

1.3 Elements of power electronics

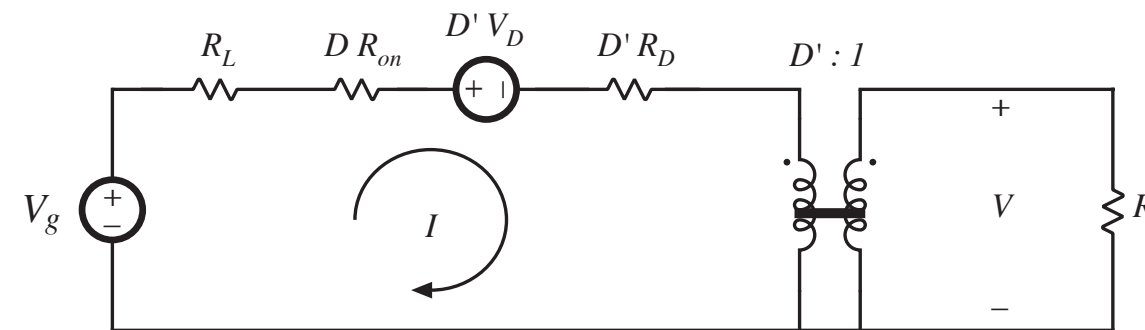
Power electronics incorporates concepts from the fields of

- analog circuits
- electronic devices
- control systems
- power systems
- magnetics
- electric machines
- numerical simulation

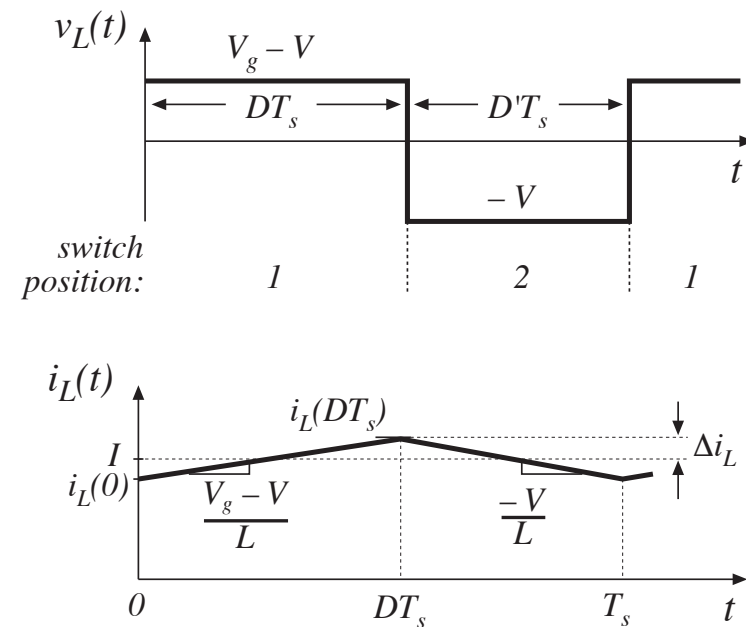
Course 1: Introduction to Power Electronics

