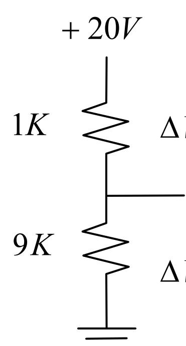
SP.764, Practical Electronics
Dr. James A. Bales
Lecture 2: Switches, Rectifiers and Generators

Topics:

1) Homework Review
2) Switches
3) Bridge Rectifiers
4) AC vs. DC
5) Function Generators and Oscilloscopes

Homework Review:

<u>Homework 1</u>: Voltage dividers



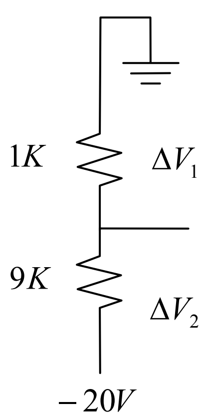
$$\Delta V_1 = IR_1 = 20V - V_{OUT}$$

$$V_{OUT} = 18V$$

$$\Delta V_2 = IR_2 = V_{OUT} - 0V$$

$$V_{OUT} = V_{IN}\left(\frac{R_2}{R_1 + R_2}\right)$$

$$= 20V\left(\frac{1k}{1k + 9k}\right) = 18V$$



$$\Delta V_1 = IR_1$$

$$V_{OUT}$$

$$\Delta V_2 = IR_2$$

$$I = \frac{\Delta V_1}{R_1} = \frac{0 - V_{OUT}}{R_1} = -\frac{V_{OUT}}{R_1}$$

$$I = \frac{\Delta V_2}{R_2} = \frac{V_{OUT} - (-20V)}{R_2}$$

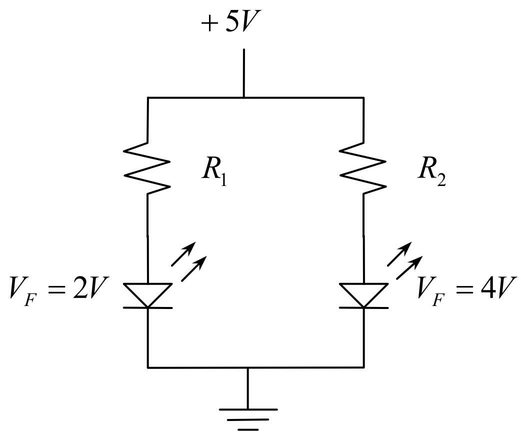
$$-\frac{V_{OUT}}{R_1} = \frac{V_{OUT}}{R_2} + \frac{20V}{R_2}$$

$$-\frac{20V}{R_1} = V_{OUT}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$V_{OUT} = -20V\left(\frac{R_1}{R_1 + R_2}\right)$$

$$= -2V$$

Homework 2: Diodes



$$R_1 = \frac{(5V - 2V)}{20mA} = 150\Omega$$

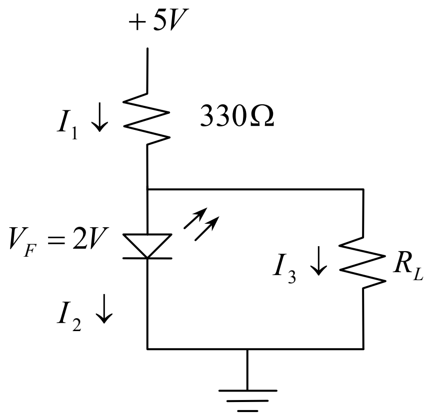
$$R_2 = \frac{(5V - 4V)}{20mA} = 50\Omega$$

There are two diodes that will be used in class:

- Zener diodes: If you put a negative voltage across a Zener diode, it has a second turn-on point. The slope of the I-V curve of the second turn-on point is even more abrupt than the slope of the I-V curve of the first turn-on point. You can tail the breakdown voltage from a couple of volts to hundreds of volts. A Zener diode is used in reverse bias to clamp and hold the voltage. The name Zener diode comes from a Physics term called the Zener effect, which is not even related to the Zener diode at all. However, the Zener diode does exhibit the Avalanche effect.

- Silicon diodes: These diodes do not emit light. Have same functionality as other diodes. Their forward voltages are really small (~0.6-0.7 volts).

