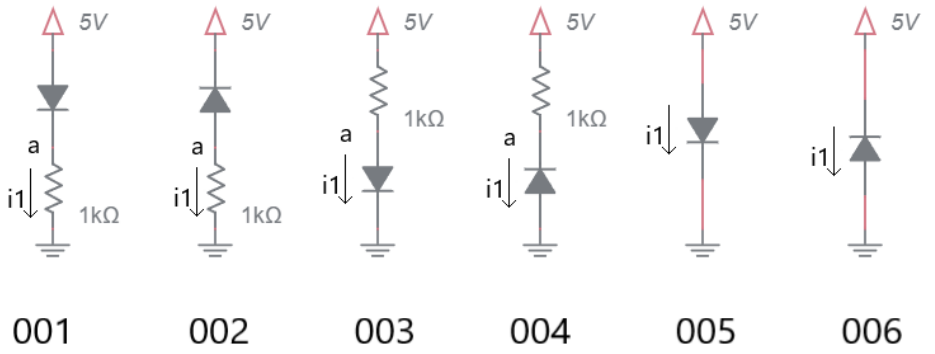
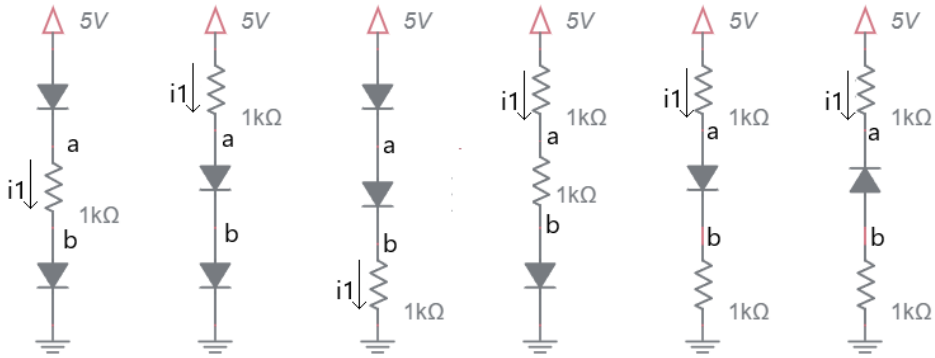
DC circuits with diodes and resistors

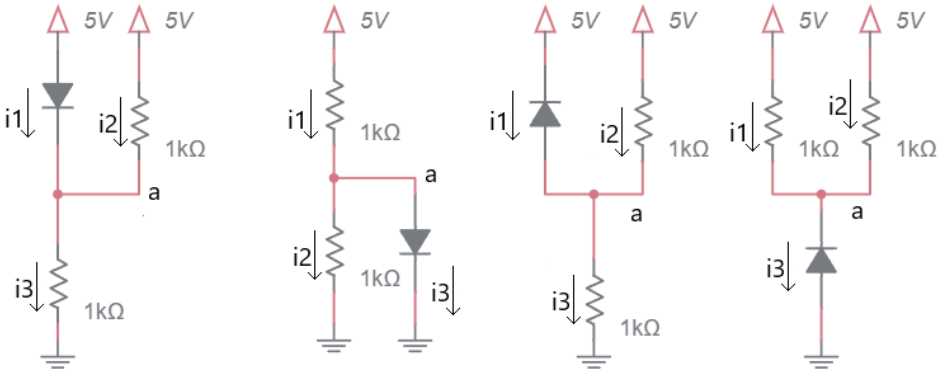
Determine the currents and voltages in the following circuit. Assume a constant voltage drop model for the diodes with a cut-in voltage of 0.7V. If a diode is reverse biased write "RB" next to the diode.