Simulation
Steady state converter analysis
Equivalent circuit modeling

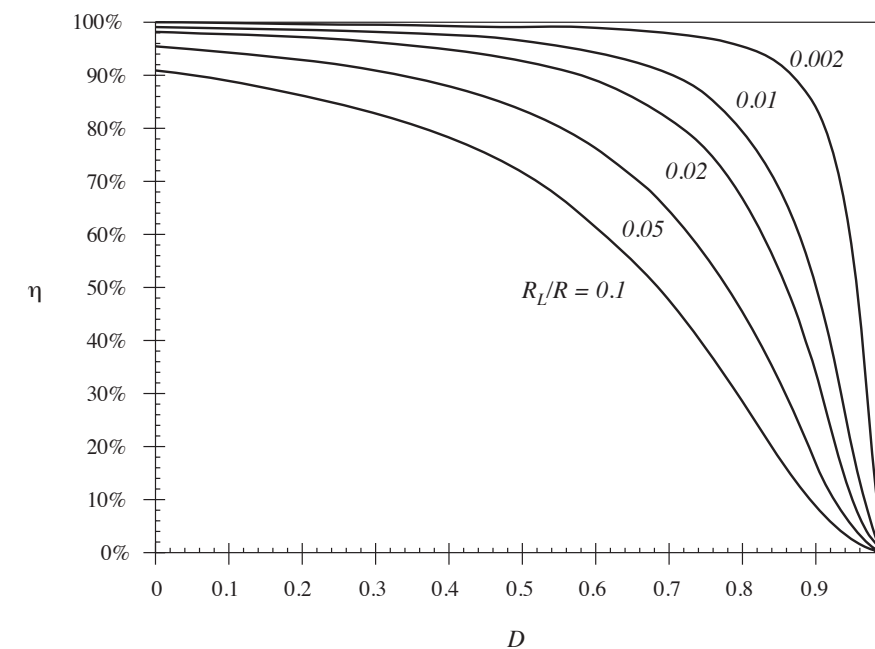
Averaged equivalent circuit



Inductor waveforms



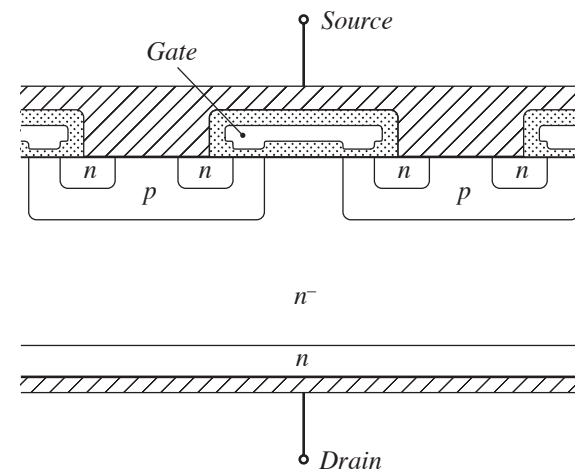
Predicted efficiency



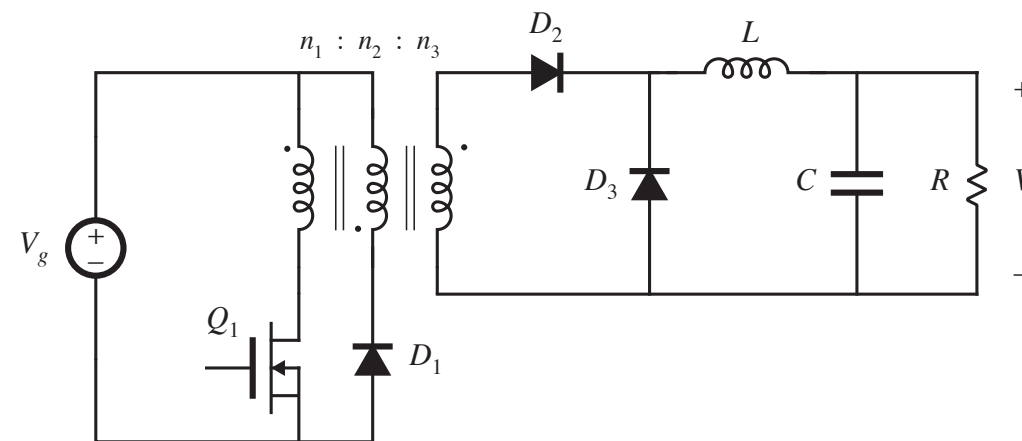
Course 2: Converter Circuits

- Switch realization
- Power semiconductor devices
- Modeling switching loss
- Discontinuous conduction mode
- Converter circuit topologies
- Transformer isolation

