STUDENTS' PROJECTS AT POWER ELECTRONICS LABORATORY

HIGH POWER SILICON CARBIDE MOSFET ACTIVITIES

Supervisor: Nicolai Hildebrandt
ELH135
nicolai.hildebrandt@epfl.ch

Keywords: PCB CAD test setup measurements Matlab

Description: Silicon Carbide (SiC) power semiconductors are widely recognized as a disruptive technology. SiC MOSFETs switch faster and more efficiently than standard components allowing very high efficiency and power density, e.g. in PV inverters, Tesla cars and emerging electric aircraft.

Join our activities and gain outstanding practical SiC experience highly demanded in leading and innovative companies!

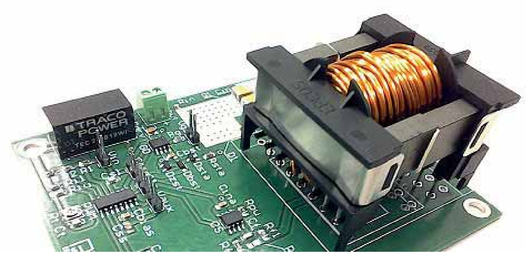
Possible tasks comprise: design of electronic circuits and printed circuit boards (PCB), high-performance CAD design of laminated busbars, construction of test setups, measurements and evaluation of devices and converters, measurement data processing and visualization in Matlab, and much more — come to discuss a very practical thesis or semester project that suits your skills and ambitions.

DESIGN OF DC/DC AND AC/DC CONVERTERS

Supervisor: Nicolai Hildebrandt
ELH135
nicolai.hildebrandt@epfl.ch

Keywords: PLECS simulation schematics PCB magnetics

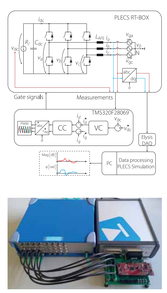
Description: Get hands-on experience in design and test of AC/DC and DC/DC converters and their components! Different tasks and projects are available as Semester Project, Thesis and *Advanced Lab in Electrical Engineering* (EE-598, 4 ECTS). Also possible in parallel to the new ***EE-365 Power Electronics*** course.



IDENTIFICATION METHODS FOR GRID CONNECTED CONVERTERS

Supervisor: Marko Petković
ELH137
marko.petkovic@epfl.ch

Keywords: #impedance #control #design #measurement #acquisition

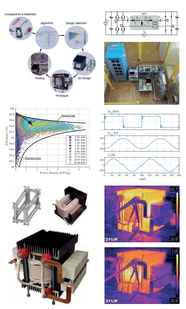


Description: Recent trends in power system design such as an increasing share of renewable energy sources and smart grids require the inclusion of grid connected converters. This addition of converter may create different subsystem interactions that require proper investigation and understanding through impedance-admittance measurement and system identification. One way of measuring impedance is through injection of perturbation signals into an unknown object and measuring the response.
System stability is even more deteriorated in the conditions of an unbalanced grid where advanced control techniques and grid synchronisation techniques need to be applied. The effect of applying these techniques needs to be properly characterised.
Student who followed courses on control theory and grid connected converters are already acquainted with the concept and are invited to broaden their practical and theoretical knowledge on the subject through on a hardware-in-the-loop setup of a grid connected converter under unbalanced grid conditions.
Theory: 50 % **Practice:** 50 % **Prerequisites:** Control theory, power electronics, signal processing but most of all motivation.
P.S: If everything goes well, you might have a publication under your name in the end.

DESIGN AND MODELLING OF MAGNETIC COMPONENTS

Supervisor: Marko Mogorovic
ELH136
marko.mogorovic@epfl.ch

Keywords: #magnetics #modelling #design #optimisation



Description: Several projects are available, dealing with advanced: design, modelling, characterisation, prototyping and testing of magnetic components. Over the last three years, we have accumulated a great deal of experience and know-how resulting in many publications and more importantly ready test setups for experimental verification of various phenomena. This allows for a quick completion of the main three prerequisites of any good publication or thesis: Hypothesis; Modelling and simulation; Experimental verification.

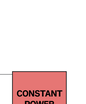
All topics are multidisciplinary and have a strong publishing potential. Depending on your motivation and capabilities we can set realistic goals and achieve great results.

Software (not mandatory): MATLAB, PLECS, ANSYS Maxwell (FEM), COMSOL Multiphysics (FEM), LaTeX.

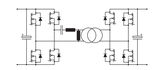
Requirements: Ambitious and motivated to learn. Your success is my success, thus ideally I want you to publish.

VERY HIGH POWER DCDC ISOLATED CONVERSION

Supervisor: Gabriele Ulissi
ELH130
gabriele.ulissi@epfl.ch



Keywords: #MV #DCDC Converter #Very High Power



The projects I have available focus on the design, simulation and testing of MVDC very high power converters (several kV, MW). The topic is broad and based on your preference you can chose which aspects of these devices you want to work on. The possibilities are:

- Converter topology simulation.
- Switching device characterisation.
- Mechanical and thermal design.
- Testing.

We can tailor the project and the expected outcome based on your background and available time. If you have some specific interest, come and discuss with me and we can see if it can be turned into something that is suitable for the both of us.

MODELING AND DESIGN OF MEDIUM FREQUENCY TRANSFORMERS

Supervisor: Nikolina Djekanovic
ELH115
nikolina.djekanovic@epfl.ch

Keywords: #Magnetics #SST #MFT #Prototype

Description: One of the latest trends is going back to DC and a vision of DC power distribution networks as future energy systems. Solid state transformers (SSTs) are in this sense considered as key enabling technology providing highly efficient, reliable and compact energy conversion. The core stage of an SST is the medium frequency transformer (MFT). A lot of research has been conducted with the idea to find an efficient design path providing application-specific optimised MFT prototypes which would match electrical and thermal requirements placed upon the transformer.

