Project memo AN 02.12.22

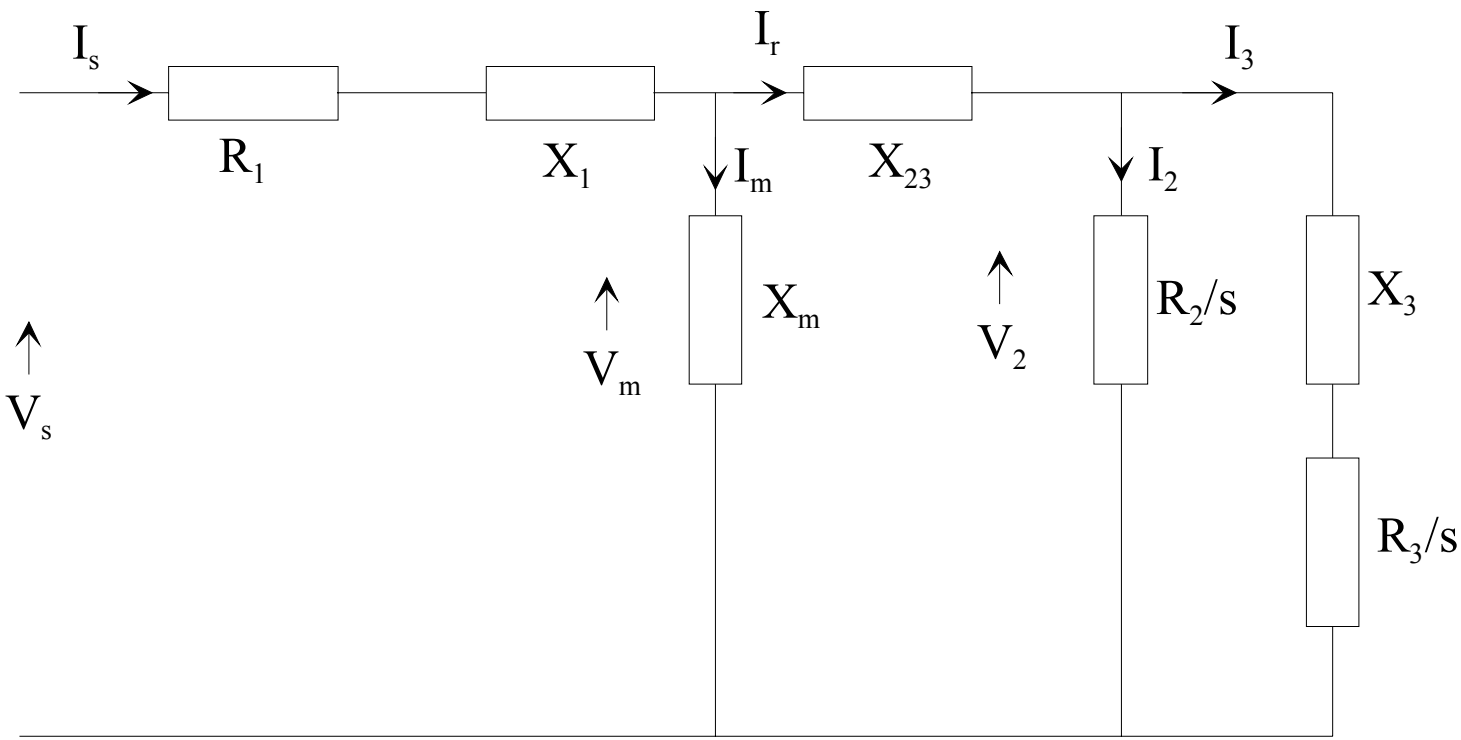
Mathcad spreadsheet dedicated for induction motor model parameter estimation

Objective

- The objective is to derive parameters for a motor model such that the model behaves as close as possible to the real motor
- Develop a Mathcad spreadsheet which estimates input parameters for the induction motor model used in PSCAD/EMTDC (two-axis model with two rotor circuits)
- Input data is to be data easily available for induction motors

Illustartion of model

- The equivalent circuit of the PSCAD/EMTDC induction motor model



Input data to spreadsheet

- Rms rated phase voltage
- Rated output mechanical power
- Rated electrical frequency
- Efficiency at rated operation
- Rated power factor
- Number of poles
- Rated speed
- Start current (relative to rated current)
- Start torque (relative to rated torque)
- Inertia

Output data

- Stator resistance (R1)
- First cage resistance (R2)
- Second cage resistance (R3)
- Stator unsaturated leakage reactance (X1)
- Mutual unsaturated reactance (Xm)
- Rotor unsaturated mutual reactance (X23)
- Second cage unsaturated reactance (X3)
- Polar moment of inertia (MW/MVA)
- Mechanical damping (p.u)