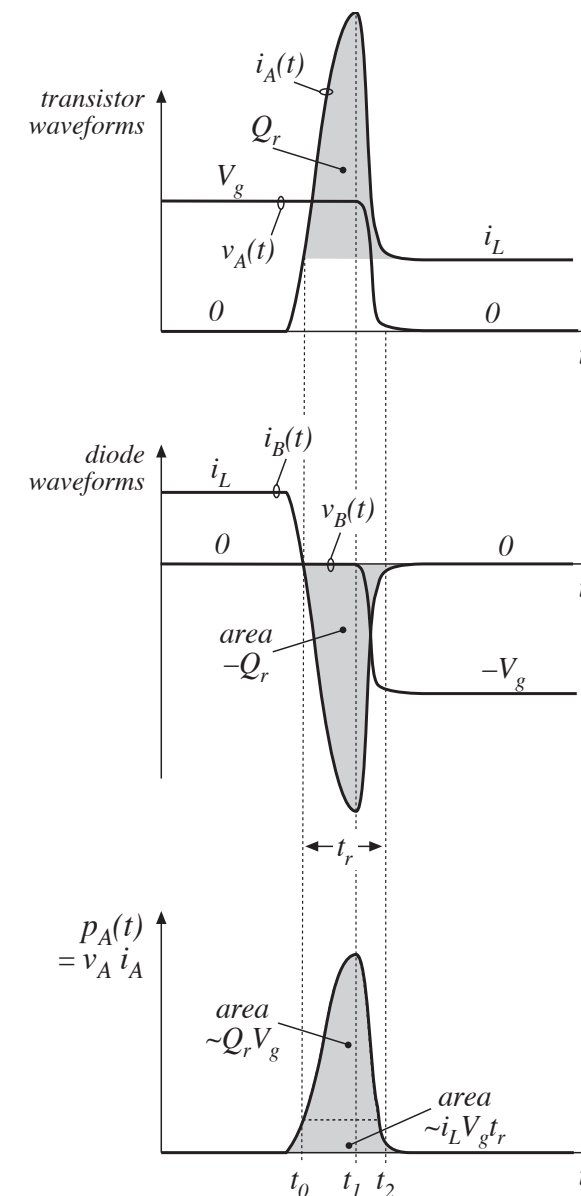
Power MOSFET



The forward converter



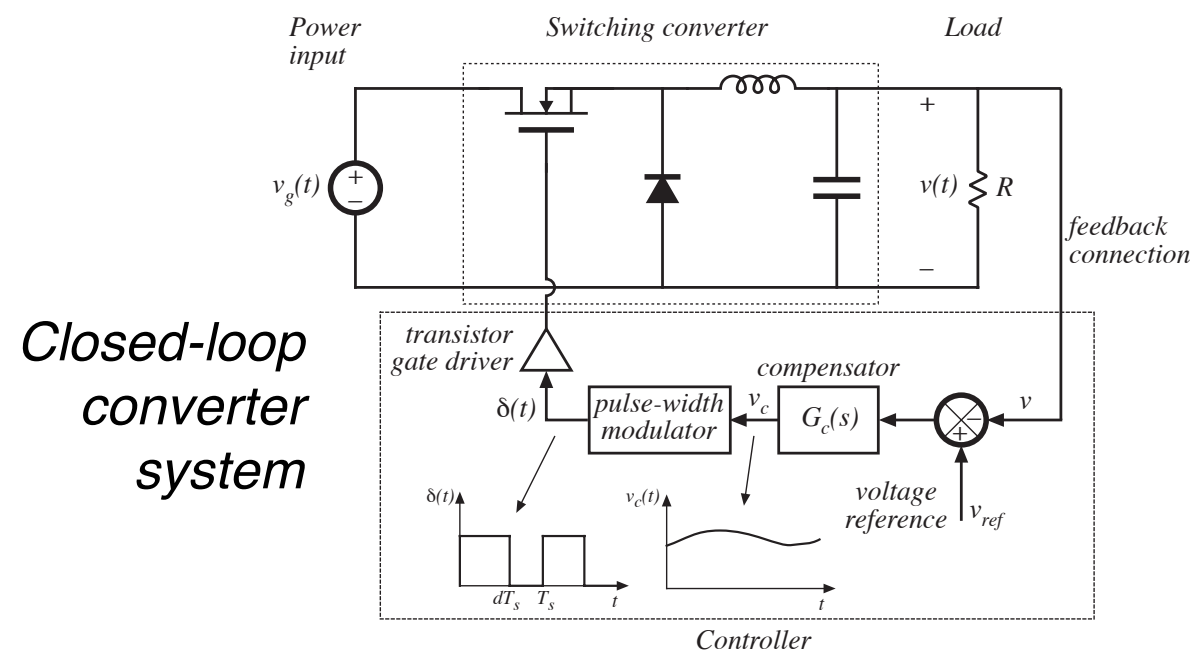
Switching loss



Course 3: Converter Control

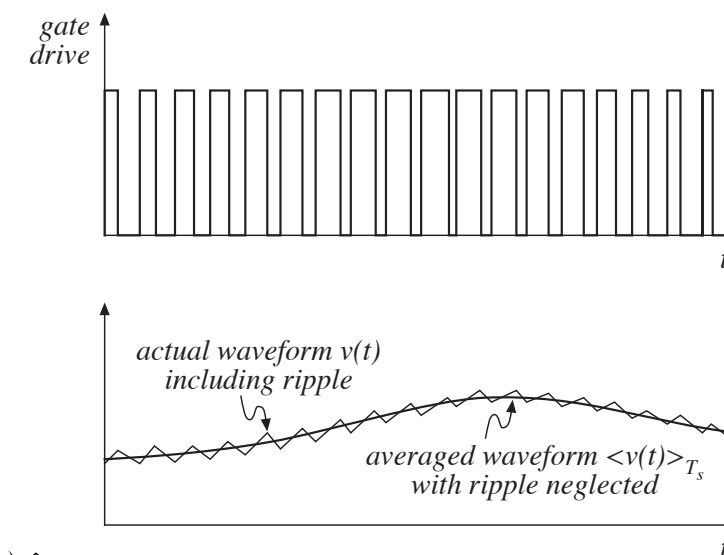
AC equivalent circuit modeling
Bode plots of converter transfer functions
Design-oriented analysis

