Department of Electrical Engineering
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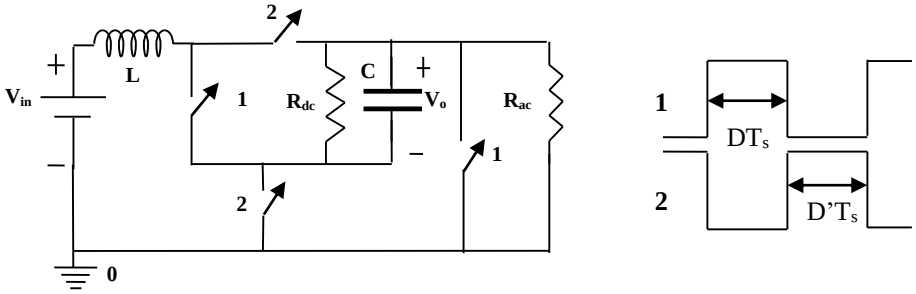
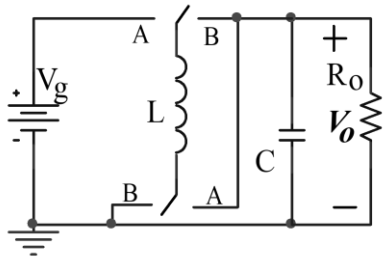
04 Feb., 2020

EE360A: Problem Set 1

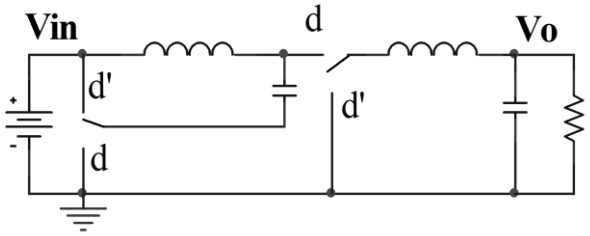
1. For the following converter switches '1' are turned-on together and the turn-on period is designated as D interval. When switches '1' are turned off, the switches '2'are turned on and the interval is designated as D' interval. Derive the voltage conversion ratio (V_o/V_{in}) as a function of D. Plot the conversion ratio as a function of D varying from 0 to 1 using Excel. Assume CCM operation. Realize switches using Mosfets.



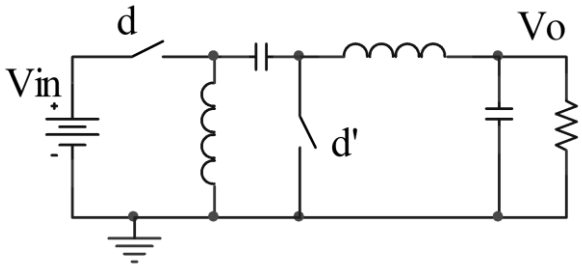
2. Determine the steady state conversion ratio between input and output voltages (Vo/Vg) for the following converter. Realize switches using Mosfets.
(Two switches connect nodes marked 'A' simultaneously in D interval. Similarly, nodes marked 'B' are connected, simultaneously, using two switches in the D' interval of a switching cycle)



3. Derive the conversion ratio under CCM mode of operation for the following converters.

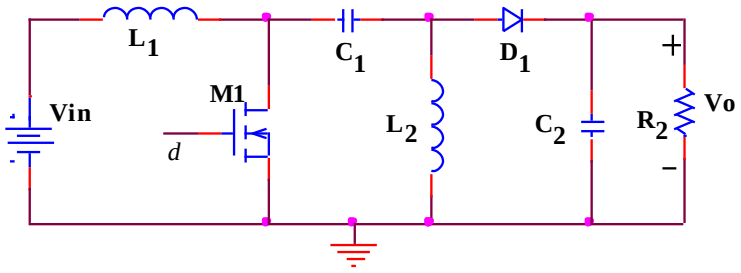


(a)



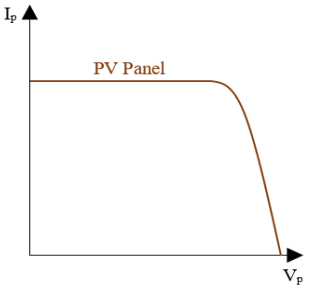
(b)

4. Derive an expression for the conversion ratio (V_o/V_{in}), in terms of the given parameters. Assume CCM mode of operation, where both the inductor currents are always positive (greater than zero). (hint: when M_1 is on, diode D_1 is off and vice versa)



SPICE Assignment

Q5. Simulate a solar cell on Spice with diode characteristic N = 1.5, I_s = 10^{-16} A, R_s = 1 mΩ. Design a solar PV Panel with I_{sc} = 2A and V_{oc} any value in the range of 7 to 10 Volts. Plot the I vs V characteristics of panel similar to Fig. 1 using PSPICE or LTSPICE.
[10]



Q6. To increase output voltage, two solar panels of same rating as designed in Q1 are connected in series. Both of the panels are under same insolation as shown in Fig. 2.
Find out value of load resistor for which voltage across load resistor is
(a) 20 % of V_{oc}
(b) 95 % of V_{oc}
For both of the cases, show the point of operation in Panel characteristic.
[10]

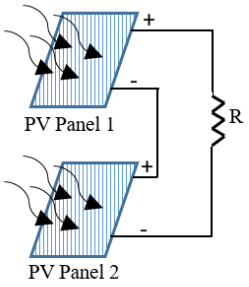


Fig. 2

Q7. Due to partial shedding**,** insolation on second panel is decreased by 25 %. As shown in Fig. 2, rest of the condition remains same. For this case find value of load resistor R so that voltage across it is
(a) 20 % of V_{oc}
(b) 95 % of V_{oc}
For both of the cases, show the point of operation in Panel characteristic. [10]

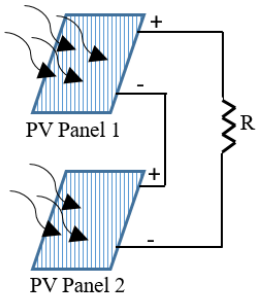


Fig. 3

Q8. A point-of-load converter is to be designed for TFT-LCDs used in central display and rear seat entertainment of an automobile. Its input voltage varies between 2.5 V to 5.5 V and its output voltage is 8 V. Select a switching frequency of 1.2 MHz. The load is such that, the average boost switch current is 1.5 A.

Select power components (L, C) for your design. (Reference design can be found in *ISL78419* datasheet page 11) Assume CCM operation. Use ideal switch model with Ron=10 mOhm.
Simulate your converter using PSPICE/LTSPICE:

(a) Plot Inductor current with 2.5 V, 3.4 V, and 5.5 V DC input. Assume 50 mOhm inductor resistance. Note that you have to keep the output constant using a different duty cycle for different input voltage.

(b) Plot the Voltage conversion ratio of the converter as a function of D with 50 mOhm inductor resistance using Excel.

Using simulation, prove that the average switch current is 1.5 A.