EE 452 – Power Electronics Design, Fall 2021

Homework 3

Due Date: Thursday October 28th 2021, 11:59pm Pacific Time

Instructions. You must scan your completed homework assignment into a pdf file, and upload your file to the Canvas Assignment page by the due date/time above. All pages must be gathered into a single file of moderate size, with the pages in the correct order. Set your phone or scanner for basic black and white scanning. You should obtain a file size of hundreds of kB, rather than tens of MB. I recommend using the "Tiny Scanner" app. Please note that the grader will not be obligated to grade your assignment if the file is unreadable or very large.

Description In Problems 1–3 on the next page, the input voltage V_g is dc and positive with the polarity shown. Specify how to implement the switches using a minimal number of diodes and transistors, such that the converter operates over the entire range of duty cycles $0 \leq D \leq 1$. The switch states should vary as shown in Fig. 1. You may assume that the inductor current ripples and capacitor voltage ripples are small. For each problem, do the following:

(a) Realize the switches using SPST ideal switches, and explicitly define the voltage and current of each switch.

(b) Express the on-state current and off-state voltage of each SPST switch in terms of the converter inductor currents, capacitor voltages, and/or input source voltage.

(c) Solve the converter to determine the inductor currents and capacitor voltages, as in Chapter 2.

(d) Determine the polarities of the switch on-state currents and off-state voltages. Do the polarities vary with duty cycle?

(e) State how each switch can be realized using transistors and/or diodes, and whether the realization requires single-quadrant, current-bidirectional two-quadrant, voltage-bidirectional two-quadrant, or four-quadrant switches.

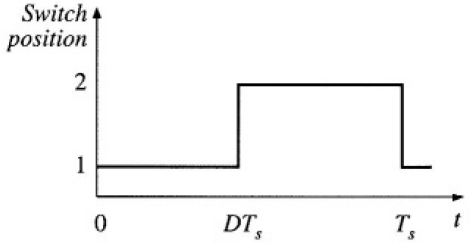
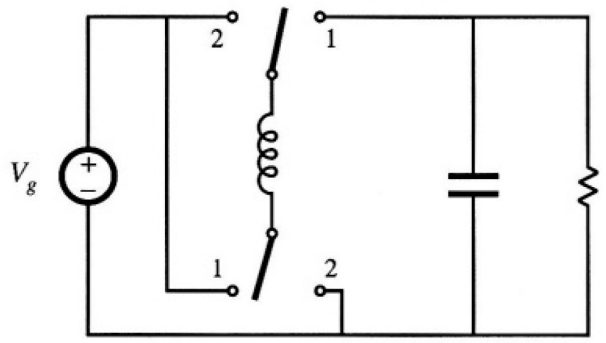
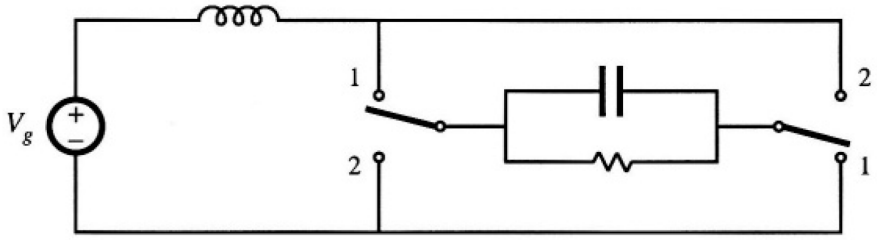


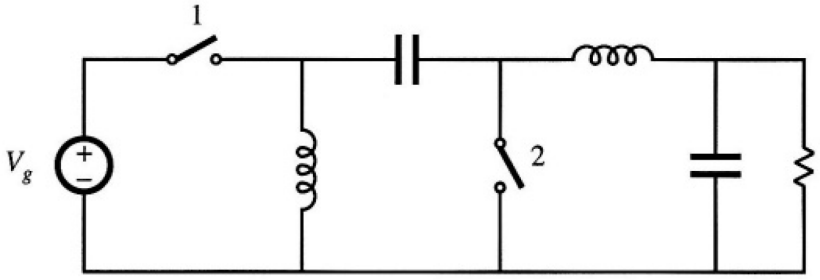
Figure 1: Switch control method for Problems 1–3.



Circuit for Problem 1.



Circuit for Problem 2.



Circuit for Problem 3.