

ECE445/545

Power Electronics I

Project

Aim: In groups students select one of two different but closely related fourth order PWM dc-to-dc converters for which a series of analyses will be performed which will lead to a complete closed loop design of a voltage regulator. The input voltage is a nominal 10 V and the output is 5 V. The switching frequency should be no less than 100 kHz. Further details will be presented later. The design will be constructed and its performance will be demonstrated in the lab verifying the design goals.

Analyses:

- 1) Steady state analysis in the presence of parasitic elements, namely inductor ESR (equivalent series resistance) and switch (both mosfet and diode) resistances. These parasitic elements represent the conduction losses in the converter. A switching loss analysis is not so easily performed. Volt-second (flux) balance in inductors and charge (Amp-second) balance in capacitors will yield the desired results. These comprise the average values of inductor currents I_1 , I_2 and capacitor voltages V_1 , V_2 . This will then give an expression of the efficiency η of the converter.
- 2) The modelling method of State Space Averaging (SSA) is used. This introduces the general method of state space description of systems which is widely used in engineering and is the basis of modern control design. SSA will be used, to model the ideal converter, that is, no losses are included, to perform:
 - i. Steady state analysis
 - ii. Ripple analysis, both first and second order ripples
 - iii. Small-signal analysis. This describes the dynamics of the converter.
- 3) Given the results of the small signal analysis, a control design will be ventured into. This involves appropriate selection of the converter inductor and capacitor values as well as design of an appropriate controller. The results of the complete design will be verified by simulation, using PECS and perhaps other simulators.

Construction:

- 1) The complete regulator system will be built and demonstrated in the lab.
- 2) Students will be responsible for ordering in a timely fashion, the required components from a suitable vendor, such as Digikey.
- 3) Step responses to a disturbance signal will be used to highlight the efficacy of the design.

Comparison:

Based on the analyses it is hoped that effective comparison of the two converters will be made. Is one better than the other? What are the trade-offs?

Note: This document may be updated as needs warrant.