# Analog Electronics - XLVI

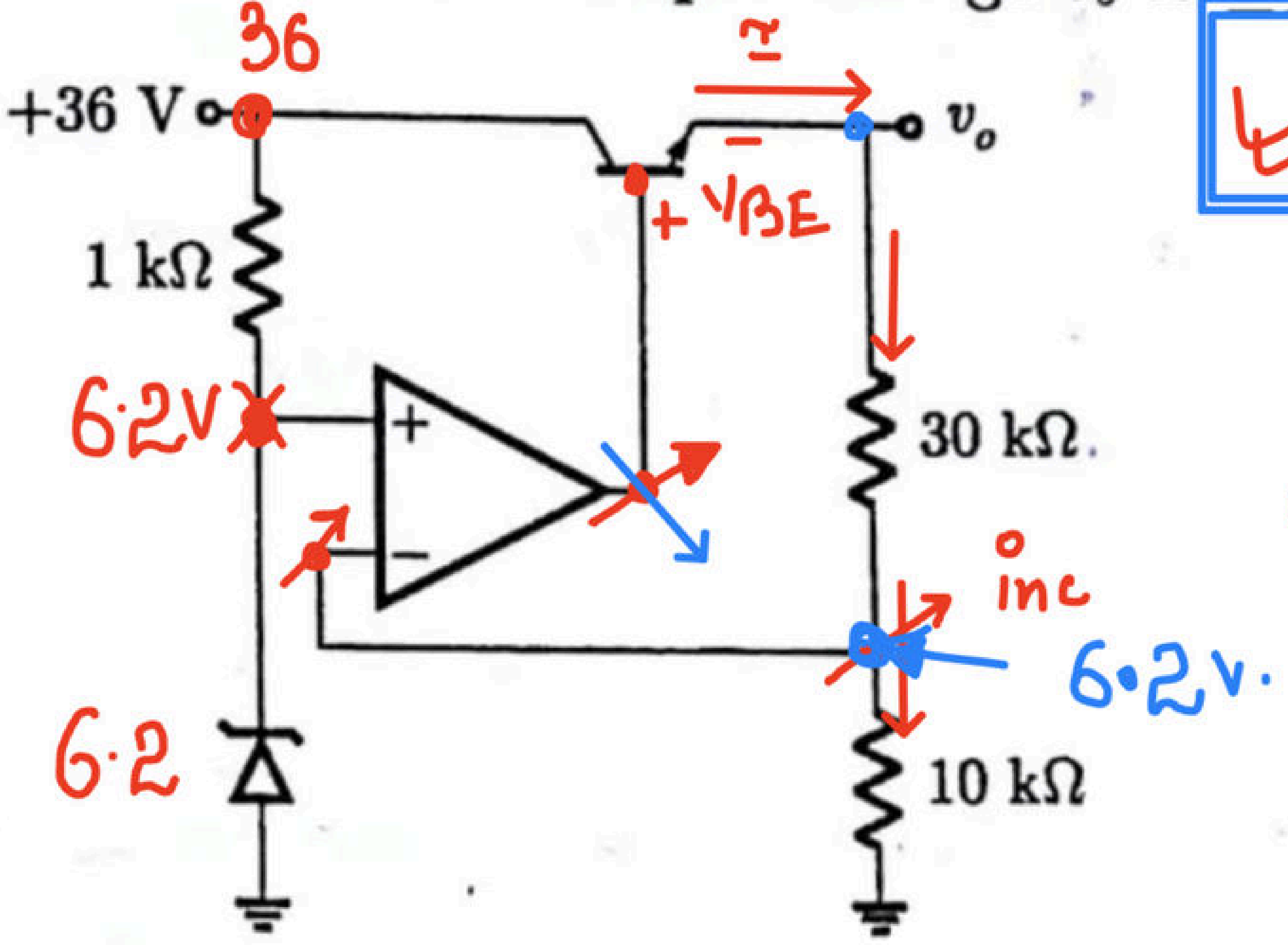
Lakshya GATE 2023: Course on Analog Electronics for ECE EE IN

Siddharth Sabharwal • Lesson 61 • June 29, 2022


THE BEST WAY
TO PREDICT THE
FUTURE IS TO
CREATE IT.
Peter Drucker

**QUES 8.2.14** In the op-amp series regulator circuit shown below, $v_z = \underline{6.2}\,\text{V}$, $V_{BE} = 0.7\,\text{V}$ and $\beta = 60$. The output voltage $v_o$ is ______ volts.

Q




$\boxed{\text{~~a)~~ neg. f/d}}$ ✓

b) +ve f/d

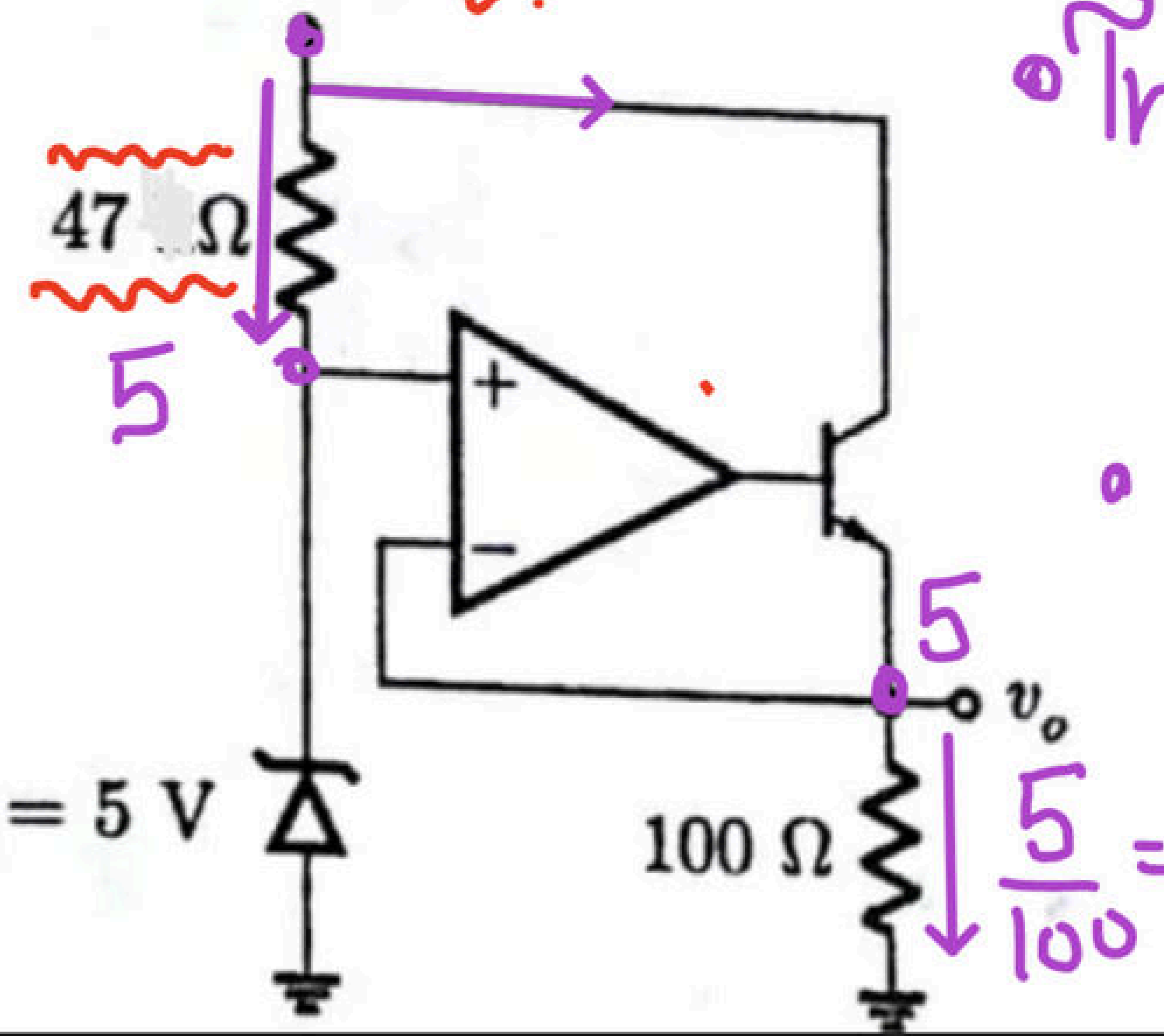
• Zener will go in B.D

$$V_o \times \frac{10}{10+30} = 6.2$$

$$V_o = 4 \times 6.2 = 24.8\,\text{V}.$$

QUES 8.2.13 In the following circuit, the op-amp is ideal. If $\beta_F = 60$, then the total current (in mA) supplied by the 15 V source is ____

Q




B.D

- The ckt is in neg feed back
- Zener in BD

a) 49

b) 152

c) 261

d) 342

I supplied by 15V source $= \frac{15-5}{47} + \frac{5}{100} \times \frac{60}{61}$

