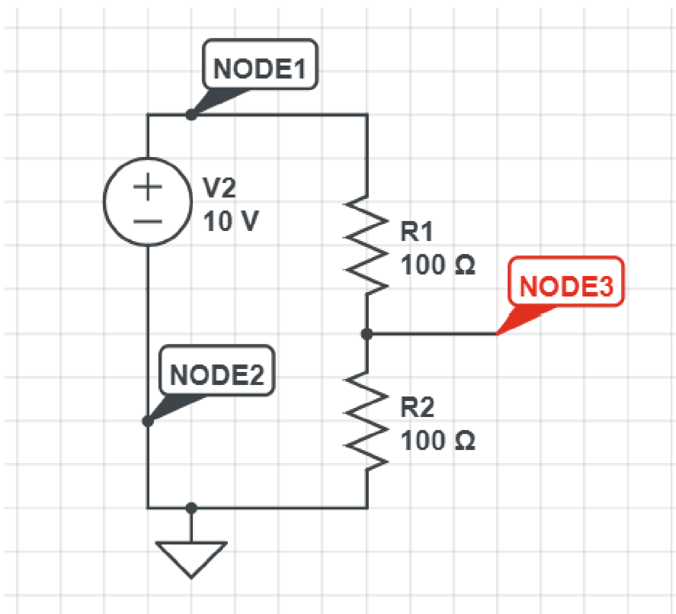
1. Resistors in series

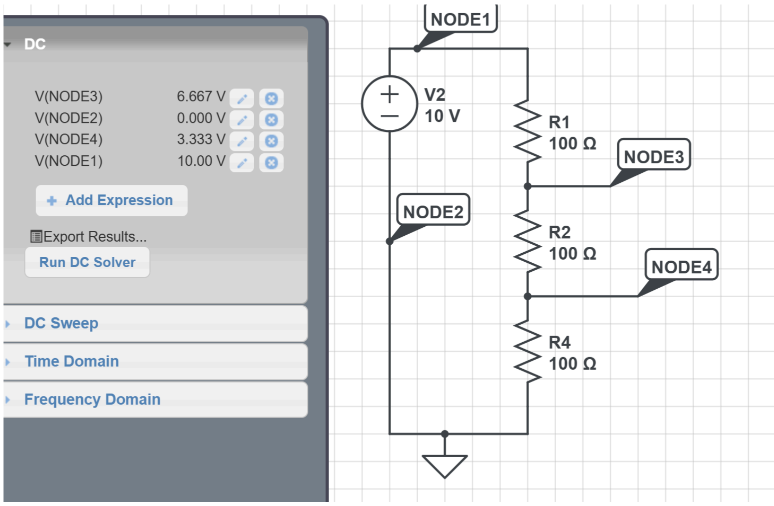
a. Build a circuit with a 10V voltage source and two resistors in series
b. Define nodes on either side of the voltage source and in between the resistors
c. Examine the voltage values at each node and the current for the system



Node 1: V = 10V
Node 3: V= 5 V
Node 2: V=0 V

Since it is one closed loop, current is 50 mA throughout the circuit

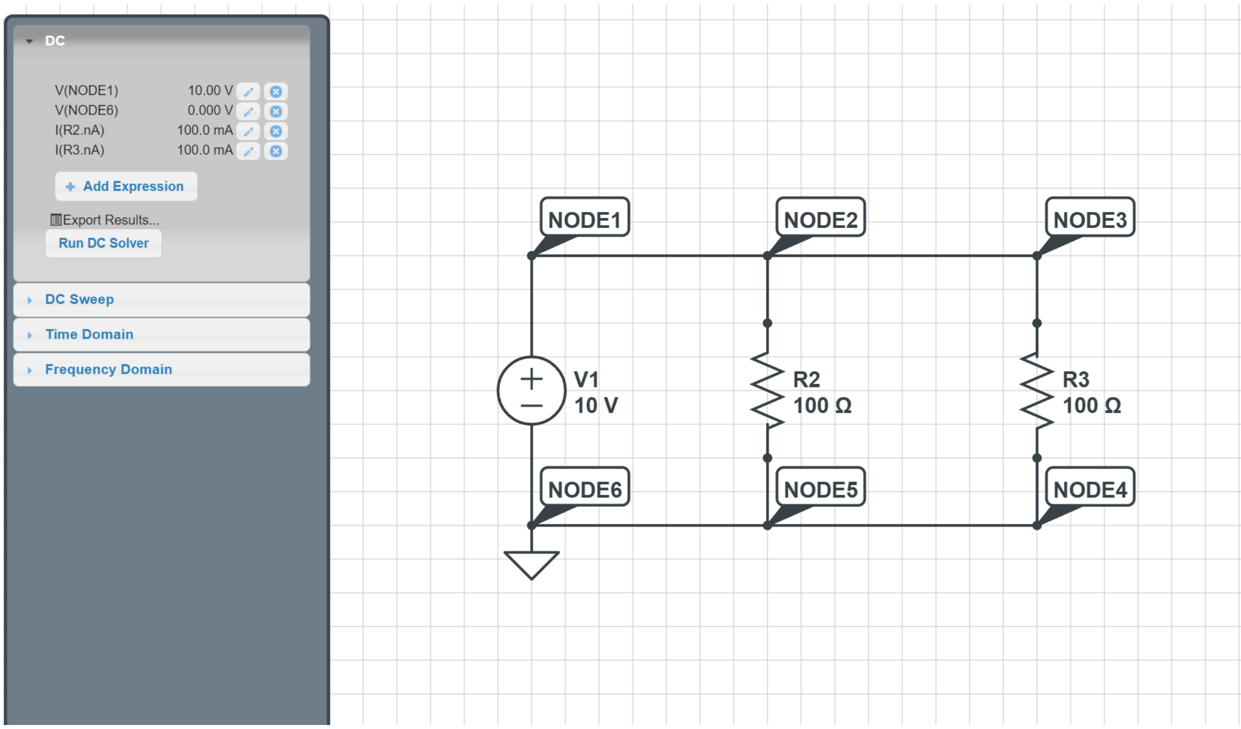
d. Add a third resistor and an additional node and make note of how this changes the voltage at each node and the current in the system.



