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 $t = 4.4\,\text{ms}$?

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 $V_+ = 0.72 - 0.08 = 0.64$
  $\Delta t = 4.4 - 2.0 = 2.4$
  $\tau = RC = 34.6 \times 35.6 = 1231.76\,\mu\text{s} = 1.23\,\text{ms}$
  $V_+(4.4) = 0.64e^{-\Delta t/\tau} = 0.0909$

- 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, $G = 1 + 43/37 = 2.16$
  Waveform at $V_o$ is an decreasing exponential, starting at $V_+ = 2.16 \times 0.64 = 1.38$
- What is $V_o$ at $t = 4.4\,\text{ms}$?
  $V_+(4.4) = 1.38e^{-\Delta t/\tau} = 0.196$
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 $t = 3.4\,\text{ms}$?

All voltages in mV

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  $V_+$ is the voltage-divider output from $V_i$.
  $V_+ = \left[\frac{3.2}{3.2 + 34.6}\right] V_o = 0.085 V_o$
  Thus, output goes from $V_+ = 0.085 \times 22.19 = 1.89$ to $V_+ = 0.085 \times 63.99 = 5.44$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  Gain, $G = G = 1 + \frac{(1800||1800)}{24} = 38.50$
  Thus, output goes from $V_o = 0.085 \times 22.19 \times G = 72.6$ to $V_o = 0.085 \times 63.99 \times G = 209.4$

- What is $V_o$ at $t = 3.4\,\text{ms}$?
  $V_o = 0.085 \times 63.99 \times G = 209.4$
The op-amp is ideal, with $V_{CC} = 15 \text{ V}$ and $V_{EE} = -15 \text{ V}$.
Input $V_A = -12 \text{ mV}$ (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 $t = 3.4 \text{ ms}$?

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

$$V_o = - \left( \frac{1100}{5.2} V_A + \frac{1100}{37} V_B \right) = - \left( 211.5 V_A + 29.7 V_B \right)$$

Thus, the output goes from

$V_o = -[211.5(-12) + 29.7(10)] = 2241 = 2.24 \text{ V}$ to

$V_o = -[211.5(-12) + 29.7(34)] = 1528 = 1.53 \text{ V}$

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

- What is $V_o$ at $t = 3.4 \text{ ms}$?

$$V_o = -(211.5(-12) + 29.7(34) = 1528 = 1.53 \text{ V}$$