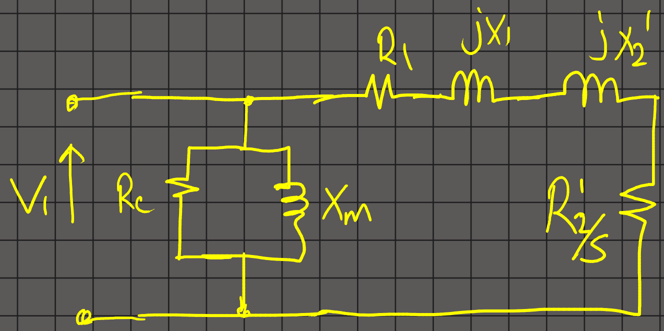
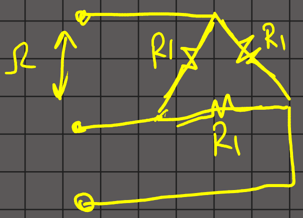
Estimate the parameters of a 30 kW, 50 Hz, Delta-connected, 415 V, 3-phase machine, if the test results are as follows:

Locked-Rotor Test:



- Input Power: 6.4 kW
- Line Current: 77 A
- Line Voltage: 130 V
- Resistance between two lines: 0.293 Ω

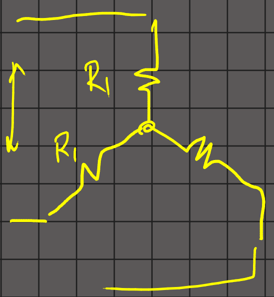


resistance between two lines $\Rightarrow R_1 // (R_1 + R_1) = \frac{2R_1}{3} = 0{,}293\,\Omega$

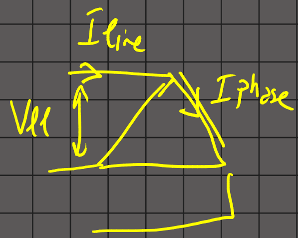
$R_1 = 0{,}44\,\Omega$ (DC resistance)

$R_{1(ac)} = 1.1 \cdot R_{dc}$

$R_{1(ac)} = 0{,}48\,\Omega$



resistance between two lines $\Rightarrow 2R_1$



Equivalent circuit in the locked rotor test

$$Z_{eq} = \frac{130}{77/\sqrt{3}}$$

$$Z_{eq} = 2{,}92\,\Omega$$

$$P_{ph} = \frac{6.4\,kW}{3} = I_{ph}^2 \cdot (R_1 + R_2')$$

$$= \left(\frac{77}{\sqrt{3}}\right)^2 \cdot (R_1 + R_2')$$

$R_{eq} = R_1 + R_2' = 1{,}08\,\Omega$ (per phase)

$R_1 = 0{,}48\,\Omega$

$R_2' = 0{,}6\,\Omega$

$$Z_{eq} = \sqrt{R_{eq}^2 + (X_1 + X_2')^2} \Rightarrow X_{eq} = X_1 + X_2' = \sqrt{2{,}92^2 - 1{,}08^2}$$

$$= 2{,}71\,\Omega$$

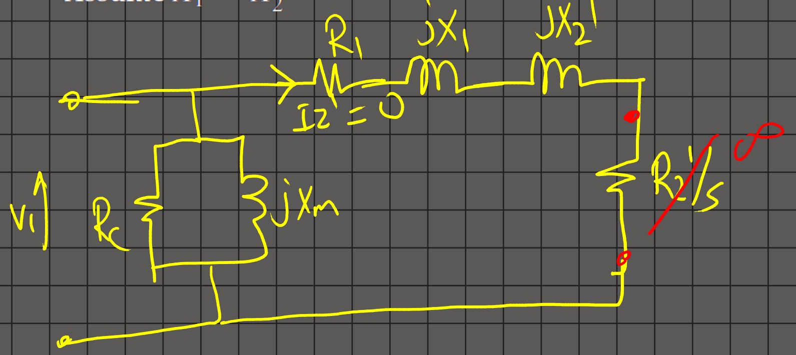
Assume $X_1 = X_2' = 1{,}36\,\Omega/ph$

Estimate the parameters of a 30 kW, 50 Hz, Delta-connected, 415 V, 3-phase machine, if the test results are as follows:

No-Load Test:

- Input Power: 1.65 kW
- Line Current: 22.8 A
- Line Voltage: 415 V
- Friction and windage losses: 1.15 kW

