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Title

EXERCISE 4: INDUCTION MACHINE SCALAR CONTROL

Course Name

EE-565 Industrial Electronics II

1 GUIDELINES

Consider the induction machine described in Tab. 1 and answer the following questions:
Note: Two sessions are allocated to complete this exercise.

Table 1 Parameters already reported to the stator

P_n	2.2 kW	U_n Y	230 V	$\Omega_{m,n}$	1 465 rpm	R_s	2.6 Ω	L_{ls}	20 mH	L_m	0.305 H	J	0.014 N m
I_n	7.7 A	U_n Δ	400 V	f_{sw}	5 kHz	R_r	1.1 Ω	L_{lr}	10.5 mH	p	2	k_F	0.003 64 N m s

2 TASKS DESCRIPTION

Par 1: Offline

1. Having the mechanical characteristic of the Induction Machine in mind, discuss the stability of the machine under the working conditions left and right from the maximum torque point.
2. Explain the principles of the U/f control of the Induction Machine.
3. Explain the necessity of the voltage compensation under the low speed operation of the machine.
4. Using PLECS, please demonstrate the open-loop speed control of the Induction Machine under the U/f control strategy. Does the machine follow the reference with or without a static error? Please clarify your answer and add a scope of the results.
5. Implement the closed-loop speed control under the U/f strategy using PLECS and show the responses of the speed and torque. How did you tune your regulators? Please clarify your answer, add a scope of the results, and discuss them.
6. Does the U/f control allows to operate the machine above rated speed? Please develop your answer.
7. With our machine, how could the design be improved to increase the torque capabilities of the machine?

Part 2: HIL and PETS

1. Implement and deploy your open-loop scalar control in the provided template for the HIL PETS and PETS.
   Show your control implementation, and discuss relevant changes with respect to your offline model.

2. Show and comment HIL and experimental results for a speed reference step from $-\Omega_n$ to $+\Omega_n$. What are the differences between your offline simulations, HIL simulations, and experimental results?

3. Show and comment HIL and experimental results for a load torque step from −5Nm to +5Nm.

4. OPTIONAL: Implement closed-loop scalar control on HIL PETS and PETS. Show and comment on your results. Note: It is suggested to tune the PI using the symmetrical optimum method.

   Hints:
   - Connect the induction machine windings in star connection, you can leave the neutral point floating.
   - Supply the MOT DC-Link through the rectifier, adjust the AC1 VARIAC to have a DC-voltage that allows to synthesize the nominal machine voltage at the inverter output.