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Induction Motor Circuit Formulas

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List of 28 Induction Motor Circuit Formulas

Induction Motor Circuit

1) Armature Current given Power in Induction Motor

Open Calculator

fx $$I_a = \frac{P_{out}}{V_a}$$

ex $$3.700361\text{A} = \frac{41\text{W}}{11.08\text{V}}$$

2) Breakdown Slip of Induction Motor

Open Calculator

fx $$s = \frac{R}{X}$$

ex $$0.19 = \frac{14.25\Omega}{75\Omega}$$

3) Field Current using Load Current in Induction Motor

Open Calculator

fx $$I_f = I_a - I_L$$

ex $$0.75\text{A} = 3.7\text{A} - 2.95\text{A}$$

4) Force by Linear Induction Motor

Open Calculator

fx $$F = \frac{P_{in}}{V_s}$$

ex $$0.296296\text{N} = \frac{40\text{W}}{135\text{m/s}}$$

5) Frequency given Number of Poles in Induction Motor

Open Calculator

fx $$f = \frac{n \cdot N_s}{120}$$

ex $$54.66371\text{Hz} = \frac{4 \cdot 15660\text{rev/min}}{120}$$

6) Gross Mechanical Power in Induction Motor

Open Calculator

fx $$P_m = (1 - s) \cdot P_{in}$$

ex $$32.4\text{W} = (1 - 0.19) \cdot 40\text{W}$$

7) Induced EMF given Linear Synchronous Speed

Open Calculator

fx $$E_i = V_s \cdot B \cdot l$$

ex $$4.8654\text{V} = 135\text{m/s} \cdot 0.68\text{T} \cdot 53\text{mm}$$

8) Induced Voltage given Power

Open Calculator

fx $$V_a = \frac{P_{out}}{I_a}$$

ex $$11.08108\text{V} = \frac{41\text{W}}{3.7\text{A}}$$

9) Linear Synchronous Speed

Open Calculator

fx $$V_s = 2 \cdot w \cdot f_{line}$$

ex $$135\text{m/s} = 2 \cdot 150\text{mm} \cdot 450\text{Hz}$$

10) Load Current in Induction Motor

Open Calculator

fx $$I_L = I_a - I_f$$

ex $$2.95\text{A} = 3.7\text{A} - 0.75\text{A}$$

11) Maximum Running Torque

Open Calculator

fx $$\tau_{run} = \frac{3 \cdot E^2}{4 \cdot \pi \cdot N_s \cdot X}$$

ex $$0.181512\text{N*m} = \frac{3 \cdot (305.8\text{V})^2}{4 \cdot \pi \cdot 15660\text{rev/min} \cdot 75\Omega}$$

12) Motor Speed given Efficiency in Induction Motor

Open Calculator

fx $N_m = \eta \cdot N_s$

ex $14094\text{rev/min} = 0.90 \cdot 15660\text{rev/min}$

13) Pitch Factor in Induction Motor

Open Calculator

fx $K_p = \cos\left(\frac{\theta}{2}\right)$

ex $0.707107 = \cos\left(\frac{90^\circ}{2}\right)$

14) Power Converted in Induction Motor

Open Calculator

fx $P_{conv} = P_{ag} - P_{r(cu)}$

ex $10.45\text{W} = 12\text{W} - 1.55\text{W}$

15) Reactance given Slip at Maximum Torque

Open Calculator

fx $X = \frac{R}{s}$

ex $75\Omega = \frac{14.25\Omega}{0.19}$

16) Resistance given Slip at Maximum Torque

Open Calculator

fx $$R = s \cdot X$$

ex $$14.25\Omega = 0.19 \cdot 75\Omega$$

17) Rotor Copper Loss given Input Rotor Power

Open Calculator

fx $$P_{r(cu)} = s \cdot P_{in(r)}$$

ex $$1.482W = 0.19 \cdot 7.8W$$

18) Rotor Copper Loss in Induction Motor

Open Calculator

fx $$P_{r(cu)} = 3 \cdot I_r^2 \cdot R_r$$

ex $$1.55952W = 3 \cdot (0.285A)^2 \cdot 6.4\Omega$$

19) Rotor Current in Induction Motor

Open Calculator

fx $$I_r = \frac{s \cdot E_i}{\sqrt{R_{r(ph)}^2 + \left(s \cdot X_{r(ph)}\right)^2}}$$

ex $$0.218591A = \frac{0.19 \cdot 67.3V}{\sqrt{(56\Omega)^2 + (0.19 \cdot 89\Omega)^2}}$$