This means that after the first resistor the voltage drops by ⅓ instead of ½
It is still one loop, but this time the current drops to 33 mA (since Req increases)

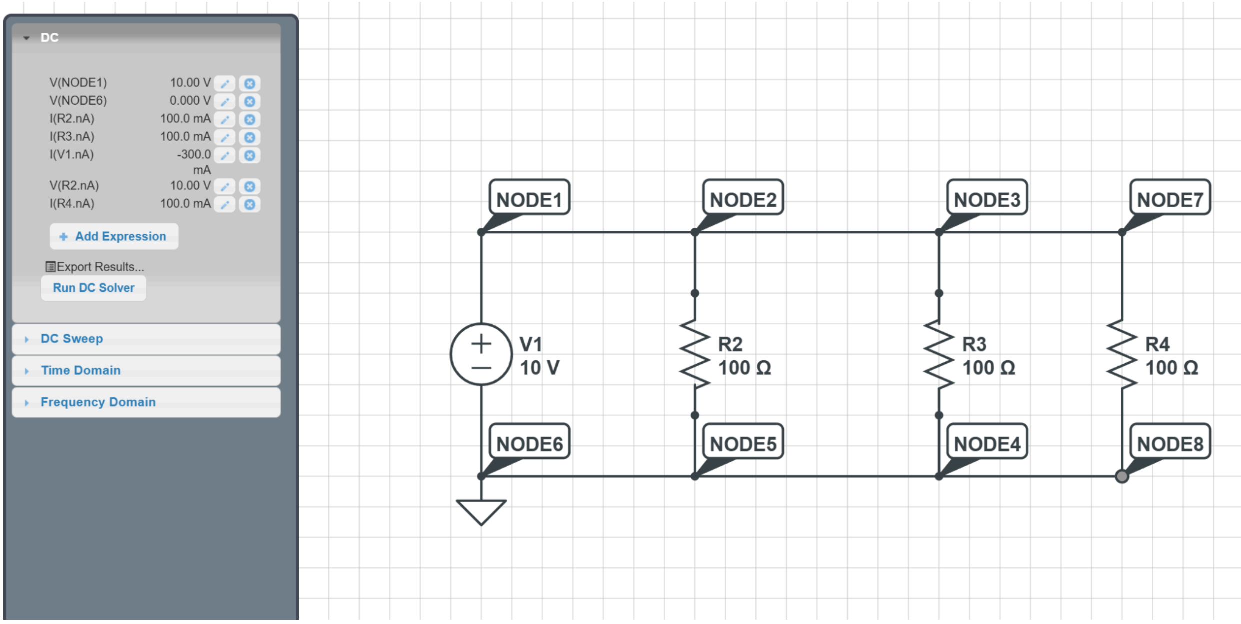
2. Resistors in parallel

a. Build a circuit with a 10V voltage source and two resistors in parallel
b. Define nodes on either side of the voltage source and each resistor
c. Examine the voltage values at each node and the current across the voltage source and each resistor



The total current is the sum of the current going through each resistor.
The voltage is the same before each resistor