Controller loop gains and closed-loop transfer functions
Compensator design

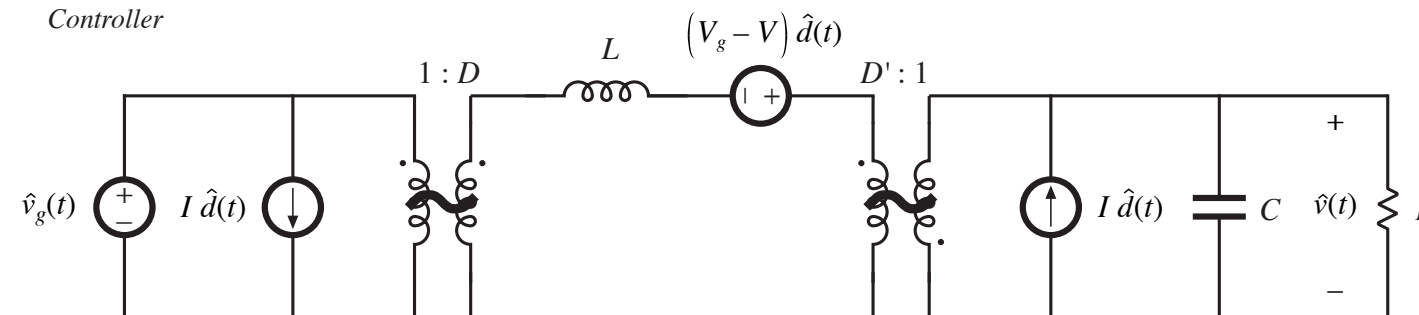


Closed-loop converter system

Averaging the waveforms

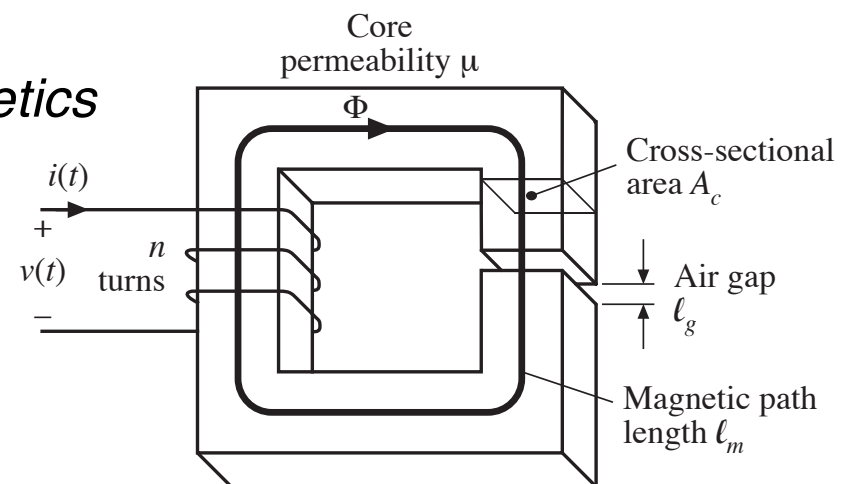


Small-signal averaged equivalent circuit