20) Rotor Efficiency in Induction Motor

Open Calculator

fx $$\eta = \frac{N_m}{N_s}$$

ex $$0.916347 = \frac{14350\text{rev/min}}{15660\text{rev/min}}$$

21) Rotor Frequency given Supply Frequency

Open Calculator

fx $$f_r = s \cdot f$$

ex $$10.374\text{Hz} = 0.19 \cdot 54.6\text{Hz}$$

22) Rotor Input Power in Induction Motor

Open Calculator

fx $$P_{in(r)} = P_{in} - P_{sl}$$

ex $$7.8\text{W} = 40\text{W} - 32.2\text{W}$$

23) Slip given Efficiency in Induction Motor

Open Calculator

fx $$s = 1 - \eta$$

ex $$0.1 = 1 - 0.90$$

24) Starting Torque of Induction Motor

Open Calculator

fx $$\tau = \frac{3 \cdot E^2 \cdot R}{2 \cdot \pi \cdot N_s \cdot \left(R^2 + X^2\right)}$$

ex $$0.066571\text{N*m} = \frac{3 \cdot (305.8\text{V})^2 \cdot 14.25\Omega}{2 \cdot \pi \cdot 15660\text{rev/min} \cdot \left((14.25\Omega)^2 + (75\Omega)^2\right)}$$

25) Stator Copper Loss in Induction Motor

Open Calculator

fx $$P_{s(cu)} = 3 \cdot I_s^2 \cdot R_s$$

ex $$13.98037\text{W} = 3 \cdot (0.85\text{A})^2 \cdot 6.45\Omega$$

26) Synchronous Speed in Induction Motor

Open Calculator

fx $$N_s = \frac{120 \cdot f}{n}$$

ex $$15641.75\text{rev/min} = \frac{120 \cdot 54.6\text{Hz}}{4}$$

27) Synchronous Speed of Induction Motor given Efficiency

Open Calculator

fx $$N_s = \frac{N_m}{\eta}$$

ex $$15944.44\text{rev/min} = \frac{14350\text{rev/min}}{0.90}$$

28) Torque of Induction Motor under Running Condition

Open Calculator

fx $$\tau = \frac{3 \cdot s \cdot E^2 \cdot R}{2 \cdot \pi \cdot N_s \cdot \left(R^2 + \left(X^2 \cdot s\right)\right)}$$

ex $$0.057962\text{N*m} = \frac{3 \cdot 0.19 \cdot (305.8\text{V})^2 \cdot 14.25\Omega}{2 \cdot \pi \cdot 15660\text{rev/min} \cdot \left((14.25\Omega)^2 + \left((75\Omega)^2 \cdot 0.19\right)\right)}$$

Variables Used

- **B** Magnetic Flux Density *(Tesla)*
- **E** EMF *(Volt)*
- E_i Induced EMF *(Volt)*
- **f** Frequency *(Hertz)*
- **F** Force *(Newton)*
- f_{line} Line Frequency *(Hertz)*
- f_r Rotor Frequency *(Hertz)*
- I_a Armature Current *(Ampere)*
- I_f Field Current *(Ampere)*
- I_L Load Current *(Ampere)*
- I_r Rotor Current *(Ampere)*
- I_s Stator Current *(Ampere)*
- K_p Pitch Factor
- **l** Length of Conductor *(Millimeter)*
- **n** Number of Poles
- N_m Motor Speed *(Revolution per Minute)*
- N_s Synchronous Speed *(Revolution per Minute)*
- P_{ag} Air Gap Power *(Watt)*
- P_{conv} Converted Power *(Watt)*
- P_{in} Input Power *(Watt)*
- $P_{in(r)}$ Rotor Input Power *(Watt)*

- P_m Mechanical Power *(Watt)*
- P_{out} Output Power *(Watt)*
- $P_{r(cu)}$ Rotor Copper Loss *(Watt)*
- $P_{s(cu)}$ Stator Copper Loss *(Watt)*
- P_{sl} Stator Losses *(Watt)*
- R Resistance *(Ohm)*
- R_r Rotor Resistance *(Ohm)*
- $R_{r(ph)}$ Rotor Resistance per Phase *(Ohm)*
- R_s Stator Resistance *(Ohm)*
- s Slip
- V_a Armature Voltage *(Volt)*
- V_s Linear Synchronous Speed *(Meter per Second)*
- w Pole Pitch Width *(Millimeter)*
- X Reactance *(Ohm)*
- $X_{r(ph)}$ Rotor Reactance per Phase *(Ohm)*
- η Efficiency
- θ Short Pitched Angle *(Degree)*
- τ Torque *(Newton Meter)*
- τ_{run} Running Torque *(Newton Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **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 Millimeter (mm)
  Length Unit Conversion
- Measurement: **Electric Current** in Ampere (A)
  Electric Current Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Magnetic Flux Density** in Tesla (T)
  Magnetic Flux Density Unit Conversion

- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Angular Velocity** in Revolution per Minute (rev/min)
  Angular Velocity Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion

Check other formula lists

- **Induction Motor Circuit Formulas**

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