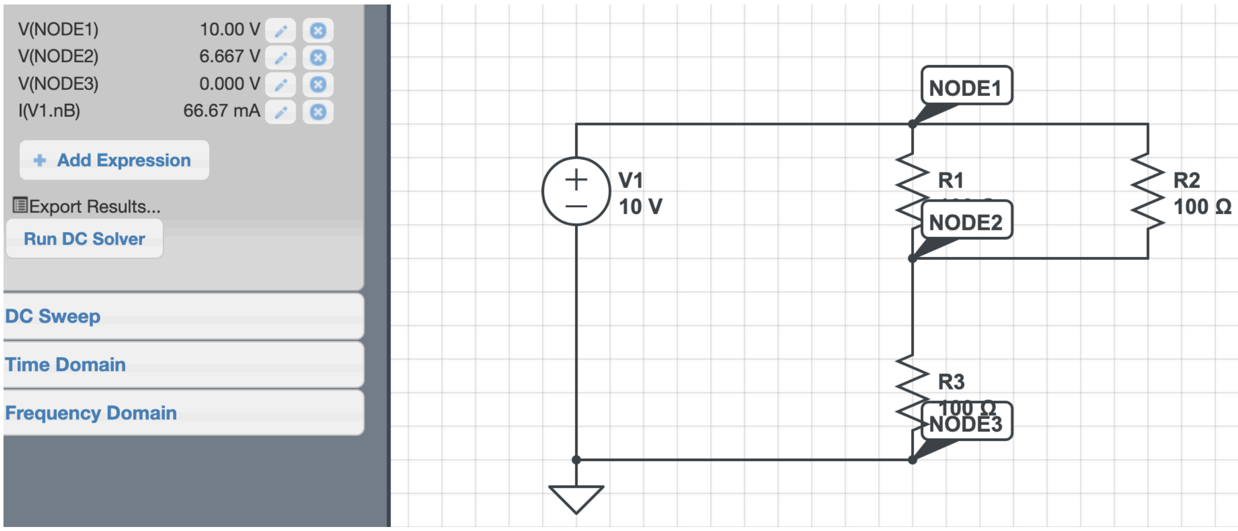
d. Add a third resistor in parallel and additional nodes. Make note of how this changes the voltage at each
node and the current across each resistor.



The voltage across each resistor is still 10V since it is in parallel, and since each resistor is 100**Ω**, so each one has 100mA, meaning that the total current increases to 300mA

3. Resistors in series and parallel

a. Build a circuit with a 10V voltage source with two resistors in parallel and a third resistor in series – the third resistor is in series with each parallel resistor in a single loop.
b. Define nodes on either side of the voltage source and across each of the resistors
c. Examine the voltage value at each node and the current across the voltage source and each resistor.
*Make note of how this compares to either the case of resistors only in parallel or only in series.



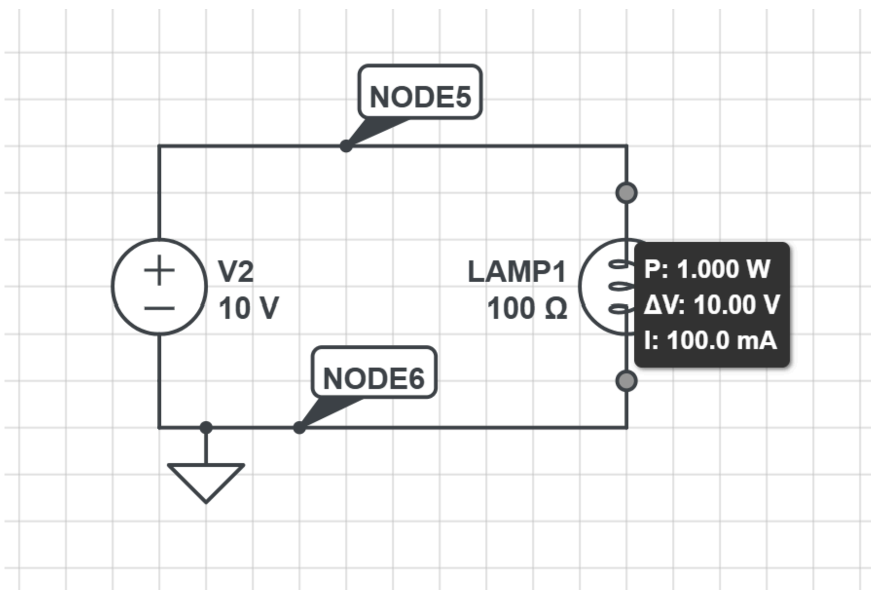
This circuit can be thought of as two resistors in series: one made up of two in parallel (That acts as a single 50 Ohm resistor, recall for parallel 1/Req = 1/R1 + 1/R2) followed by a 100 Ohm in series. Then ⅓ of the total voltage is lost across the first resistor and ⅔ across the second.