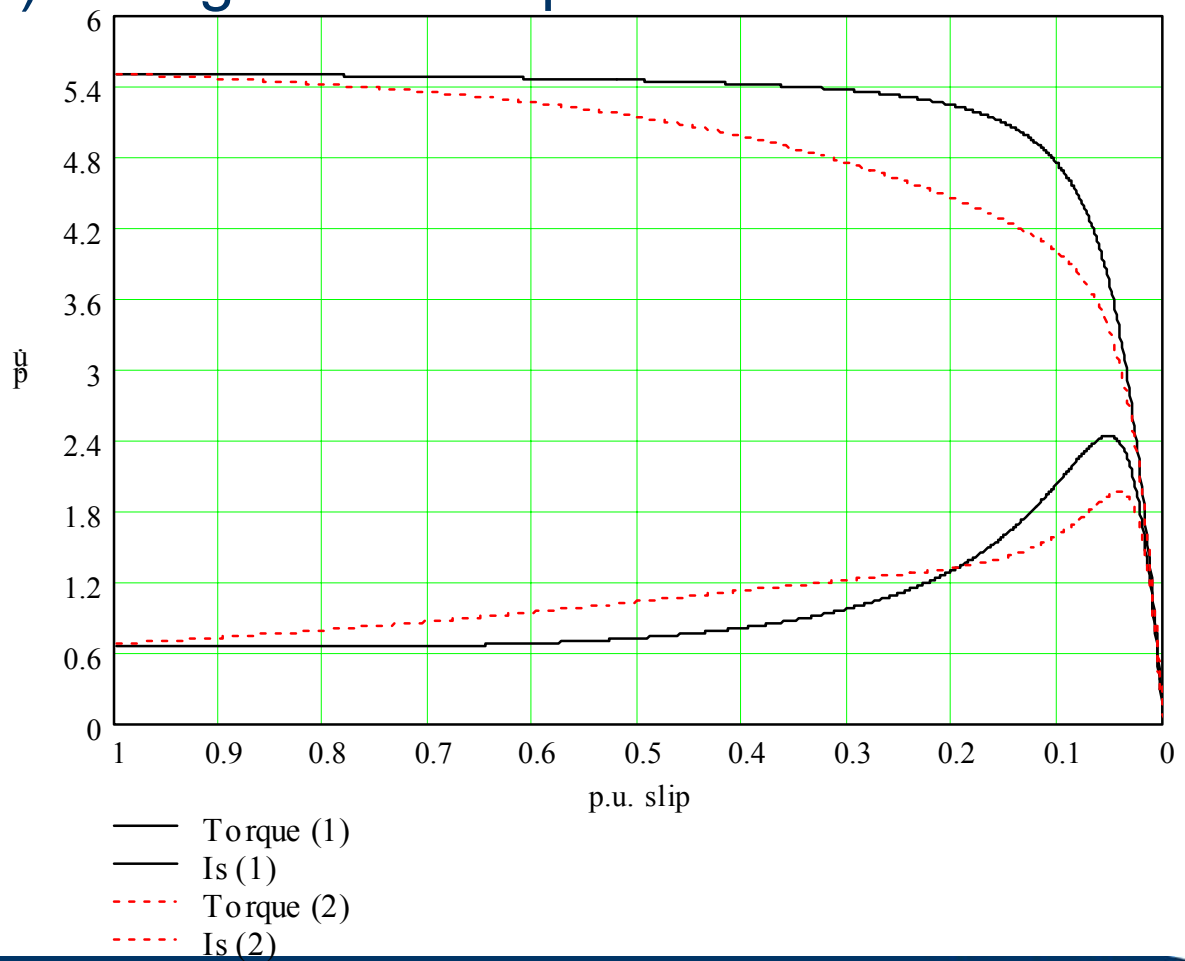
Additional input data

- User must also specify:
  - Approximate amount of stator losses relative to total losses (minor influence on final model)
  - Stator reactance relative to the motor reactance when rotor is blocked (minor influence on final model)
  - Artificial factor K not reflecting any physical motor parameter (see next slide)

Effect of the artifical factor K

- Influences the shape of the torque curve and the current amplitude (Is) during the start-up

- Figure shows torque and current for two different K values



Verification

- The verification part of the spreadsheet presents curves and percent error between desired quantities and model quantities:

Rated speed

$$\left|\frac{N_v - N_{rated}}{N_{rated}}\right| = 0.0028\%$$

Power factor

$$\left|\frac{\cos\phi_v - \cos\phi}{\cos\phi}\right| = 0.1868\%$$

Start current

$$\left|\frac{|I_{start\_v}| - I_{start}}{I_{start}}\right| = 0.0096\%$$

Start torque

$$\left|\frac{T_{start\_Nm\_v} - T_{start\_rel} T_{rated\_Nm}}{T_{start\_rel} T_{rated\_Nm}}\right| = 1.3268\%$$

Output power

$$\left|\frac{P_{mech\_kW\_v} - P_{out}}{P_{out}}\right| = 0.2052\%$$

Efficiency

$$\left|\frac{\eta_v - \eta}{\eta}\right| = 0.0183\%$$

Rated torque

$$\left|\frac{T_{rated\_Nm\_v} - T_{rated\_Nm}}{T_{rated\_Nm}}\right| = 0.2079\%$$

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PROJECT MEMO

MEMO CONCERNS

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This memo presents a method for estimation of parameters for the induction motor-model in the PSCAD/EMTDC simulation software.

The parameter estimation is based on the following motor data:

- Rms rated phase voltage
- Rated output mechanical power
- Rated electrical frequency
- Efficiency at rated operation
- Rated power factor
- Number of poles
- Rated speed
- Start current (relative to rated current)
- Start torque (relative to rated torque)
- Inertia

In addition it is possible to “tune” one free input variable to get a desired break down torque (peak torque)

The method is implemented in a Mathcad spreadsheet. The spreadsheet also includes a verification part. It is therefore possible to directly see the resulting performance data of the model including a torque-speed curve

The estimated parameters are those needed for “Explicit” parameter specification in the induction motor model in the PSCAD/EMTDC simulation software. This method of specification gives behaviour much closer to the input data than the alternative “EMTP Type 40” parameter input that are found in the PSCAD/EMTDC simulation software.

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