EE 560 – Electric Machines and Drives

Prof. N.J. Nagel, Autumn 2020 – Final Project

TESLA Induction Machine Parameters[1]

$P = 4$	number of motor poles (not pole pairs)
$R_s = 0.015\ \Omega$	stator resistance
$R_r = 0.020\ \Omega$	rotor resistance
$L_m = 0.9$ mH	mutual inductance
$L_{ls} = 0.0668$ mH	stator leakage inductance
$L_{lr} = 0.0668$ mH	rotor leakage inductance
$L_s = L_m + L_{ls}$	stator inductance
$L_r = L_m + L_{lr}$	rotor inductance
$J = 0.005$ kg-m^2	machine inertia
$b = 1.0 \times 10^{-4} \frac{\text{N-m}}{\left(\frac{\text{rad}}{\text{sec}}\right)}$	machine damping
$T_{rated} = 100$ N-m	rated machine torque
$\lambda_{rated} = 0.125$ Wb	rated machine flux
$I_{de_rated} = 138.9$A	rated d-axis current
$V_{bus} = 375$ V	bus voltage
$I_{max} = 350$ A	maximum motor current

To Do:

1) Simulate the TESLA induction machine using PLECS. Use notation consistent with the notation from the class notes. Create your own transformation blocks, do not use the PLECS blocks (because they use different notation then our class notes).
2) Simulate the current regulated induction machine with indirect field-oriented control. Assume an ideal inverter and perfectly estimated parameters.
    a. Implement a synchronous reference frame current regulator
    b. Tune the q and d axis regulators for bandwidths of 1 kHz assuming that the parameter estimates are accurate.
    c. Simulate a locked rotor step response for a rated torque command with d-axis current held constant at its rated value.
    d. Simulate a locked rotor 10 Hz, 100 Hz, and 1000 Hz sine wave response for a rated torque command with d-axis current held constant at its rated value. (A frequency response sweep is also acceptable).
3) Close a speed loop around the torque loop and demonstrate speed control of the motor.
    a. Tune the speed loop for a bandwidth of 50 Hz
    b. Simulate sine wave speed commands of 5 Hz and 50 Hz with a 10 rad/sec amplitude.

Note: You can use the SVPWM block in PLECS (make sure to negate the d-axis command to do this).

[1] Note: Tesla machine parameters were not available, these parameters are best guess by me.

To Hand In:

1) A neatly typed report highlighting the simulation methodology, a discussion of what was simulated, and the simulation results.
2) The report must include a block diagram of the system being simulated using a commercially available charting software (i.e. Visio). This must be included and discussed in the main body of the report. This should not consist of PLECS block diagrams.
3) Plots of the simulation results
4) A discussion of the simulation results from above.
5) Project conclusions
6) An appendix with PLECS model used for the simulation.