001 002 003 004 005 006



007 008 009 010 011 012

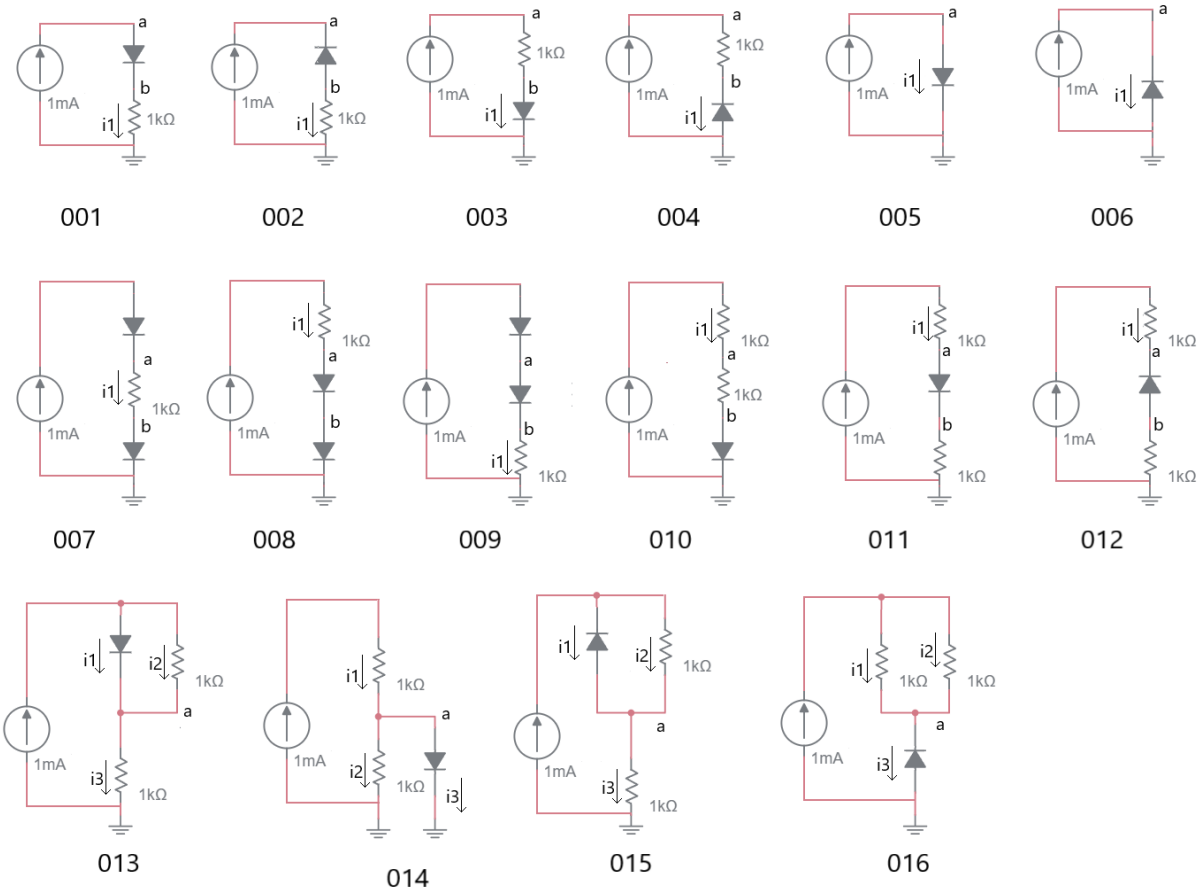


013 014 015 016

Problem	a	b	I1	I2	I3
001					
002					
003					
004					
005					
006					
007					
008					
009					
010					
011					
012					
013					
014					
015					
016					

Current Source circuits with diodes and resistors

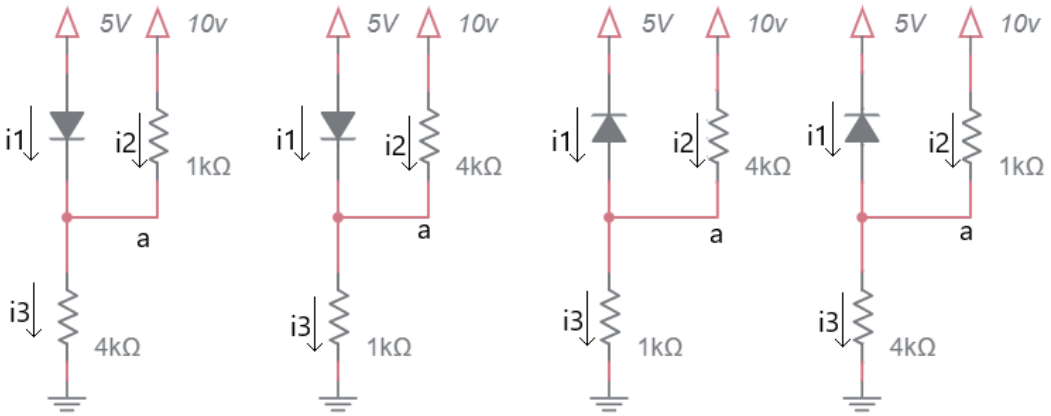
Determine the currents and voltages in the following circuit. Assume a constant voltage drop model for the diodes with a cut-in voltage of 0.7V. **Note, the circuits are powered by a current source!**

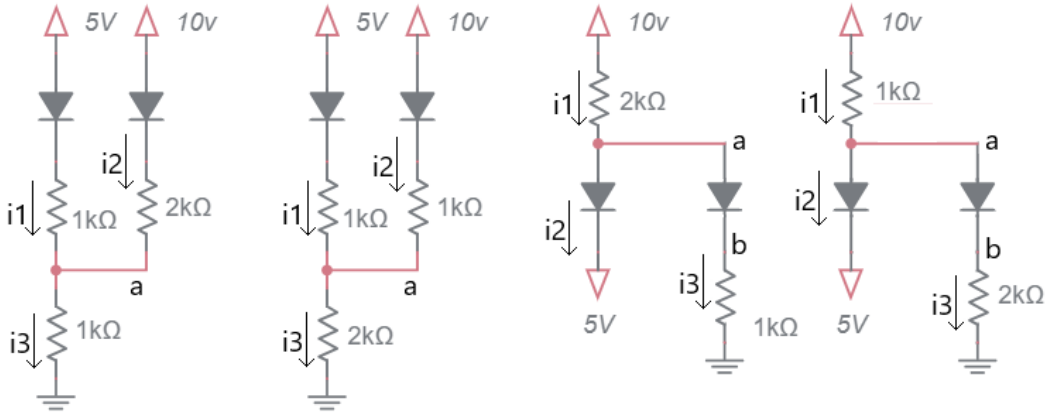


Problem	a	b	i1	i2	i3
001					
002					
003					
004					
005					
006					
007					
008					
009					
010					
011					
012					
013					
014					
015					
016					

