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

![Circuit Diagram]

- 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 $t = 3.8$ ms?

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 $V_+ = 0.83 - 0.34 = 0.49$
  
  $\Delta t = 3.8 - 1.1 = 2.7$
  
  $\tau = RC = 38.8 \times 31.4 = 1218.32 \mu s = 1.22$ ms
  
  $V_+(3.8) = 0.49e^{-\Delta t/\tau} = 0.0536$

- 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, $G = 1 + 67/37 = 2.81$
  
  Waveform at $V_o$ is an decreasing exponential, starting at $V_+ = 2.81 \times 0.49 = 1.38$

- What is $V_o$ at $t = 3.8$ ms?
  
  $V_+(3.8) = 1.38e^{-\Delta t/\tau} = 0.151$
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** \( t = 4.2 \, \text{ms} \)?

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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 \( V_i \).
  
  \[
  V_+ = \frac{5.0}{(5.0 + 38.8)} V_o = 0.114V_o
  \]
  
  Thus, output goes from \( V_+ = 0.114 \times 23.33 = 2.66 \) to \( V_+ = 0.114 \times 60.34 = 6.88 \)

- **Sketch the output** \( V_o \) **as** a function of the voltage input \( V_i \). (label times and voltages)
  
  **Gain**, \( G = G = 1 + \frac{(1900\parallel1900)}{37} = 26.68 \)
  
  Thus, output goes from \( V_o = 0.114 \times 23.33 \times G = 71.0 \) to \( V_o = 0.114 \times 60.34 \times G = 183.5 \)

- **What is** \( V_o \) **at** \( t = 4.2 \, \text{ms} \)?
  
  \[
  V_o = 0.114 \times 60.34 \times G = 183.5
  \]
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 $t = 4.2\, \text{ms}$?

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

\[
V_o = -\left(\frac{1700}{5.8} V_A + \frac{1700}{37} V_B\right) = -(293.1V_A + 45.9V_B)
\]

Thus, the output goes from

$V_o = -[293.1(-3) + 45.9(36)] = -773 = -0.77\, \text{V}$ to

$V_o = -[293.1(-3) + 45.9(45)] = -1186 = -1.19\, \text{V}$

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

- What is $V_o$ at $t = 4.2\, \text{ms}$?

$V_o = -(293.1(-3) + 45.9(45)) = -1186 = -1.19\, \text{V}$