MASSACHUSETTS INSTITUTE OF TECHNOLOGY

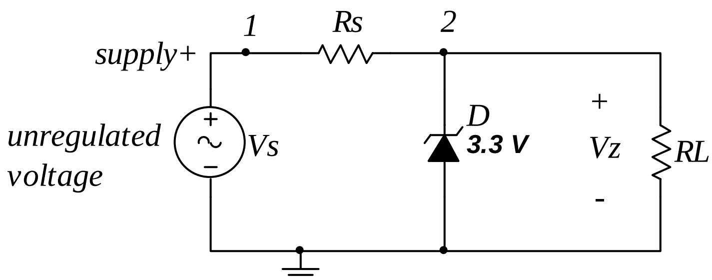
6.071 Introduction to Electronics, Signals and Measurement

Spring 2006

Laboratory 17: Diodes: Signal conditioning: Voltage regulation

Voltage Regulator

The Zener diode with its well defined breakdown voltage may be used for building a very effective voltage regulator. In this exercise we will construct and test a voltage regulator circuit.



The supply is able to provide a maximum current of 1.5A, and the Zener diode has an effective resistance of 30Ω.

Using Rs ~ 500Ω and RL ~ 10kΩ build the above circuit. From the class web site download the instrument called **ZenerRegulator**. This instrument controls the variable power supply of your ELVIS unit. Make the following connections to your protoboard.

Node 1: Connected to ACH1 (measures the unregulated voltage *Vs*)
Node 2: Connected to ACH2 (measures the regulated voltage *Vz*)

Run your instrument and observe the response of the circuit (regulated voltage *Vz*) as the unregulated voltage Vs is varied. Try adding noise to Vs and observe *Vz*.

Note the loading effect of this voltage regulator circuit. As *Vs* gets larger what is the max *Vz* across the load?

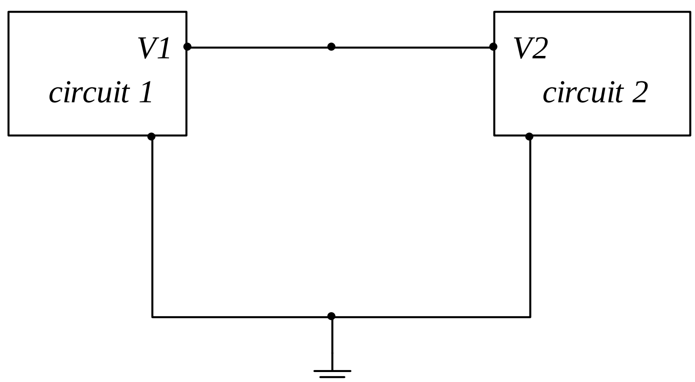
Given the maximum *Vz* and the diode's effective resistance calculate the maximum current through the diode *Iz*. What is the maximum current *Is*?

Voltage Level Protection.

The signal *V1* generated by circuit 1 is transmitted to circuit 2 for further processing. However circuit 2 is very sensitive to voltage excursions above a certain level. In this example this voltage level is 6.6 Volts. The signal generated by circuit 1 is expected to be less than 6.6 Volts but it has been observed that certain transients that were not taken into consideration in the original design of circuit 1 may create voltage spikes greater than 6.6 Volts. These voltage spikes destroy circuit 2 and that is bad.

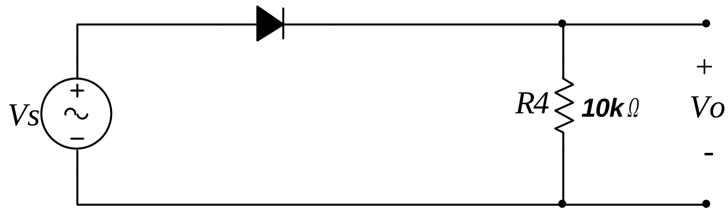
We would like to modify the circuit arrangement shown below so that the voltage seen by circuit 2 is always “clamped at 6.6 Volts.

Show your solution.

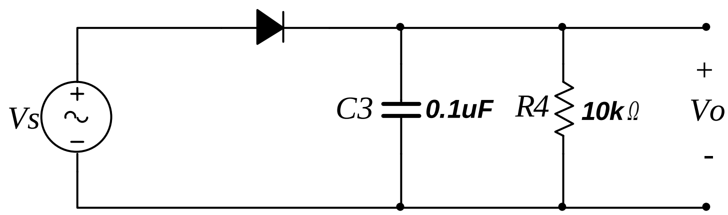


Peak Finder (and Keeper) Circuit

The rectifier circuit studied in the previous lab consisted of a diode in series with a resistor as shown below.



Now by incorporating an energy storage element, the capacitor C_3 in the circuit below, the behavior of the circuit is modified in a very useful way.



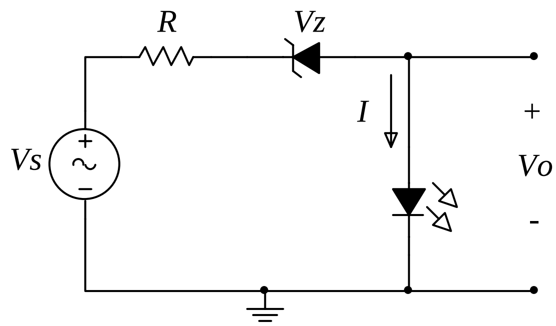
For this exercise let's construct and test the circuit above. For Vs use the function generator and observe the input and output signals of your circuit with the oscilloscope. How are the amplitudes of Vs and Vo related?

What is the characteristic time τ_c of this circuit? (τ_c is the time it takes for a signal to fall to 1/e of it's peak value or grow to 1 – 1/e of it's peak value. In this case determine how the voltage *Vo* across *C3* decays as the capacitor dissipates power in *R4* when *Vs* is negative and the diode is off.)

Provide a signal *Vs* from your function generator and observe the output as a function of the frequency. In the space provided below, draw the superimposed signals Vs and Vo for a the following frequencies: 5Hz, 50Hz, and 1kHz.

LED Voltage Level Indicator.

Consider the following circuit.



This circuit is constructed with a Zener diode an LED, a resistor and a voltage source.

Calculate the minimum voltage Vs that will turn the LED on. Assume that the forward voltage of the LED is *Vg*.

Build the circuit with a 3.3 Volt Zener diode.
Determine the value of *R* required to limit the current through the diodes to 10 mA.

For *Vs* start a triangular wave signal with a frequency 5 Hz varying from 0 to 5 Volts.

Observe the output voltage *Vo*.

Increase the frequency of Vs and determine the highest frequency that you can observe the blinking of the LED.