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

![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 $t = 3.7\, \text{ms}$?

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 $V_+ = 0.77 - 0.02 = 0.75$
  
  $\Delta t = 3.7 - 1.0 = 2.7$
  
  $\tau = RC = 21.2 \times 23.0 = 487.6\, \mu\text{s} = 0.49\, \text{ms}$
  
  $V_+(3.7) = 0.75e^{-\Delta t/\tau} = 0.0030$

- 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, $G = 1 + 48/36 = 2.33$
  
  Waveform at $V_o$ is an decreasing exponential, starting at $V_+ = 2.33 \times 0.75 = 1.75$

- What is $V_o$ at $t = 3.7\, \text{ms}$?
  
  $V_+(3.7) = 1.75e^{-\Delta t/\tau} = 0.007$
The op-amp is ideal, with $V_{CC} = 10$ V and $V_{EE} = -10$ V.

\[ V_{i}(\text{mV}) \]
\[ 22.69 \]
\[ 60.16 \]
\[ 1.7 \quad 4.2 \quad \text{ms} \]

- 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 $t = 4$ ms?

All voltages in mV

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  
  $V_+$ is the voltage-divider output from $V_i$.
  
  \[ V_+ = \left[\frac{3.6}{(3.6 + 21.2)}\right] V_o = 0.145V_o \]
  
  Thus, output goes from $V_+ = 0.145 \times 22.69 = 3.29$ to $V_+ = 0.145 \times 60.16 = 8.72$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  
  Gain, $G = G = 1 + \frac{(1800\parallel1800)}{21} = 43.86$
  
  Thus, output goes from $V_o = 0.145 \times 22.69 \times G = 144.3$ to $V_o = 0.145 \times 60.16 \times G = 382.6$

- What is $V_o$ at $t = 4$ ms?
  
  $V_o = 0.145 \times 60.16 \times G = 382.6$
The op-amp is ideal, with $V_{CC} = 15$ V and $V_{EE} = -15$ V. Input $V_A = -2$ 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 $t = 4$ 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

  $$V_o = -\left(\frac{1200}{3.2} V_A + \frac{1200}{36} V_B\right) = -(375.0 V_A + 33.3 V_B)$$

  Thus, the output goes from
  
  $V_o = \left[-375.0(-2) + 33.3(4)\right] = 617 = 0.62$ V to
  
  $V_o = \left[-375.0(-2) + 33.3(39)\right] = -549 = -0.55$ V

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

- What is $V_o$ at $t = 4$ ms?
  
  $V_o = -(375.0(-2) + 33.3(39)) = -549 = -0.55$ V