$= \frac{10}{47} + \frac{5}{100} \times \frac{60}{61}$

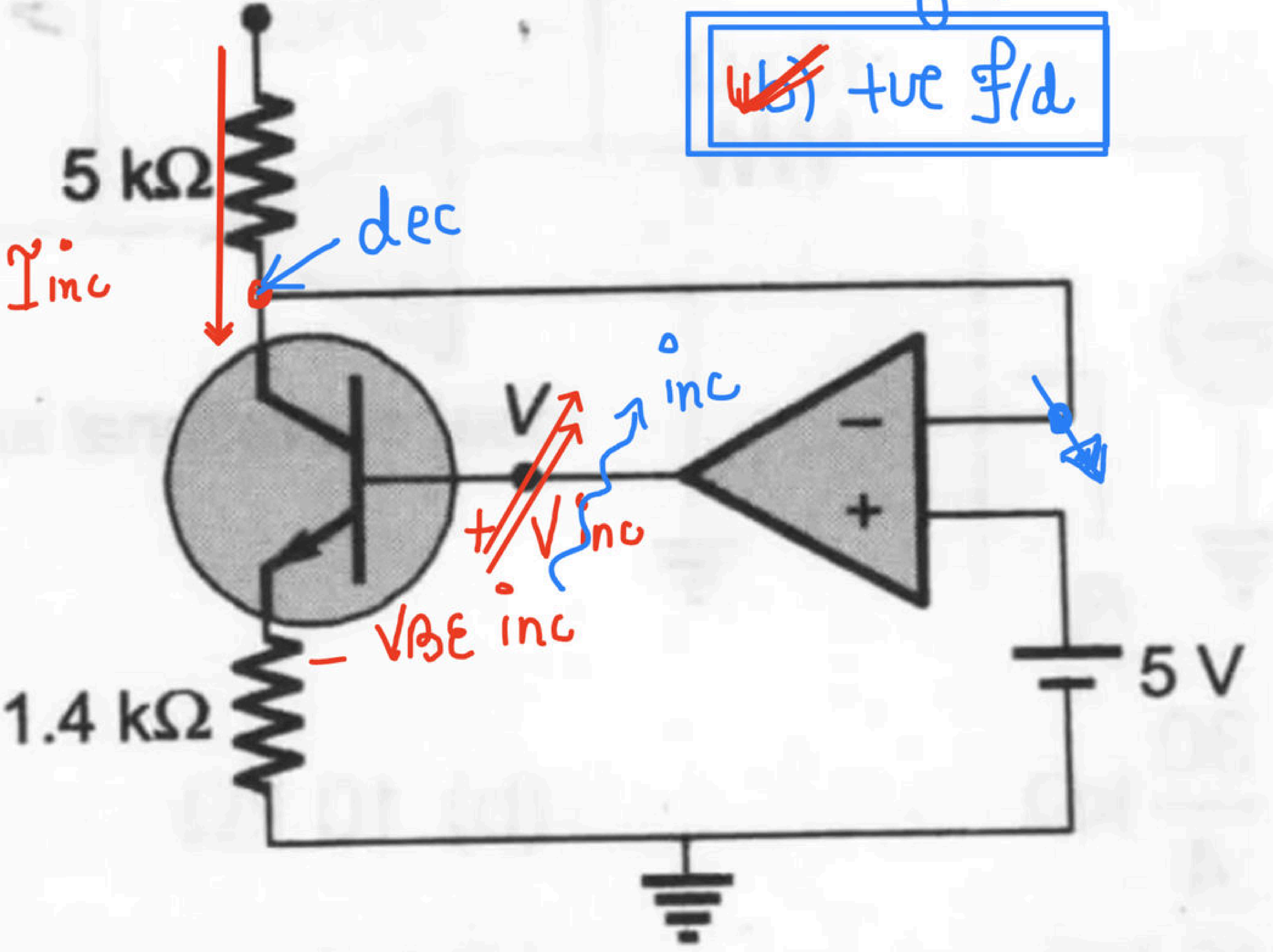
$= .261$ Amp

$= 261$ mA

Q

a) neg f/d

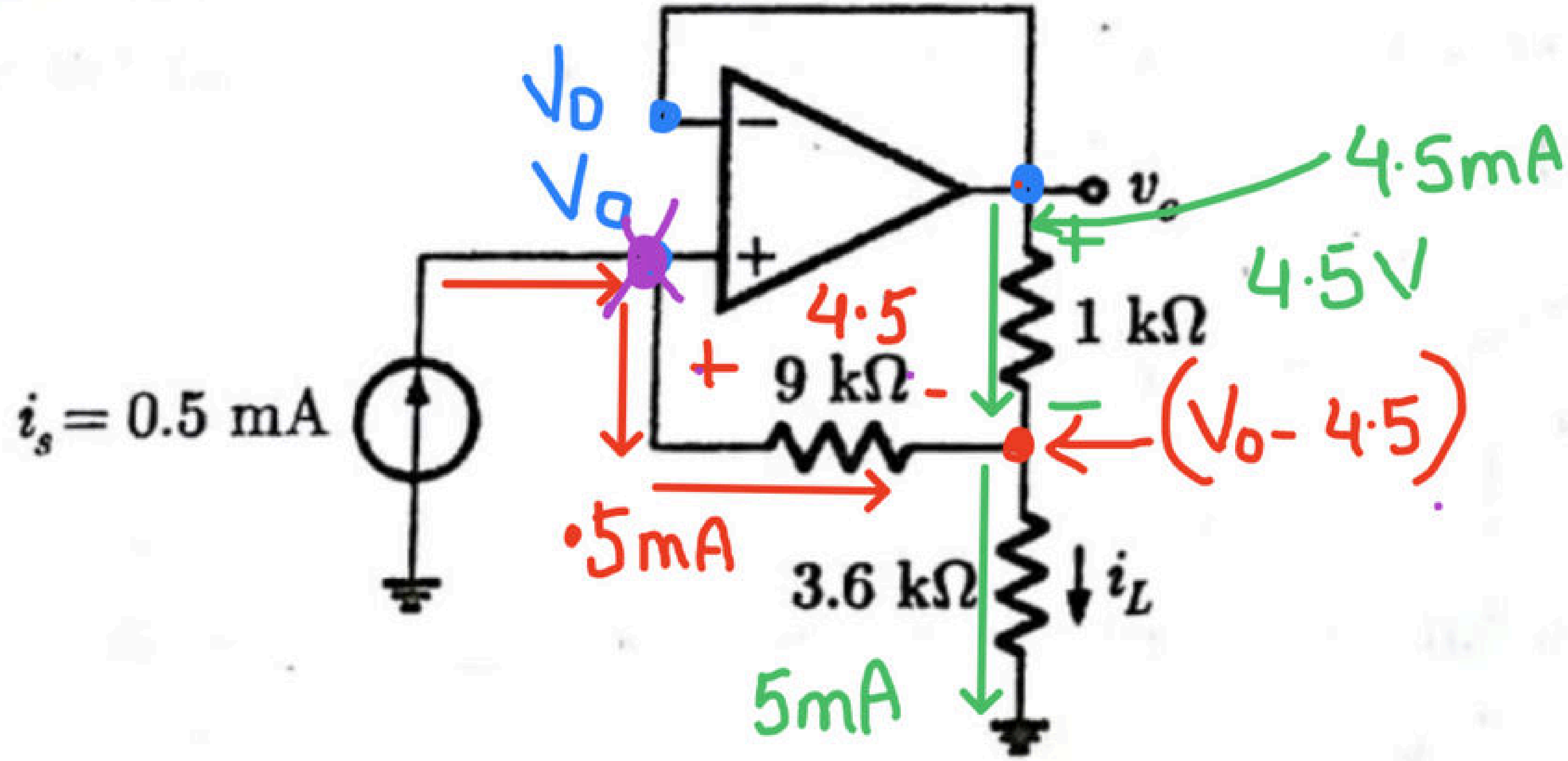
b) +ve f/d



Q.

## Common Data For Q. 8 and 9 :

An ideal op-amp circuit is shown in figure




$V_o = 4.5 + 18$

$V_o = 22.5V$ $Z = V_o/i_o$

a) 22.5 ~~b)~~ 45

c) 67.5 d) 90

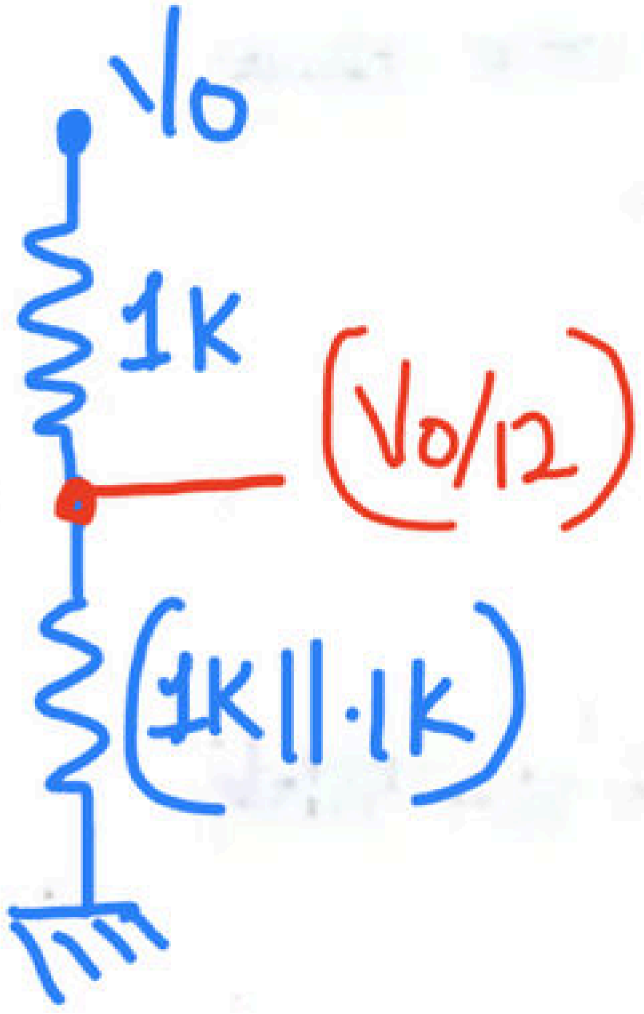
**QUES 8.2.8** Current $i_L$ is 5mA mA.

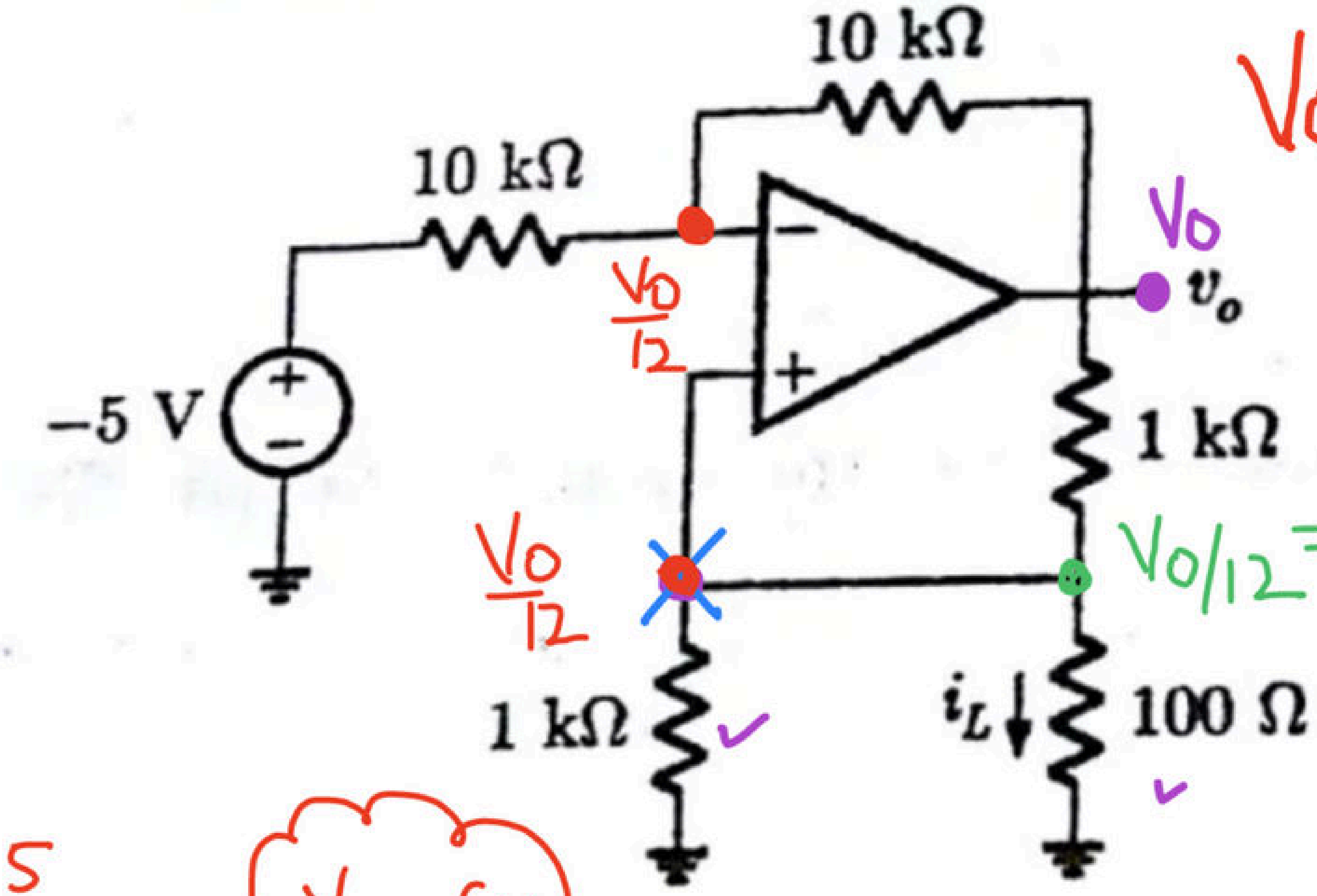
**QUES 8.2.9** In above circuit, input impedance ($Z_{in}$) seen by the current source is ______ kΩ

Q

## Common Data For Q. 6 and 7 :

Consider ideal op-amp circuit shown below.