DC circuits with diodes and resistors

Determine the currents and voltages in the following circuit. Assume a constant voltage drop model for the diodes with a cut-in voltage of 0.7V. **Note, the power rails are 5V and 10V to the circuits!**

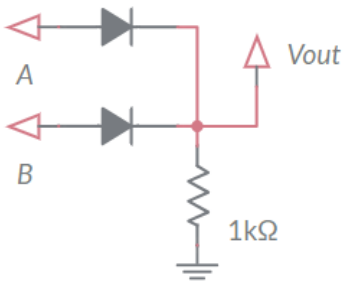




Problem	a	b	i1	i2	i3
001					
002					
003					
004					
005					
006					
007					
008					

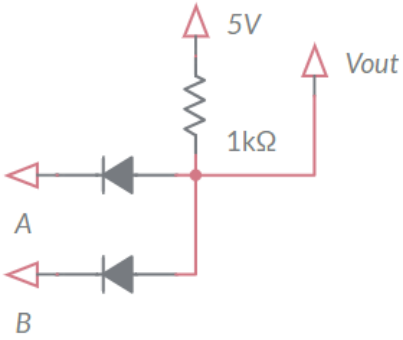
Diodes as logic gates

In the following circuits consider 5V logic 1 and GND as logic 0. Use the ideal diode model for analysis. Complete the truth table for the circuit shown and describe the logic function instantiated by each.



001

A	B	Vout
0	0	
0	1	
1	0	
1	1	

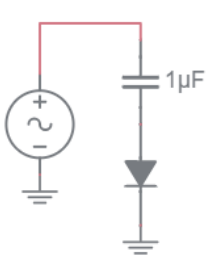


002

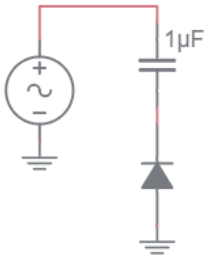
A	B	Vout
0	0	
0	1	
1	0	
1	1	

AC circuits with diodes and resistors

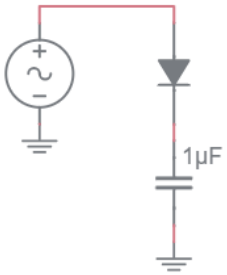
For each of the circuits below, complete the timing diagrams.