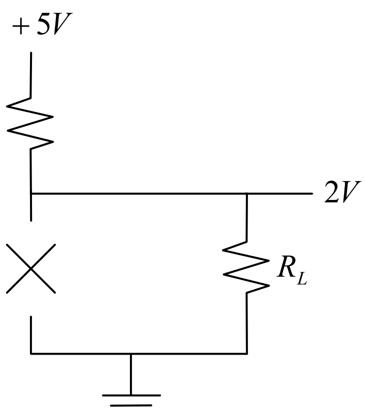
Diodes don't have resistance. If the voltage is below a diode's forward voltage, then the element looks like an open circuit. If the voltage is below the forward voltage, the element behaves as a short circuit.

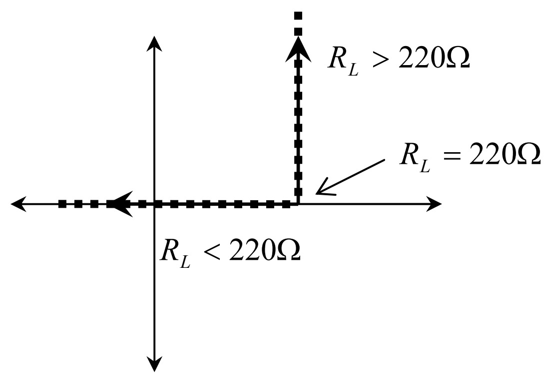


$$I_1 = \frac{(5V - 2V)}{330\Omega} = 9mA$$

$$I_1 = I_2 + I_3 = 9mA$$

If R_L is such that V_{OUT} = 1V, there is no current flow through the diode. The diode conducts (turns on) when V_{OUT} hits R_L.



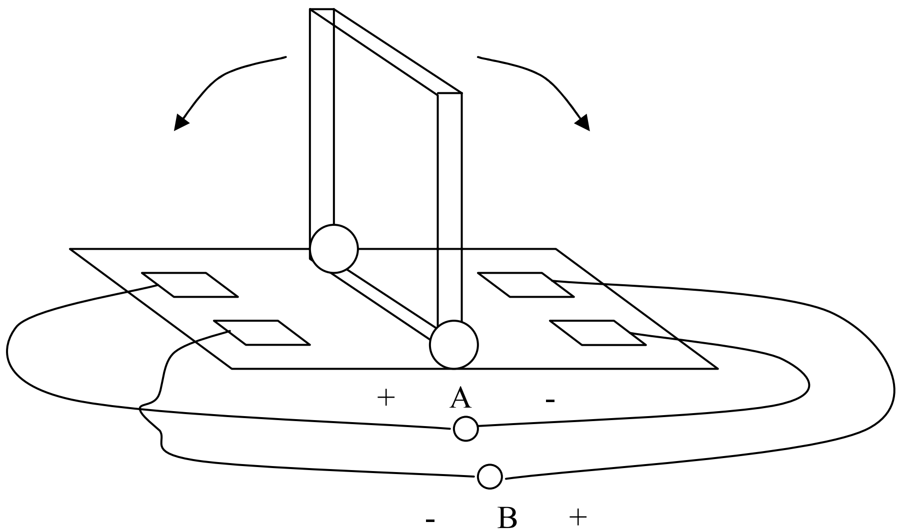


One gets V_{OUT} = 2V when R_L = 220 ohms.

Now, try R_L = 330 ohms. The voltage divider predicts V_{OUT} = 2.5V. BUT the diode clamps at 2.0V! The diode will steal any necessary current to stay at 2V. The bigger R_L is, the more current passes through the diode.

AC vs. DC

One can implement a simple DC to AC converter with a switch configuration like the following:

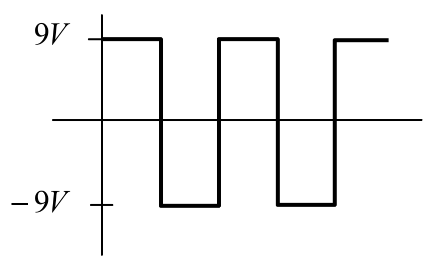


With switch to one position:

$V_A - V_B = 9V$

With switch on the other position:

$V_B - V_A = -9V$



EC.S06 / EC.S11 Practical Electronics
Fall 2004