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 $t = 4.6\,\text{ms}$?

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 $V_+ = 0.84 - 0.08 = 0.76$
  $\Delta t = 4.6 - 1.9 = 2.7$
  $\tau = RC = 32.4 \times 31.1 = 1007.64 \,\mu\text{s} = 1.01 \,\text{ms}$
  $V_+(4.6) = 0.76e^{-\Delta t/\tau} = 0.0524$

- 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, $G = 1 + 77/31 = 3.48$
  Waveform at $V_o$ is an decreasing exponential, starting at $V_+ = 3.48 \times 0.76 = 2.64$

- What is $V_o$ at $t = 4.6\,\text{ms}$?
  $V_+(4.6) = 2.64e^{-\Delta t/\tau} = 0.182$
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 $t = 3.7 \text{ ms}$?

All voltages in mV

- Sketch the input $V_+$ as a function of the voltage input $V_i$. 
  $V_+$ is the voltage-divider output from $V_i$. 
  $V_+ = [5.8/(5.8 + 32.4)] V_o = 0.152 V_o$ 
  Thus, output goes from $V_+ = 0.152 \times 23.42 = 3.56$ to $V_+ = 0.152 \times 63.42 = 9.64$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  Gain, $G = G = 1 + (1500 || 1500)/24 = 32.25$ 
  Thus, output goes from $V_o = 0.152 \times 23.42 \times G = 114.8$ to $V_o = 0.152 \times 63.42 \times G = 310.9$
- What is $V_o$ at $t = 3.7 \text{ ms}$? 
  $V_o = 0.152 \times 63.42 \times G = 310.9$
The op-amp is ideal, with $V_{CC} = 15\, V$ and $V_{EE} = -15\, V$.

Input $V_A = -11\, mV$ (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 $t = 3.7\, ms$?

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

$$V_o = - \left( \frac{1900}{4.9} V_A + \frac{1900}{31} V_B \right) = -(387.8V_A + 61.3V_B)$$

Thus, the output goes from

$V_o = -[(387.8(-11) + 61.3(10)] = 3653 = 3.65\, V$ to

$V_o = -[(387.8(-11) + 61.3(46)] = 1446 = 1.45\, V$

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

- What is $V_o$ at $t = 3.7\, ms$?

$V_o = -(387.8(-11) + 61.3(46) = 1446 = 1.45\, V$