| From: | "CircuitLab Academy" <support@circuitlab.com> |
To:	"Metha Kerdkeaw" <chon7540@chontech.ac.th>
Date:	11/8/2023 11:56:53 PM
Subject:	HV voltage multipliers with diodes and capacitors

Hi Metha,

Voltage multipliers are fun and practical. In just a few screenshots you'll learn how to use a few diodes and capacitors to turn a low voltage into a higher one.
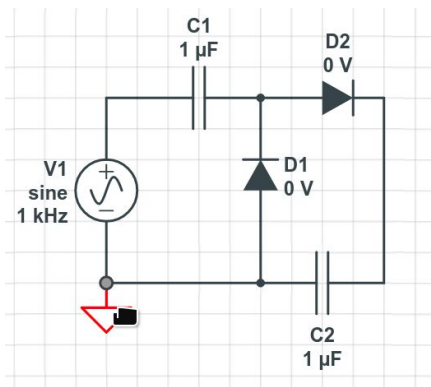
Click and drag a Voltage Function Generator, two capacitors, and two ideal diodes from the toolbox onto your schematic, pressing R to rotate and H or V to flip them as shown:
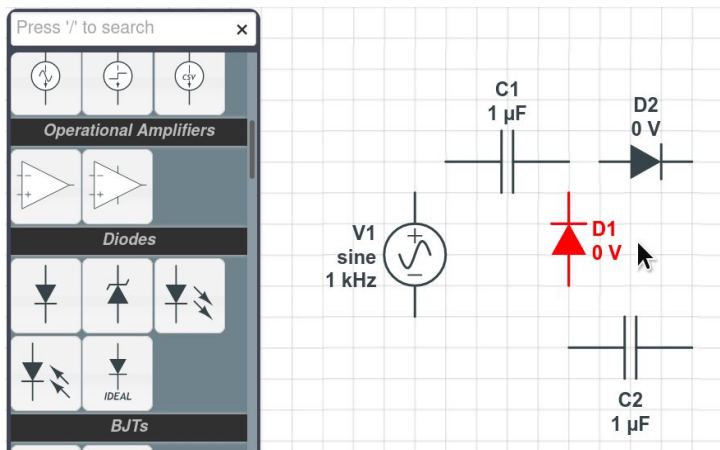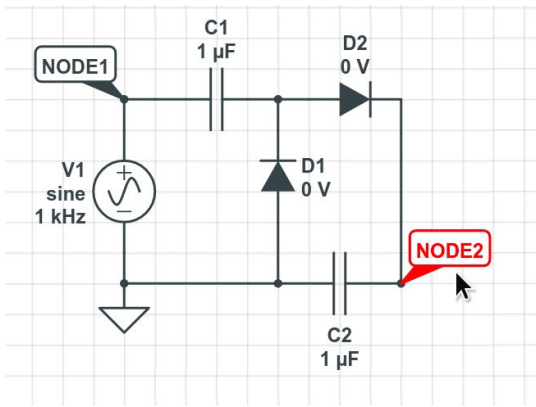

Click and drag wires from the component terminals to wire up the circuit:
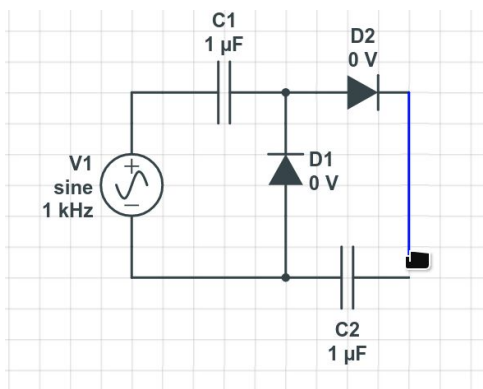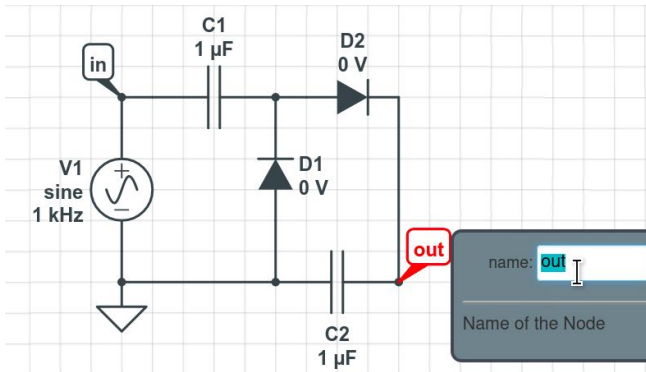