Assume $X_1 = X_2'$



At no load $s \cong 0$

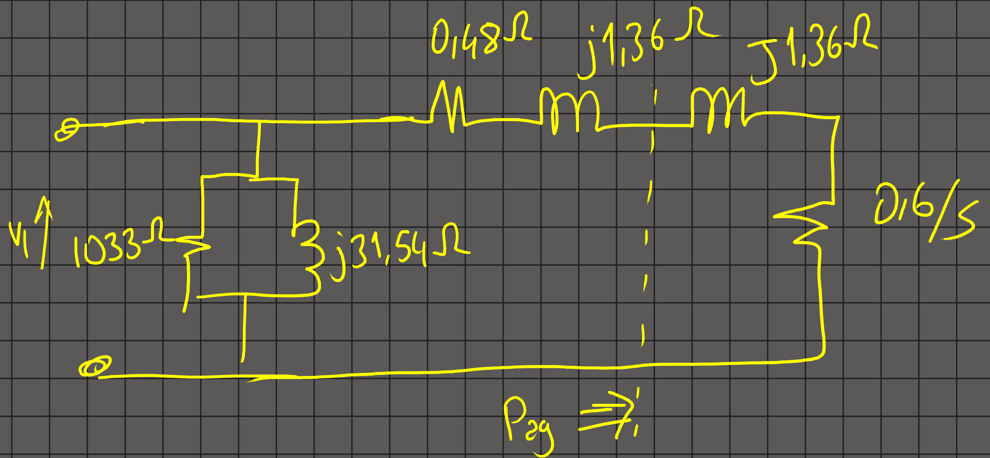
$$Z_{nl} = \frac{V_{ph}}{I_{ph}} = \frac{415}{(22.8/\sqrt{3})} = 31{,}53\ \Omega/ph.$$

$P_{noload} = 1{,}65\,kW \quad P_{friction} = 1{,}15\,kW \Rightarrow P_{core} = 1{,}65 - 1{,}15 = \underline{500\,W}$

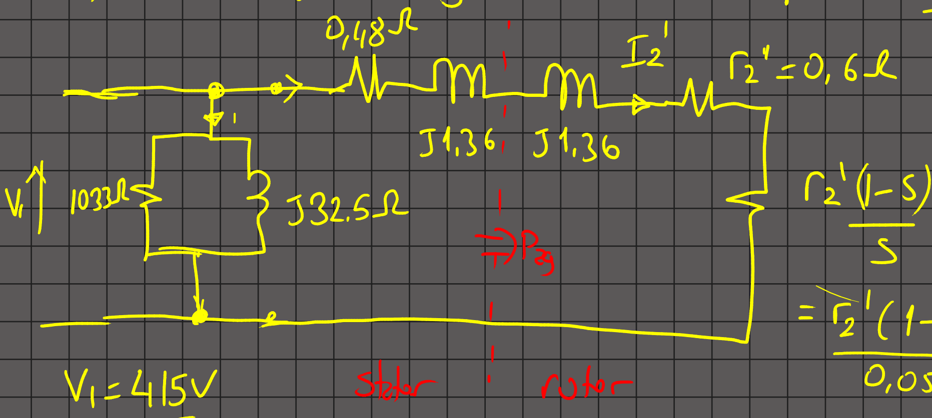
$$P_{core} = \frac{3 . V_1^2}{R_c} = 500 \Rightarrow \underline{R_c = 1033\ \Omega}$$

$Z_{nl} = (R_c // X_m) = 31{,}53\ \Omega \qquad \left(\frac{1}{X_m}\right)^2 + \left(\frac{1}{R_c}\right)^2 = \left(\frac{1}{Z_{nl}}\right)^2$

$\underline{X_m = 31{,}54\ \Omega}$



find the efficiency when the slip is $= 0{,}05$



$V_1 = 415V$

$\frac{r_2'(1-s)}{s} \Rightarrow$ Gross Mech. power

$= \frac{r_2'(1-0{,}05)}{0{,}05} = 19 . r_2'$

$|Z_{eq}| = \sqrt{(1{,}36+1{,}36)^2 + (0{,}48+12)^2} = 12{,}77\Omega$

$I_2' = \frac{415V}{12{,}77} = 32{,}5A$

$P_{core} = \frac{3V_1^2}{R_c} = \frac{3 . 415^2}{1033} \cong 500W$

$P_{cu_1} = 3I^2 . r_1 = 3.(32{,}5)^2 . 0{,}48 = 1521\,W$

$P_{cu_2} = 3I_2'^2 . r_2' = 3(32{,}5)^2 . 0{,}6 = 1901\,W$

$P_{mech\,(gross)} = 3I_2'^2 . r_2' \frac{(1-s)}{s} = 3.(32{,}5)^2 . 0{,}6 . \underbrace{\frac{(1-0{,}05)}{0{,}05}}_{19} = 36{,}123\,W$

$P_{rotational\ loss} = 1{,}15\,kW = 1150\,W$

$P_{net} = P_{mech\,(gross)} - P_{rot.loss} = 36123 - 1150$

$= 34{,}973\,W$

$\eta = \frac{P_{net}}{P_{in}} = \frac{34{,}973}{34{,}973 + 1150 + 1901 + 1521 + 500}$

$\eta = \frac{34{,}973\,W}{40.045\,W} = 87{,}3\,\%$