ASSIGNMENT 05 – Switching Circuits

Prologue

In the discussion we had in the class, we developed a "theoritically" lossless circuit to step-down the voltage. We analysed that circuit and established a set of tools to easily find the voltage gain function of such "switching circuits". Considering the application span, there are electronic devices which may also require higher voltages than its voltage source (i.e. the battery). Sometimes, a voltage which is negative and large in the magnitude. Therefore, in this assignment, you will be analysing such a "switching circuit" which has the ability to ***invert*** *and* ***step-up*** *its supply voltage.*

INSTRUCTIONS

- This assignment contains 7 questions which accounts for 25 marks.
- Clearly state any assumptions you made.
- Scan your answer scripts using a tool such as cam-scanner to compile it as a PDF. Submission file name should be in the following format.

  <assignment_number>_<index_number>

  For example, if your index number is 070022G and you are submitting the answers for assignment 1, the file name should be,

  A01_070022G

- If you are having any problems, send an email to "thilinaa@uom.lk" with the subject "EN2110-B18-<assignment number>".

Circuit diagram of a switching converter is shown in Fig 1 below.

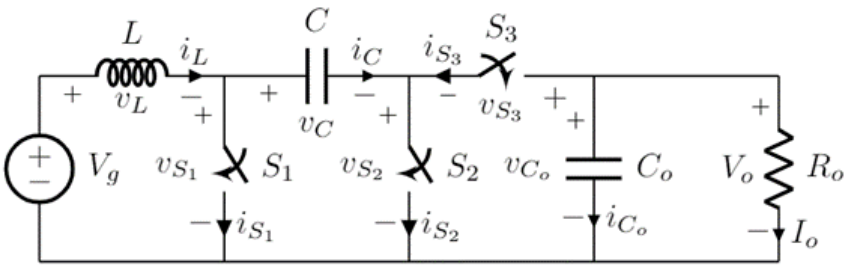

Figure 1: The schematic of swtching converter.

Switches are operated with a switching frequency of fs(=1/Ts) and their turn -ON and -OFF conditions are as stated below.

$$S_1, S_3 = \begin{cases} ON, & \text{for } 0 \leq t < DT_s \\ OFF, & \text{for } DT_s \leq t < T_s \end{cases}$$

$$S_2 = \begin{cases} OFF, & \text{for } 0 \leq t < DT_s \\ ON, & \text{for } DT_s \leq t < T_s \end{cases}$$

1. Draw the equivalent circuit of the above converter circuit when S_1, S_3 are turned -ON and S_2 is turned -OFF. [1 mark]
2. Draw the equivalent circuit of the above converter circuit when S_1, S_3 are turned -OFF and S_2 is turned -ON. [1 mark]
3. State the three main assumptions which can be used to simplify the analysis of a switching circuit. [3 marks]
4. Draw the inductor current ($i_L(t)$) and inductor voltage ($v_L(t)$) waveforms. [4 marks]
5. Derive an expression for the relationship between source voltage (Vg) and output voltage (Vo) using inductor volt-second balance. [5 marks]
6. Calculate the input resistance of stage 2. [2 marks]
7. Propose suitable semiconductor devices to replace S_1, S_2, and S_3 considering the ON-current and blocking-voltage of each element. [9 marks]