This is a non-inverting amplifier with a gain of \( G = 1 + \frac{577}{113} = 511.6 \).
With such a large gain, it will saturate when \( V_i = \pm 10 \text{ V} / G = \pm 0.020 \text{ V} \).

Times when \( |V_i| < 0.020 \text{ V} \), are
\[
T_1 = \pm \frac{0.1-0.020}{0.05/100\text{ ms}} = \pm 1.600 \text{ ms}.
\]
\[
T_2 = \pm \frac{0.1+0.020}{0.05/100\text{ ms}} = \pm 2.400 \text{ ms}.
\]

- Sketch \( V_o \).
- At what times does \( V_o \) reach \( \pm 10 \text{ V} \)?
- Does this circuit suffer from multiple transitions?

(Notes: voltage axis not to scale. The slope of the voltage may be approximated as 5 V/100 ms. Op amps are ideal)
• Sketch $V_o$.

• At what times does $V_o$ reach ±10 V?

• Does this circuit suffer from multiple transitions?

(Notes: voltage axis not to scale. The slope of the voltage may be approximated as 5 V/100 ms. Op amps are ideal)

Thresholds at $\pm \frac{1.92\, \text{k}\Omega}{376+1.92\, \text{k}\Omega} \times 10 \, \text{V} = \pm 0.051 \, \text{V}$.  

Conditions:
1) If $V_i < V_+ \implies V_o = +10 \, \text{V}$ and $V_+ = +0.051 \, \text{V}$.  
2) If $V_i > V_+ \implies V_o = -10 \, \text{V}$ and $V_+ = -0.051 \, \text{V}$.  

• Sketch $V_o$.
  1) Initially, $V_o = +10$ and $V_+ = +0.051 \, \text{V}$
  2) when $V_i$ crosses $+0.051 \, \text{V}$, then $V_o = -10$ and $V_+ = -0.051 \, \text{V}$
  3) when $V_i$ crosses $-0.051 \, \text{V}$, then $V_o = +10$ and $V_+ = +0.051 \, \text{V}$
  4) when $V_i$ crosses $+0.051 \, \text{V}$, then $V_o = -10$ and $V_+ = -0.051 \, \text{V}$

• At what times does $V_o$ reach ±10 V?
  Transitions at $\pm \frac{0.9\,\text{V}}{100\,\text{ms}} = \pm 0.98 \, \text{ms}$.
  1) Beginning until $-0.98 \, \text{ms} \implies V_o = +10 \, \text{V}$.
  2) $-0.98 \, \text{ms}$ until $0 \, \text{ms} \implies V_o = -10 \, \text{V}$.
  3) $0 \, \text{ms}$ until $+3.02 \, \text{ms} \implies V_o = +10 \, \text{V}$.
  4) $+3.02 \, \text{ms}$ until end $\implies V_o = -10 \, \text{V}$.

• Does this circuit suffer from multiple transitions?  
  Yes
This is a low pass filter with a gain of $G = \frac{-575 \text{k}\Omega}{18.5 \text{k}\Omega} = -31.08$.
With such a large gain, it will saturate when $V_i = \pm 10 \text{ V} / G = \pm 0.322 \text{ V}$.
The time constant is $\tau = 575 \text{k}\Omega \times 339 \text{nF} = 194.9 \text{ ms}$.

- At what times does $V_o$ reach $\pm 10 \text{ V}$?
  
  Transitions at $\pm \frac{0.1+0.322}{5 \text{V}/100 \text{ms}} = \pm 8.4 \text{ ms}$.
  
  Thus: 1) Beginning until $-8.4 \text{ ms} \implies V_o = +10 \text{ V}$.
  
  2) $+8.4 \text{ ms}$ until end $\implies V_o = -10 \text{ V}$.

- Sketch $V_o$ (this is difficult because of the exponential – indicate the main features of the curve)

  Beginning until $-8.4 \text{ ms} \implies V_o = +10 \text{ V}$. Then, from $+8.4 \text{ ms}$ until $-8.4 \text{ ms}$ the will go from $+10$ to $-10 \text{ V}$, following the flipped the blue line (with gain) but with a slight delay. However, it will only deviate slightly at the zigzag. The time constant $\tau$ is longer than the gap in the zigzag. Finally, from $+8.4 \text{ ms}$ until end $\implies V_o = -10 \text{ V}$.

- Does this circuit suffer from multiple transitions?

  [No]

  Explanation: In the above case, the response is linear throughout the +/-0.1V transition of the input signal. The addition of the capacitor turns the circuit into a “lossy integrator”. Its step response would be an exponential with time constant $RC = 194.9 \text{ ms}$. We don’t have exactly a step at the input; however, if the input transitions are short compared to the time constant we can approximate the output as an exponential (perhaps with a “bump” $V_i$ briefly changes sign). Assuming the input transitions are short compared to $RC$, then $V_o$ will NOT suffer from multiple transitions.