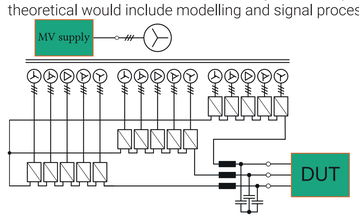
Available student projects would deal with design and modelling aspects of MFTs, as well as magnetic core characterisation, testing and developing of an MFT prototype.
Requirements: Passion for science and knowledge.

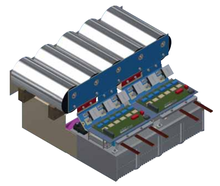
DESIGN OF MEDIUM VOLTAGE IMPEDANCE MEASUREMENT UNIT

Supervisor: Marko Petković
ELH137
marko.petkovic@epfl.ch

Keywords: #control #design #measurement #converter cell

Description: 1 MW Cascaded H-Bridge converter for medium-voltage impedance measurement is currently being designed in PEL. First prototype of the cell has been designed and you could be a part of the design process and help us build the rest of the converter. The converter design includes many aspects, some theoretical, some practical.
Practical parts would include CAD design, assembly, measurements, PCB design, while theoretical would include modelling and signal processing.





CONTROL AND GRID IMPLEMENTATION OF A DC TRANSFORMER

Supervisor: Aleksandra Mikic
ELH115
aleksandra.mikic@epfl.ch

Keywords: DC grid modelling grid implementation control

Description: DC power distribution grids can effectively support energy transformation and high penetration of distributed energy resources and energy storage integration. In order to support this shift towards flexible DC grids, the project deals with development of DC transformer regarding the behavioural point of view under normal and external fault conditions so suitable control actions would be developed.

Studies will be carried by means of both offline simulations and Real-Time Hardware-in-the-Loop system simulation, so that large models and scenarios would be explored. If you are willing to have a contribution in a very trending field of direct current, then come on board!

VARIABLE-SPEED GENERATOR MODELLING FOR DC SHIPS

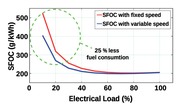
Supervisor: Seongil Kim
ELH130
seongil.kim@epfl.ch

Keywords: #generator #modelling #simulation

Description: Generators driven by mechanical engines are commonly used in marine power systems as a primary electrical power source. Unlike AC ships, there is no need to keep the constant power frequency (50 or 60 Hz) in DC ships. This provides freedom to employ variable-speed generators and it gives a big advantage in fuel savings.

The goal of this project is the transient modelling of the variable-speed generator including a rectifier and a constant power load. In addition, the controllers (an exciter, a governor and a power controller) should be implemented by EMTP (Electro-Magnetic Transient Program) software. With this, a student who will involve in this project will learn the power supply systems of the DC ship and its control strategy (1 student).

Theory: 40 %, Practice: 60 %



DIRECT MODULAR MULTILEVEL CONVERTER FOR PHSP

Supervisor: Ignacio Polanco
ELH134
ignacio.polanco@epfl.ch

Keywords: #MMC #DMMC

Description: This research project is focused in to fully explore the technical boundaries of using the Direct Modular Multilevel Converter (D-MMC) as an interface between the power grid and the machine generator in a pumped hydro storage plant(PHSP), covering relevant aspects of design and control. To accomplish this, different and advanced modeling and control approaches have to be formulated to get a stable and high-performance functioning of the converter, as well as, at the system-level application. Additionally, to ensure the reliability of the research, offline simulations, hardware-in-the-loop (HIL) validations, and laboratory-scale experimental tests should be performed.

Complement your studies and challenge your abilities by participating in this project. Microcontroller programming, mathematical modeling, system simulation, PCBs design and construction, and a lot of laboratory work are the main activities of this project.

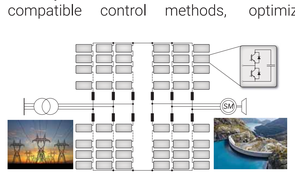
MODULAR MULTILEVEL CONVERTER FOR PUMPED HYDRO STORAGE

Supervisor: Miodrag Basić
ELH134
miodrag.basic@epfl.ch

Keywords: #MMC #control #design #hydro

Description: We aim to increase flexibility and grid support of large Pumped Hydro Storage Plants (PHSP) through variable speed operation. **MW-scale** Modular Multilevel Converter (MMC) is considered, offering superior voltage scalability, redundancy, filter-less design, and thus retrofit to existing hydro plants. A reduced-scale prototype converter rated at **6kV/0.5MVA** is built in our lab.

Broaden your knowledge and gain experience in high power converter control, system-level simulations for the application, investigation of grid code-compatible control methods, optimization of machine-side performance.



HIL FOR PUMPED HYDRO STORAGE

Supervisor: Philippe Bontemps
ELH133
philippe.bontemps@epfl.ch

Keywords: #HIL #Hydro #RTsimulations #control

Description: The main objective of this project is to increase the potential of the hydroelectric technologies in providing flexibility to the electric power system while achieving an improved average annual overall efficiency of the hydroelectric machinery. The available research setup at PEL consists of a 6kV/0.5MW induction machine connected to a 6kV/0.5MVA synchronous or doubly fed induction generator.

This project consists of wide-ranging tasks reaching from offline Plecs simulations of the research setup to real-time HIL simulations of various existing hydroelectric power plants using the Speedgoat real-time target machine.