

ELECTROTECHNICS

INDUCTION MOTORS

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INDUCTION MOTORS

Example 1

Assignment

Three-phase induction motor has these parameters:

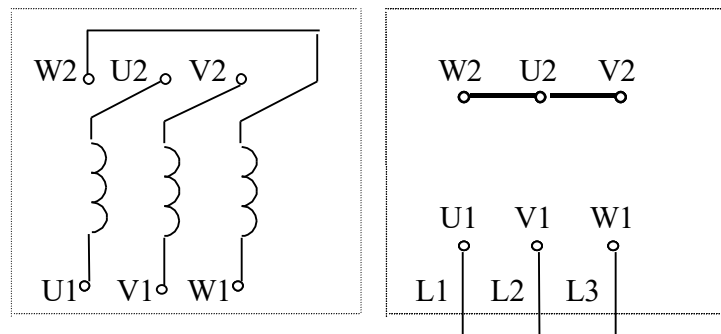
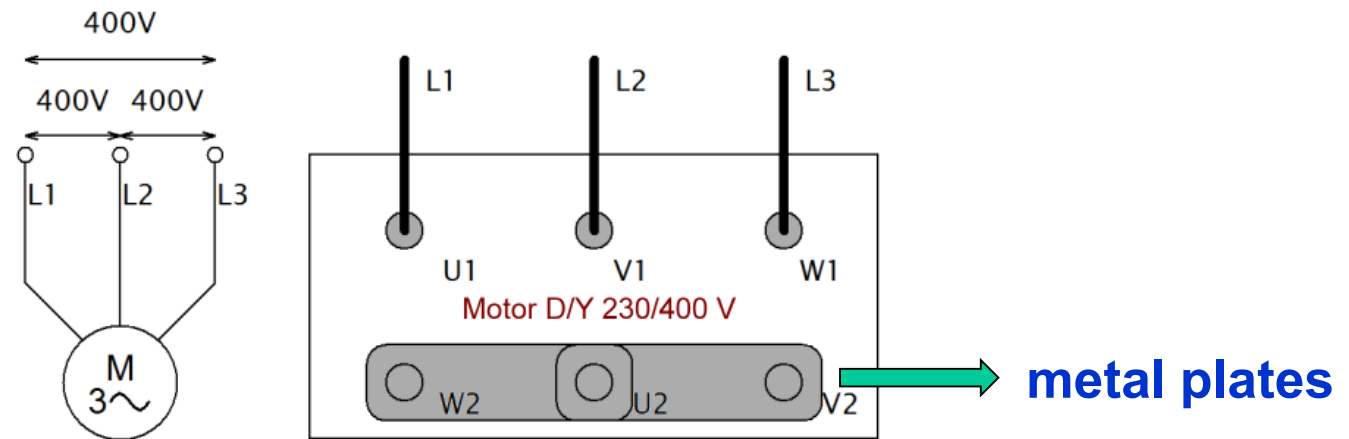
- nominal power: $P_N = 1,5 \text{ kW}$
- nominal voltage: $V_N = 230/400 \text{ V (D/Y)}$
- nominal current: $I_N = 6,1/3,5 \text{ A (D/Y)}$
- nominal speed : $n_N = 1425 \text{ min}^{-1}$
- number of poles: $2p = 4$
- nominal efficiency: $\eta_N = 78\%$
- frequency: $f = 50 \text{ Hz}$

Calculate input electrical power P_1 , power factor $\cos \varphi$, nominal torque T and synchronous speed n_{s1} .

INDUCTION MOTORS

Example 1

Motor terminal connection



INDUCTION MOTORS

Example 1

Solution

The input power drawn by the motor from the network is calculated from the formula for motor efficiency:

$$\eta_N = \frac{P_N}{P_1} \rightarrow P_1 = \frac{P_N}{\eta_N} = \frac{1500}{0,78} = 1923 \text{ W}$$

Power factor:

$$P_1 = \sqrt{3} \cdot V_N \cdot I_N \cdot \cos\varphi_N \rightarrow \cos\varphi_N = \frac{P_1}{\sqrt{3} \cdot V_N \cdot I_N} = \frac{1923}{\sqrt{3} \cdot 400 \cdot 3,5} = 0,79$$

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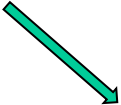
Example 1

Solution

Nominal torque on the motor shaft:

$$T_N = 9,55 \cdot \frac{P_N}{n_N} = 9,55 \cdot \frac{1500}{1425} = 10,05 \text{ N} \cdot \text{m}$$

Motor synchronous speed (speed of the stator magnetic field):

$$n_{s1} = \frac{60 \cdot f}{p} = \frac{60 \cdot 50}{2} = 1500 \text{ min}^{-1}$$


pole pairs

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Example 2

Assignment

Three-phase induction motor has these parameters (from its catalogue):