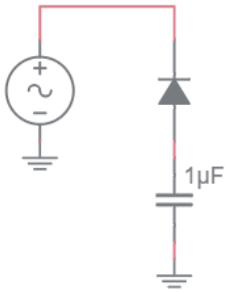
001



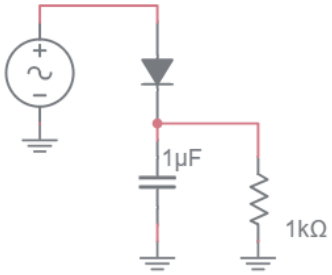
002



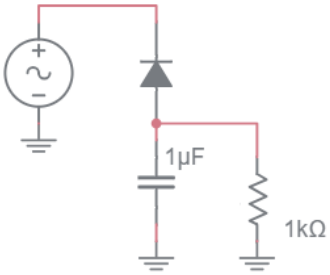
003



004



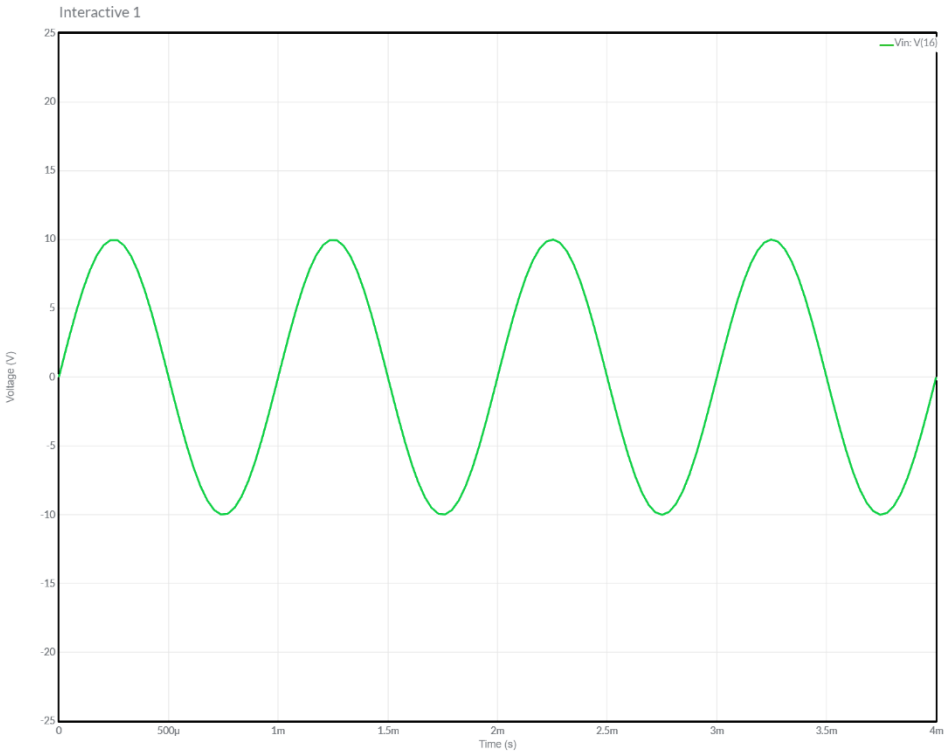
005



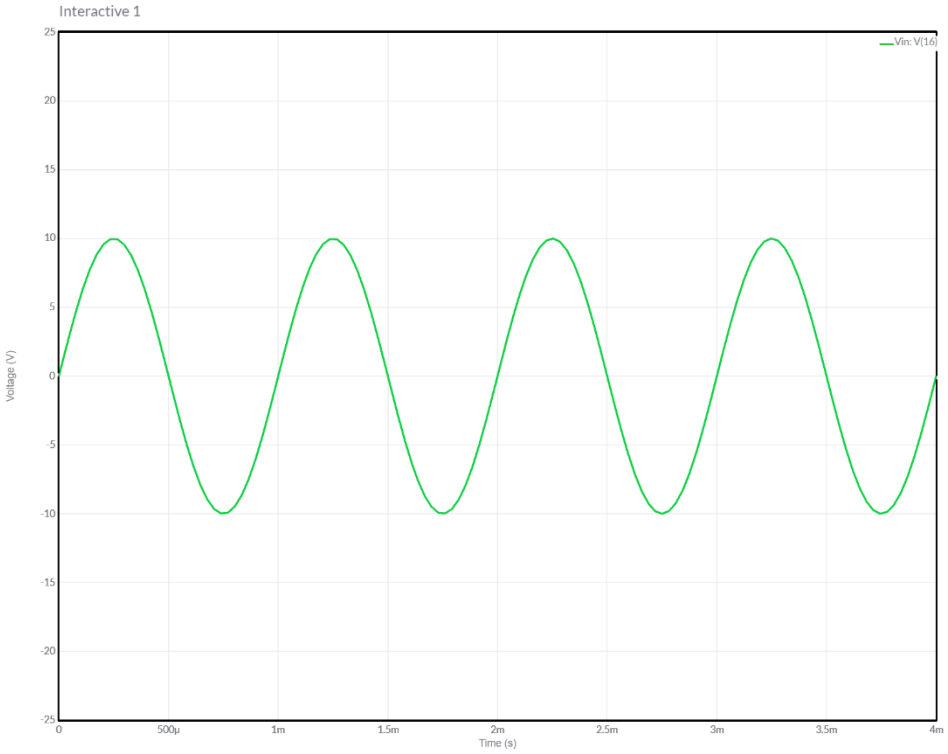
006

After you complete the timing diagrams for circuits 001 to 004, look at their behavior and assign the circuits one of the following names – one name for each circuit.

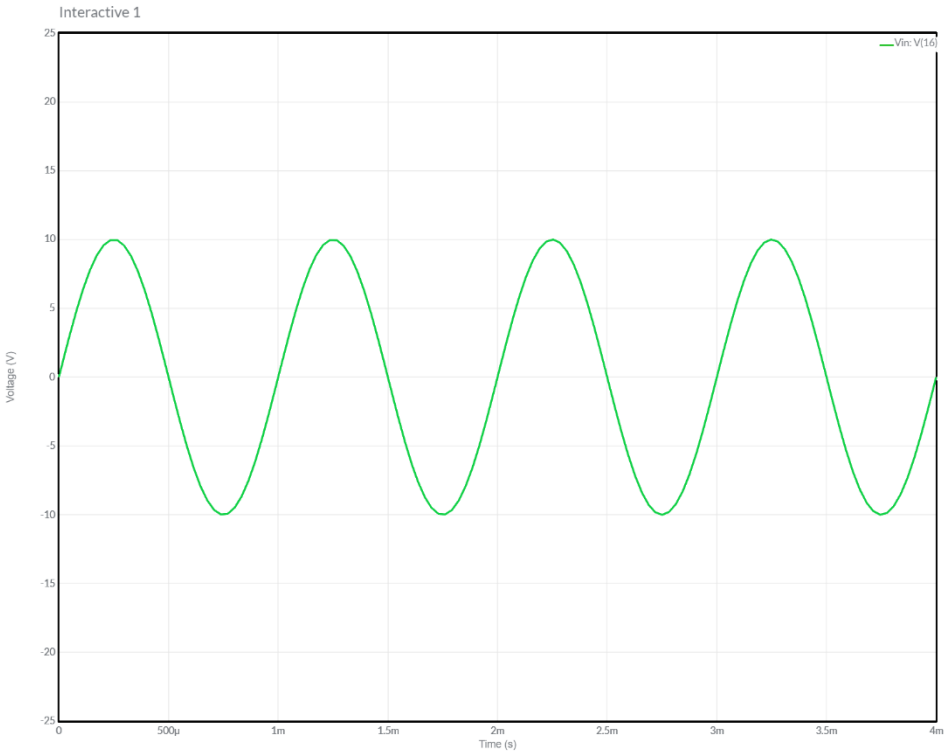
- Peak detector
- Positive level shifter
- Trough detector
- Negative level shifter