4. Powering light bulbs

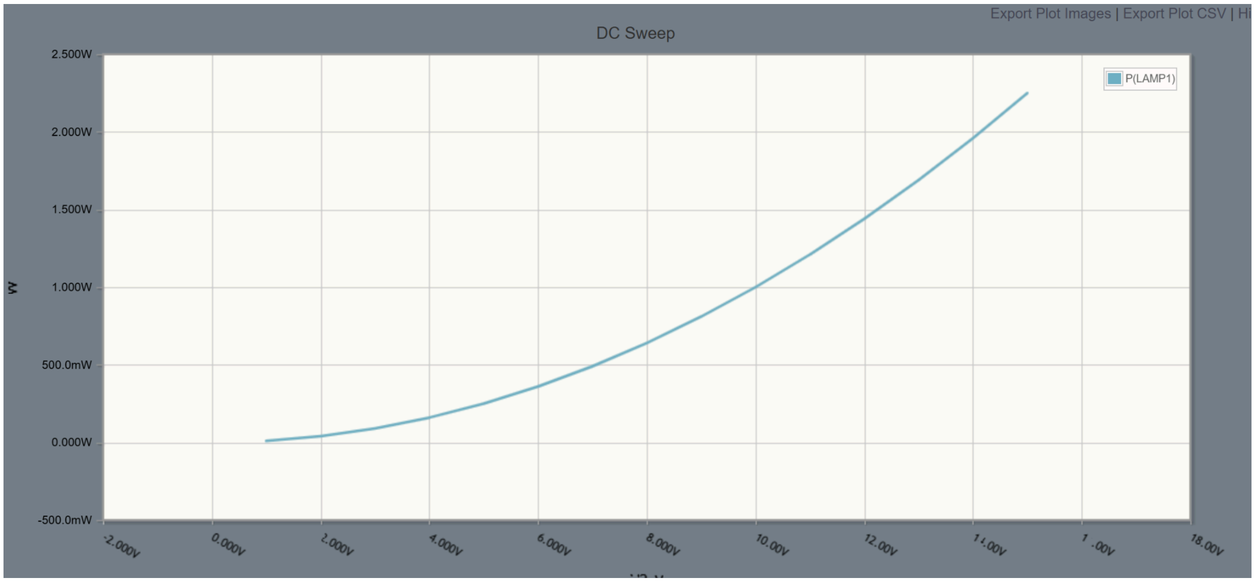
a. Build a circuit with a 10V voltage source with a single 100Ohm lightbulb connected. What will the power output be for this lightbulb?

P = I* V
V = I*R
P = V^2/R= 100* V^2/(100 * Ohm) = 1W

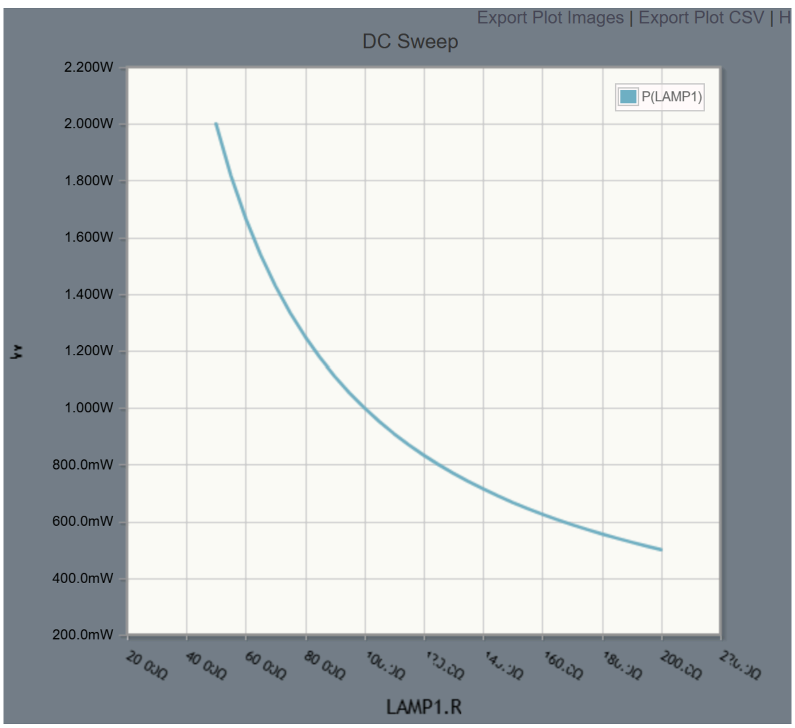
b. Use the simulation DC solver to evaluate the lightbulb power and check your answer.



c. Use the DC sweep simulation tool to examine how the lightbulb power varies with the voltage of the battery (voltage source) and how it varies with the internal resistance of the lightbulb.



Power increases when the voltage increases, as squared.

