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EE-490(c) - Lab in Electrical Energy Systems - Project 8

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Topic: **Scalar Control (V/f) of the Induction Machine**

Objectives of the project

Objectives of the project are:

1) **UNDERSTAND** the operating principles behind the scalar control (V/f) for the 3-phase induction machine.
2) **OFFLINE SIMULATIONS:** Select modulation method, implement and develop V/f control method for induction machine fed from two-level three-phase converter in PLECS. Induction machine can be used from the PLECS library. Adjust the V/f profile parameters for the machine available in the lab and investigate the performance of the control method. The complete converter as in PETS will be used, supplied from the AC source through a diode rectifier, and with an induction machine connected on the inverter side.
3) **RT-HIL SIMULATIONS:** Program the control functions on the DSP for the RT-HIL (Fig.1a)) testing and validate results obtained from the offline simulations.
4) **EXPERIMENTAL VALIDATION:** Use already developed DSP code and validate experimentally correct operation with the induction machine connected to the PETS (Fig.1b)). AC source of the PETS will be used to supply the converter, while the induction machine is available in the lab. Experiments will involve acceleration and deceleration of the induction machine change of direction of rotation and operation at a set speed point.

Fig. 1 PETS HIL (left) and actual PETS (right) that will be used for RT-HIL simulations and experimental investigations.

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Background and methodology:

The goal of the projects offered in the EE-490(c) course is to provide practical experience with digital control for power electronics systems. Each project is relatively small in scope, but it allows for gradual learning through four steps:

1) **Theory:** Understanding certain concept that is of key relevance for the objectives of the project. Each project is therefore dealing with a well-defined topic.
2) **Modeling and Offline Simulations:** Developing models (hardware and software) and verifying theoretical concepts through offline simulations. PLECS software from PLEXIM is used for this.
3) **Real-Time Hardware-in-the-Loop Simulations:** This step requires programming of the Digital Signal Processor (DSP) from Texas Instruments in order to deploy relevant control algorithms on it. The model of the system to be controlled is developed on the RT-Box from PLEXIM (shown in Fig.1), and typically will be provided already on the RT-Box. In this way, a complete control algorithm can be verified in a safe manner. Programming of the DSP will be done using the Code Generation option from PLECS, avoiding the need for prior knowledge in C-coding.
4) **Experimental Verification:** With control software developed in the previous step, experimental verification can be performed, using the same software, on the Power Electronics Teaching Setup (PETS).

Foreseen project steps

To carry out the **project** successfully, the following tasks are foreseen:

1) Getting familiar with the theory behind the project assignment, purpose and operating principles.
2) Getting familiar with PLECS which will be used for offline simulations.
3) Implementing the required models and/or controllers in PLECS for offline simulations and verification of correct operation. Collecting, analyzing and reporting the simulation results. Detailed goals and instructions will be provided during the project.
4) Getting familiar with PETS in order to be able to carry out experimental investigations.
5) Development of the required control software function which will be executed on the DSP.
6) Verification of the correct operation. Testing and collection of results.
7) Testing of the developed software function on the PETS. Collecting results
8) Documenting the work in the form of short technical report, continuously updated during the semester.
9) Presenting the work at the end of the semester.