Name: ______________________
Basic DC Lab - ELEC 101L

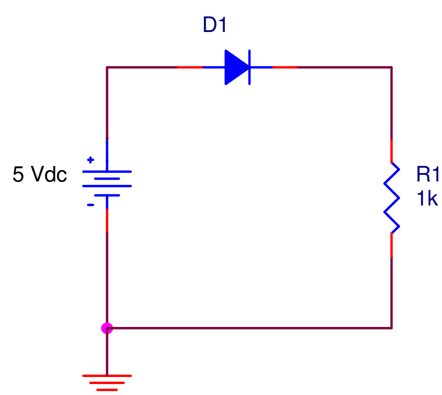
LAB #10: Voltage Blocking, and Circuit Transients

In this lab the use of diodes, switches, and capacitors in circuits will be explored. Diodes are commonly used to block or control voltage in circuits. Switches are used to turn circuits on and off, but the transition between on and off is not always smooth. The use of the oscilloscope will also be introduced to understand how circuits change with time. These concepts are very important to circuit analysis. Remember to show all calculations and use complete sentences when answering questions.

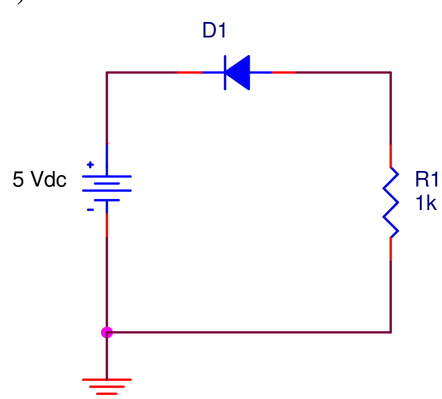
PART I: The Voltage Blocking diode (25 pts)

Given:

a)



b)



Diode Forward Voltage depends on the semiconductor material used.
Germanium diodes have ~0.27V when they are conducting.
Silicon diodes have ~0.7V while conducting.

Diode reverse voltage depends on the rest of the circuit to balance Kirchoff's voltage law.

Build the circuits at right and measure the voltages and currents of the circuit. Write these values on the schematic diagram.

What type of diodes are being used? ___________

In the left margin label which circuit is forward biased and which is reverse biased.

Is there <u>any</u> current in the reverse biased circuit? ___

If there is any current, how much, and why might there be some?

What value of resistor does the diode look like in the two different circuits?

a)

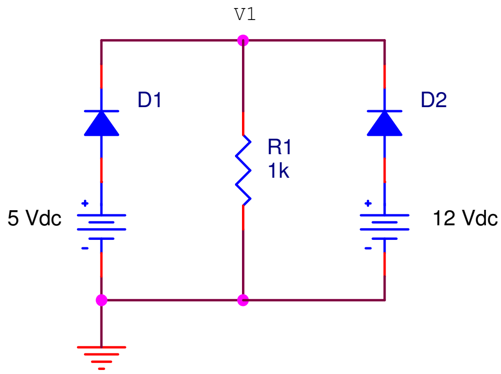
b)

What is the total power in the two different circuits:

a) P_T = _____________

b) P_T = ____________

PART II: Parallel Blocking Diodes (25 pts)



Voltages can be combined in series easily, but when connecting them in parallel caution must be observed to prevent one source from damaging the other. Voltage blocking diodes as shown in the circuit at left are one common way to allow different voltage sources to be connected in parallel. Look at the circuit at left and using what you know about circuit analysis try to predict what the voltage V1 will be.

V1 (pred) = __________ because

Now build the circuit and take some measurements to see what's really going on with this circuit. Use the +6V and +25V sources from the power supply. Get extra leads from the back of the lab if necessary. Using the DMM measure the voltages across diodes D1 and D2.

D1 = ___________ and is forward/ reverse biased.

D2 = ___________ and is forward/ reverse biased.

Finally measure V1 and state if your original prediction was correct. If not, can you now describe why V1 is the value you measured?

V1(meas) = ______________. Explanation:

PART III: Getting Familiar with the Oscilloscope (25 pts)

This part of the lab will provide some instruction on the oscilloscope (scope or o'scope) and how its different knobs and buttons allow different measurements in a circuit. The primary measurement of a scope is voltage. Resistance can't be measured directly and measuring current requires special probes or small resistors (called shunts) which are inserted into the circuit. The primary use of an oscilloscope is to observe how **voltages change with time**. These changes are the primary interest for all circuits in electronics (both analog and digital), so the oscilloscope is an extremely valuable instrument.

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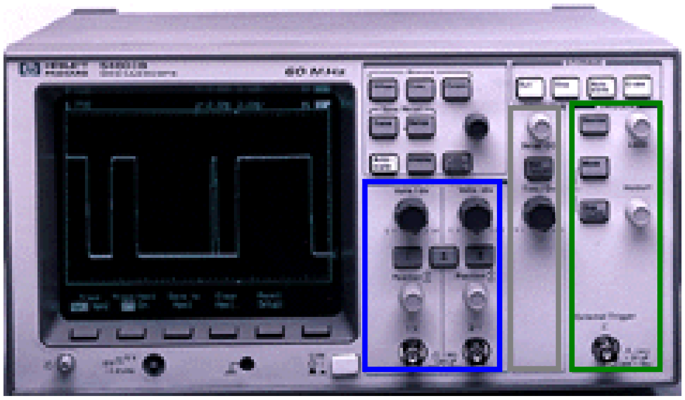
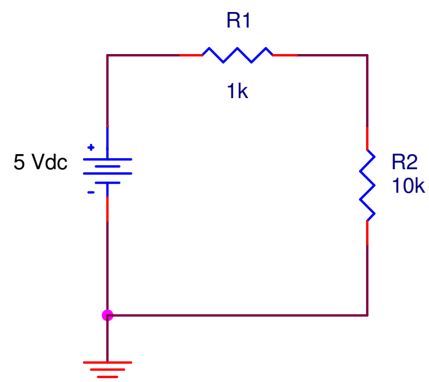