$V_0 \Rightarrow$ a) 6 b) 12 c) 8 d) 4

$$\frac{V_0 - \frac{V_0}{12}}{10K} = \frac{\frac{V_0}{12}+5}{10K}$$

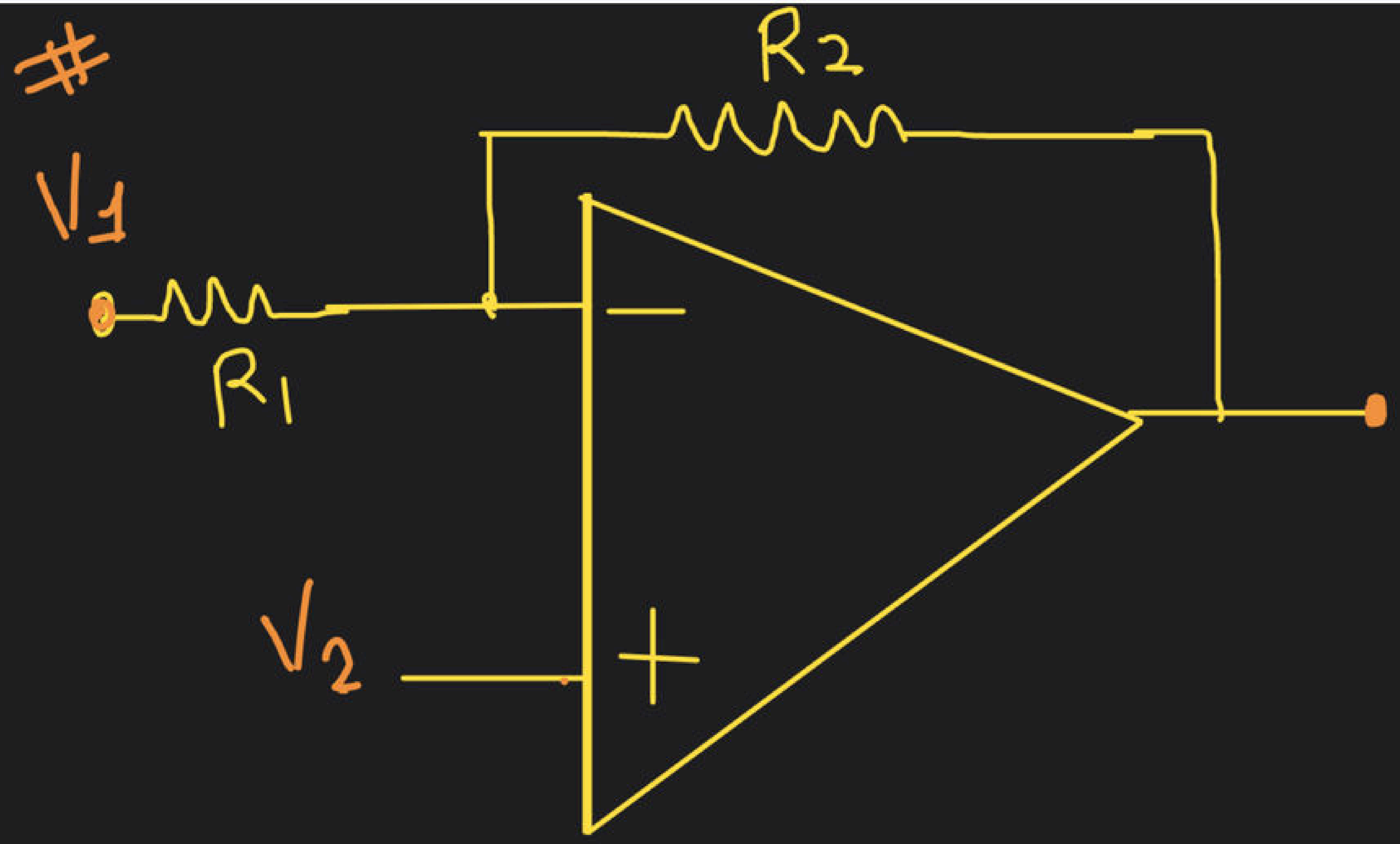
$V_0 = 6V$

$i_L = \frac{.5}{100} = \frac{5}{1000} =$ 5mA

**QUES 8.2.6** Load current $i_L$ is _____ mA.

**QUES 8.2.7** Output voltage $v_o$ is _____ volts.

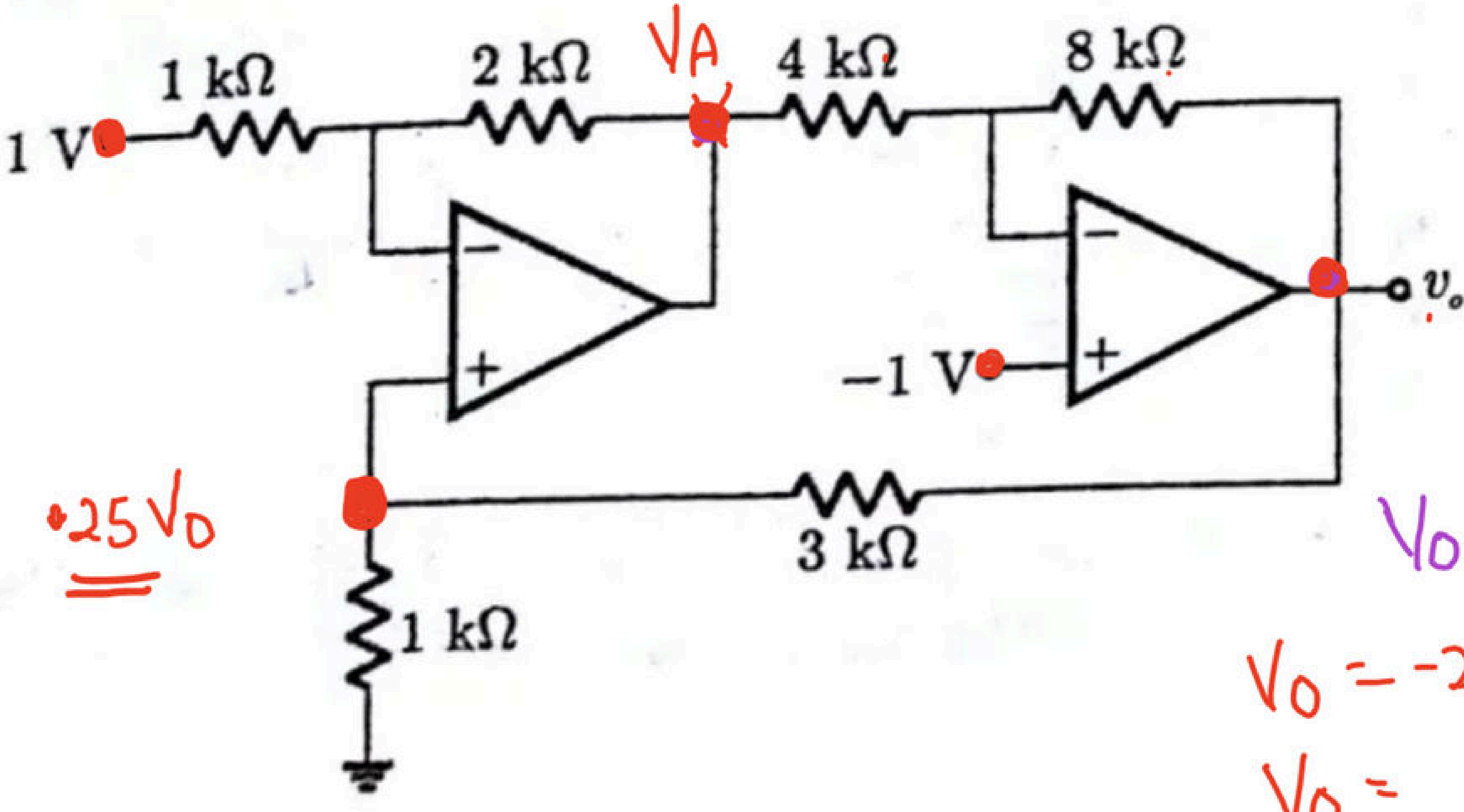
#




$$V_2\left(1+\frac{R_2}{R_1}\right)+\left(-V_1\frac{R_2}{R_1}\right)$$

**QUES 8.2.19** For the op-amp circuit shown in figure. Assume that the op-amps are ideal. The output voltage $v_o$ is _____ volt.

Q




$V_A = -2 + \frac{V_o}{4}(1+2)$

$V_A = -2 + .75V_o$

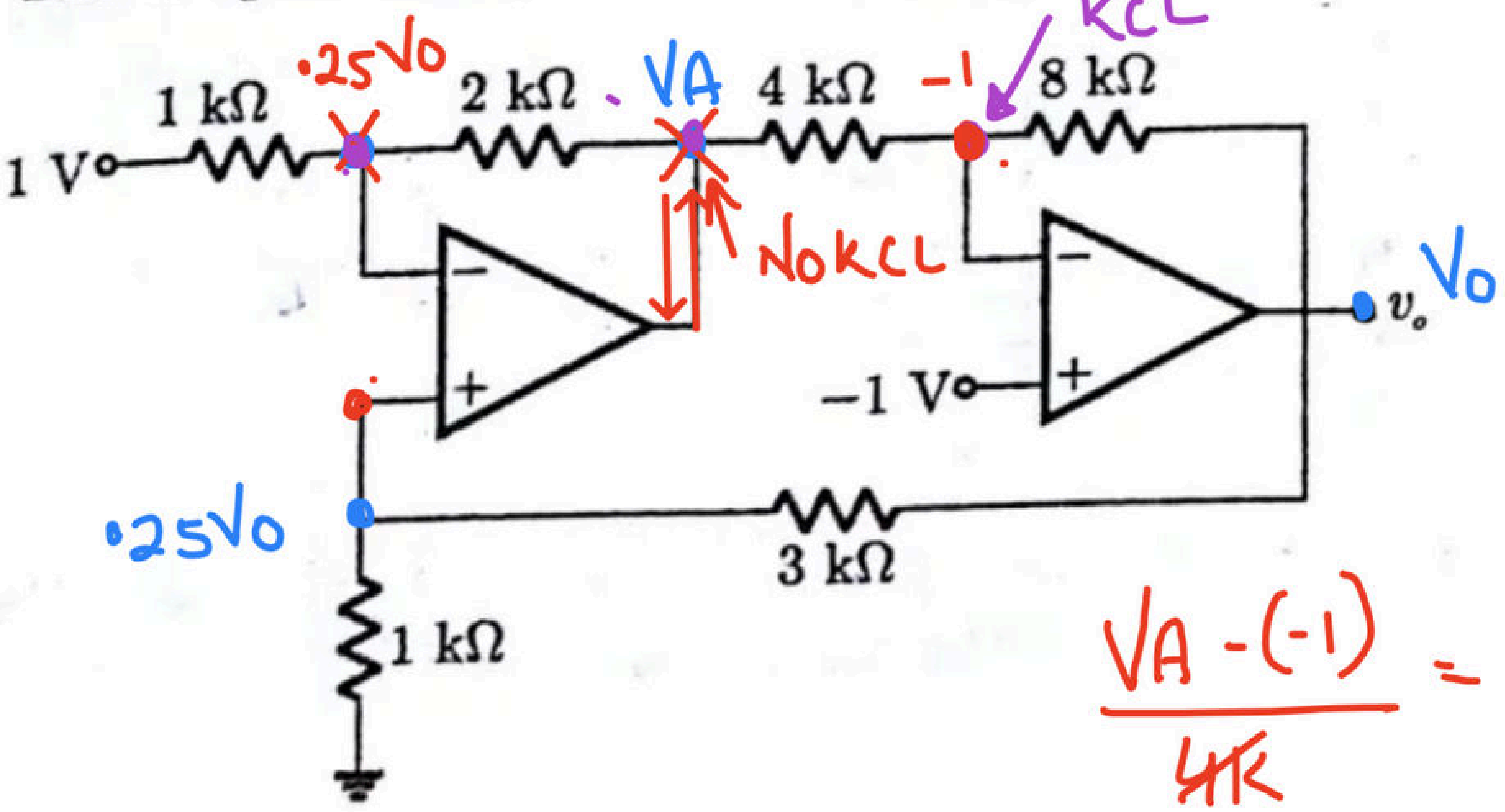
$V_o = -2V_A - 1(3)$

$V_o = -2(-2 + .75V_o) - 3$

$V_o = 4 - 1.5V_o - 3$

$$\boxed{V_o = 1/2.5 = .4}$$

**QUES 8.2.19** For the op-amp circuit shown in figure. Assume that the op-amps are ideal. The output voltage $v_o$ is _____ volt.




