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 $t = 4.9\, \text{ms}$?

All voltages in V

- Sketch the input $V_+$ as a function of the voltage input $V_i$.
  
  Waveform at $V_+$ is a decreasing exponential, starting at $V_+ = 0.57 - 0.15 = 0.42$
  
  $\Delta t = 4.9 - 2.0 = 2.9$
  
  $\tau = RC = 23.1 \times 29.2 = 674.52\, \mu\text{s} = 0.67\, \text{ms}$
  
  $V_+(4.9) = 0.42e^{-\Delta t/\tau} = 0.0055$

- 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, $G = 1 + 65/28 = 3.32$
  
  Waveform at $V_o$ is a decreasing exponential, starting at $V_+ = 3.32 \times 0.42 = 1.39$

- What is $V_o$ at $t = 4.9\, \text{ms}$?
  
  $V_+(4.9) = 1.39e^{-\Delta t/\tau} = 0.018$
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 $t = 4.6$ 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 $V_i$.
  
  $V_+ = [4.9/(4.9 + 23.1)]V_o = 0.175V_o$
  
  Thus, output goes from $V_+ = 0.175 \times 20.75 = 3.63$ to $V_+ = 0.175 \times 63.95 = 11.19$

- Sketch the output $V_o$ as a function of the voltage input $V_i$. (label times and voltages)
  
  Gain, $G = G = 1 + (1400||1400)/27 = 26.93$
  
  Thus, output goes from $V_o = 0.175 \times 20.75 \times G = 97.8$ to $V_o = 0.175 \times 63.95 \times G = 301.4$

- What is $V_o$ at $t = 4.6$ ms?
  
  $V_o = 0.175 \times 63.95 \times G = 301.4$
The op-amp is ideal, with $V_{CC} = 15$ V and $V_{EE} = -15$ V. Input $V_A = -12$ 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 $t = 4.6$ 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

$$V_o = - \left( \frac{1600}{3.5} V_A + \frac{1600}{28} V_B \right) = -(457.1V_A + 57.1V_B)$$

Thus, the output goes from

$V_o = -[457.1(-12) + 57.1(17)] = 4514 = 4.51$ V to

$V_o = -[457.1(-12) + 57.1(19)] = 4400 = 4.40$ V

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

- What is $V_o$ at $t = 4.6$ ms?

$V_o = -(457.1(-12) + 57.1(19)) = 4400 = 4.40$ V