University of Cape Town: Department of Electrical Engineering

EEE 4123C: Electrical Machines and Drives

Project 2

(Due: 23h59 on Thursday, 24 August 2023)

Attempt this project in Matlab-Simulink. The following file "EEE4123C_Proj2_Example.mdl", should be accessed from the EEE4123C course directory, on the Vula Website. This file should be renamed and saved in your student directory. This file should be used to build your model as it provides you with all the necessary blocks and settings for building the model.

Using the Simulink block-set in **Simscape/SimPowerSystems** and **Simulink** libraries, setup the **practical implementation of the FOC algorithm for a surface PM motor**. The necessary machine parameters are given below. All current and speed controllers are standard PI controllers and should have the same proportional and integral gain constants, which are given below. It should be noted that the output of each **current controller** should be limited to a minimum and maximum saturation value of -300 and +300, whereas the saturation limit for the **speed controller** should be -30 and +30.

p (pole pairs) = 4

$r_s = 2.9\Omega$

$L_s = 8.5mH$

$\lambda_{pm} = 0.175 Wb\text{-}turns$

$J = 0.8\text{x}10^{-3}\, kg.m^2$

$K_p = 50$

$K_i = 2.6$

Ensure the maximum $\boldsymbol{T_e/Amp}$ condition is satisfied. The initial setpoint speed (ω_e*) should be set at 600rad/s and should be stepped to 300rad/s at 0.2sec. The initial load torque (T_L) should be 2Nm and should be stepped to 4Nm at 0.1sec. The following plots, where necessary, should be based on the above conditions

Part1

(i) Use appropriate transformations, show plots of the stator current in dq, $\alpha\beta$ and abc reference frames. Make sure all current components in each reference frame are shown on the same scope. (i.e. i_d & i_q must be shown on the same scope etc.) Explain whether the simulated results correspond with your expectations.

(ii) Show ω_e^*, ω_e and T_L, T_e on two separate scopes. Comment on the behaviour of ω_e and T_e when T_L is increased at t = 0.1s. Explain the change, if any, in i_d and i_q during this load torque transient period. Also comment on the transient behaviour of T_e, i_d and i_q when ω_e^* is decreased at t = 0.2s.

Save the model at this point as an .mdl file, name it "Proj2_Part1".

Part2

For this part, change the saturation limit of each **current controller** to a minimum and maximum saturation value of -30 and +30. Show ω_e^*, ω_e and i_d^*, i_d on two separate scopes. How do the output values compare to the reference values. It is well known that the dq-axes cross coupling effect is non-ideal for machine control, explain why using your results? Propose a method to compensate for this issue. Implement the proposed method and comment on your results.

Save the model at this point as an .mdl file, name it "Proj2_ Part2".