- nominal power on the shaft: $P_N = 100 \text{ kW}$
- nominal supply voltage: $V_N = 3 \times 400 \text{ V (D)}$
- nominal power factor: $\cos \varphi_N = 0,87$
- nominal speed: $n_N = 1480 \text{ min}^{-1}$
- number of poles: $2p = 4$
- nominal efficiency: $\eta_N = 93,5\%$
- starting (inrush) current ratio: $i_l = 7,5$
- starting torque ratio: $t_l = 2,4$
- breakdown torque ratio: $t_b = 2,6$
- frequency: $f = 50 \text{ Hz}$

INDUCTION MOTORS

Example 2

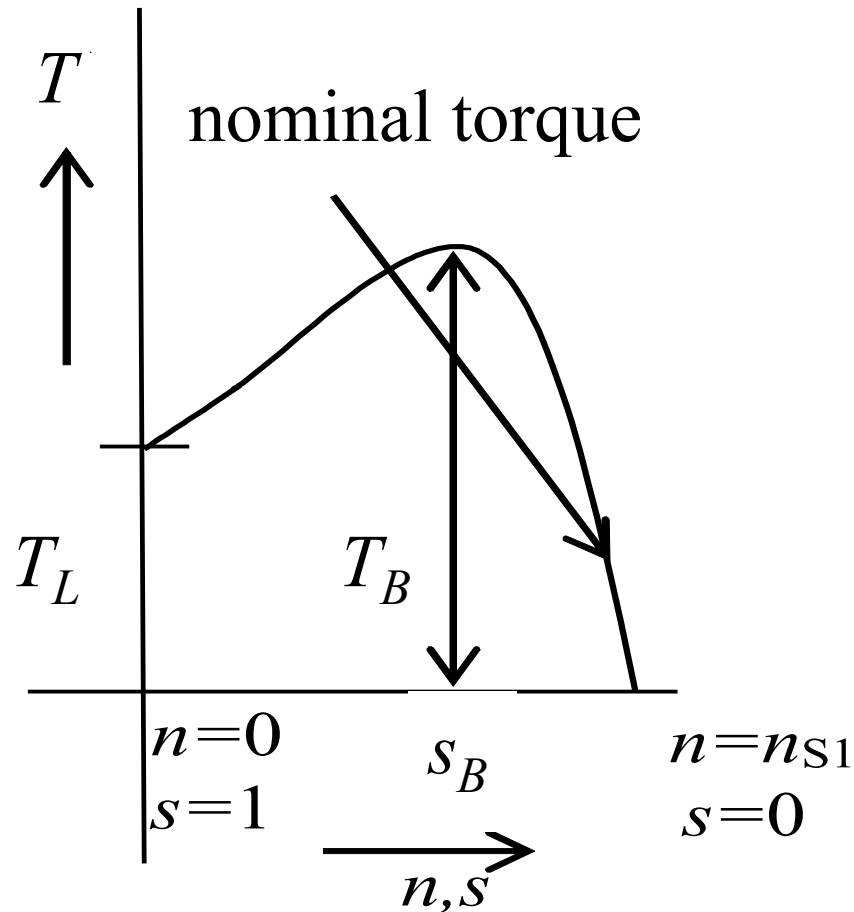
Assignment

Calculate synchronous speed n_{s1} , input electrical power P_1 , nominal input current I_N , starting current I_L , nominal torque on the motor shaft T_N , starting torque T_L , breakdown torque T_B , power factor $\cos\varphi$, nominal slip s_N and frequency in the motor rotor.