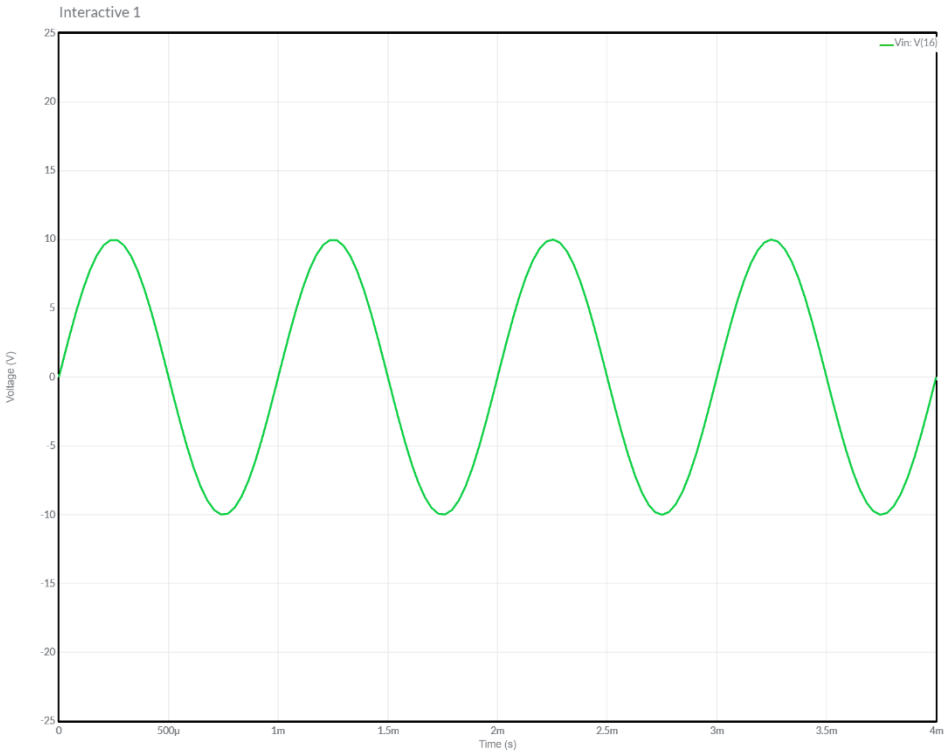
Plot the voltage for the circuit labeled 001.



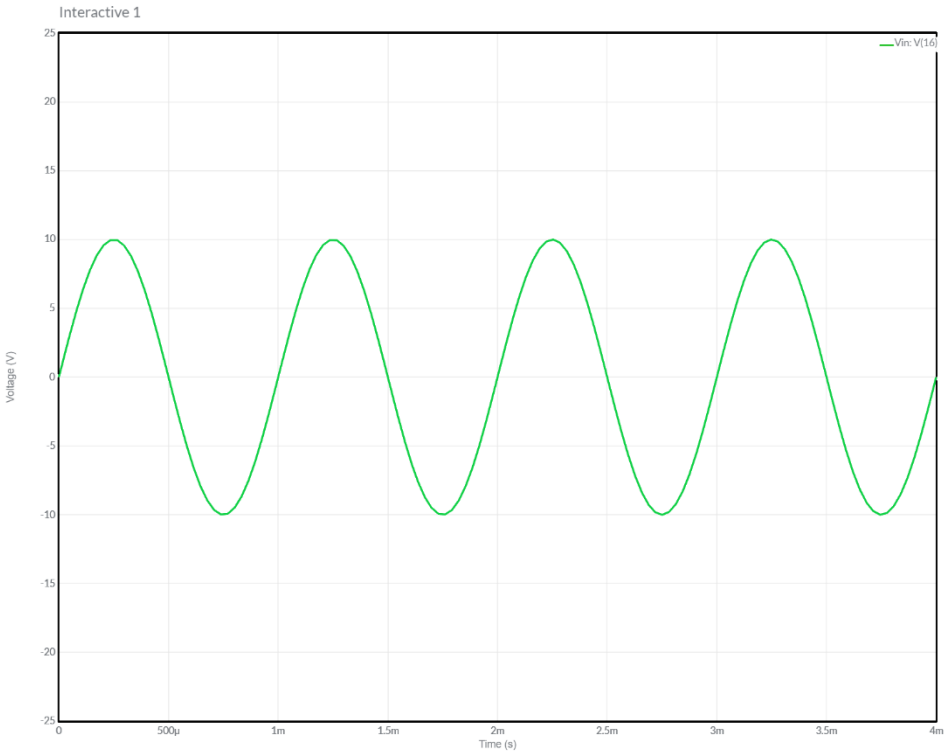
Plot the voltage for the circuit labeled 002.



