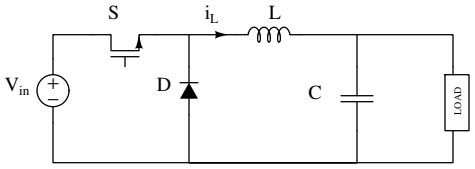
EE3203: Power Electronics

Tutorial 2

1. A step down converter is operating with the following parameters. $V_{in} = 30\,V$ and $T_s = 1000\,\mu s$ and $T_{ON} = 125\,\mu s$. Find

   (a) The steady state output voltage of the converter (Assume sufficiently large filter elements are present and the switches are ideal)

   (b) The steady state current flowing through the inductor, if a load of $R = 5\,\Omega$ is connected at the output of the converter.



2. Find the range of duty ratio for a step down converter operating in figure 1 at $f_s = 50\,kHz$ when the input voltage varies from $30\,V$ to $70\,V$ keeping the output voltage at $15\,V$.

3. A buck converter is operating with an input voltage $V_{in} = 60\,V$, switching frequency $f_s = 50\,kHz$, duty ratio of the switch $d = 0.25$. The filter inductance and capacitance are $L = 10\,mH$ and $C = 100\,\mu F$ respectively. For a load of $R = 5\,\Omega$ find

   (a) Steady state output voltage across the load and current through the load

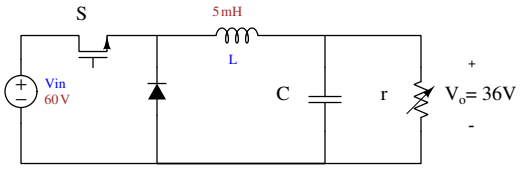
   (b) Ripple current in the inductor expressed as a fraction of output dc current

   (c) Energy stored in the indcutor in one switching cycle

   (d) Ripple voltage in the capacitor expressed as a fraction of output dc voltage

   (e) Energy stored in the capacitor in one switching cycle

4. A buck converter feeding a variable resistance load. The converter is operating at a switching frequency of $f_s = 100\,kHz$ and duty ratio $d = 0.6$, filter inductance $L = 5\,mH$. The output voltage is $36\,V$ while the input is $60\,V$. Assuming all ideal components and the output to be ripple free, find the value of the load resistance such that the inductor current is just continuous.



5. A boost converter has an average voltage of $V_a = 15\,V$ for an input voltage of $V_s = 5\,V$. The average load current is $I_a = 0.5\,A$. The switching frequemcy is $25\,kHz$. If $L = 150\,\mu H$ and $C = 220\,\mu F$, determine

   (a) Duty cycle, d

   (b) Ripple current of the inductor, ΔI

   (c) Peak current of the inductor, I_L

   (d) Ripple voltage of the filter capacitor, ΔV

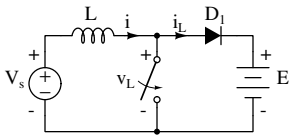
   (e) Critical values of L and C

6. The dc-dc converter shown is used to control power flow from a dc voltage, $V_s = 110\,V$ to a battery voltage, $E = 220\,V$. The power transferred to the battery is $30\,kW$. The current ripple of the inductor is negligible. Determine:

   (a) Duty cycle, d

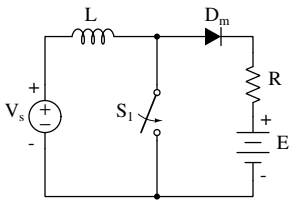
   (b) Effective load resistance, R_{eq}

   (c) Average input current, I_s



7. For the problem 6, plot the instantaneous inductor current and current through the battery, E if the inductor L has a finite value of $L = 7.5\,mH$, $f = 250\,Hz$ and $d = 0.5$.

8. The boost converter shown has $R = 10\,\Omega$, $L = 6.5\,mH$, $E = 5\,V$ and $d = 0.5$. Find I_1, I_2 and ΔI.



9. In a buck-boost converter, consider all components to be ideal. Let V_s vary between $8\,V$ to $40\,V$, $V_o = 15\,V$, $f_S = 20\,kHz$ and $C = 470\,\mu F$. Calculate L_{min} that will keep the converter operating in continous conduction mode if $P_o \geqq 2W$.

10. In a buck-boost converter, $V_s = 12\,V$, $V_O = 1\,V$, $I_o = 250\,mA$, $L = 150\,\mu H$, $C = 470\,\mu F$, and $f_s = 20\,kHz$. Calculate ΔV_o (peak-peak).

11. Calculate the rms value of the ripple current in problem 10 through diode and, hence, through the capacitor.

12. In a buck-boost converter operating at $20\,kHz$, $L = 0.05\,mH$. The output capacitor C is sufficiently large and $V_s = 15\,V$. The output is to be regulated at $10\,V$ and the converter is supplying a load of $10\,W$. Calculate the duty ratio, D.

13. A dc-dc converter has diode voltage and current as shown in the figure given below. The source voltage,$V_s = 12\,V$, duty ratio, $D = 0.6$, switching frequency, $f_s = 25\,kHz$, inductance, $L = 250\,\mu H$ and filter capacitance is $C = 220\,\mu F$. For average load current, $I_a = 1.5\,A$, determine:

    (a) average output voltage, V_a

    (b) peak-to-peak output ripple voltage, ΔV_C

    (c) peak-to-peak ripple current of inductor, ΔI_L

    (d) critical values of L and C