Press G and click to insert a ground node at the bottom of the function generator:
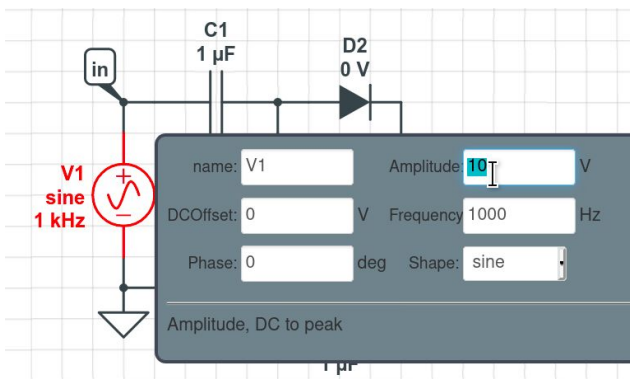

Press N and click to insert a named node at the top of the function generator (using R to rotate), and do so again for another node at the bottom right:
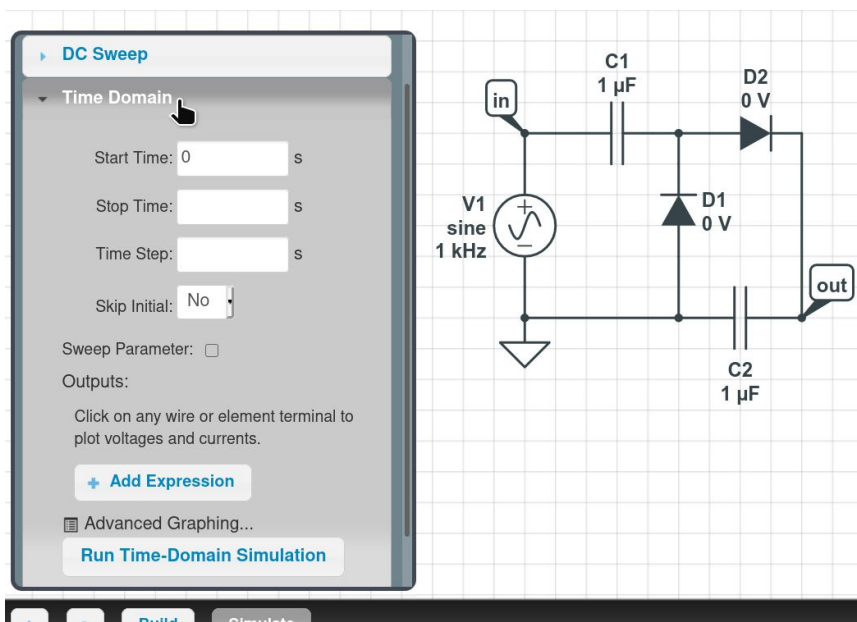
Double-click the named nodes and name one "in" and the other "out":