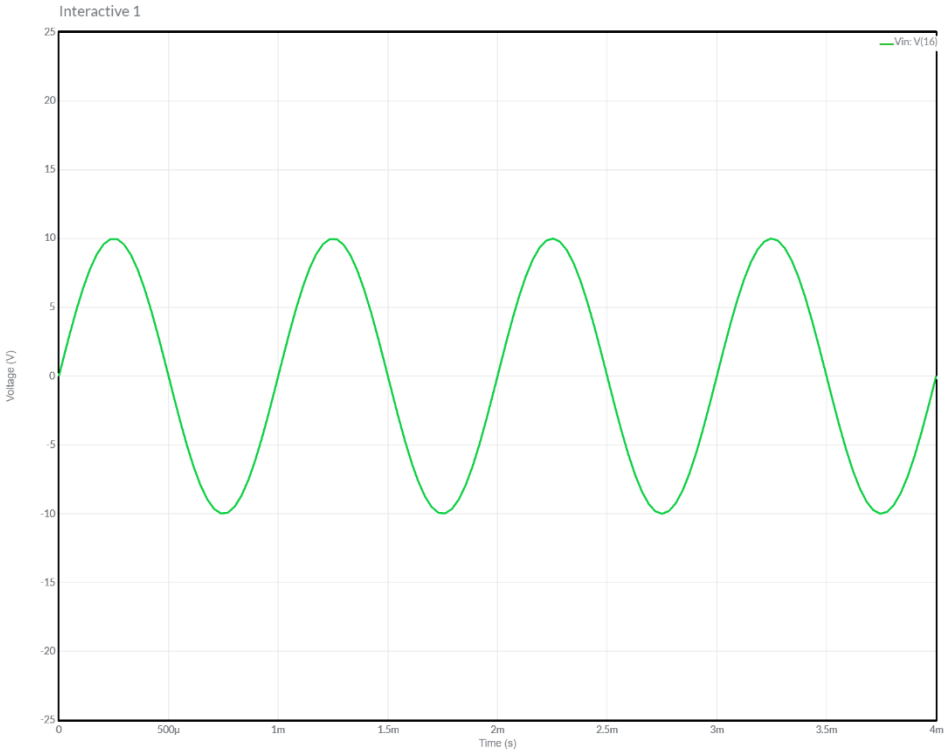
Plot the voltage for the circuit labeled 003.



Plot the voltage for the circuit labeled 004.



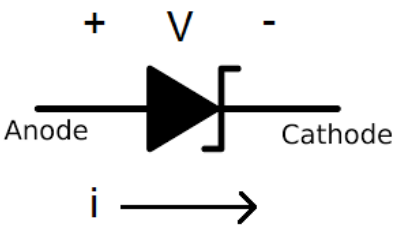
Plot the voltage for the circuit labeled 005.

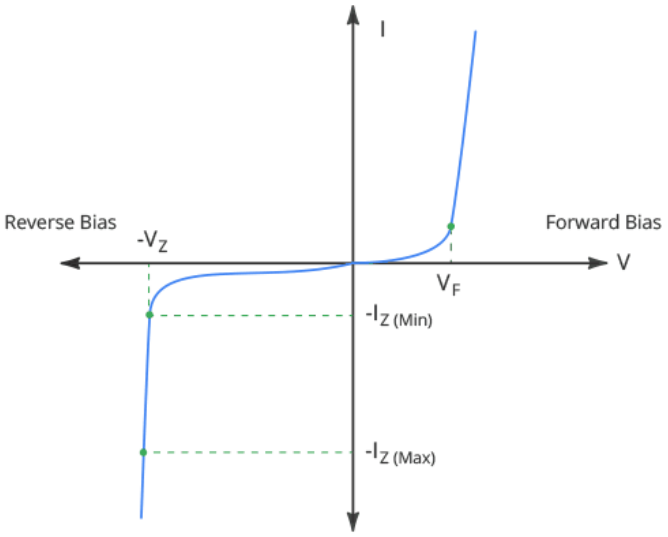


Plot the voltage for the circuit labeled 006.

Special Types of Diodes – The Zener Diode

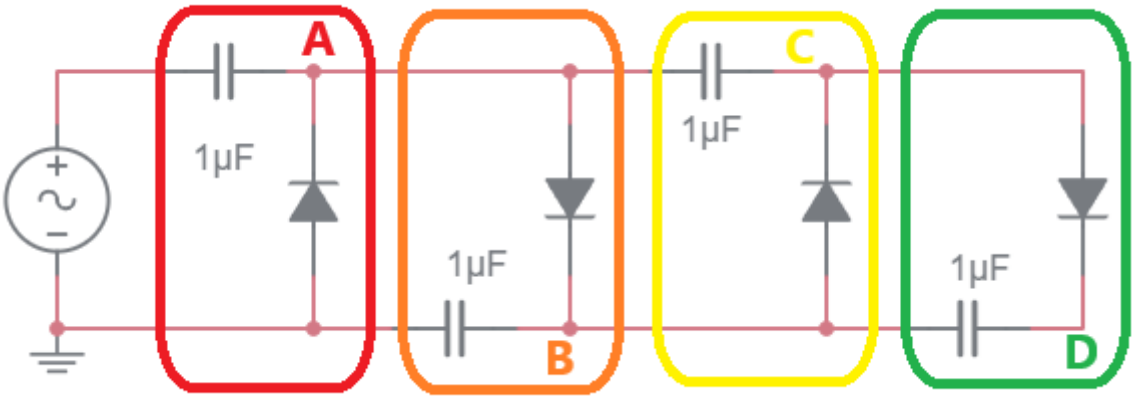
The Zener diode shown below is first and foremost a diode. In the I/V graph below, the forward biased Zener diode starts conducting current at V_F, typically about 0.7V. However, Zener diodes have a trick, when the reverse biased voltage exceeds the Zener diodes' Zener voltage it conducts current from the cathode to the diode while clamping the voltage at the Zener voltage $-V_Z$. Manufactures of Zener diodes produce them with a variety of Zener voltages. In order to maintain a clamped reverse biased voltage, a Zener diode must pass at least $-I_Z$ amps, the minimum Zener current.





Practical Application – Voltage Doubler

The circuit below takes combinations of circuits from the **AC circuits with diodes and resistors** section and combines them to produce a larger voltage than the input voltage. Before starting on this analysis, you must first have successfully completed all the problems in the **AC circuits with diodes and resistors** section.



