

## Assignment 2: Speed control of a PMSM with FOC

A three-phase permanent magnet (PM) synchronous motor (PMSM) is Y-connected in the stator windings. The motor has the following parameters:

Number of pole pairs  $p=4$   
Stator d-axis inductance  $L_d=5.25$  mH  
Stator q-axis inductance  $L_q=12$  mH  
Stator resistance  $R_s=0.958$  ohm  
PM flux linkage  $\psi_f=0.1827$  Wb  
Inertia:  $J=0.003$  kg\*m<sup>2</sup>  
Damping coefficient:  $B=0.008$  N\*m\*s  
Rated torque  $T_N=10$  Nm  
Rated speed  $n_N=1000$  rpm  
DC bus voltage  $U_{dc}=311$  V

Using the FOC strategy, the motor is started with no-load to 1000 rpm.

At  $t=0.2$  s, a torque of 10 Nm is applied.

In your assignment report, please provide:

- (1) Briefly state the control theory and basic analytical formulas for motor performance analysis.
- (2) Calculate some steady-state performance using the analytical formulae, e.g. the maximum back EMF at rated speed, and phase current at full-load. Note that these results might be used to validate your Simulink simulations later.
- (3) Build a Simulink model of FOC for controlling the motor speed as required. Report your model and machine and control parameters. The models should be attached for checking if they functions well.
- (4) Report various dynamic and steady-state performance, e.g. the speed curve, torque profile, phase current waveforms, output power profile, etc.
- (5) Analyse and validate your simulated results.
- (6) Any further analyses.