Double-click the function generator V1 and change its Amplitude to 10 volts:
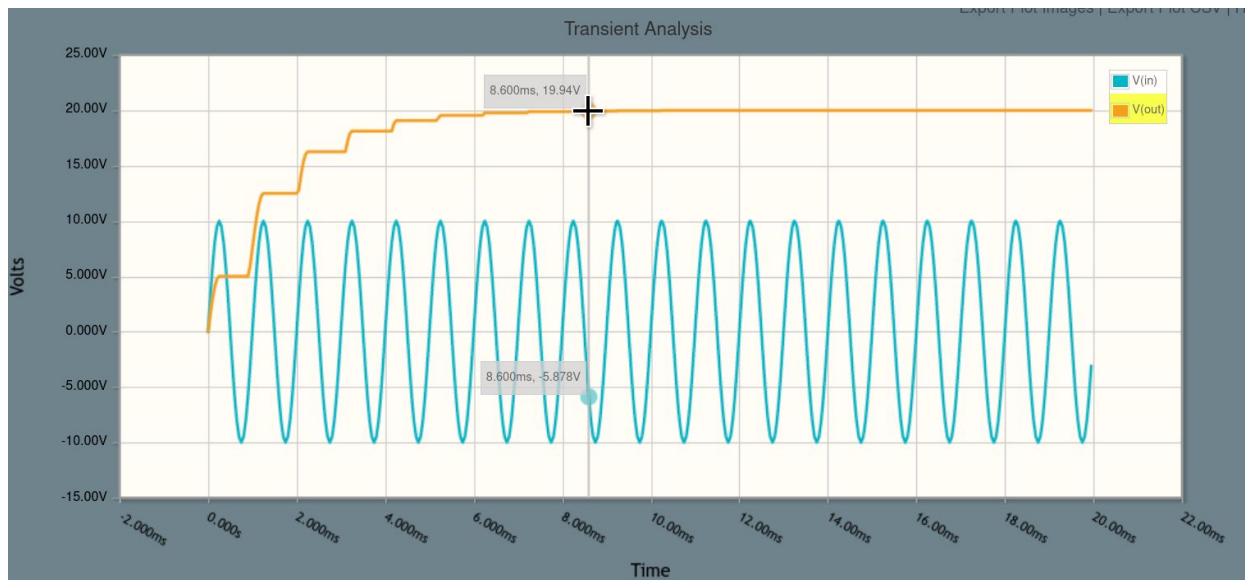

We're done building the circuit! Click Simulate at the bottom of the window, then click Time Domain:

Enter "20m" for Stop Time and "50u" for Time Step. Then, click on the two node labels to add V(in) and V(out) to the

Outputs list:

Click Run Time-Domain Simulation and a plot window appears:

It works! After a few cycles, the output voltage is about 20 V, even though the input is only 10 V in amplitude.

What happens if we connect a load to the output?

Press / (forward slash) to begin a toolbox search, and type "10k" to quickly create a 10k resistor. Click and drag this resistor to the schematic:

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Press G and click to insert a ground node at one end of the resistor. Click and drag a wire to connect the other end of the resistor to the output node:
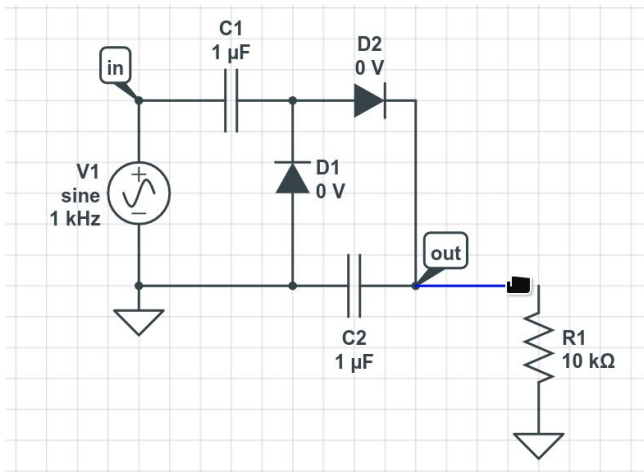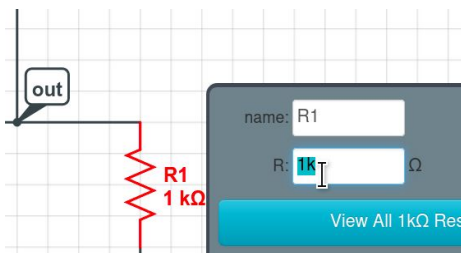