$$\frac{V_A - .25V_0}{2K} = \frac{.25V_0 - 1}{1K}$$

$$V_A - .25V_0 = .5V_0 - 2$$

$$\underline{V_A = .75V_0 - 2}$$

$$\frac{V_A - (-1)}{\cancel{4K}} = \frac{(-1) - V_0}{\cancel{8K}\,2}$$

$$2V_A + 2 = -1 - V_0$$

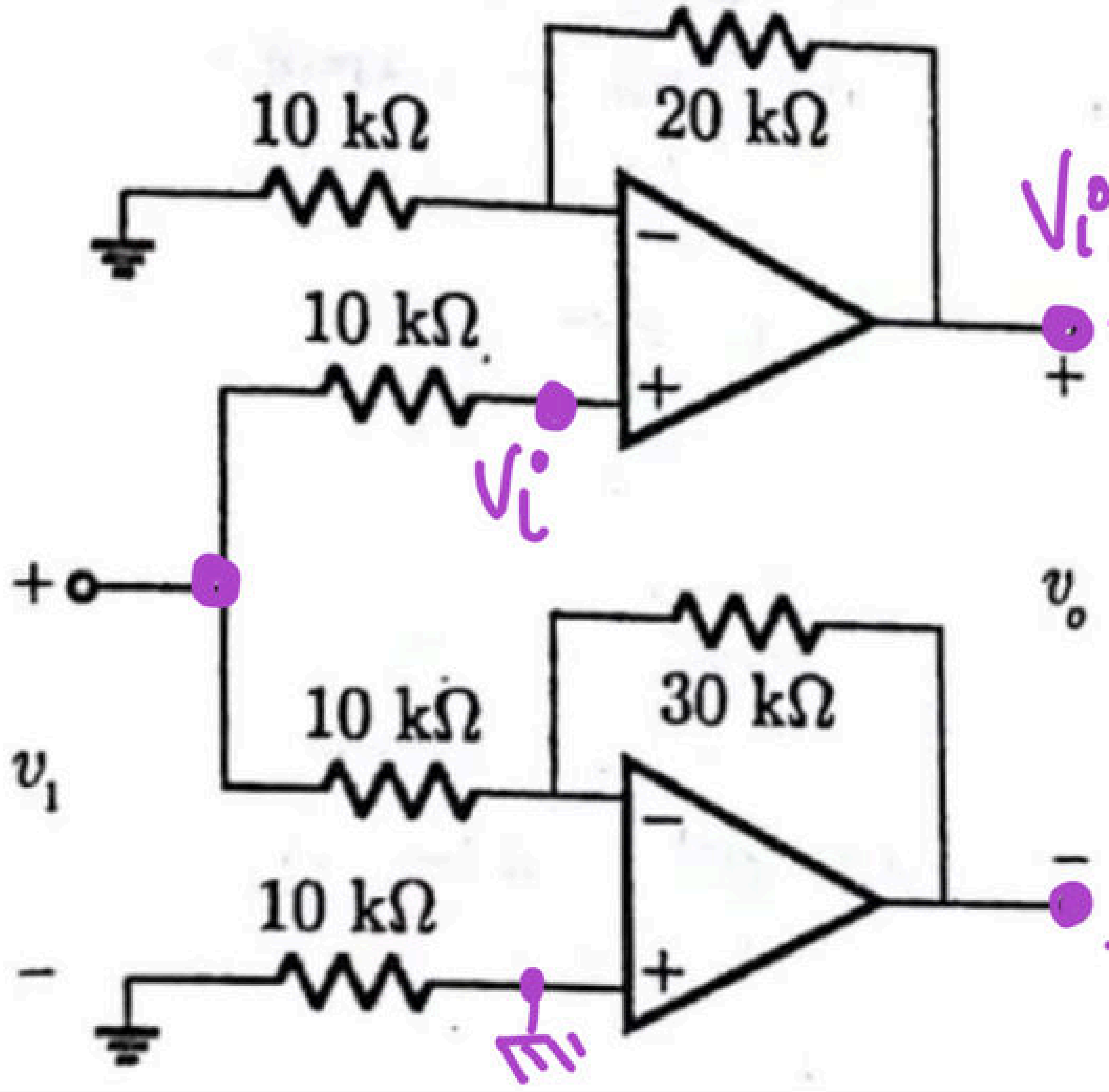
$$1.5V_0 - 4 + 2 = -1 - V_0$$

$$2.5V_0 = -1 - 2 + 4$$

$$\boxed{V_0 = \frac{1}{2.5}}$$

**QUES 8.2.24** Consider the amplifier circuit shown in figure below. Assume op-amp is ideal. What is the value of voltage gain $A_v = \frac{v_o}{v_1}$ ?

