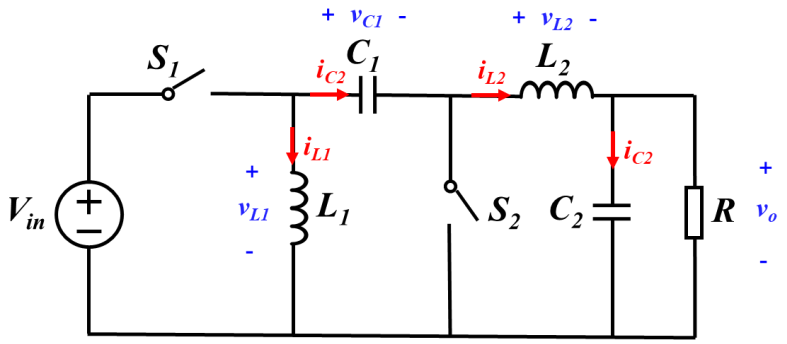
Homework #1 (2024 Spring, EE 171)

- Deadline: Mar. 25th 8:00 a.m.
- Please submit your homework through Gradescope (Course Entry Code: 3PV4VP)
- **Handwriting is not suggested, and a poor format will lose at most 10% of your final score.**
- Giving your solution in English, solution in Chinese is not allowed.
- Plagiarism is not allowed. Those plagiarized solutions will get 0 point.

Analysis and design of Zeta converter (200 points)



In a period, when $0<t< DT_s$, switch S_1 turns on, S_2 turns off; when $DT_s <t< T_s$, switch S_1 turns off, S_2 turns on.

a) Derive the dc components of each capacitor voltage and inductor current, in terms of the duty cycle D, the input voltage V_{in}, and the load resistance R. **(40 points)**

b) Derive the current ripple and voltage ripple for all passive components. Express these quantities as functions of the switching period T_S; the component values L_1 L_2 C_1 and C_2; the duty cycle D; the input voltage V_{in}; and the load resistance. Plot the current and voltage for these components. **(40 points)**

c) Please plot the waveform of the switches. **(20 points)**

d) In practice, switch S_1 is a MOSFET and has switch-on resistor R_{on}. Switch S_2 is a diode with switch-on resistor R_D and forward voltage drop V_D. Both inductors would have equivalence series resistor R_L. Derive the equivalent dc model for the converter. **(50 points)**

e) Using the dc model, derive the efficiency for d). **(10 points)**

f) Assume the ripples of each component exist, i.e., all the state variables would be time dependent. When the duty cycle is 0.5 and all the ripples are 20% of the corresponding dc components, please calculate the losses of all lossy components, and compare them with the those without considering the ripples. **(40 points)**