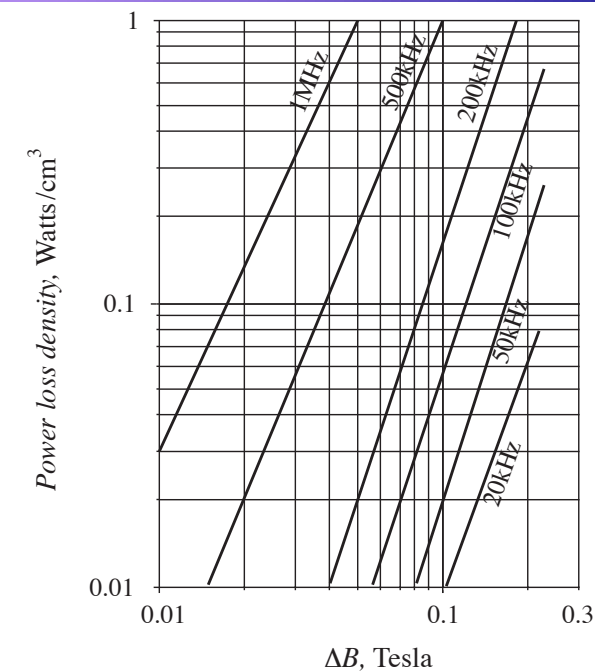


Course 4: Magnetics for Power Electronics Converters

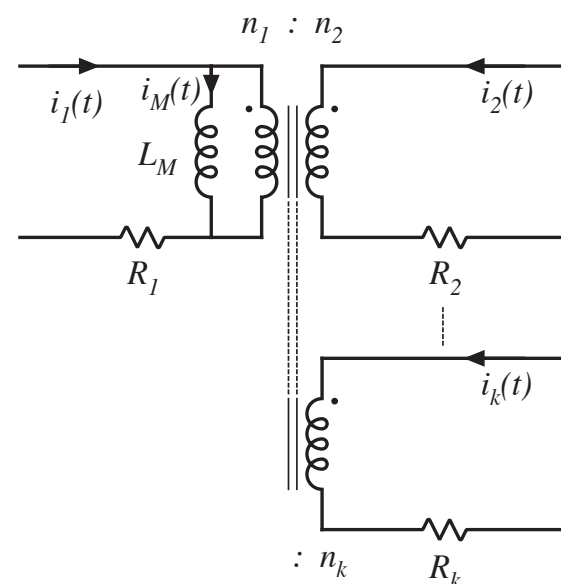
Basic
magnetics



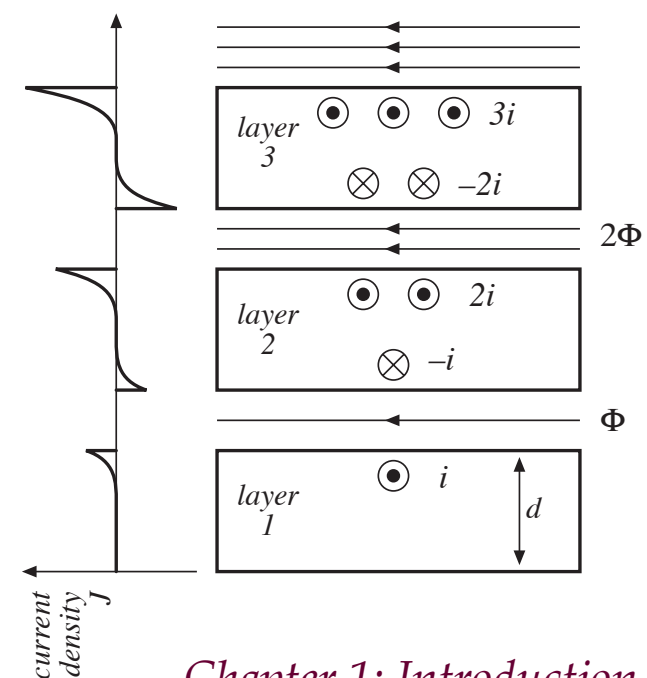
Magnetics
loss
mechanisms



Inductor and