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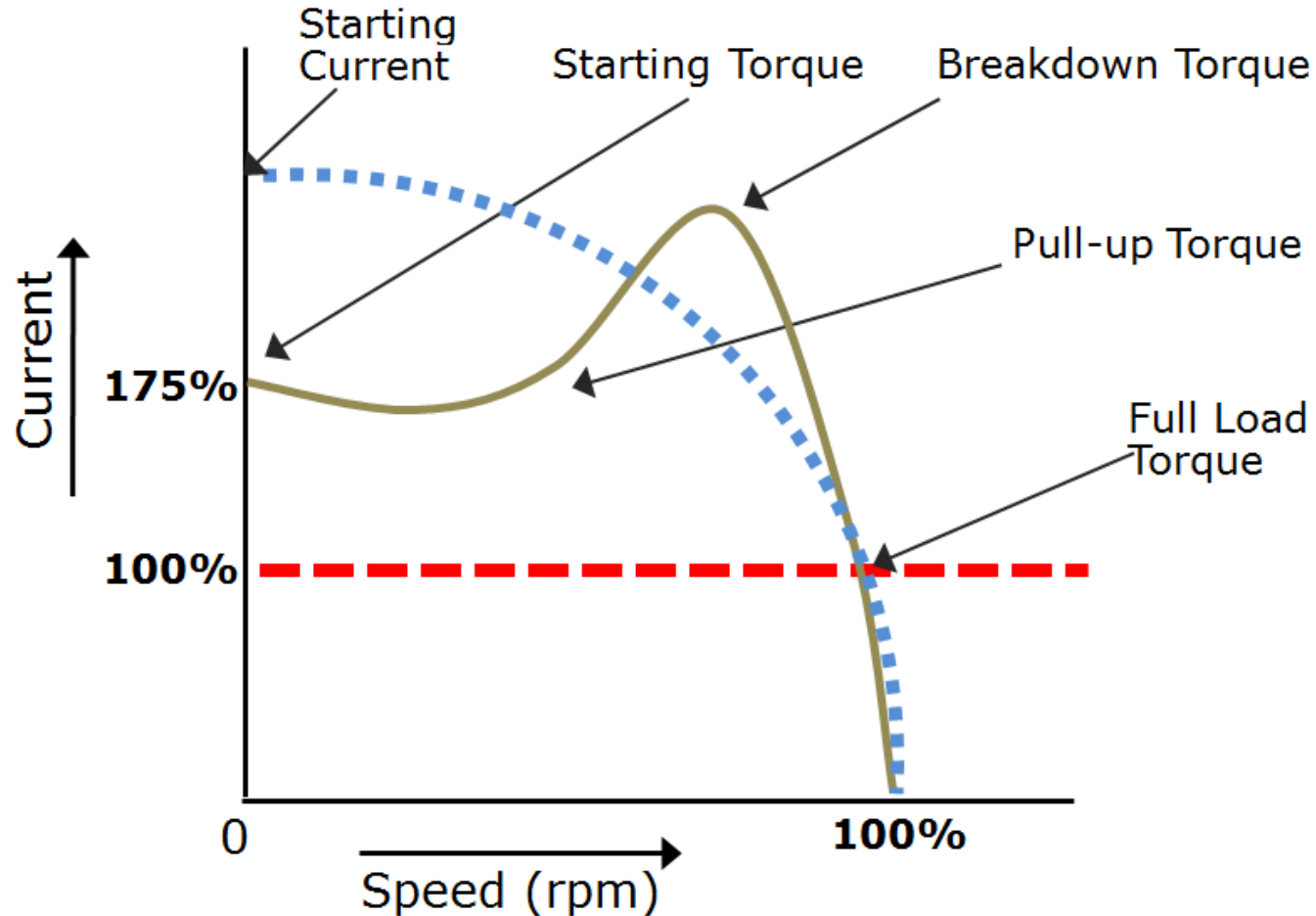
Example 2

Mechanical characteristics of motor



INDUCTION MOTORS

Example 2



INDUCTION MOTORS

Example 2

Solution

Motor synchronous speed:

$$n_{s1} = \frac{60 \cdot f_1}{p} = \frac{60 \cdot 50}{2} = 1500 \text{ min}^{-1}$$

Input power:

$$\eta_N = \frac{P_N}{P_1} \cdot 100 \rightarrow P_1 = \frac{P_N}{\eta_N} \cdot 100 = \frac{100 \cdot 10^3}{93,5} 100 = 107000 \text{ W} = 107 \text{ kW}$$

INDUCTION MOTORS

Example 2

Solution

Nominal input current:

$$P_1 = \sqrt{3} \cdot V_N \cdot I_N \cdot \cos\varphi_N \rightarrow I_N = \frac{P_1}{\sqrt{3} \cdot V_N \cdot \cos\varphi_N} = \frac{107 \cdot 10^3}{\sqrt{3} \cdot 400 \cdot 0,87} = 177,5 \text{ A}$$

Starting current ratio is defined as:

$$i_1 = \frac{I_L}{I_N}$$

$$I_L = i_1 \cdot I_N = 7,5 \cdot 177,5 = 1331,3 \text{ A}$$

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Example 2

Solution

Nominal torque on the motor shaft:

$$T_N = 9,55 \cdot \frac{P_N}{n_N} = 9,55 \cdot \frac{100000}{1480} = 645,2 \text{ N} \cdot \text{m}$$

Starting torque ratio is defined as:

$$t_1 = \frac{T_L}{T_N}$$

Breakdown torque ratio is defined as:

$$t_b = \frac{T_B}{T_N}$$

ELEKTROMOTORY

Příklad 2

Řešení

Starting torque:

$$T_{L_1} = t_{L_1} \cdot T_N = 2,4 \cdot 645,2 = 1548,5 \text{ N} \cdot \text{m}$$

Breakdown torque:

$$T_B = t_b \cdot T_N = 2,6 \cdot 645,2 = 1677,5 \text{ N} \cdot \text{m}$$

Nominal slip:

$$s_N = \frac{n_{s1} - n_N}{n_{s1}} \cdot 100 = \frac{1500 - 1480}{1500} \cdot 100 = 1,33\%$$

Frequency in the motor rotor:

$$f_{2N} = s_N \cdot f_{1N} = 0,0133 \cdot 50 = 0,67 \text{ Hz}$$