The HP 54603B scope will be used for this lab. This scope and almost all newer scopes are commonly called digital storage scopes. Originally scopes were analog and most did not store the signals being measured. Only the phosphor from the CRT was what displayed the signal. Being able to store signals for future inspection was once a very challenging problem. Since the advent of digital scopes, once the signal is sampled and converted into a number it can be easily stored for temporary or permanent reference.



- Build the circuit at right and then Turn the scope on.
- First make sure you see a solid green horizontal trace across the middle of the screen (zero reference for now). Ask for assistance if needed.
- In the Vertical section of the front control panel (blue border) adjust the knob to set Channel 1 input to 2 Volts/div. This is called the vertical sensitivity.
- The probe that is connected to Channel 1 will be used to measure the voltage source in the circuit.
- Next connect the black alligator clip (looks like an alligators teeth from the side) on the probe to the power supply ground or circuit reference point, and connect the long probe tip to the positive voltage.
- You should see the flat trace move 2.5 divisions higher than before. (because 2.5 div x 2 volts/div = 5 volts.)

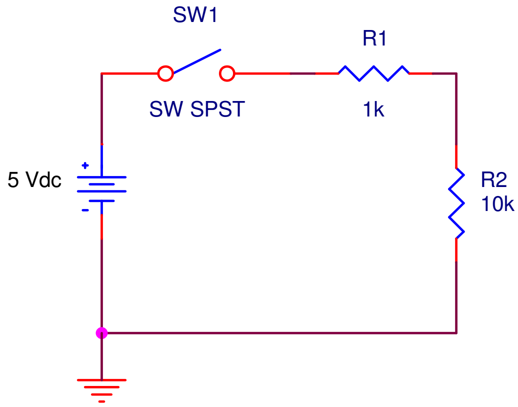
Does the trace appear as predicted? Make sure it does before proceeding.

Change the scale to 5 volts/div and describe what happens.

Now change the scale to 1 volt/div and describe what happens.

To get the trace to be visible, first disconnect your probe tip (sets the input to 0V) and find the Position knob that adjusts the horizontal trace up and down on the screen. This is called the vertical position or offset. Move the line down 2 or 3 div. and then reconnect the probe. The trace should now appear on the screen 5 div. above where you moved the zero reference line to. By having a smaller vertical sensitivity it is possible to see the signal in greater detail. This will allow better measurement of a DC or AC signal.

Part IV: Observing and Removing Switch Bounce (35 pts)



Mechanical switches operate in ways that are electrically non-ideal. The transition from off-on or on-off is not usually perfect and designers usually need to take it into account.
Modify the previous circuit to add a switch in series with the resistors (shown at left). The switch that will be used needs alligator clips to connect them to the breadboard. Get the switch and clips from the instructor.

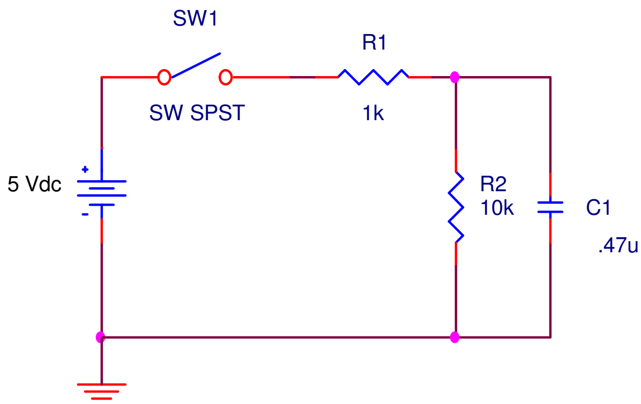
- Connect Channel 1 of the scope across the 10k resistor.
- In the Horizontal section of the control panel (gray border) set the time base (Time/div knob) on the scope to 500 msec/div. It should take the trace 2.5 seconds to move across the screen.
- In the Trigger section of the front panel (green border) press the Mode button. Turn the Level knob until it says ~ 2.5V. Finally on the buttons below the screen, press Normal.
- Turn the switch on and off at about 1 second intervals and watch the voltage changes on the screen.

Draw what you observe below. (5 pts)

- Now change the time scale to 500 μsec/div. Repeat turning the switch on and off at one second intervals.

Draw your observations for when the voltage changes from 0V-5V below. (5 pts)
The signal will be different each time so just pick one that is a good representation.

What you should be seeing on this time scale is many fast transitions between 0V-5V. This is called "switch bounce".
To help eliminate switch bounce, a capacitor is used to slow down the transition from 0V to 5V when the switch is turned on, and from 5V to 0V when the switch is turned off. Add a capacitor to the circuit as shown and repeat the observations at 500msec/div and 500 µsec/div.



Draw your observations for both time scales below. (10 pts)