transformer
design



The
proximity
effect



Simulation via LTspice

A theme throughout the specialization

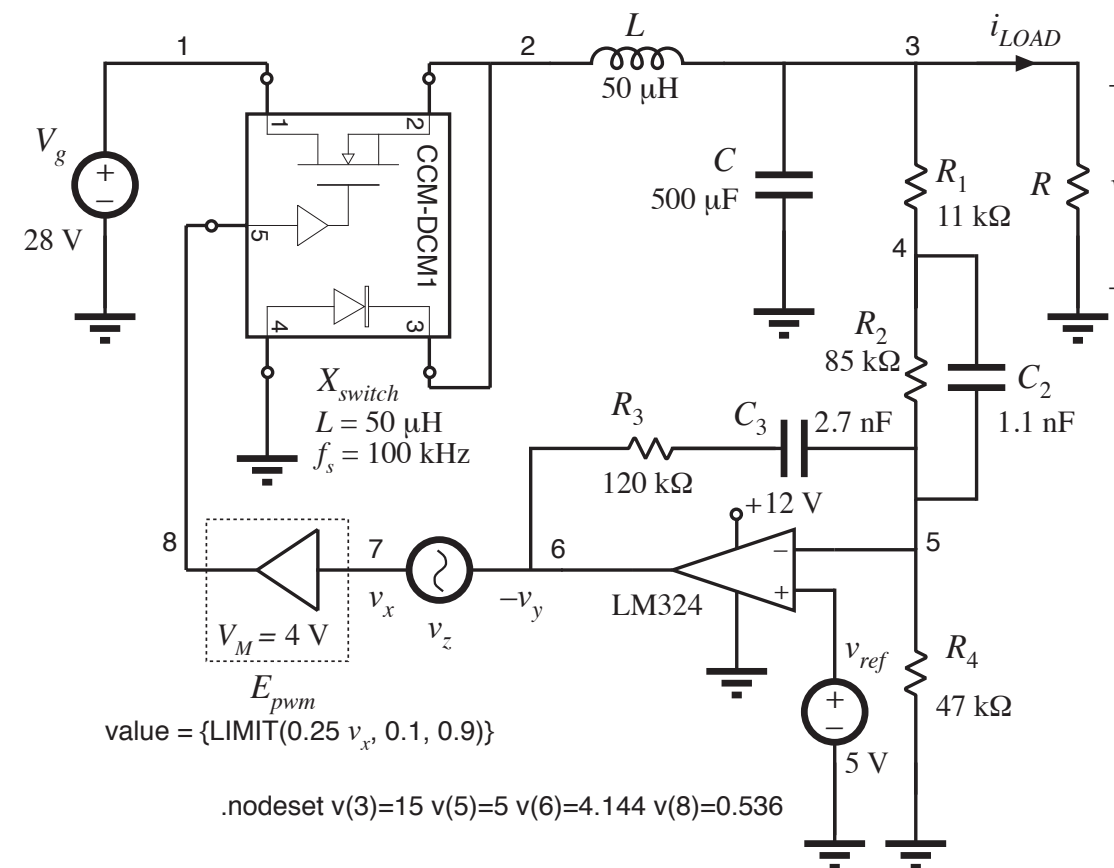
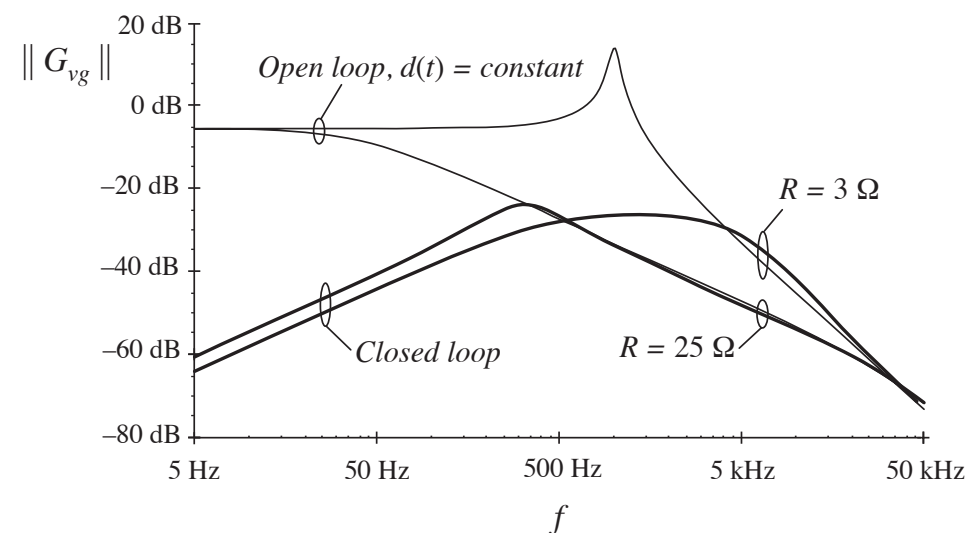
Time-domain simulations of converters beginning this week