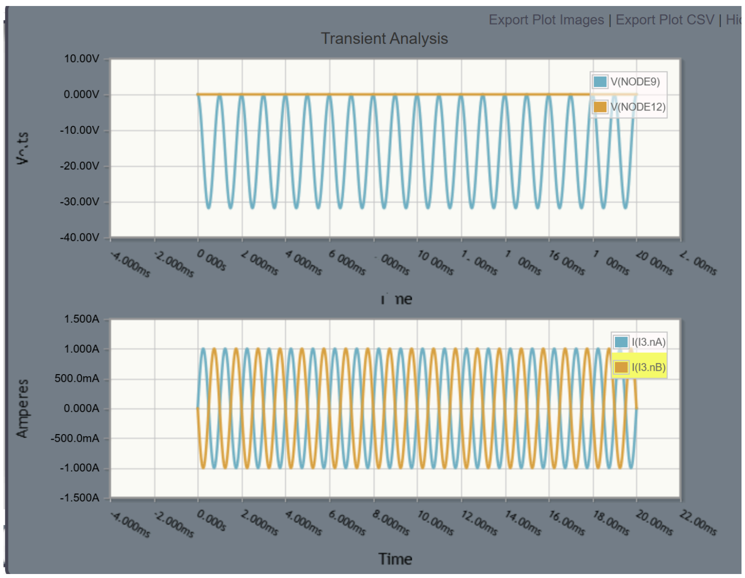


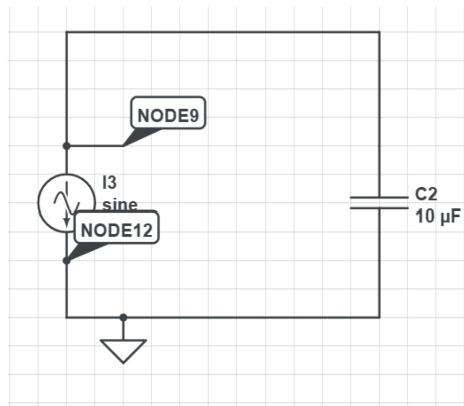
As the resistance increases, the power out decreases as 1/R.

5. Capacitor circuit

a. Build a circuit with a 10uF capacitor connected to a varying 1kHz current source (try both sine and step sources).

b. Use the time sweep simulation tool to examine how the voltage and current in the system varies over time. Try a few values for the capacitor.



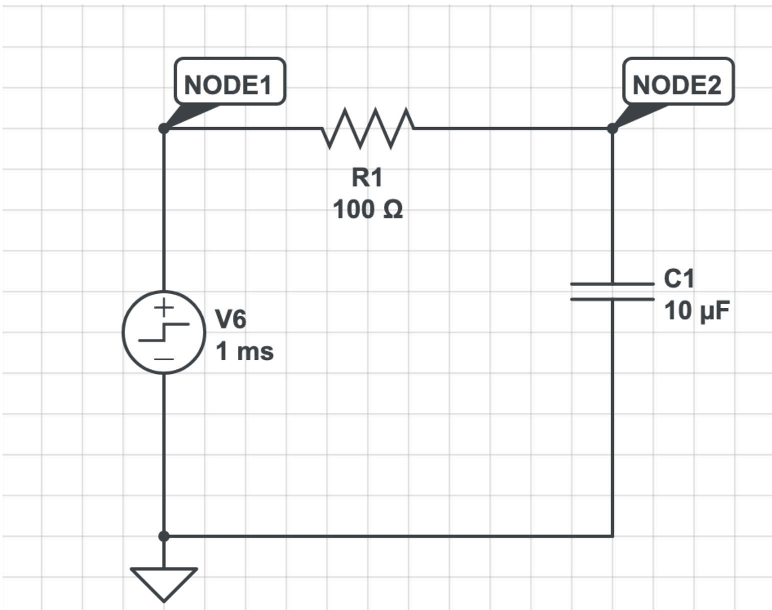


The current doesn't change as the capacitor changes. However the voltage, while maintaining the same shape (1uF is 300V, 100uF is 3V). Can see how as you increase the capacitance, the voltage decreases.

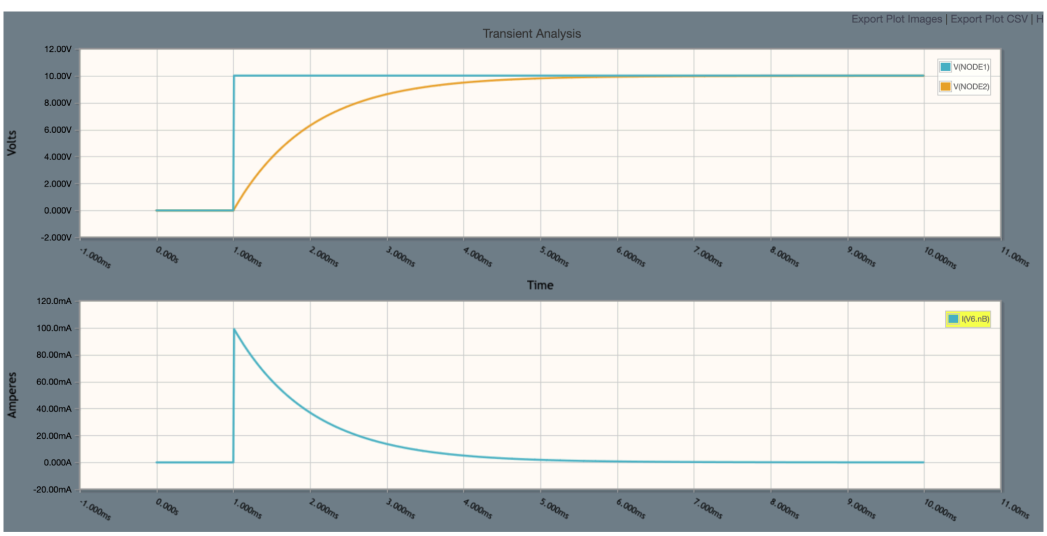
Voltage across the capacitor stays the same, currents alternating.