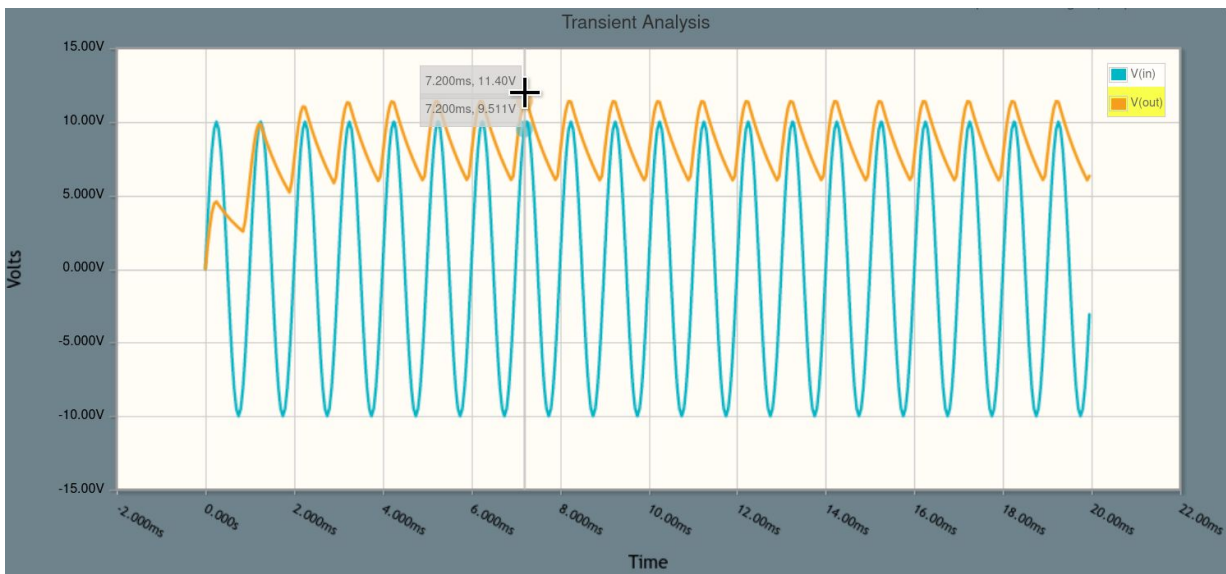Press F5 to repeat the simulation. A plot window appears:
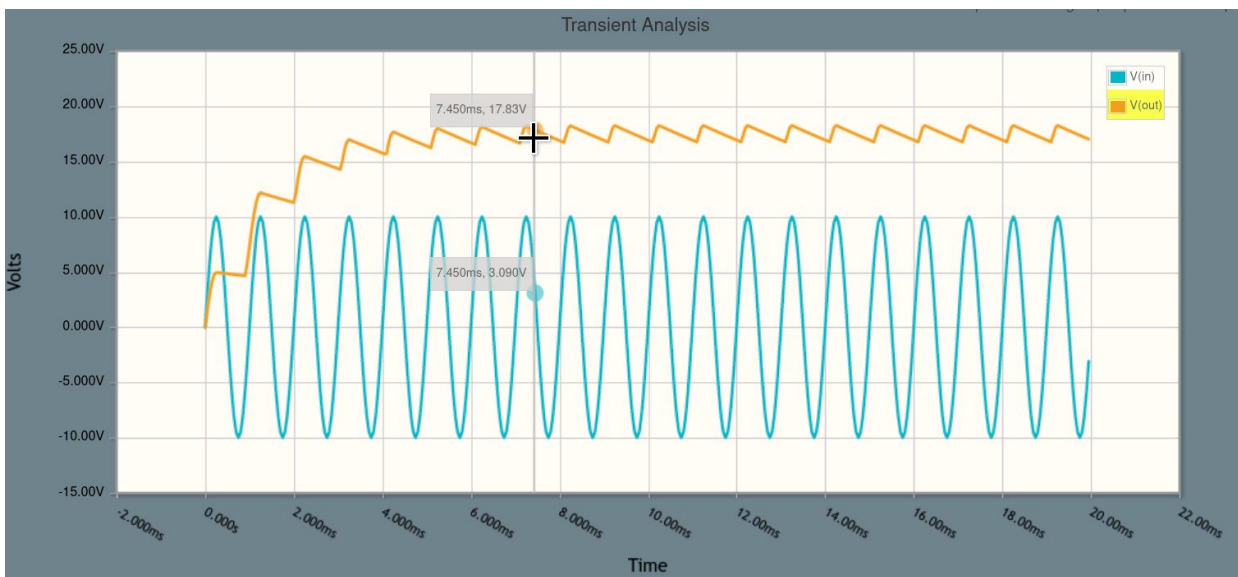
Now, we see some ripple as the load resistor is discharging the stored charge. What if we load it even more?