Q




$V_i(1+\frac{2}{1}) = 3V_i$ ✓

$-3V_i$

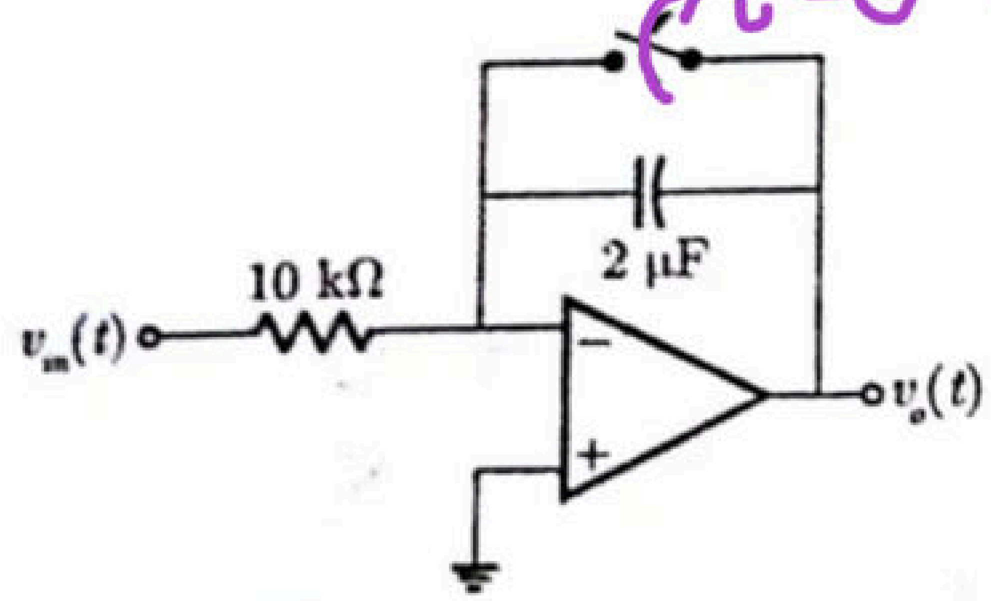
a) 5 ~~b)~~ 6

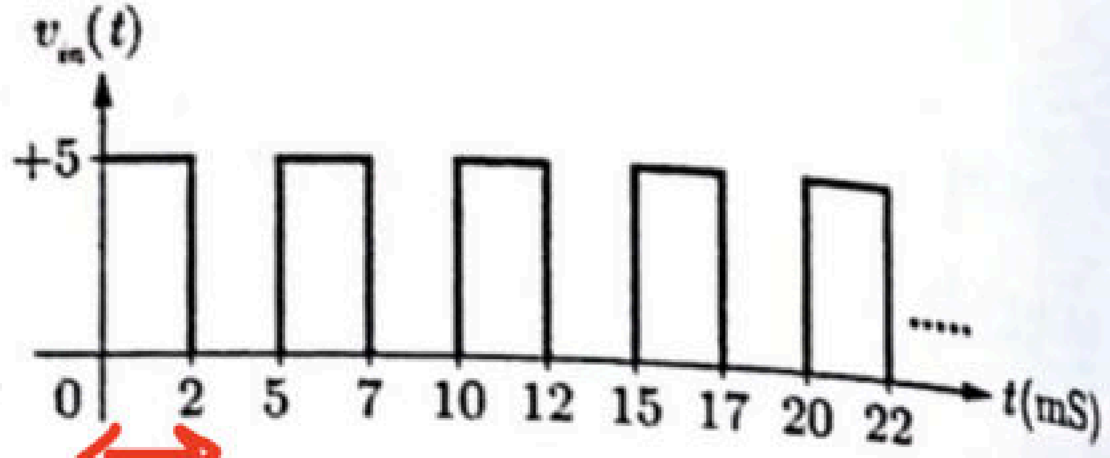
c) −5 d) −6

$V_o = 3V_i - (-3V_i)$
$= 6V_i$

**MCQ 5.1.45** Consider the circuit shown in below. Assume op-amp is ideal. Input waveform is also shown in this figure.

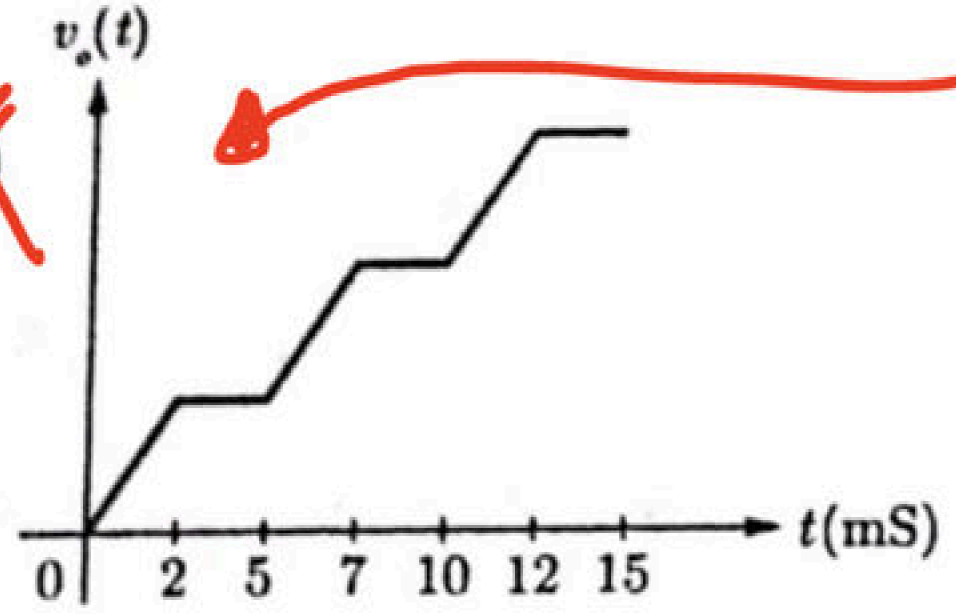
t=0 opens



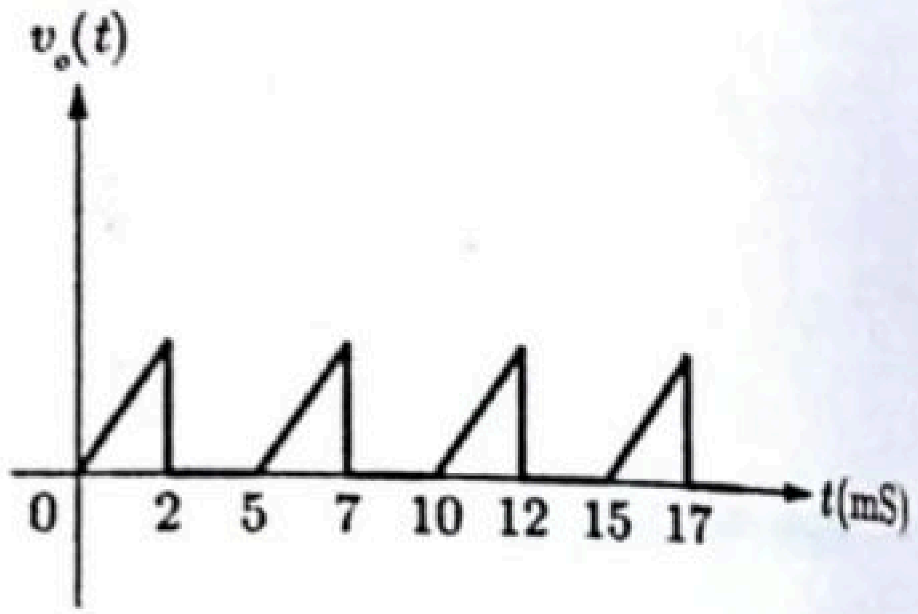




The output waveform will be

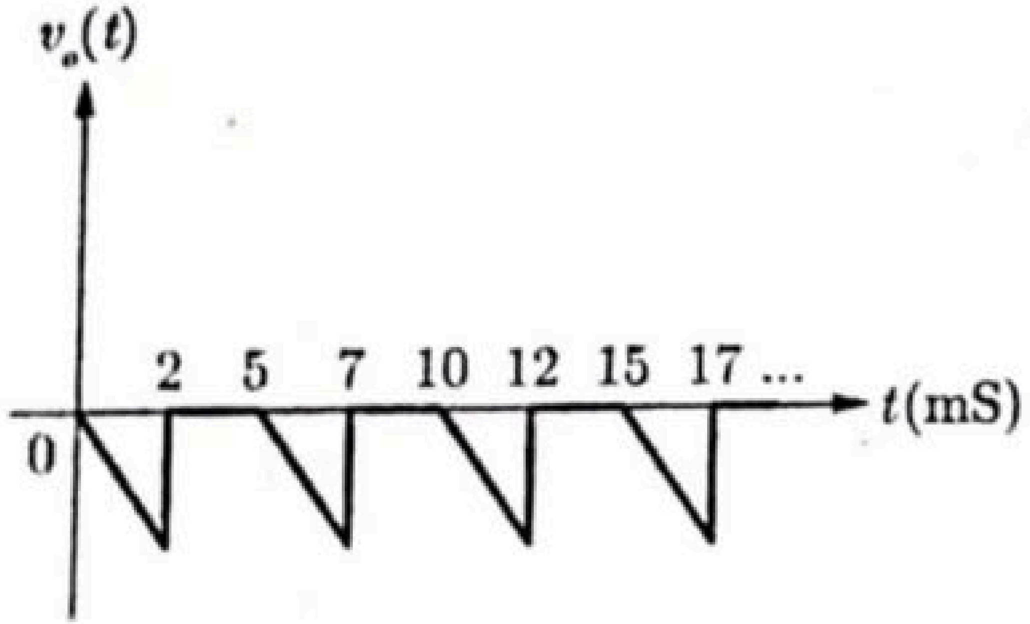
(A)



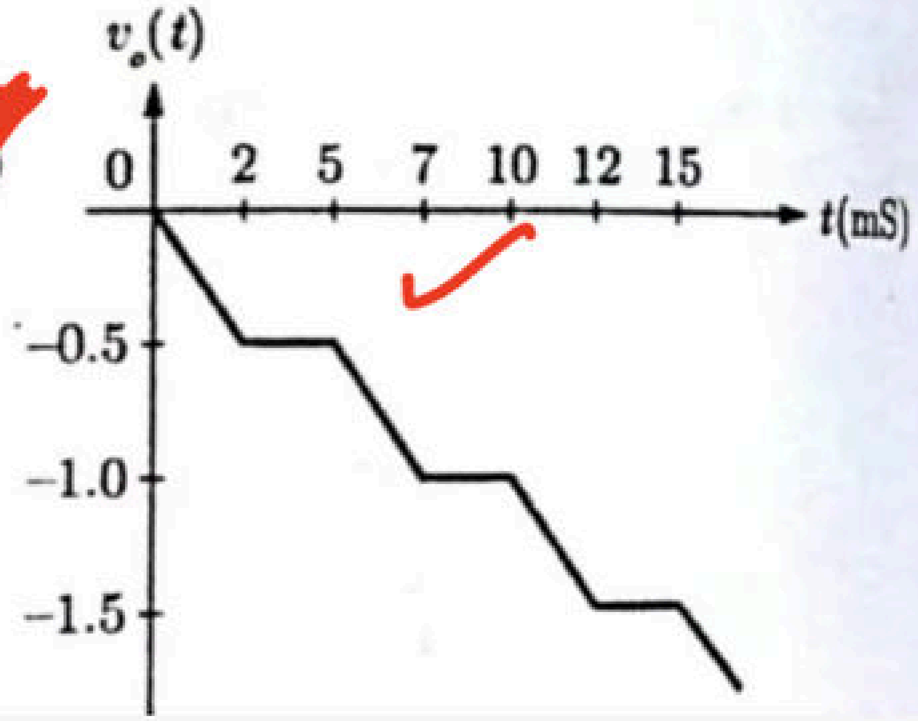

(B)

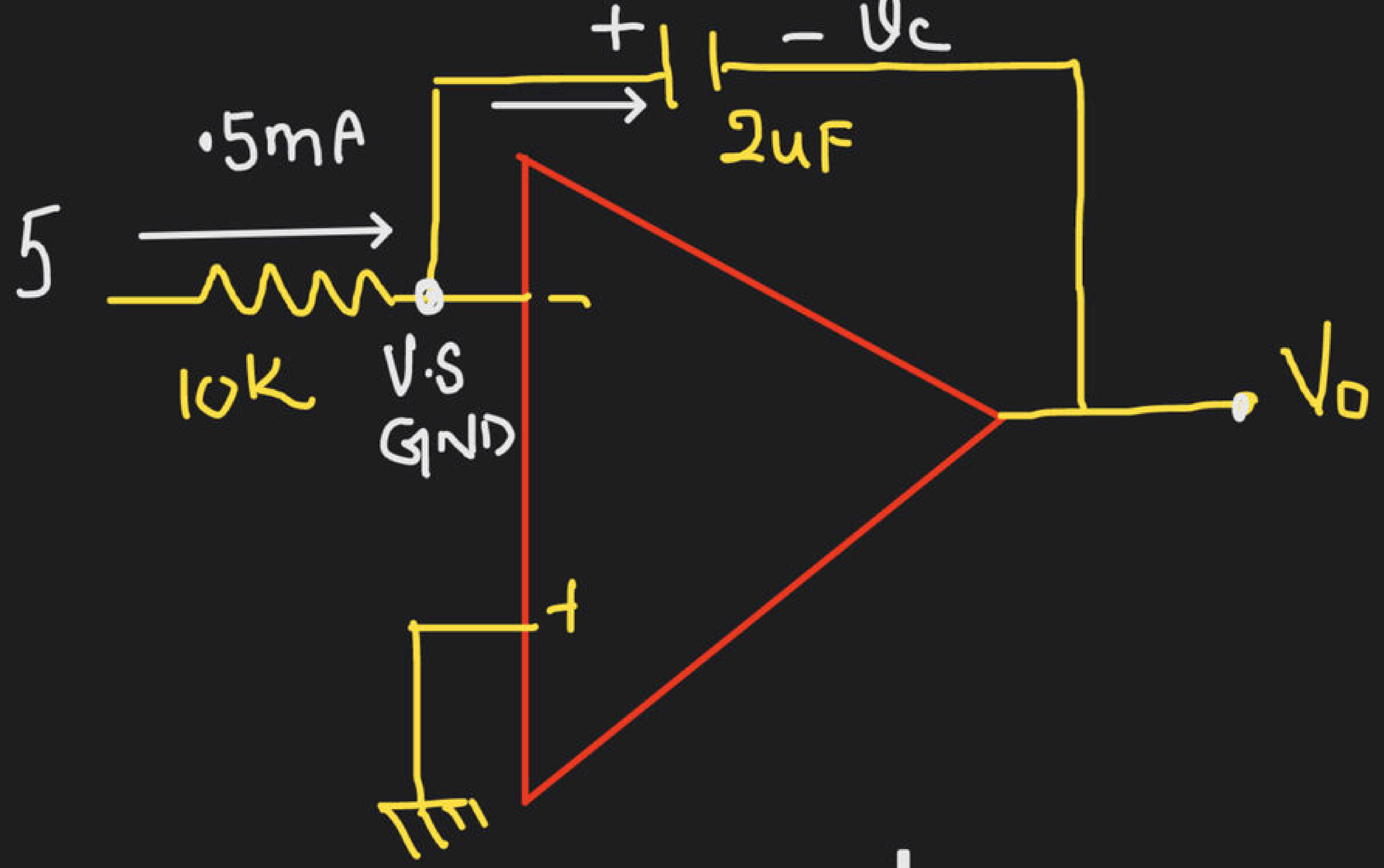



(C)




(D)



