***Exercise:* Study of an induction motor**

The descriptive plate (“la plaque signalétique”) of the induction motor of a milling machine shows the following indications:

3 ~	50 Hz	
Δ	220 V	11 A
Y	380 V	6,4 A
1455 tr/min		cos φ = 0,80

1- This motor is supplied by an electric grid **220 V / 380 V**; **50 Hz**. How do we have to couple the stator windings of this machine? Justify your answer.
2- Give the number of poles of machine stator.
3- Calculate the nominal slip g_n (in **%**).
4- A no-load test (“essai à vide”) was performed for this motor powered by the grid mentioned above. We obtained the following results:
   - **No-load current :** $I_0 = 3.2\ A$
   - **No-load absorbed power :** $P_{a0} = 260\ W$

We **neglect** the joule losses of the rotor at no-load: P_{jr0}.
The **mechanical losses** p_{mec} are evaluated at **130 W**.
The warm measurement of the resistance of a stator winding gives **Rs = 0.65 Ω**.

Deduce the iron losses in the stator at no-load : P_{fs0}.

In the following, we will consider that the iron losses in the stator is constant and equal to P_{fs0}.

5- We perform a test in **the nominal conditions** of the machine:
a) Calculate the stator joule losses P_{js}
b) Calculate the joule losses in the rotor P_{jr}
c) Calculate the useful torque C_u of the motor
d) Calculate the efficiency of the motor **η**

Correction

1) Star coupling as this motor is supplied by an electric grid 220 V / 380 V: grid voltages are equal to those of the machine.

2) 4 poles (synchronism speed: 1500 rpm).

3) $g_n = \frac{N_s - N}{N_s} = \frac{1500-1455}{1500} = 3\%$

4) First, we calculate:

- Stator joule losses : $P_{js0} = 3\, R_s I_0^2 = 3 \times 0.65 \times 3.2^2 = 20W$

We **neglect** the joule losses of the rotor at no-load: $\boldsymbol{P_{jr0}}$.

Based on power balance for no load test, we obtain:

$$P_{fs0} = P_{a0} - \left(P_{js0} + P_{jr0} + p_{mec}\right) = 260 - (20 + 0 + 130) = 110\ W$$

5)

a) Stator joule losses: $P_{js} = 3\, R_s I_n^2 = 3 \times 0.65 \times 6.4^2 = 80W$

b) Rotor joule losses:

$$P_{jr} = g_n P_{em} = g_n\left[P_a - \left(P_{js} + P_{fs}\right)\right] = 0.03 \times [3380 - (80 + 110)] = 95.6\ W$$

With: $P_a = 3V_n I_n \cos\varphi_n = 3 \times 220 \times 6.4 \times 0.8 = 3380\ W$

c) $C_u = \frac{P_u}{\Omega_n} = \frac{3380-80-110-95.6-130}{1455 \times \frac{\pi}{30}} = 19.46\ Nm$

d) $\eta = \frac{P_u}{P_a} = \frac{3380-80-110-95.6-130}{3380} = 87.7\ \%$