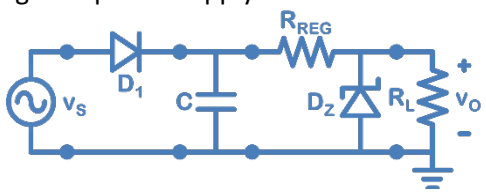
EECS312-HW7: Designing a 9V power supply based on the circuit below. Due 03/03/25



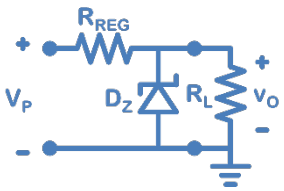
A transformer has been used to step down the 120Vrms outlet voltage to 11.8V peak:

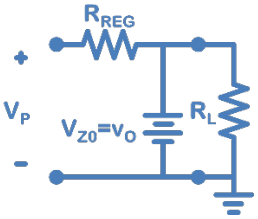
$$v_S(t) = 11.8 \cdot \cos(2\pi 60t)$$

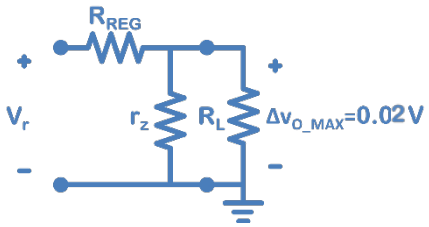
The rectifier diode, D_1, is modeled as a 0.7V CVD and the Zener diode, D_Z, has parameters of r_z=7.2Ω and V_{Z0} = 8.8V. The load is modeled using resistance, R_L=180Ω. What is the peak voltage at the output of the rectifier (D1:cathode, Top of the Capacitor) ?

V_P = _____

The circuit below (**left circuit**) will be used to find the value for R_{REG}, assuming the input voltage has a constant value of V_P. Replace the Zener diode with a 9V CVD model (9V battery – **center circuit**) and find the maximum value of R_{REG} that ensures the diode continues to conduct current. Choose an actual value for R_{REG} that is 70% the maximum to include some error margin.







R_{REGMAX} = _____

R_{REG} = _____

Find the line regulation ($\Delta v_O/V_r$ – **right circuit**) using R_{REG}, r_z, and R_L.

Line Reg = _____

If we want a maximum ripple at the output, Δv_O, to be 0.02V, what is the allowable ripple, V_r, at the input of the regulator (based on the Line Reg)?

V_r = _____

Find the effective resistance, R_C, that would be in parallel with the filter capacitor. Also, find the minimum capacitance to meet the ripple voltage, V_r.

R_C = _____

C = _____

Find the duration the rectifier diode is conducting and the maximum current through the diode.

Δt = _____

I_{DMAX} = _____

Run a simulation using your circuit simulator to generate plots of $v_S(t)$, $v_C(t)$, $v_O(t)$, and $i_D(t)$. Estimate values for V_r, Δv_O, Δt, and I_{DMAX} from the plots.

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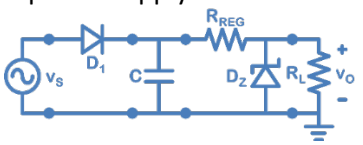

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V_P = 11.8-0.7= 11.1V

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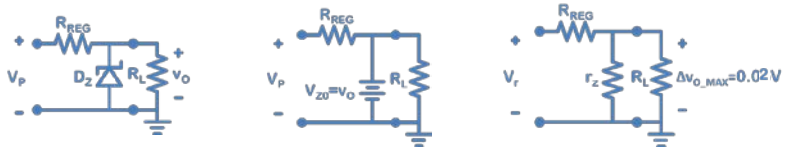

$I_Z = (11.1-9)/R_{REG} - 9/180 > 0 \ldots R_{REGMAX} < (2.1/9)\cdot 180 = 42\Omega$

R_{REGMAX} = 42Ω

R_{REG} = 29.4Ω

Find the line regulation ($\Delta v_O/V_r$ – **right circuit**) using R_{REG}, r_z, and R_L.

$$\text{Line Reg} = (r_Z||R_L)/(r_Z||R_L + R_{REG}) =$$

Line Reg = .19

If we want a maximum ripple at the output, Δv_O, to be 0.02V, what is the allowable ripple, V_r, at the input of the regulator (based on the Line Reg)?

V_r = .02/.19 = .105V

Find the effective resistance, R_C, that would be in parallel with the filter capacitor. Also, find the minimum capacitance to meet the ripple voltage, V_r.

$$R_C = V_{REG}/I_{REG} = 11.1/((11.1-9)/29.4) = 155\Omega$$

R_C = 155Ω

$$C = V_P/(f \cdot R_C \cdot V_r) = 11.1/(60*155*0.105)$$

C = 11360uF

Find the duration the rectifier diode is conducting and the maximum current through the diode.

Δt = 0.365mSec

I_{DMAX} = 6.7Amps