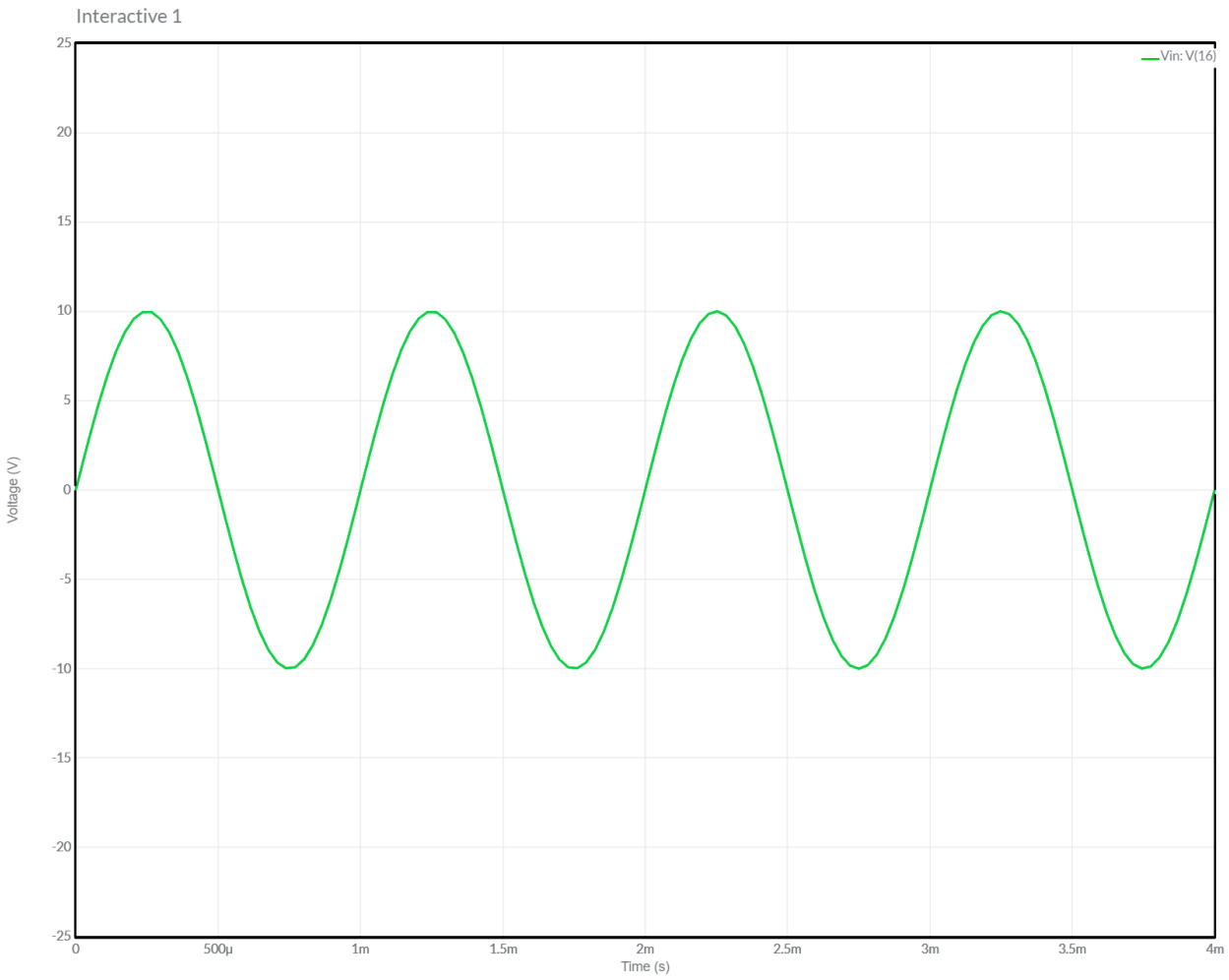
1. Look at the circuit outlined in red and compare it to circuits 001 to 004 in the **AC circuits with diodes and resistors** section. Which circuit is it and what name did you assign it?

2. The circuit outlined in orange gets it input from A. Look at the circuit outlined in orange and compare it to circuits 001 to 004 in the **AC circuits with diodes and resistors** section. Which circuit is it and what name did you assign it?

3. The circuit outlined in yellow gets it input from A and its ground terminal is connected to B. Look at the circuit outlined in yellow and compare it to circuits 001 to 004 in the **AC circuits with diodes and resistors** section. Which circuit is it and what name did you assign it?

4. The circuit outlined in green gets it input from C and its ground terminal is connected to B. Look at the circuit outlined in green and compare it to circuits 001 to 004 in the **AC circuits with diodes and resistors** section. Which circuit is it and what name did you assign it?

Use this information to plot the output of each colored stage given the input shown.


Interactive 1
Vin: V(16)
Voltage (V)
25
20
15
10
5
0
-5
-10
-15
-20
-25
0
500µ
1m
1.5m
2m
2.5m
3m
3.5m
4m
Time (s)

Practical Application – I/V Curve for LED

You are required to illuminate a Cree Xlamp XM-L2 High Power LED using either a current source or voltage source, the choice is yours. The LED has a I vs. V curve is shown in Figure 1. You are tasked to operate the LED at 3V and 1.3A – the point in the middle of the curve.

