

Important Electric Traction Drives Formulas PDF



Formulas Examples with Units

List of 13 Important Electric Traction Drives Formulas

1) Average Back Emf with Negligible Commutation Overlap Formula

Formula

$$E_b = 1.35 \cdot E_L \cdot \cos(\theta)$$

Example with Units

$$145.6046 \text{ v} = 1.35 \cdot 120 \text{ v} \cdot \cos(26^\circ)$$

Evaluate Formula 

2) DC Output Voltage of Rectifier in Scherbius Drive Given Maximum Rotor Voltage Formula

Formula

$$E_{DC} = 3 \cdot \left(\frac{E_{\text{peak}}}{\pi} \right)$$

Example with Units

$$210.0845 \text{ v} = 3 \cdot \left(\frac{220 \text{ v}}{3.1416} \right)$$

Evaluate Formula 

3) DC Output Voltage of Rectifier in Scherbius Drive Given Rotor RMS Line Voltage Formula

Formula

$$E_{DC} = (3 \cdot \sqrt{2}) \cdot \left(\frac{E_r}{\pi} \right)$$

Example with Units

$$210.674 \text{ v} = (3 \cdot \sqrt{2}) \cdot \left(\frac{156 \text{ v}}{3.1416} \right)$$

Evaluate Formula 

4) DC Output Voltage of Rectifier in Scherbius Drive Given Rotor RMS Line Voltage at Slip Formula

Formula

$$E_{DC} = 1.35 \cdot E_{\text{rms}}$$

Example with Units

$$210.897 \text{ v} = 1.35 \cdot 156.22 \text{ v}$$

Evaluate Formula 

5) Energy Dissipated during Transient Operation Formula

Formula

$$E_t = \int (R \cdot (i)^2, x, 0, T)$$

Example with Units

$$160.224 \text{ J} = \int (4.235 \Omega \cdot (2.345 \text{ A})^2, x, 0, 6.88 \text{ s})$$

Evaluate Formula 



6) Equivalent Current for Fluctuating and Intermittent Loads Formula

Formula

$$I_{eq} = \sqrt{\left(\frac{1}{T}\right) \cdot \int \left((i)^2, x, 1, T \right)}$$

Evaluate Formula 

Example with Units

$$2.1679_A = \sqrt{\left(\frac{1}{6.88_s}\right) \cdot \int \left((2.345_A)^2, x, 1, 6.88_s \right)}$$

7) Gear Tooth Ratio Formula

Formula

$$a_{gear} = \frac{n_1}{n_2}$$

Example

$$3 = \frac{60}{20}$$

Evaluate Formula 

8) Motor Terminal Voltage in Regenerative Braking Formula

Formula

$$V_a = \left(\frac{1}{T}\right) \cdot \int \left(V_s \cdot x, x, t_{on}, T \right)$$

Evaluate Formula 

Example with Units

$$385.8454_v = \left(\frac{1}{6.88_s}\right) \cdot \int \left(118_v \cdot x, x, 1.53_s, 6.88_s \right)$$

9) Slip of Scherbius Drive given RMS Line Voltage Formula

Formula

$$s = \left(\frac{E_b}{E_r}\right) \cdot \text{mod } \underline{us} \left(\cos(\theta) \right)$$

Example with Units

$$0.8354 = \left(\frac{145_v}{156_v}\right) \cdot \text{mod } \underline{us} \left(\cos(26^\circ) \right)$$

Evaluate Formula 

10) Starting Time for Induction Motor under No Load Formula

Formula

$$t_s = \left(-\frac{\tau_m}{2}\right) \cdot \int \left(\left(\frac{s}{s_m} + \frac{s_m}{s}\right) \cdot x, x, 1, 0.05 \right)$$

Evaluate Formula 

Example with Units

$$1.2036_s = \left(-\frac{2.359_s}{2}\right) \cdot \int \left(\left(\frac{0.83}{0.67} + \frac{0.67}{0.83}\right) \cdot x, x, 1, 0.05 \right)$$



11) Time Taken for Drive Speed Formula

Formula

$$t = J \cdot \int \left(\frac{1}{\tau - \tau_L}, x, \omega_{m1}, \omega_{m2} \right)$$