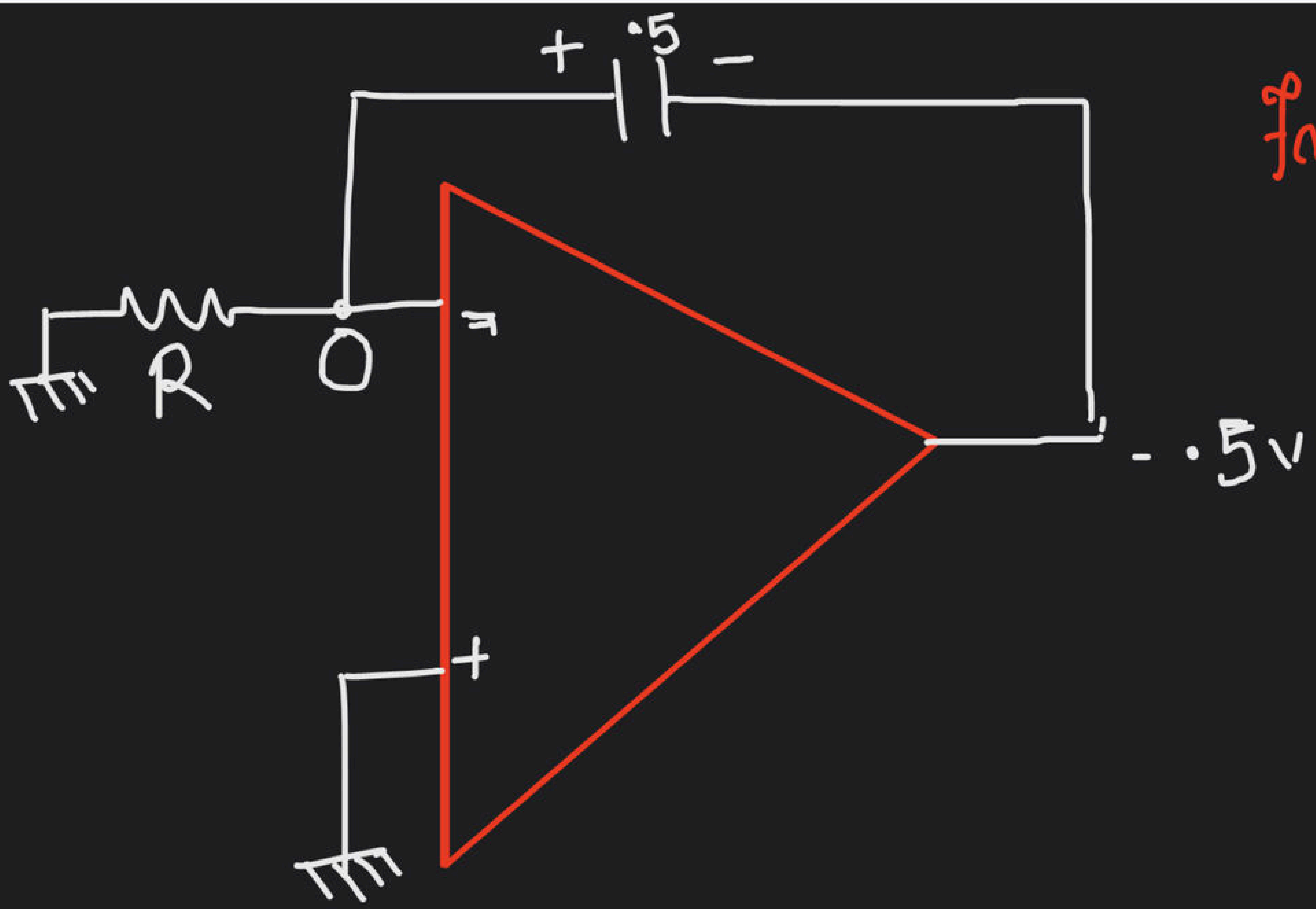



$$v_c = \frac{1}{C}\int i\,dt$$

$$v_c = \frac{1}{2\times10^{-6}}\,.5\,\text{mF}\ t$$

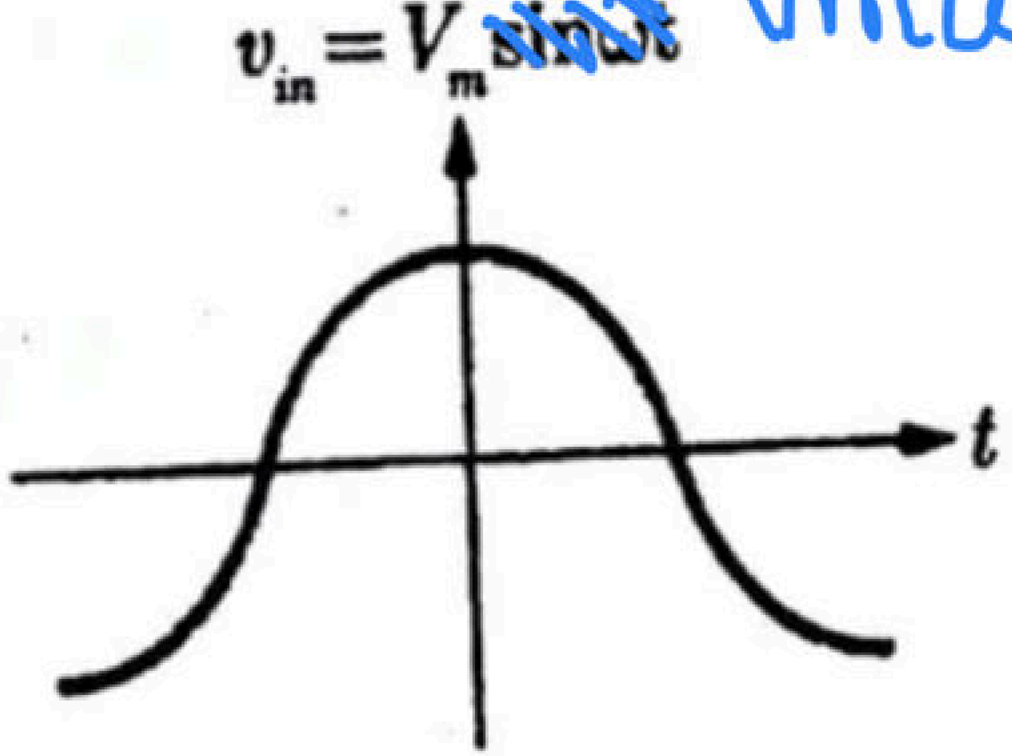
$$v_c = \frac{t}{4}\times10^{3}$$

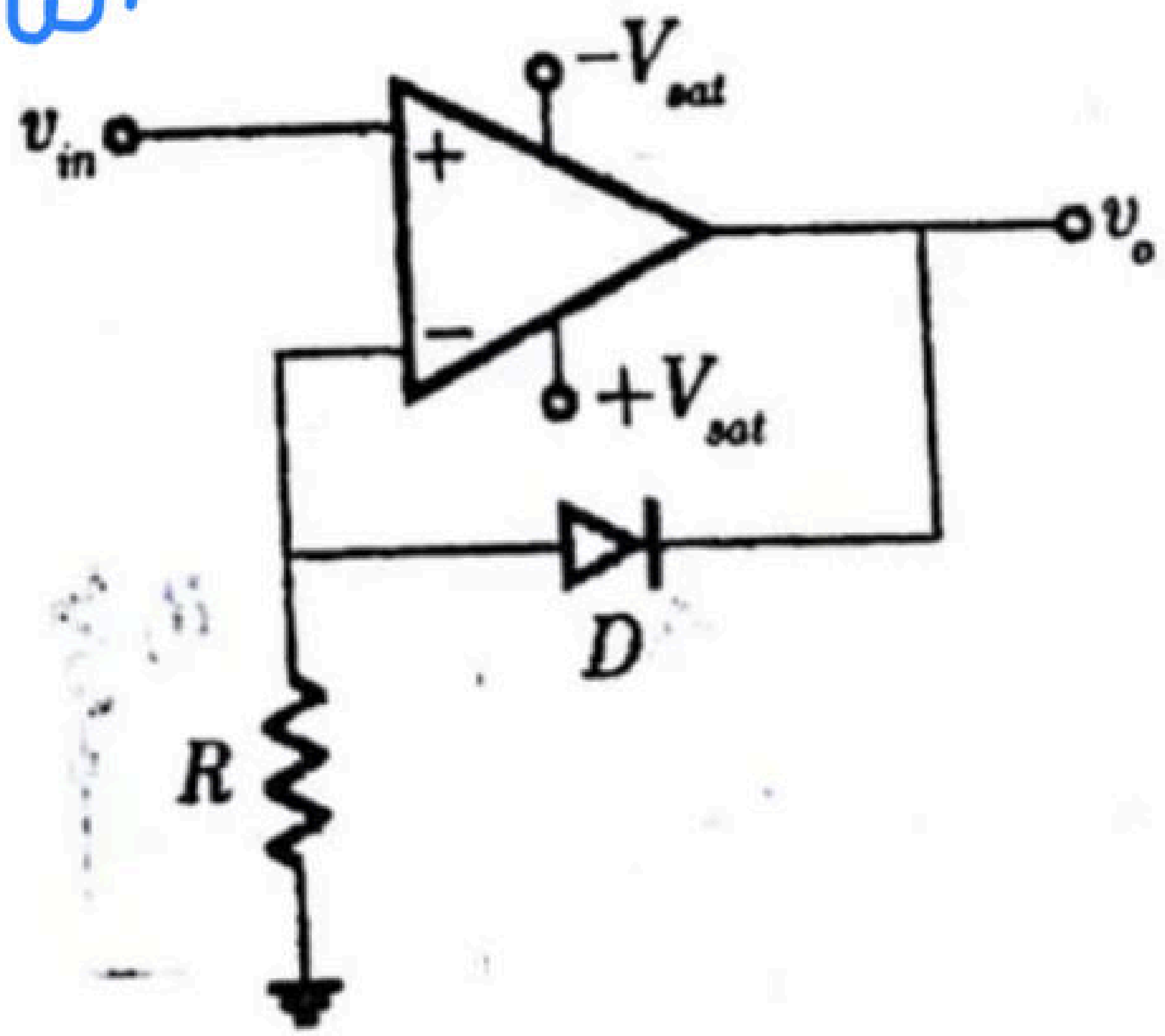
$$V_o = -V_c = -\frac{t}{4}\times10^{3}$$

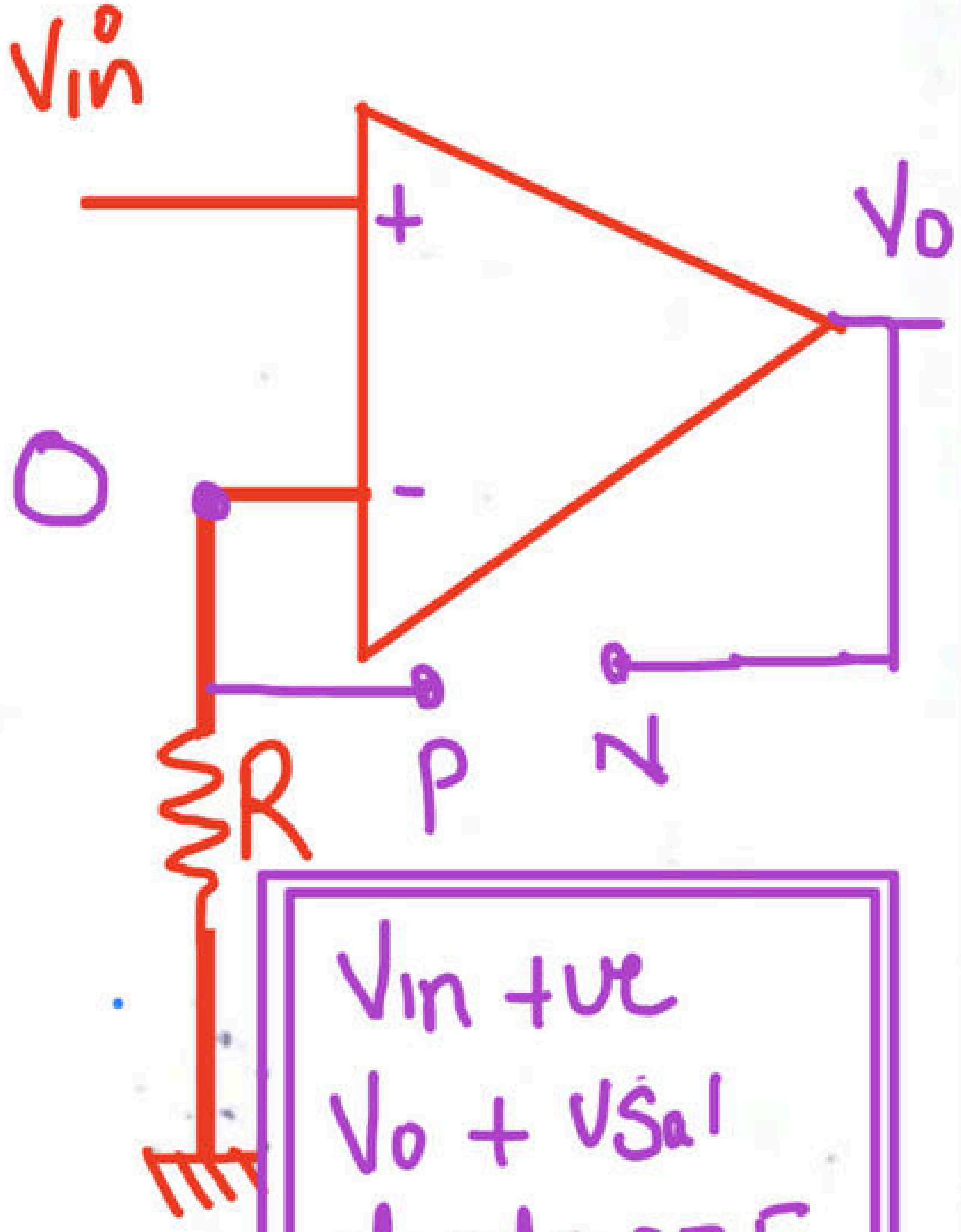



from 2 – 4ms
Cap. has no path to discharge

MCQ 8.1.50 Consider the circuit shown in figure below. Cut in voltage of diode is 0.7 V and op-amp is ideal.