Open- and closed-loop simulations

In the certificate:

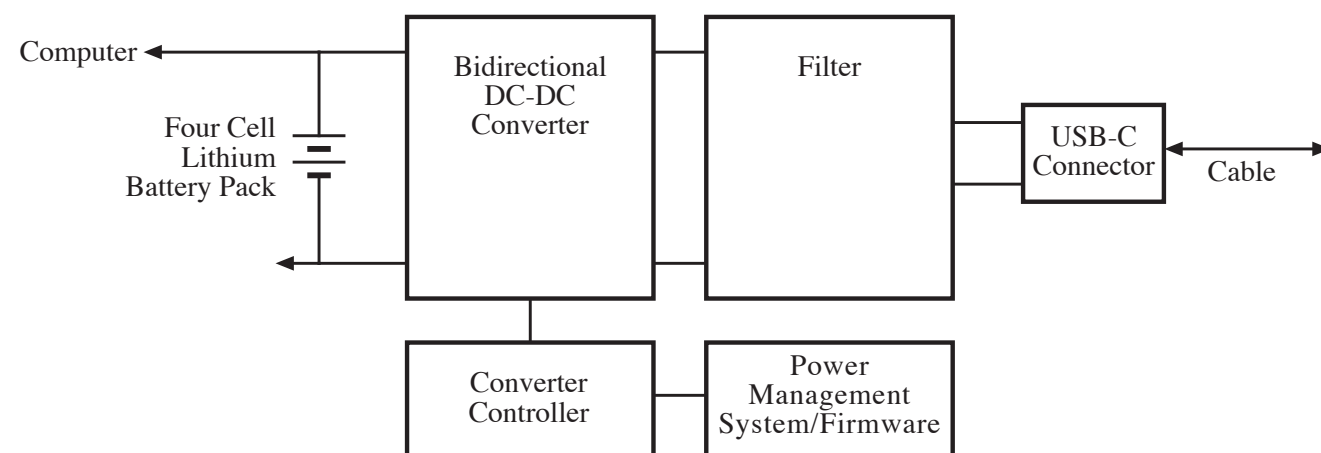
Averaged models (shown)

Capstone design project



Capstone Project (in Graduate Certificate)