6. RC circuit

a. Build a simple RC circuit with a step function voltage supply, a 100 Ohm resistor and 10uF capacitor. Add voltage in and out nodes on either side of the resistor.
b. Use the time domain simulator to examine how the voltage and current change over time.
c. Explore how the time dependence of the system changes as you vary the resistance and capacitance in
the system.



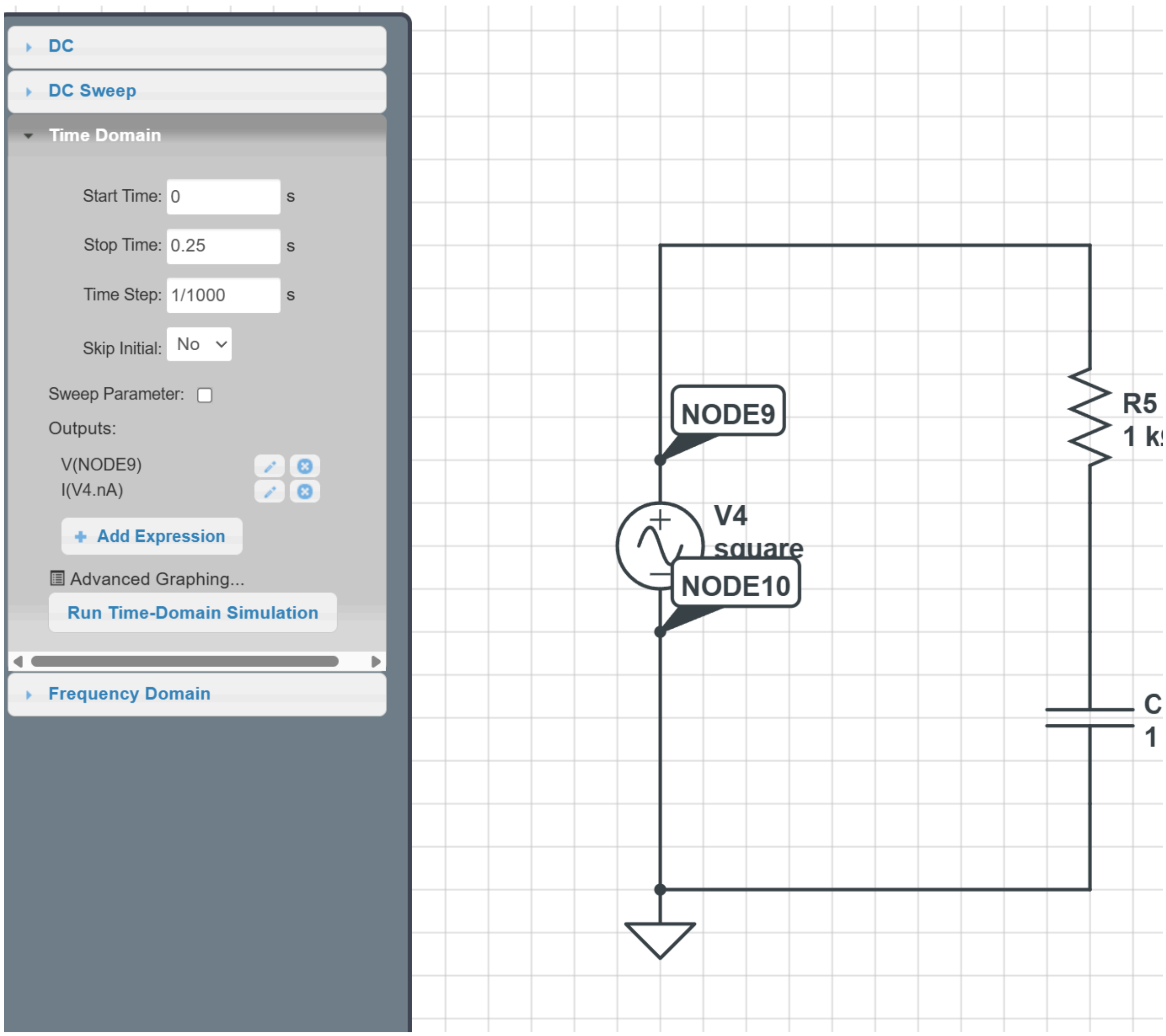
Standard:



Increased capacitance → increased length of time necessary to plot the graph.
Increased Resistance → the time necessary for the second node to reach 10v increases as resistance increases.