Evaluate Formula 

Example with Units

$$4.5092s = 10.0 \text{ kg}\cdot\text{m}^2 \cdot \int \left(\frac{1}{5.4 \text{ N}\cdot\text{m} - 0.235 \text{ N}\cdot\text{m}}, x, 2.346 \text{ rad/s}, 4.675 \text{ rad/s} \right)$$

12) Torque Generated by Scherbius Drive Formula

Formula

$$\tau = 1.35 \cdot \left(\frac{E_b \cdot E_L \cdot I_r \cdot E_r}{E_b \cdot \omega_f} \right)$$

Example with Units

$$5.346 \text{ N}\cdot\text{m} = 1.35 \cdot \left(\frac{145 \text{ V} \cdot 120 \text{ V} \cdot 0.11 \text{ A} \cdot 156 \text{ V}}{145 \text{ V} \cdot 520 \text{ rad/s}} \right)$$

Evaluate Formula 

13) Torque of Squirrel Cage Induction Motor Formula

Formula

$$\tau = \frac{K \cdot E^2 \cdot R_r}{\left(R_s + R_r \right)^2 + \left(X_s + X_r \right)^2}$$

Evaluate Formula 

Example with Units

$$5.3398 \text{ N}\cdot\text{m} = \frac{0.6 \cdot 200 \text{ V}^2 \cdot 2.75 \Omega}{\left(55 \Omega + 2.75 \Omega \right)^2 + \left(50 \Omega + 45 \Omega \right)^2}$$



Variables used in list of Electric Traction Drives Formulas above

- a_{gear} Gear Tooth Ratio
- E Voltage (Volt)
- E_b Back Emf (Volt)
- E_{DC} DC Voltage (Volt)
- E_L AC Line Voltage (Volt)
- E_{peak} Peak Voltage (Volt)
- E_r RMS Value of Rotor Side Line Voltage (Volt)
- E_{rms} Rotor RMS Line Voltage with Slip (Volt)
- E_t Energy Dissipated in Transient Operation (Joule)
- i Electric Current (Ampere)
- I_{eq} Equivalent Current (Ampere)
- I_r Rectified Rotor Current (Ampere)
- J Moment of Inertia (Kilogram Square Meter)
- K Constant
- n_1 Number 1 of Teeth of Driving Gear
- n_2 Number 2 of Teeth of Driven Gear
- R Resistance of Motor Winding (Ohm)
- R_r Rotor Resistance (Ohm)
- R_s Stator Resistance (Ohm)
- s Slip
- s_m Slip at Maximum Torque
- t Time Taken for Drive Speed (Second)
- T Time Taken for Complete Operation (Second)
- t_{on} On-Period Time (Second)
- t_s Starting Time For Induction motor on No Load (Second)
- V_a Motor Terminal Voltage (Volt)
- V_s Source Voltage (Volt)
- X_r Rotor Reactance (Ohm)
- X_s Stator Reactance (Ohm)
- θ Firing Angle (Degree)

Constants, Functions, Measurements used in list of Electric Traction Drives Formulas above

- **constant(s):** pi, 3.14159265358979323846264338327950288
Archimedes' constant
- **Functions:** cos, cos(Angle)
Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- **Functions:** int, int(expr, arg, from, to)
The definite integral can be used to calculate net signed area, which is the area above the x -axis minus the area below the x -axis.
- **Functions:** modulus, modulus
Modulus of a number is the remainder when that number is divided by another number.
- **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:** Time in Second (s)
Time Unit Conversion 
- **Measurement:** Electric Current in Ampere (A)
Electric Current Unit Conversion 
- **Measurement:** Energy in Joule (J)
Energy Unit Conversion 
- **Measurement:** Angle in Degree (°)
Angle 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 Radian per Second (rad/s)
Angular Velocity Unit Conversion 
- **Measurement:** Torque in Newton Meter (N*m)
Torque Unit Conversion 
- **Measurement:** Moment of Inertia in Kilogram Square Meter (kg·m²)
Moment of Inertia Unit Conversion 
- **Measurement:** Angular Frequency in Radian per Second (rad/s)



- T Torque (Newton Meter)
- T_L Load Torque (Newton Meter)
- T_m Mechanical Time Constant of Motor (Second)
- ω_f Angular Frequency (Radian per Second)
- ω_{m1} Initial Angular Velocity (Radian per Second)
- ω_{m2} Final Angular Velocity (Radian per Second)

Angular Frequency Unit Conversion 



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