Click Build at the bottom of the window, then double-click R1 and change its resistance to "1k":
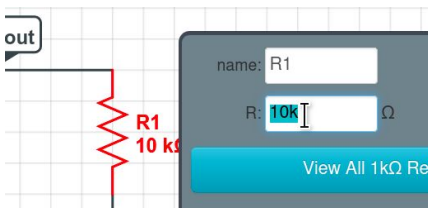

Press F5 to repeat the simulation:

This time the voltage doesn't even get very high, peaking at just over 11 volts! That's because our load resistance is draining the stored charge too fast.

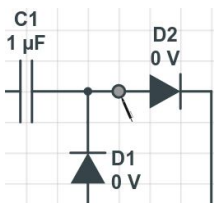Go back to Build mode and double-click to change R1 back to 10k:

Now, let's look at the currents through our two diodes so we can try to understand what's going on in this circuit.
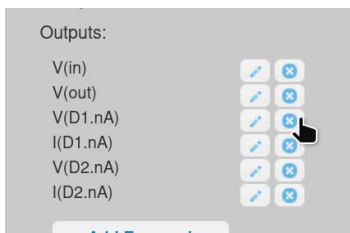
Go back to Simulate mode and hover over the anode of D1. When a grey circle appears, click it:
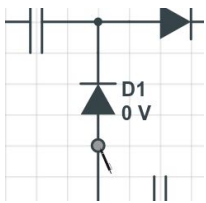
Do the same over the anode of D2, clicking the grey circle indicating the component's anode terminal:

This has added a few items to our Outputs list:

Delete the unnecessary items, V(D1.nA) and V(D2.nA) but leave the two diode currents I(D1.nA) and I(D2.nA):
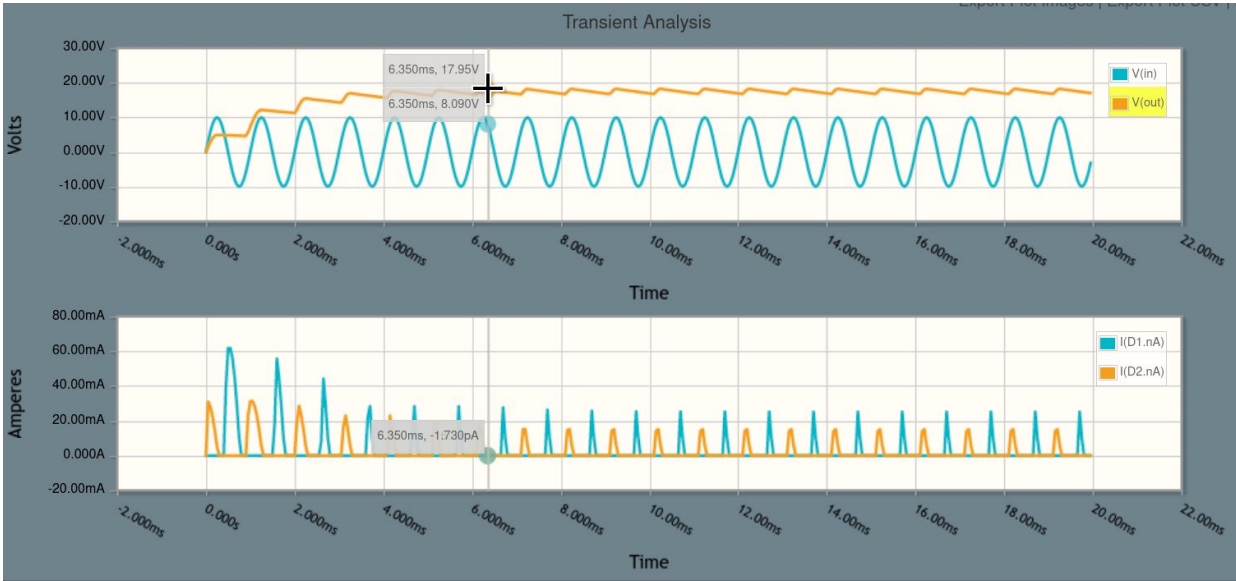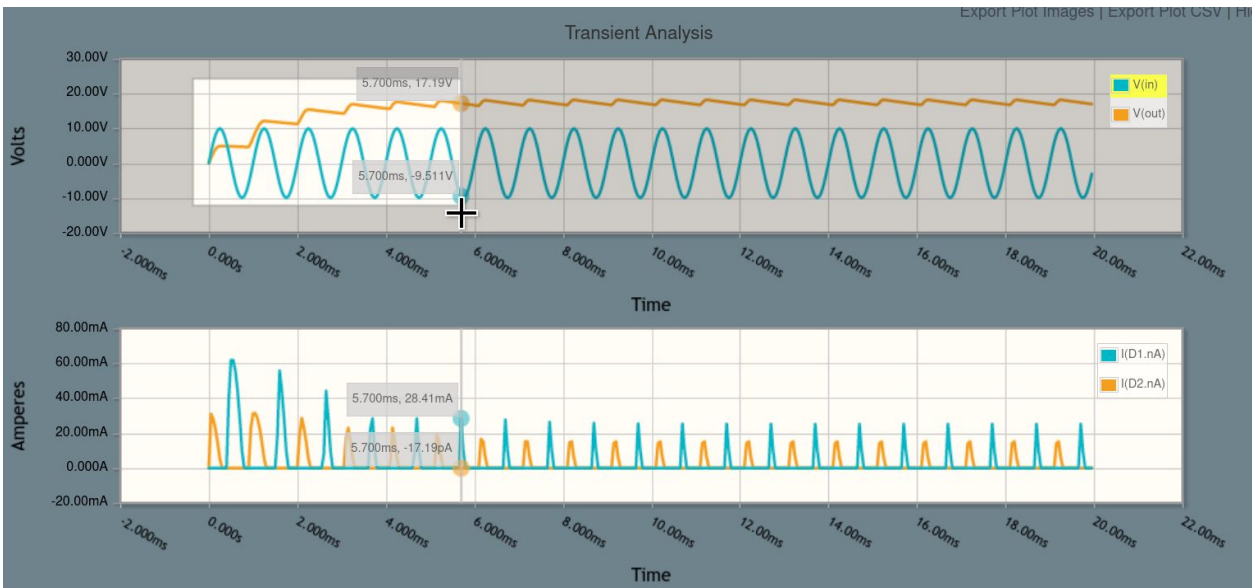
Outputs:
V(in)
V(out)
I(D1.nA)
I(D2.nA)