7. RC filter

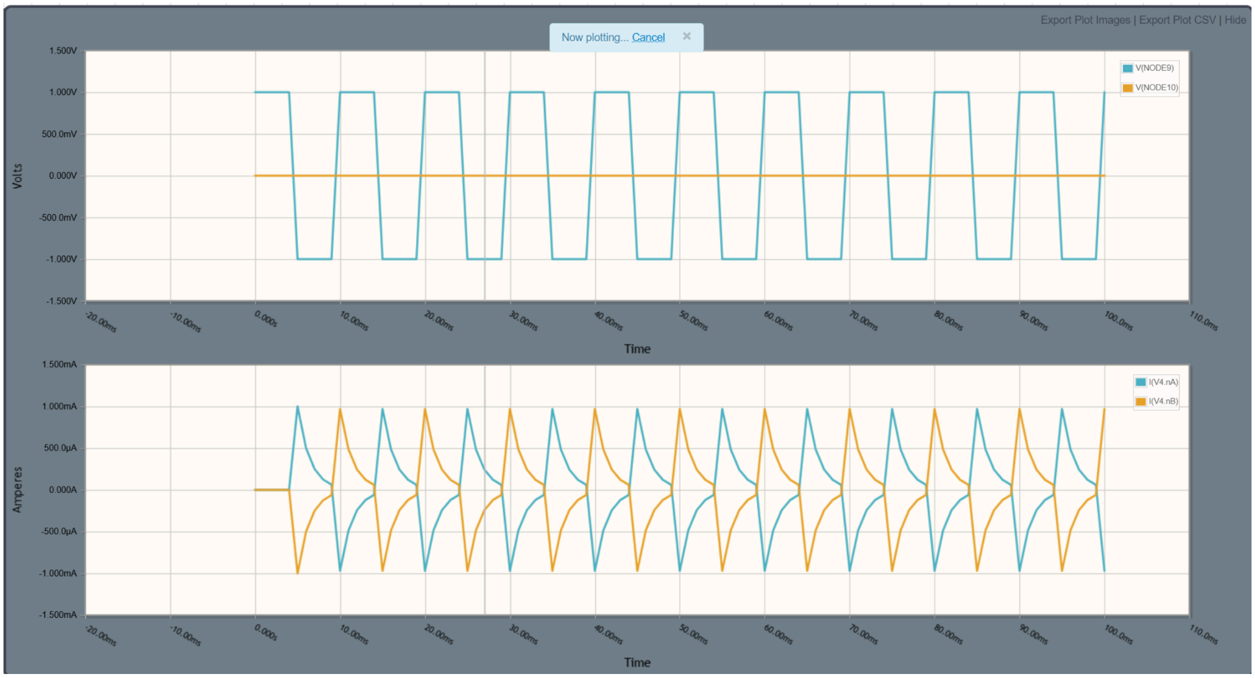
a. Build a circuit with an oscillating square wave (this is a parameter you can set) voltage supply, initially
with a 100 Hz frequency. Include a 1kO resistor and a 1uF capacitor. Add nodes to examine the input
and output voltage.



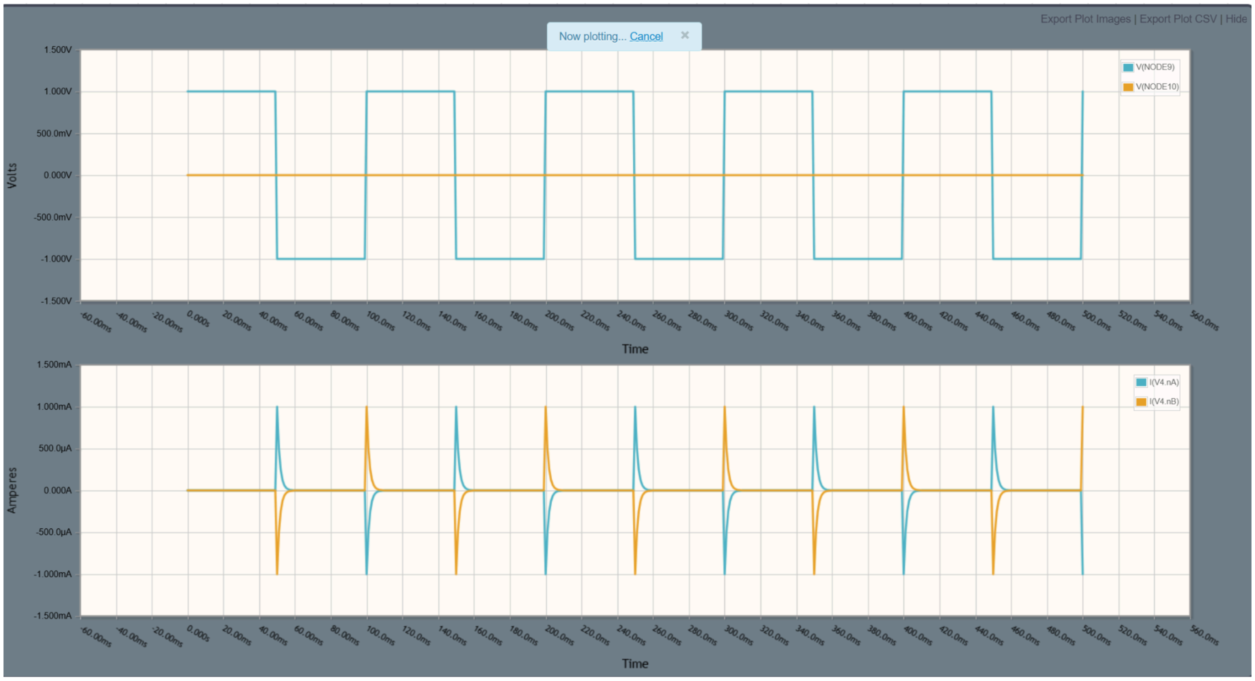
b. Use the time domain simulator to examine how changes to the resistance (and/or capacitance) effects
the output voltage. Try out different input voltage frequencies.