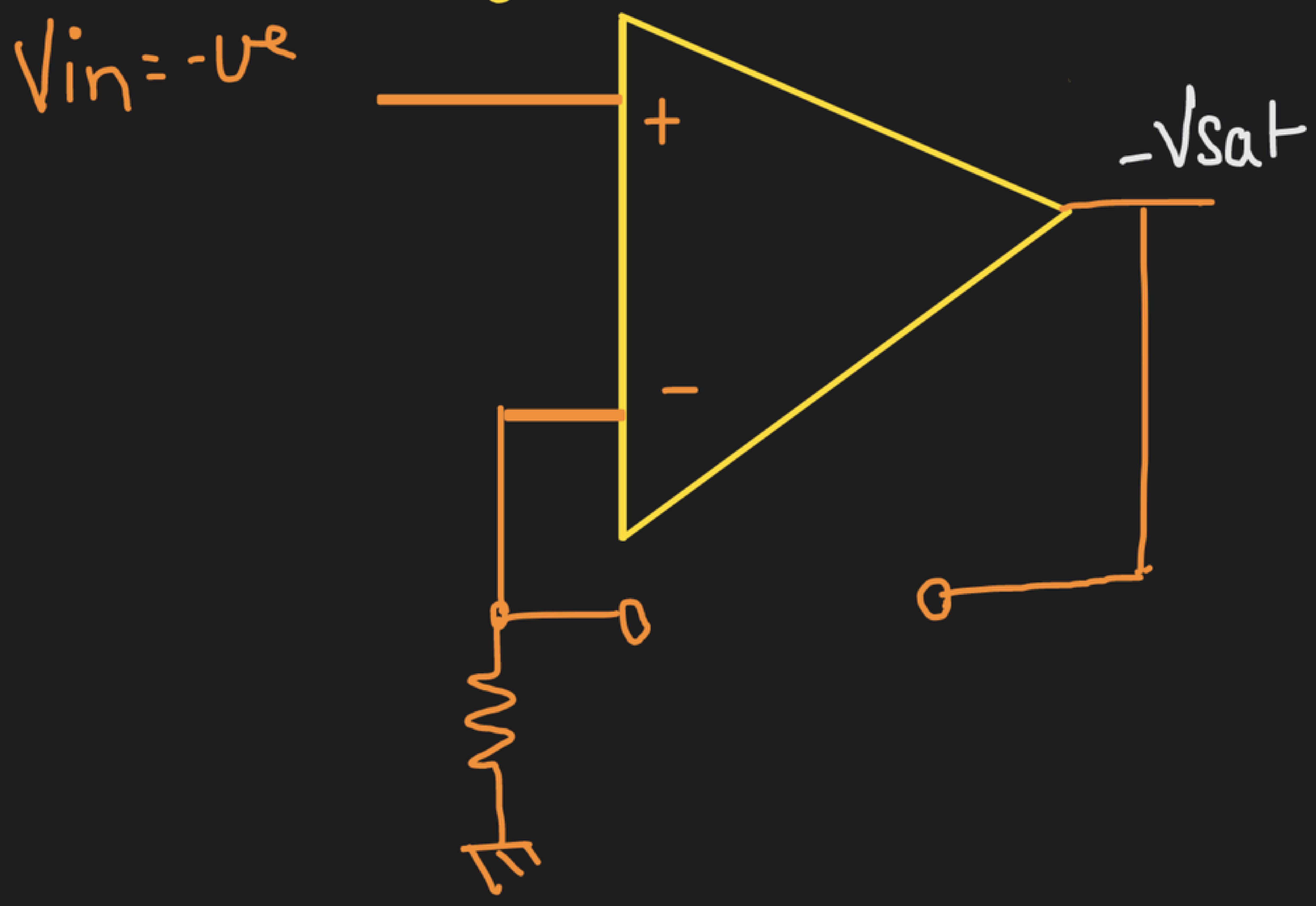

Vin +ve
Vo + Vsat
diode OFF

If $V_{in} = V_m \cos\omega t$, then the output waveform $V_{out}$ is

"diode OFF"

$\boxed{V_{in} > 0 \quad V_o = +V_{sat}}$

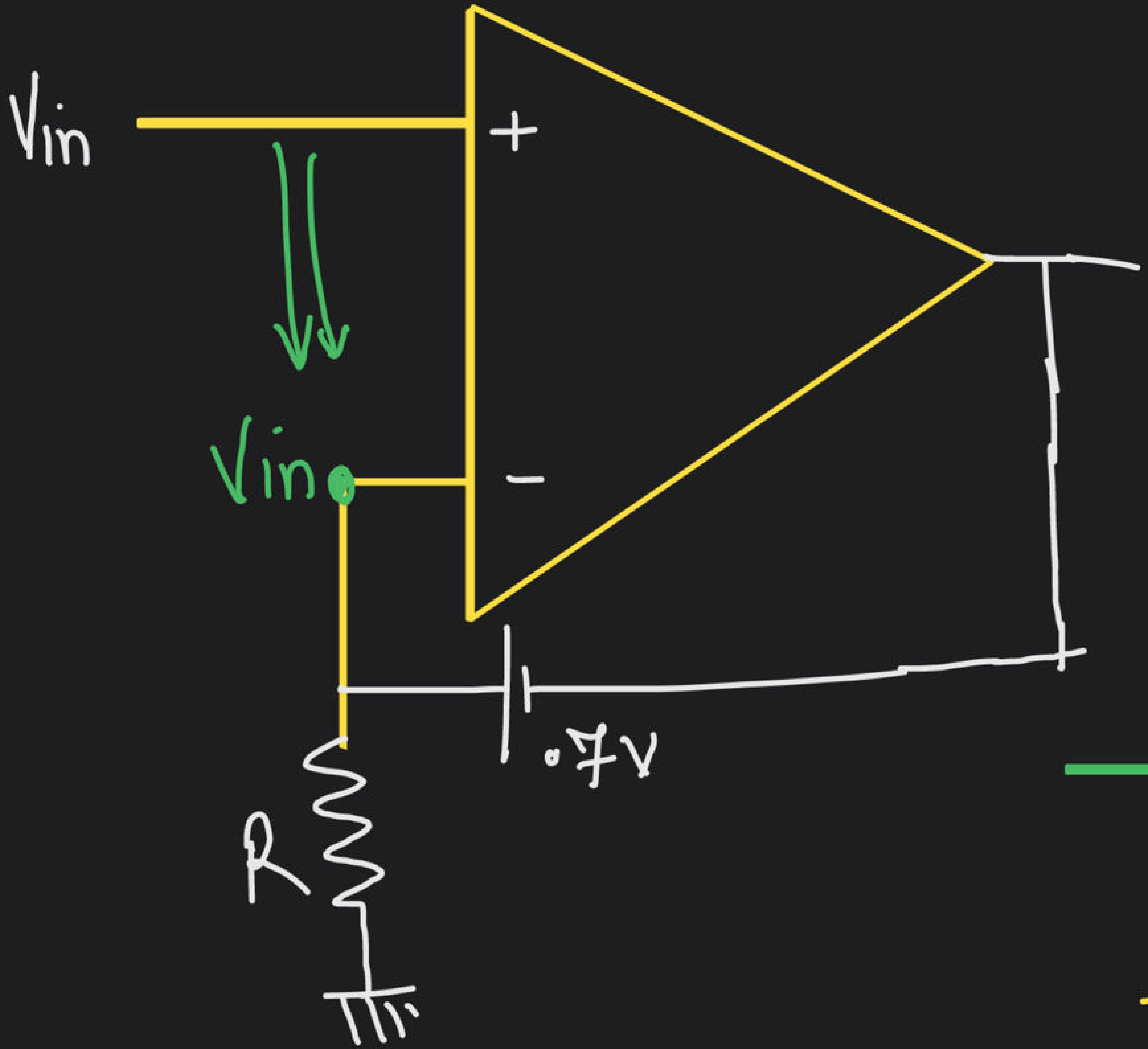
and Simply when Vin =-ve diode on.




