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 $t = 3.6\, \text{ms}$?

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All voltages in V

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  
  Waveform at $V_+$ is an decreasing exponential, starting at $V_+ = 0.78 - 0.14 = 0.64$
  
  $\Delta t = 3.6 - 1.3 = 2.3$
  
  $\tau = RC = 25.1 \times 21.8 = 547.18\, \mu\text{s} = 0.55\, \text{ms}$
  
  $V_+(3.6) = 0.64e^{-\Delta t/\tau} = 0.0098$

- 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, $G = 1 + 79/30 = 3.63$
  
  Waveform at $V_o$ is an decreasing exponential, starting at $V_+ = 3.63 \times 0.64 = 2.32$

- What is $V_o$ at $t = 3.6\, \text{ms}$?
  
  $V_+(3.6) = 2.32e^{-\Delta t/\tau} = 0.035$
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 $t = 4.1$ ms?

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All voltages in mV

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  $V_+$ is the voltage-divider output from $V_i$.
  $V_+ = [5.9/(5.9 + 25.1)] V_o = 0.190V_o$
  Thus, output goes from $V_+ = 0.190 \times 22.83 = 4.34$ to $V_+ = 0.190 \times 61.15 = 11.62$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  Gain, $G = G = 1 + (1500||1500)/27 = 28.78$
  Thus, output goes from $V_o = 0.190 \times 22.83 \times G = 124.8$ to $V_o = 0.190 \times 61.15 \times G = 334.4$

- What is $V_o$ at $t = 4.1$ ms?
  $V_o = 0.190 \times 61.15 \times G = 334.4$
The op-amp is ideal, with $V_{CC} = 15\,\text{V}$ and $V_{EE} = -15\,\text{V}$.

Input $V_A = -5\,\text{mV}$ (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 $t = 4.1\,\text{ms}$?

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

  $$V_o = -\left(\frac{2000}{3.8}V_A + \frac{2000}{30}V_B\right) = -(526.3V_A + 66.7V_B)$$

  Thus, the output goes from

  $V_o = -[526.3(-5) + 66.7(16)] = 1564 = 1.56\,\text{V}$ to

  $V_o = -[526.3(-5) + 66.7(40)] = -36 = -0.04\,\text{V}$

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

- What is $V_o$ at $t = 4.1\,\text{ms}$?

  $V_o = -(526.3(-5) + 66.7(40)) = -36 = -0.04\,\text{V}$