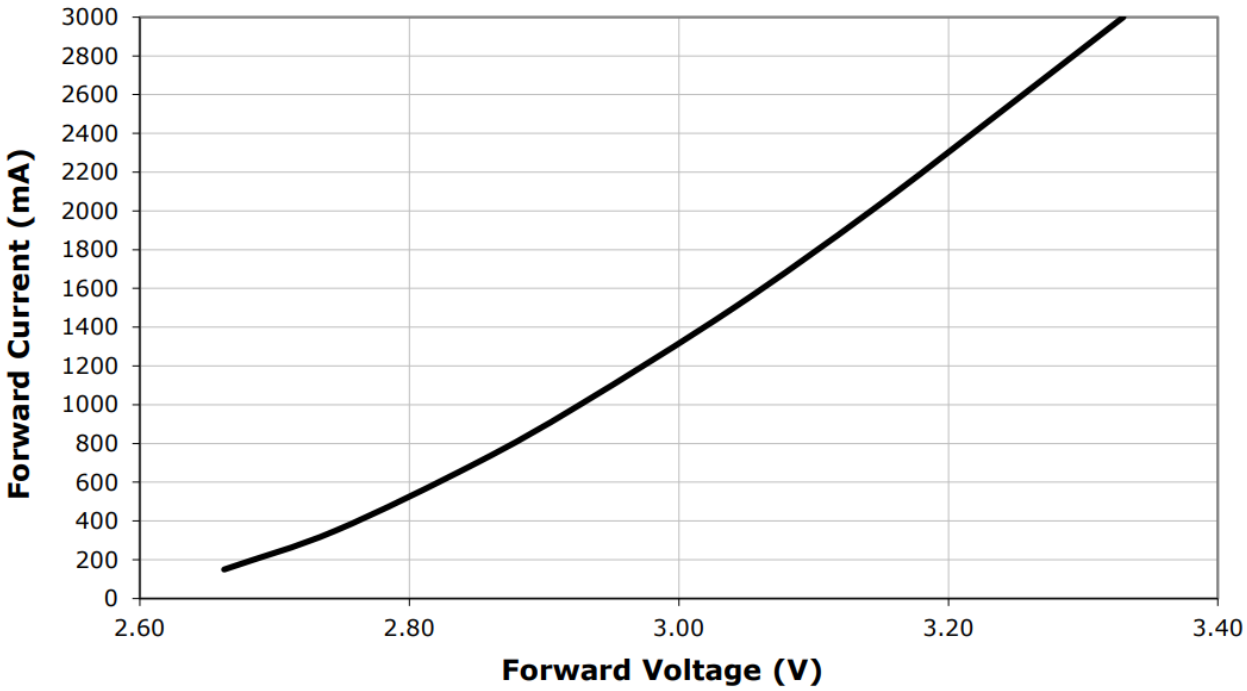


Figure 1: I/V curve for a Cree Xlamp XM-L2 High Power LED.

If you use a voltage source, you will have a ±10% variation in voltage.

a. What is the range of voltages across the LED?
b. Using the I/V curve in Figure 1, what is the range of current through the LED?
c. What is the range of power dissipated by the LED voltage source?

If you use the current source, you will have a ±10% variation in current.

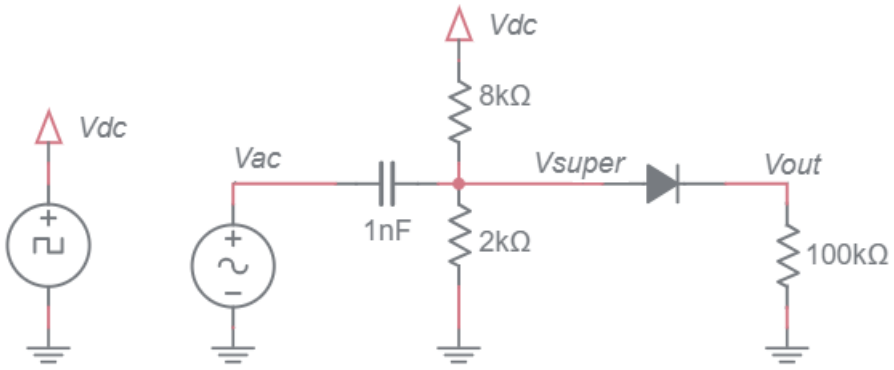
a. What is the range of current through the LED?
b. Using the I/V curve in Figure 1, what is the range of voltage across the LED?
c. What is the range of power dissipated by the LED using the current source?

What supply (voltage and current) produces the least variation in power?

What characteristic of the I/V curve determines the sensitivity to changes in voltage or current?

Practical Application – Using diodes as a switch

The following circuit shows how you can use a diode to switch a (small) AC signal on or off.



Your first task is to determine the signal *Vsuper* from the *Vac* and *Vdc* signals. To do this ignore the diode and 100kΩ resistor and use superposition. Note that the *Vdc* signal is a square wave that alternates between 0V and 10V at 10kHz (see graph below). If you are having a problem with this open the workbook to the Review section and find the **Practical Application – Coupling AC signal on a DC bias** section.

Now compute the *Vout* by running the *Vsuper* signal through a diode modeled as a constant voltage drop. You should see that when the *Vdc* signal is at 10V the AC signal passes through to *Vout*. When the *Vdc* signal is at 0V, *Vout* = 0V.