The op-amp is ideal, with $V_{CC} = 10\, \text{V}$ and $V_{EE} = -10\, \text{V}$.

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
- What is $V_o$ at $t = 4.1\, \text{ms}$?

All voltages in $\text{V}$

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  
  Waveform at $V_+$ is an decreasing exponential, starting at $V_+ = 0.56 - 0.22 = 0.34$
  
  $\Delta t = 4.1 - 1.1 = 3$
  
  $\tau = RC = 21.5 \times 39.5 = 849.25\, \text{ms} = 0.85\, \text{ms}$
  
  $V_+(4.1) = 0.34e^{-\Delta t/\tau} = 0.0100$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  
  From $V_+$ to $V_o$ is a non-inverting amplifier of gain, $G = 1 + 61/36 = 2.69$
  
  Waveform at $V_o$ is an decreasing exponential, starting at $V_+ = 2.69 \times 0.34 = 0.91$
  
- What is $V_o$ at $t = 4.1\, \text{ms}$?
  
  $V_+(4.1) = 0.91e^{-\Delta t/\tau} = 0.027$
The op-amp is ideal, with $V_{CC} = 10$ V and $V_{EE} = -10$ V.

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
- What is $V_o$ at $t = 4.7$ ms?

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All voltages in mV

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  
  $V_+ = \frac{4.6}{4.6 + 21.5}V_i = 0.176V_i$
  
  Thus, output goes from $V_+ = 0.176 \times 20.61 = 3.63$ to $V_+ = 0.176 \times 60.56 = 10.66$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)

  \[
  G = G = 1 + \frac{1800 \parallel 1800}{31} = 30.03
  \]
  
  Thus, output goes from $V_o = 0.176 \times 20.61 \times G = 108.9$ to $V_o = 0.176 \times 60.56 \times G = 320.1$

- What is $V_o$ at $t = 4.7$ ms?

  $V_o = 0.176 \times 60.56 \times G = 320.1$
The op-amp is ideal, with $V_{CC} = 15 \text{ V}$ and $V_{EE} = -15 \text{ V}$.
Input $V_A = -3 \text{ mV}$ (constant over time).

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
- What is $V_o$ at $t = 4.7 \text{ ms}$?

All voltages in mV

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  This is an added circuit

$$V_o = - \left( \frac{1500}{3.2} V_A + \frac{1500}{36} V_B \right) = - (468.8 V_A + 41.7 V_B)$$

Thus, the output goes from

$V_o = -[468.8(-3) + 41.7(24)] = 406 = 0.41 \text{ V}$ to
$V_o = -[468.8(-3) + 41.7(18)] = 656 = 0.66 \text{ V}$

Test: Is $V_o \geq V_{CC}$ or $V_o \leq V_{EE}$?

- What is $V_o$ at $t = 4.7 \text{ ms}$?
  $V_o = -(468.8(-3) + 41.7(18)) = 656 = 0.66 \text{ V}$