ECE692

Exact analysis of a lossy buck boost

The inverting buck-boost converter of Fig. 1 operates with large C_o such that V_{out} is nearly constant. Switch S_1 is on during DT_s, and switch S_2 is on for the remainder of the period. Other than resistance R_1 all circuit elements are lossless. Inductor L has significant ac current ripple under normal operating conditions.

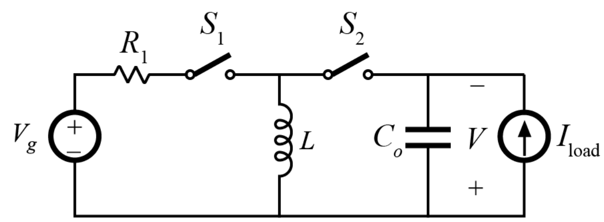

Fig. 1: Inverting Buck-Boost Converter

For subparts (a) and (b), allow the small-ripple approximation to be applied to both L and C_o

a) Solve for an expression for the switching period averaged output voltage, V, of the converter as a function of only V_g, I_{load}, switch timing parameters, and passive values of the converter.
b) Find the value of the duty cycle, D, necessary to achieve $V = 5$ V when $V_g = 48$ V, $R_{in} = 1\ \Omega$, and $I_{out} = 5$ A.

For subparts (c) and (d), solve without asserting any approximations other than those mentioned in the problem introduction

c) Solve for an expression for the switching period averaged output voltage, V, of the converter as a function of only V_g, I_{load}, switch timing parameters, and passive values of the converter.
d) Find and plot the value of the duty cycle, D, necessary to achieve $V = 5$ V when $V_g = 48$ V, $R_{in} = 1\ \Omega$, $L = 1\mu$H, and $I_{out} = 5$ A, for values of T_s ranging from 10µs to 1µs. Under what conditions does your answer from part (d) converge to that of part (b)?