdot R_a}{K_f \cdot \Phi}$$

Example with Units

$$1290.5863\,\text{rev/min} = \frac{240\,\text{V} - 0.724\,\text{A} \cdot 80\,\Omega}{1.135 \cdot 1.187\,\text{Wb}}$$

19) Motor Torque given Mechanical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\tau = \frac{\tau_a}{\eta_m}$$

Example with Units

$$0.7067\,\text{N*m} = \frac{0.424\,\text{N*m}}{0.60}$$

20) Motor Torque of Series DC Motor given Machine Constant Formula

Evaluate Formula

Formula

$$\tau = K_f \cdot \Phi \cdot I_a^2$$

Example with Units

$$0.7062\,\text{N*m} = 1.135 \cdot 1.187\,\text{Wb} \cdot 0.724\,\text{A}^2$$

21) Output Power given Overall Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$P_{out} = P_{in} \cdot \eta_o$$

Example with Units

$$36.66\,\text{W} = 78\,\text{W} \cdot 0.47$$

22) Overall Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$\eta_o = \frac{P_m}{P_{in}}$$

Example with Units

$$0.4615 = \frac{36\,\text{W}}{78\,\text{W}}$$

23) Overall Efficiency of DC Motor given Input Power Formula

Evaluate Formula

Formula

$$\eta_o = \frac{P_{in} - \left(P_{cu(a)} + P_{cu(f)} + P_{loss} \right)}{P_{in}}$$

Example with Units

$$0.4179 = \frac{78\,\text{W} - \left(1.25\,\text{W} + 2.81\,\text{W} + 41.34\,\text{W} \right)}{78\,\text{W}}$$

24) Supply Voltage given Electrical Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$V_s = \frac{\omega_s \cdot \tau_a}{I_a \cdot \eta_e}$$

Example with Units

$$239.9963\,\text{V} = \frac{52.178\,\text{rev/s} \cdot 0.424\,\text{N*m}}{0.724\,\text{A} \cdot 0.8}$$

25) Supply Voltage given Overall Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$V_s = \frac{\left(I - I_{sh} \right)^2 \cdot R_a + L_m + P_{core}}{I \cdot \left(1 - \eta_o \right)}$$

Example with Units

$$240.5996\,\text{V} = \frac{\left(0.658\,\text{A} - 1.58\,\text{A} \right)^2 \cdot 80\,\Omega + 9.1\,\text{W} + 6.8\,\text{W}}{0.658\,\text{A} \cdot \left(1 - 0.47 \right)}$$

26) Total Power Loss given Overall Efficiency of DC Motor Formula

Evaluate Formula

Formula

$$P_{loss} = P_{in} - \eta_o \cdot P_{in}$$

Example with Units

$$41.34\,\text{W} = 78\,\text{W} - 0.47 \cdot 78\,\text{W}$$

Variables used in list of DC Motor Characteristics Formulas above

- C_{loss} Constant Loss *(Watt)*
- E_b Back EMF *(Volt)*
- f Frequency *(Hertz)*
- I Electric Current *(Ampere)*
- I_a Armature Current *(Ampere)*
- I_{sh} Shunt Field Current *(Ampere)*
- K_f Constant of Machine Construction
- L_m Mechanical Losses *(Watt)*
- n Number of Poles
- N Motor Speed *(Revolution per Minute)*
- $n_{||}$ Number of Parallel Paths
- P_{conv} Converted Power *(Watt)*
- P_{core} Core Losses *(Watt)*
- $P_{cu(a)}$ Armature Copper Loss *(Watt)*
- $P_{cu(f)}$ Field Copper Losses *(Watt)*
- P_{in} Input Power *(Watt)*
- P_{loss} Power Loss *(Watt)*
- P_m Mechanical Power *(Watt)*
- P_{out} Output Power *(Watt)*
- R_a Armature Resistance *(Ohm)*
- V_a Armature Voltage *(Volt)*
- V_s Supply Voltage *(Volt)*
- Z Number of Conductors
- η_e Electrical Efficiency
- η_m Mechanical Efficiency
- η_o Overall Efficiency
- τ Motor Torque *(Newton Meter)*
- τ_a Armature Torque *(Newton Meter)*
- Φ Magnetic Flux *(Weber)*
- ω_s Angular Speed *(Revolution per Second)*

Constants, Functions, Measurements used in list of DC Motor Characteristics Formulas above

- Measurement: **Electric Current** in Ampere (A)
  Electric Current Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Magnetic Flux** in Weber (Wb)
  Magnetic Flux Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Angular Velocity** in Revolution per Second (rev/s), Revolution per Minute (rev/min)
  Angular Velocity Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion

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