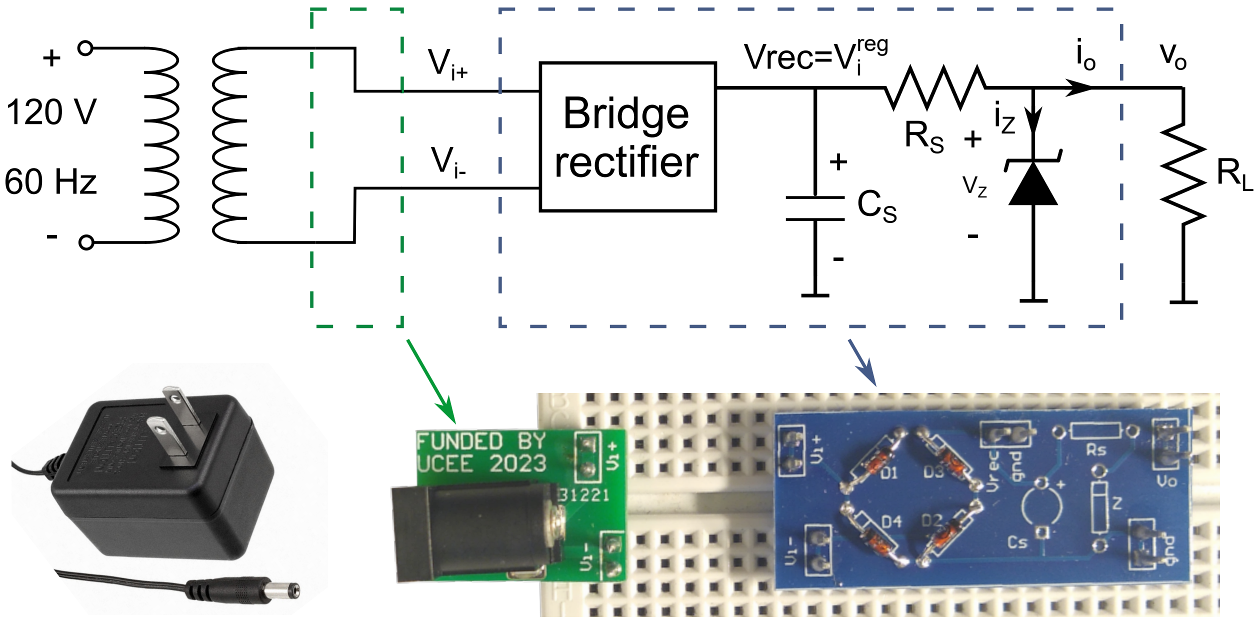
ENEL361: Rectifiers, Smoothing and Zener Regulation

In this lab you will test the operation of a bridge rectifier, smooth its output and design and build a 12 V regulated dc power supply using a 12 V Zener diode (1N4742A).

1 Background

You will solder a bridge rectifier on a PCB, smooth its output and create a Zener diode based regulator. As mentioned in class, the bridge rectifier can not have the same input-side and output-side ground. We will use a floating (i.e. without a ground) AC/AC transformer on the input side. The transformer input is 120 V, 60 Hz and the nominal output is about 12-13.5 V RMS. We'll use an adapter PCB that allows you to connect the barrel connector on the transformer to a breadboard. Two precautions for this lab - be careful not to short the outputs of the transformer and remember that diodes and electrolytic capacitors have a certain polarity and must be connected accordingly. This polarity is indicated on diodes by a marking on the cathode end and on capacitors by marking the negative terminal with a stripe or a -ve sign.



1.1 Experimental Work

1. If you haven't already done so, populate the PCB as outlined in soldering exercise 1 on D2L.

2. Plug in the barrel jack to breadboard adapter PCB and the PCB with the bridge rectifier into the breadboard. Connect a 470 Ω, 1 W resistor as the load from `Vrec` (the rectifier output and the regulator input) to ground. Connect the transformer output between the `Vi+` and `Vi-` headers. Observe the rectified output on the oscilloscope. Make a note of the frequency and the maximum value of the output.

3. Calculate the minimum capacitance needed to bring the peak-to-peak ripple of the rectifier to under 1 V. Note, you're looking at the rectifier output, it is not the regulator output. Insert the capacitor into the breadboard and confirm your calculation by measuring the ripple. **Show this to a TA or the instructor.**

4. You will now design a regulated supply with the following specifications. Output voltage between 11.8 and 12 V. Output current between 0 and 30 mA. You will be using a 1N4742A Zener diode (V_{BK}=12 V). Design equations are provided below.

$$R_S < \frac{v_{i,min}^{reg} - v_{o,max}}{i_{z,min} + i_{o,max}} \tag{1}$$

$$R_S > \frac{v_{i,max}^{reg} - v_{o,min}}{P_Z/V_{BK}} \tag{2}$$

$$R_S > \frac{(v_{i,max}^{reg} - v_{o,min})^2}{P_{R_S}} \tag{3}$$

$$C_S > \frac{i_{o,max} + i_{z,max}}{f(v_{i,max}^{reg} - v_{i,min}^{reg})} \tag{4}$$

   The lecture notes also provide an Excel spreadsheet with these equations set up. Populate cells B2-B12. $v_{i,max}^{reg}$ and f were measured in #1 above. $i_{z,max}$, $i_{z,min}$ and P_Z can be found in the datasheet as shown during the class. We have 1 W resistors. Choose values for R_S and C_S that satisfy the equations. **Show a TA or the instructor your spreadsheet and chosen values before proceeding.**

5. Solder your chosen components to create your regulator. Be careful of the capacitor and Zener diode polarity. Use the oscilloscope to measure the mean value and peak-to-peak ripple in the regulated output for two conditions (a) ~25 mA load i.e. R_L ~470 Ω and (c) ~50 mA load i.e. R_L ~220 Ω. Make sure you're not exceeding the power limit of the load resistors i.e. $V^2/R_L < P_{R_L}$. **Show your regulator operation to a TA or the instructor.**

6. Think about what the Zener diode allowed you to do. In #3 you calculated the capacitance needed to get the ripple down to 1 V. Repeat that if you want to get the ripple down to 200 mV for a 30 mA current. Compare that capacitance to the one you actually used in your design.