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Title

EXERCISE 2 - PART 2: DC MACHINE CONTROL WITH HIL AND PETS

Course Name

EE-565 Industrial Electronics II

1 GUIDELINES

Consider the DC machine described in Tab. 1 and answer the following questions:

Table 1 Machine parameters

P_n	2 500 W	$U_{a,n}$	400 V	R_a	3.8 Ω	$U_{f,n}$	340 V	R_f	729 Ω	N_f	5	J	0.001 2 N m s
$\Omega_{m,n}$	1500rpm	$I_{a,n}$	7.8 A	L_a	50 mH	$I_{f,n}$	0.45 A	L_f	34.6 H	k_e, k_m	0.8375	k_F	0.003 64 N m s

2 TASKS DESCRIPTION

Part 2: HIL and PETS

1. Implement and deploy your DC machine control in the provided template for the HIL and PETS. Test the behavior of the controller first in HIL and then in PETS. When starting to work with PETS, before testing your full controller in closed loop, validate first the functionality of each section. For example, start with your modulation techniques, then your armature current controller, then the current reference generator and finally the speed controller. Provide relevant details and scope captures for every step.
   Use legs U and V of the inverter as a full bridge for the armature. Use leg W of the inverter as a half bridge for the excitation winding. Due to the low value of excitation current, closed-loop excitation control is not possible. Simply apply the nominal excitation voltage to the leg W. No field weakening will be implemented.
   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 −5 Nm to 5 Nm.

Notes and remarks:

- When testing with PETS, use the voltage and current probes to display the measurements in the oscilloscope.
- For validation of armature current control, the shaft must be blocked. Ask your TA for assistance.
- Right after the Position and Speed computation block, there is a -1 gain. For HIL simulations, you need to disable it, but for PETS it is important to enable it. Use the switch to exchange it.
- Energize always in the first place the field winding.
- To test the speed controller, first try small steps of speed before trying from $-\Omega_n$ to $+\Omega_n$, e.g., from 0 to 100 rpm, then from 0 to 500 rpm, and so on.
- For the speed controller, it is suggested to tune using the Magnitude Optimum criteria, considering the friction torque in the model.
- For speed measurement, you will be provided with a speed interface to connect the bench to the PETS.
- Pay attention to the speed measurement and how much time it takes to acquire precisely the speed.