This is a non-inverting amplifier with a gain of \( G = 1 + \frac{546}{121} = 452.2 \).
With such a large gain, it will saturate when \( V_i = \pm 10 V/G = \pm 0.022 V \).

Times when \( |V_i| < 0.022, V \), are
\[
T_1 = \pm \frac{0.1 - 0.022}{5 V/100 ms} = \pm 1.560 ms.
\]
\[
T_2 = \pm \frac{0.1 + 0.022}{5 V/100 ms} = \pm 2.440 ms.
\]

- 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 $\pm 10\, \text{V}$?

• Does this circuit suffer from multiple transitions?

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

Thresholds at $\pm \frac{1.82\, \text{k}\Omega}{443+1.82\, \text{k}\Omega} \times 10\, \text{V} = \pm 0.041\, \text{V}$.

Conditions:
1) If $V_i < V_+ \implies V_o = +10\, \text{V}$ and $V_+ = +0.041\, \text{V}$.
2) If $V_i > V_+ \implies V_o = -10\, \text{V}$ and $V_+ = -0.041\, \text{V}$.

• Sketch $V_o$.
  1) Initially, $V_o = +10$ and $V_+ = +0.041\, \text{V}$
  2) when $V_i$ crosses $+0.041\, \text{V}$, then $V_o = -10$ and $V_+ = -0.041\, \text{V}$
  3) when $V_i$ crosses $-0.041\, \text{V}$, then $V_o = +10$ and $V_+ = +0.041\, \text{V}$
  4) when $V_i$ crosses $+0.041\, \text{V}$, then $V_o = -10$ and $V_+ = -0.041\, \text{V}$

• At what times does $V_o$ reach $\pm 10\, \text{V}$?
  Transitions at $\pm \frac{0.1-0.041}{5\, \text{V}/100\, \text{ms}} = \pm 1.18\, \text{ms}$.
  1) Beginning until $-1.18\, \text{ms} \implies V_o = +10\, \text{V}$.
  2) $-1.18\, \text{ms}$ until $0\, \text{ms} \implies V_o = -10\, \text{V}$.
  3) $0\, \text{ms}$ until $+2.82\, \text{ms} \implies V_o = +10\, \text{V}.$
  4) $+2.82\, \text{ms}$ 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 $G = -\frac{314\,k\Omega}{13.2\,k\Omega} = -23.79$.
With such a large gain, it will saturate when $V_i = \pm 10\,V/G = \pm 0.420\,V$.
The time constant is $\tau = 314\,k\Omega \times 363\,nF = 114.0\,ms$.

- At what times does $V_o$ reach $\pm 10\,V$?
  Transitions at $\pm \frac{0.1+0.420}{5\,V/100\,ms} = \pm 10.4\,ms$.
  Thus: 1) Beginning until $-10.4\,ms \implies V_o = +10\,V$.
  2) $+10.4\,ms$ 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 $-10.4\,ms \implies V_o = +10\,V$. Then, from $+10.4\,ms$ until $-10.4\,ms$ 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 $+10.4\,ms$ 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 $RC = 114.0\,ms$. 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.