+ Add Expression
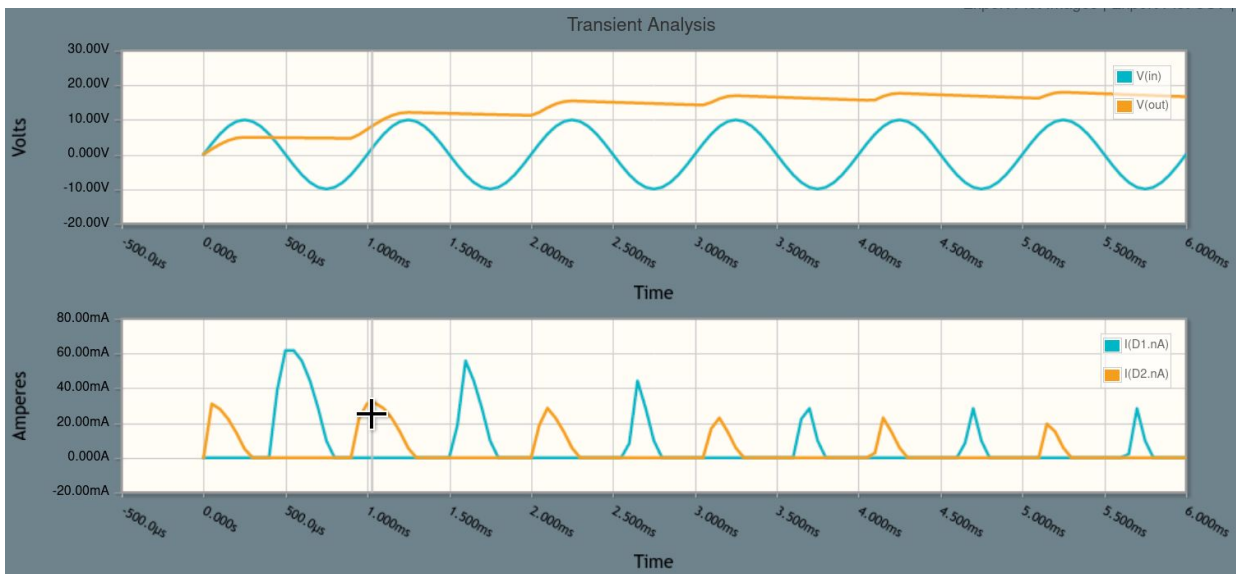
Advanced Graphing...

Click Run Time-Domain Simulation and a new plot window appears:

We can drag to zoom on the plot to just look at the first few cycles:

When you zoom on one plot, the other one also updates the shared time x-axis:
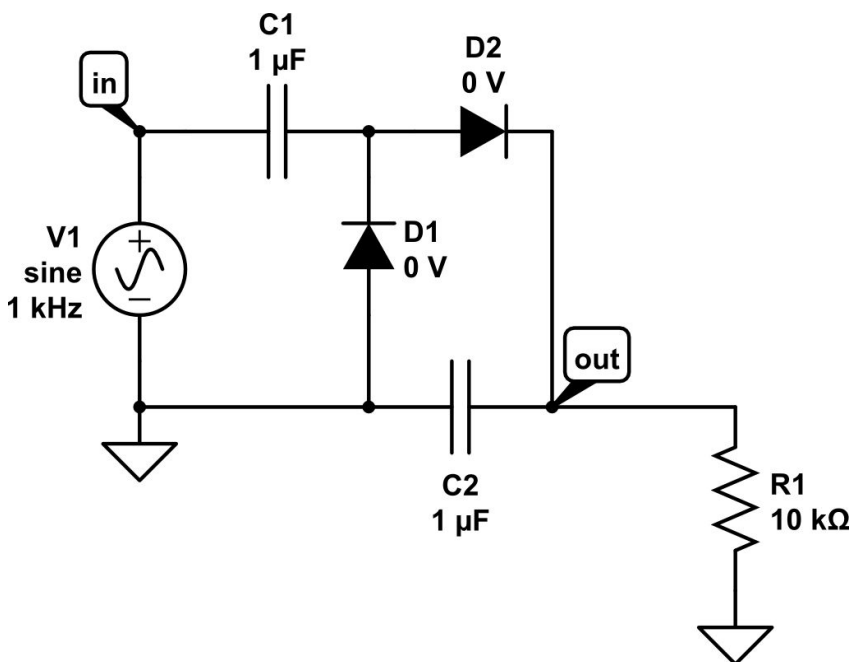
It basically looks like when V(in) swings negative, current flows through D1, which charges up capacitor C1.

When V(in) goes positive, current flows through D2, as capacitor C1 (boosted by the rising input voltage) discharges to fill C2.

That's it! A few ideas: you can extend this configuration with more stages to get more voltage amplification, or try it with real PN junction diodes instead of ideal diodes, or try driving it with a square wave instead of a sine wave.

Click below to open the final circuit , or try it yourself from scratch (recommended).

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