The capacitor charges in one direction then as the voltage switches charges in the other direction. Since current relies on the charge in the capacitor it will decrease exponentially as it gets charged. When the voltage switches to the other direction, the current is at a maximum again as it discharges, then again decreases exponentially until the capacitor is charged.

With the given values:

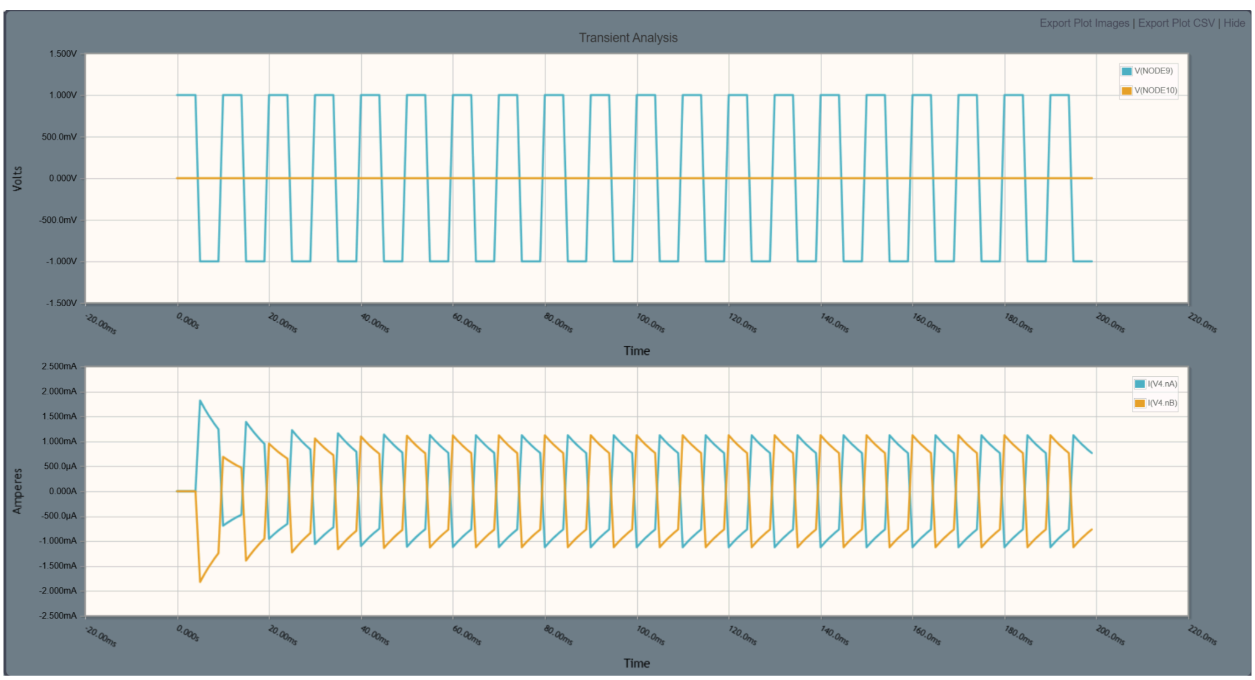


Decreasing the frequency spreads out the peaks:



This means that the capacitor has time to fully charge, so instead of dropping to near zero the current goes to zero and stays there a while before the voltage switches sign

Increasing the capacitance to 10 μF:



Since the capacitance is greater, the capacitor does not have time to fully charge or discharge before the voltage switches, meaning that the waves seen earlier are cut short and blend into one another.