PHY 240: Basic Electronics
Homework Problem H9

October 17, 2024

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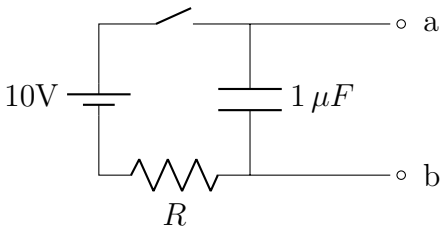


1. **Charge Bucket.**

   (a) Consider the circuit above, in which the capacitor is initially uncharged. In this configuration, and with the output taken between terminals a and b, would you consider this a "high-pass circuit" or a "low-pass circuit"?

   (b) Suppose that we choose a 2 kΩ resistor for R. If we close the switch at time $t = 0$, sketch the voltage between terminals a and b, V_{ab}, for the time interval -1 ms $\leq t \leq$ 2 ms. Make your sketch quantitative, labeling relevant voltages and times.

   (c) Suppose that we now discharge the capacitor completely, replace the 2 kΩ resistor that we used for R with a 200 Ω resistor, and again close the switch at time t = 0. Sketch the voltage that we now see between terminals a and b, Vab, for the time interval -1 ms $\leq t \leq$ 2 ms. Make your sketch quantitative, labeling relevant voltages and times.

   (d) Explain clearly how the generic behavior that you sketched in parts (b) and (c) justifies the name that you gave in part (a).

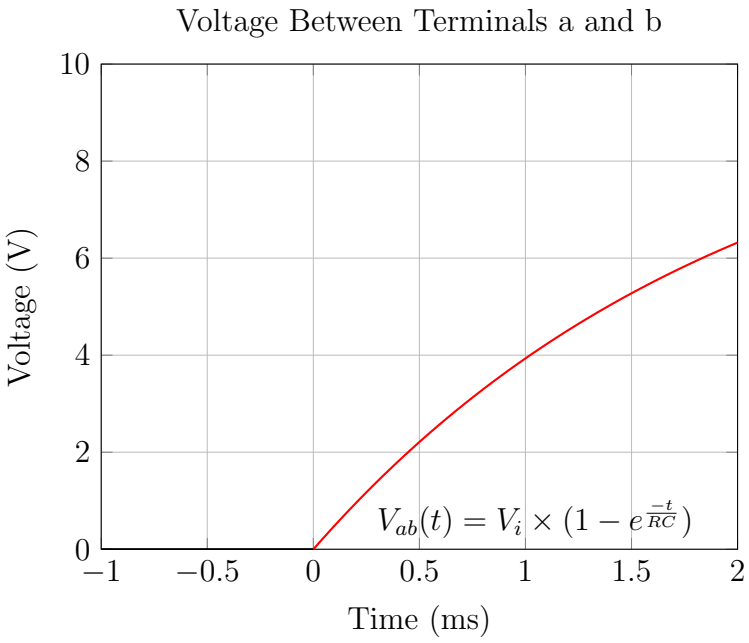
Solution:

(a) I believe that this is a high pass filter because the low frequencies get consumed by the high impedance of the capacitor before returning to ground through the resistor.
Note: I now know I was wrong, I'm keeping my original answer here though.

(b) With,

$$R = 2000\,\Omega$$

$$C = 0.000001 \text{ F}$$



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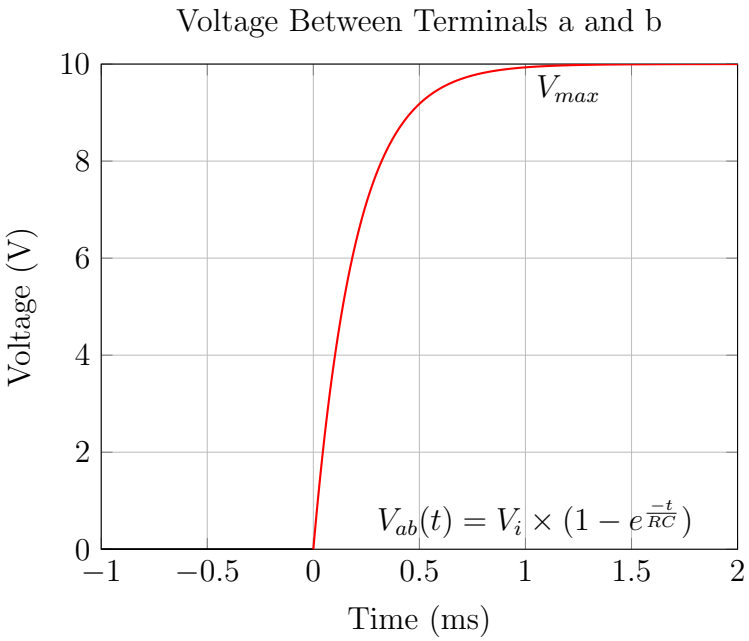

(d) After graphing the voltage over time for this circuit, this circuit would actually appear to be a low pass filter instead! It appears that voltages applied over a very tiny time span (1 ms or so) are mostly ignored. We can change the value of the resistor in order to adjust the band of frequencies we allow through on the high side, where higher resistor values will cut off more high frequencies, and lower resistor values will allow more high frequencies.