This is a non-inverting amplifier with a gain of \( G = 1 + \frac{403}{171} = 236.7 \).
With such a large gain, it will saturate when \( V_i = \pm 10 V/G = \pm 0.042 V \).

Times when \( |V_i| < 0.042 \), \( V_o \) are:

\[
T_1 = \pm \frac{0.1-0.042}{5V/100\text{ms}} = \pm 1.160 \text{ ms}.
\]
\[
T_2 = \pm \frac{0.1+0.042}{5V/100\text{ms}} = \pm 2.840 \text{ ms}.
\]

- Sketch \( V_o \).
- At what times does \( V_o \) reach \( \pm 10 V \)?
- 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)
• Sketch $V_o$.

• At what times does $V_o$ reach $\pm 10$ 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 $\pm \frac{1.34 \text{k} \Omega}{452 + 1.34 \text{k} \Omega} \times 10 \text{ V} = \pm 0.030 \text{ V}$.

Conditions:
1) If $V_i < V_+ \implies V_o = +10$ V and $V_+ = +0.030$ V.
2) If $V_i > V_+ \implies V_o = -10$ V and $V_+ = -0.030$ V.

• Sketch $V_o$.

1) Initially, $V_o = +10$ and $V_+ = +0.030$ V
2) when $V_i$ crosses $+0.030$ V, then $V_o = -10$ and $V_+ = -0.030$ V
3) when $V_i$ crosses $-0.030$ V, then $V_o = +10$ and $V_+ = +0.030$ V
4) when $V_i$ crosses $+0.030$ V, then $V_o = -10$ and $V_+ = -0.030$ V

• At what times does $V_o$ reach $\pm 10$ V?

Transitions at $\pm \frac{0.1 - 0.030}{5 \text{ V}/100 \text{ ms}} = \pm 1.40$ ms.
1) Beginning until $-1.40 \text{ ms} \implies V_o = +10$ V.
2) $-1.40 \text{ ms}$ until $0$ ms $\implies V_o = -10$ V.
3) $0$ ms until $+2.60$ ms $\implies V_o = +10$ V.
4) $+2.60$ ms until end $\implies V_o = -10$ V.

• Does this circuit suffer from multiple transitions?

Yes
This is a low pass filter with a gain of $G = -\frac{386 \, k\Omega}{13.3 \, k\Omega} = -29.02$.
With such a large gain, it will saturate when $V_i = \pm 10 \, V / G = \pm 0.345 \, V$.
The time constant is $\tau = 386 \, k\Omega \times 512 \, nF = 197.6 \, ms$.

- At what times does $V_o$ reach $\pm 10 \, V$?
  Transitions at $\pm \frac{0.1+0.345}{5 \, V / 100 \, ms} = \pm 8.9 \, ms$.
  Thus: 1) Beginning until $-8.9 \, ms \implies V_o = +10 \, V$.
  2) +8.9 ms until end $\implies V_o = -10 \, V$.

- Sketch $V_o$ (this is difficult because of the exponential – indicate the main features of the curve)
  Begining until $-8.9 \, ms \implies V_o = +10 \, V$. Then, from +8.9 ms until $-8.9 \, ms$ the will go from +10 to $-10 \, V$, 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 +8.9 ms until end $\implies V_o = -10 \, V$.

- 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 $RC = 197.6 \, ms$. 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.