



**Aalto University
School of Electrical
Engineering**

**PhD Course (4 ECTS):
Advanced Control in Electrical Energy Conversion**

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About the Course

- ▶ **State feedback** control is widely applied amongst control engineers
- ▶ It is often considered too complicated for electric drives and power converters
- ▶ This is not true
 - ▶ Computational efficiency is comparable to that of PID controllers or other commonly used schemes
 - ▶ State feedback controllers can be easily or even **automatically tuned** based on the identified plant parameters
- ▶ **Discrete-time design** methods may also be needed
 - ▶ High-power converters switching at low frequencies
 - ▶ High-speed drives
- ▶ With more advanced control methods the **robustness** against parameter errors can also be increased

Structure of the Course

Material is divided into 6 modules:

1. State feedback current control: continuous-time design
2. Switched-mode conversion: full bridge and unipolar PWM
3. Discrete-time control design
4. Magnetic saturation and gain-scheduling
5. Resonance damping: converter equipped with an LCL filter
6. Observer-based state feedback current control

Very simple example systems are considered in order to be able to focus on control challenges

Key Control Challenges to Be Considered

1. Good reference tracking and disturbance rejection at the same time
2. Converter voltage saturation (actuator saturation)
3. Robustness against the digital delays in the system
4. Effect of the magnetic saturation (motor drives)
5. Resonance damping of an LCL filter (grid converters)
6. Automatic tuning based on the known model parameters, taking the above aspects into account