Power conversion system for USB Type C interfaces

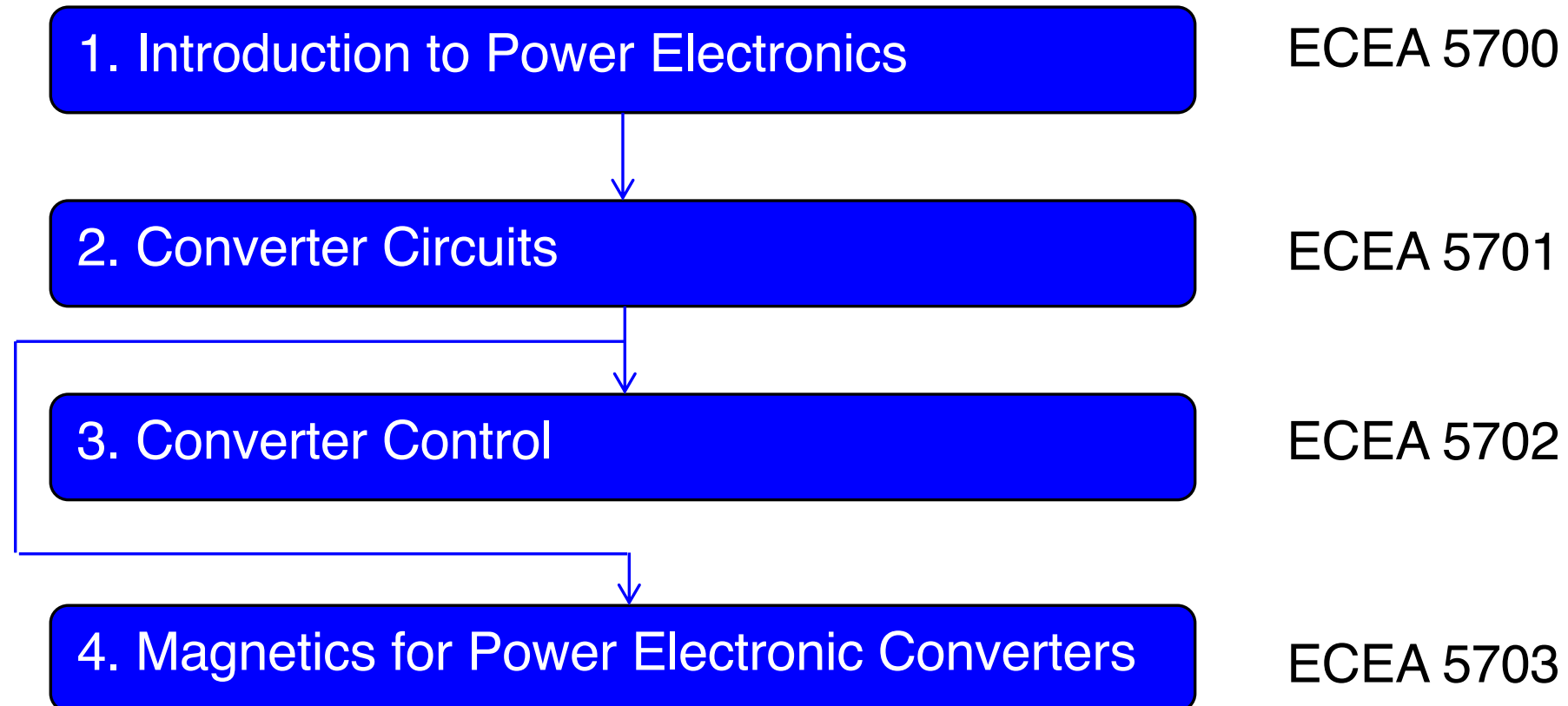


A Profile 5 system that is capable of supplying and receiving 5 V, 12 V, and 20 V at up to 5 A.

- Selection of DC-DC converter topology and power stage design
- Magnetics design
- Analog controller design
- Simulation and design verification

Prerequisite Chain

Specialization in Power Electronics



Beyond this specialization:

Specialization: Modeling and Control of Power Electronics

Power Electronics Project course