Power Supply Homework 2: The Zemer Diode

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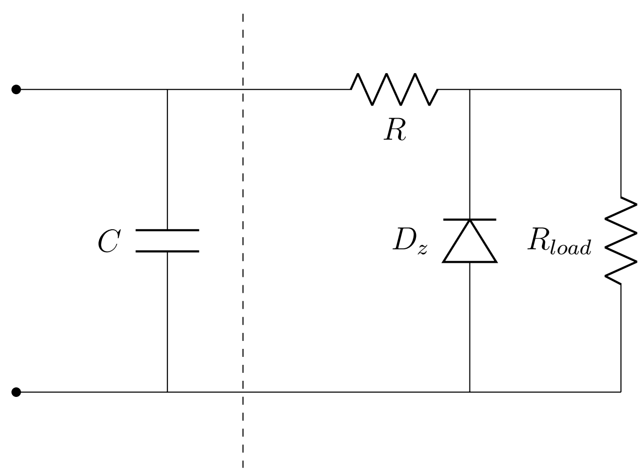
Using The parameters $V_{out}, i_{load}, \langle P_z \rangle, I_{zmin}, V_p, f$, solve for the parameters $R, C, \Delta V$ in the following circuit.



Firstly, we concern ourselves with the ripple voltage. We know from earlier analysis that the ripple voltage is given as

$$\Delta V = V_p \frac{1}{C R_{eq} f}$$

It is clear from analysis of the right side that the Thevevin equivalent resistance is just R. Thus, we have

$$\boxed{\Delta V = V_p \frac{1}{CRf}} \tag{1}$$

Next,we will analyze the average power requirement. It can be approximated that the average power through the Zemer diode is

$$\langle P_z \rangle = \overline{IV}$$

Thus,

$$\begin{aligned} \overline{I} &= \frac{\langle P_z \rangle}{V_{out}} \\ i_{zmax} - \frac{\Delta i_z}{2} &= \frac{\langle P_z \rangle}{V_{out}} \end{aligned}$$

Since $i_z = i_R - i_l$, and $i_R = \frac{v_r}{R}$, it follows that

$$\begin{aligned} \frac{V_p - V_{out}}{R} - i_l - \frac{\Delta i_z}{2} &= \frac{\langle P_z \rangle}{V_{out}} \\ \frac{V_p - V_{out}}{R} - i_l - \frac{\Delta V}{2R} &= \frac{\langle P_z \rangle}{V_{out}} \\ V_p - V_{out} - i_l R - \frac{\Delta V}{2} &= \frac{\langle P_z \rangle}{V_{out}} R \end{aligned}$$

Thus,

$$\boxed{V_p - V_{out} - \frac{\Delta V}{2} = \left(\frac{\langle P_z \rangle}{V_{out}} - i_l \right) R} \tag{2}$$

Finally, we will analyze the minimum current requirement. Following a similar process to equation (2),

$$\begin{aligned} i_{zmin} &= i_{zmax} - \Delta i \\ &= i_{Rmax} - i_l - \Delta i \\ &= \frac{V_p - V_{out}}{R} - i_l - \frac{\Delta V}{R} \\ i_{zmin} R &= V_p - V_{out} - i_l R - \Delta V \end{aligned}$$

This leads to the final relation

$$\boxed{V_p - V_{out} - \Delta V = (i_{zmin} + i_l) R} \tag{3}$$