no effect of diode

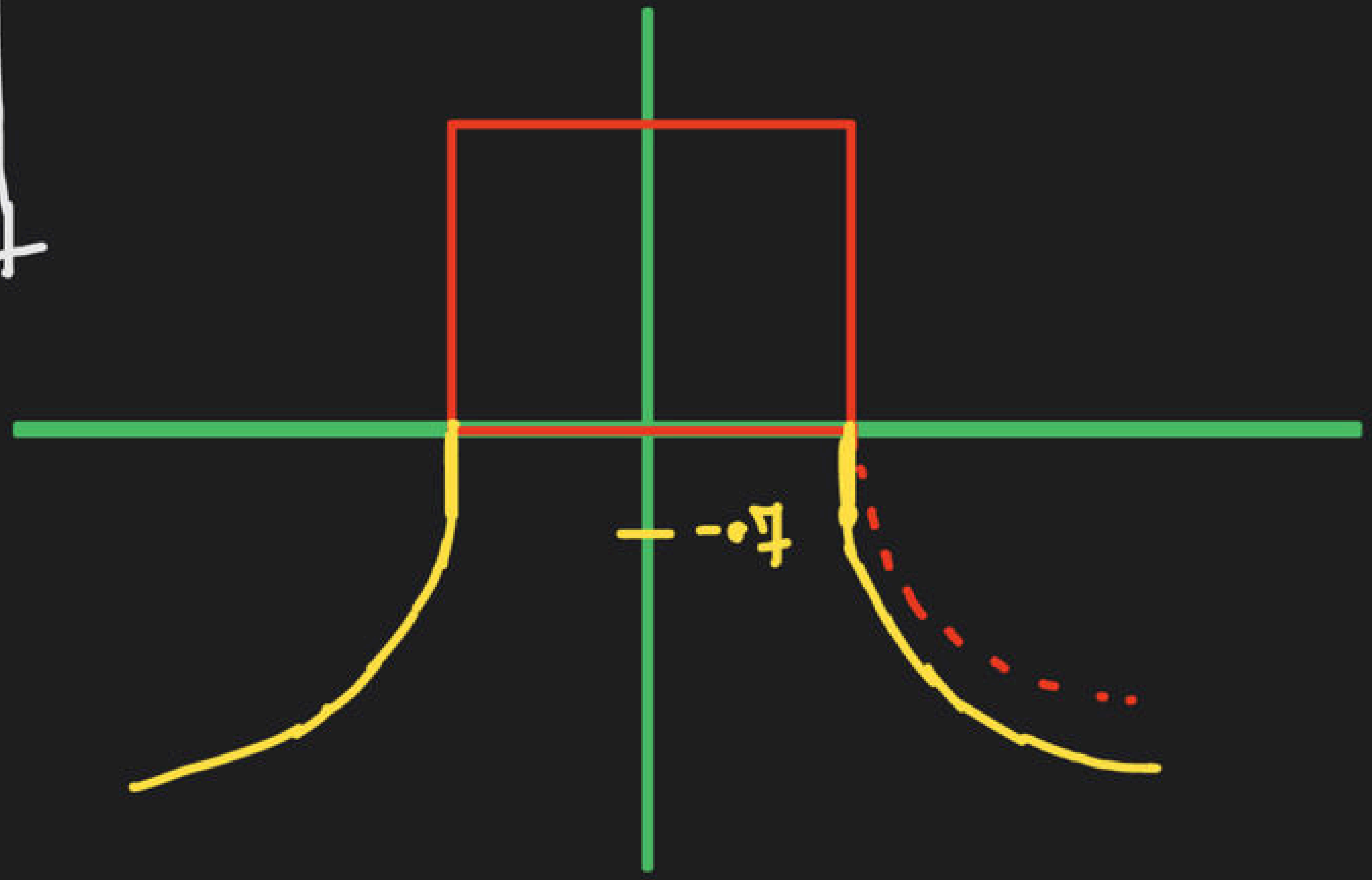
cut in, diode

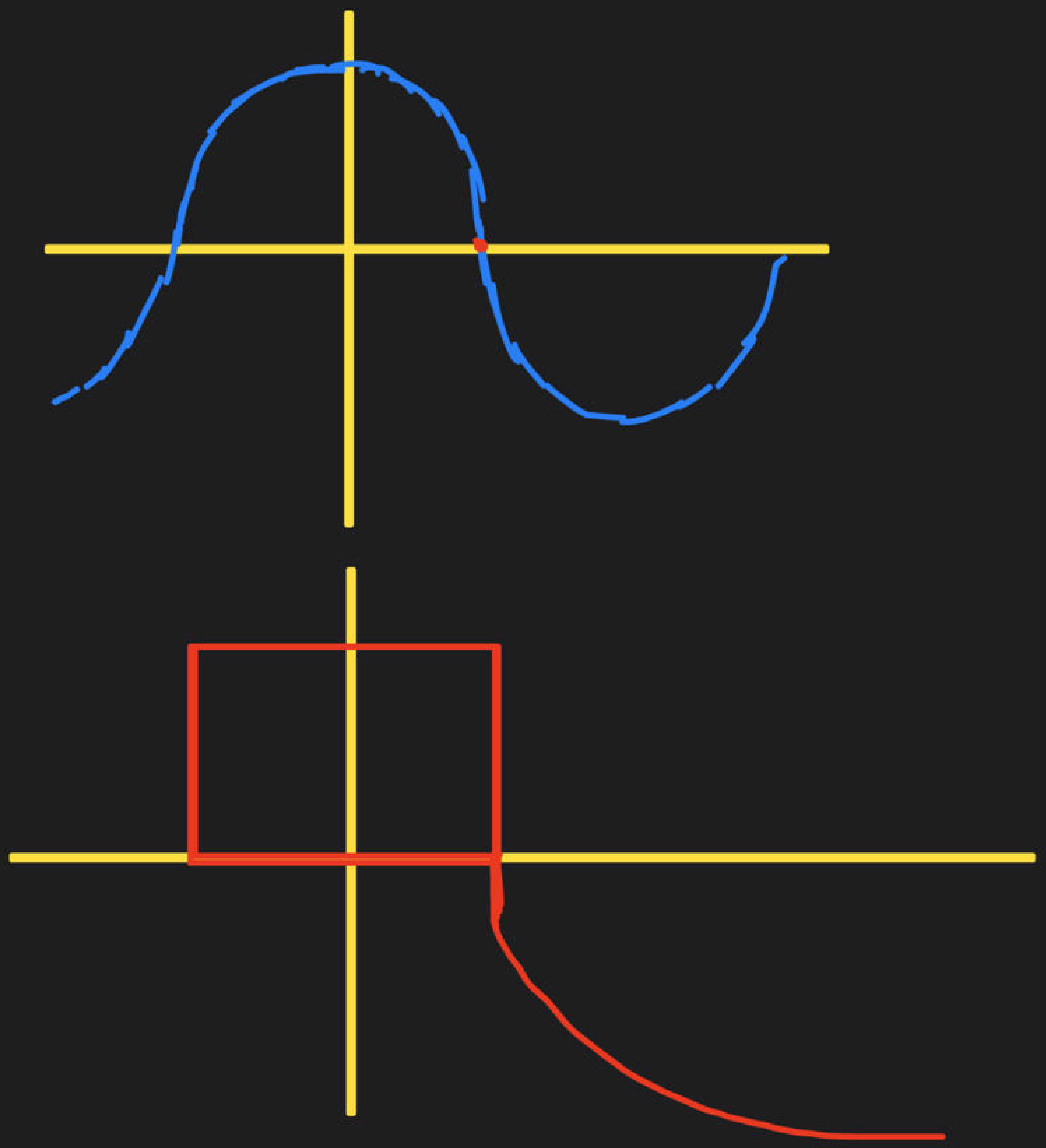
on Vin<0

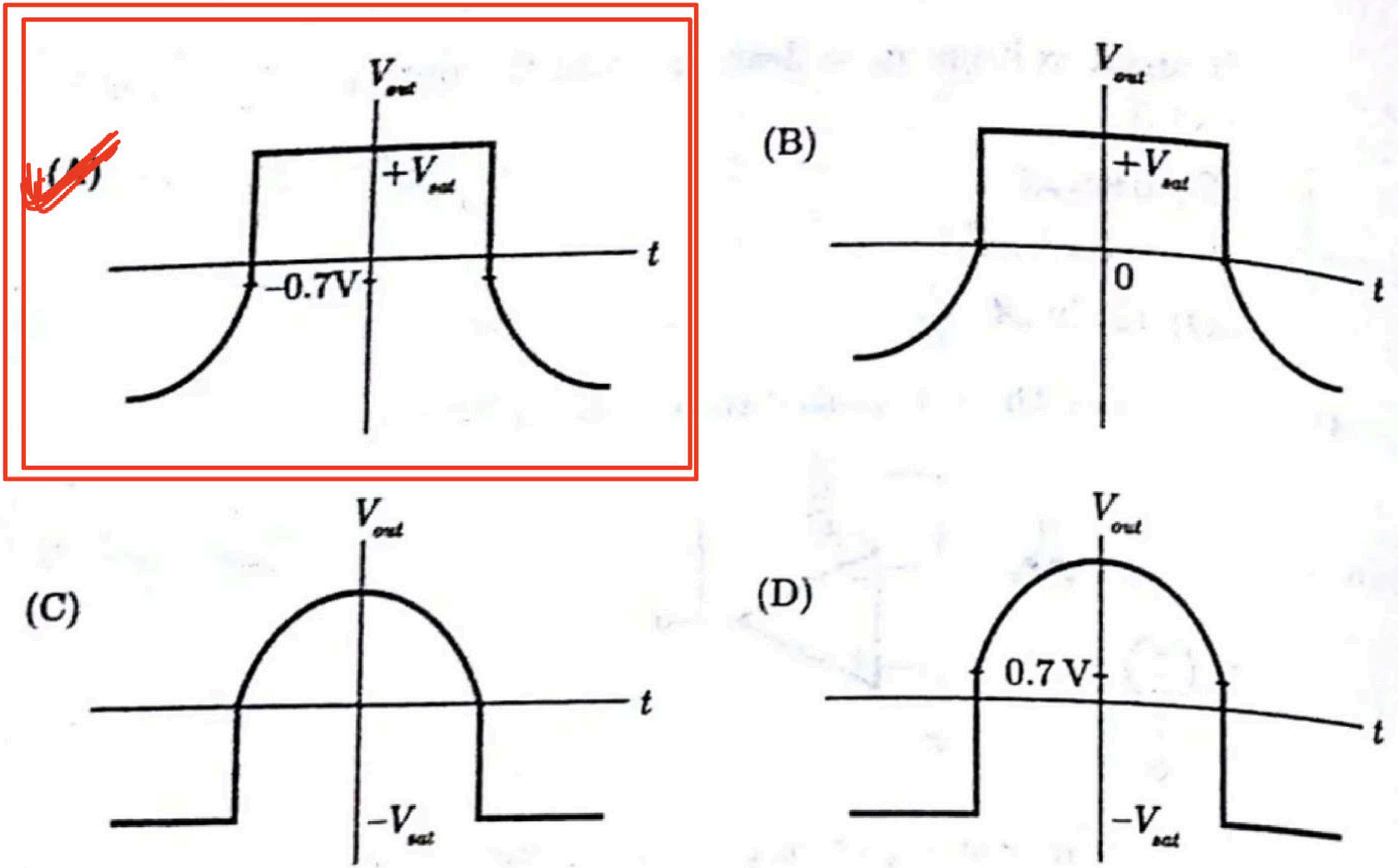



So $V_{in} < 0$ diode on

$V_O = V_{in} - .7$

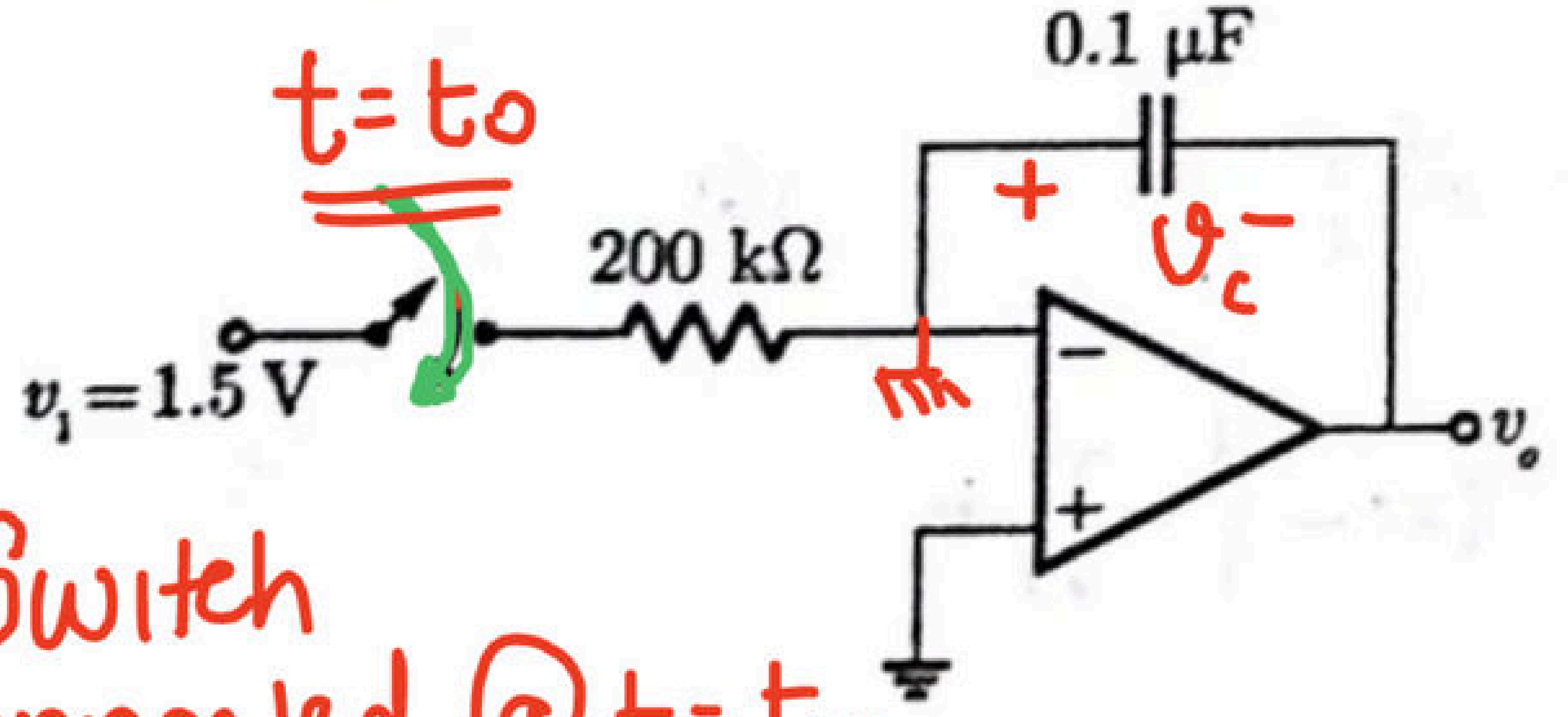





(A)
$V_{out}$
$+V_{sat}$
–0.7V
$t$
(B)
$V_{out}$
$+V_{sat}$
0
$t$
(C)
$V_{out}$
$-V_{sat}$
$t$
(D)
$V_{out}$
0.7 V
$-V_{sat}$
$t$

**MCQ 8.1.51** Consider the circuit shown in figure below. Assume op-amp is ideal.

Q




Switch Connected @ $t = t_o$

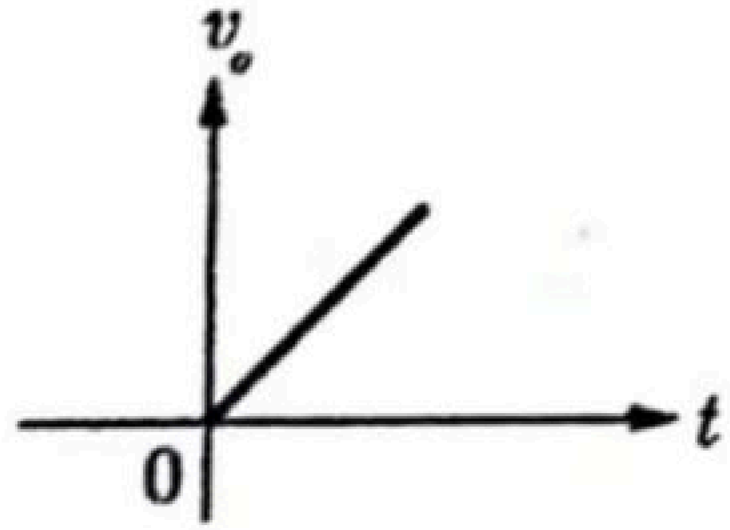
$i = \frac{1.5}{200}$ mA

$v_c = \frac{1}{C}\int i\,dt$

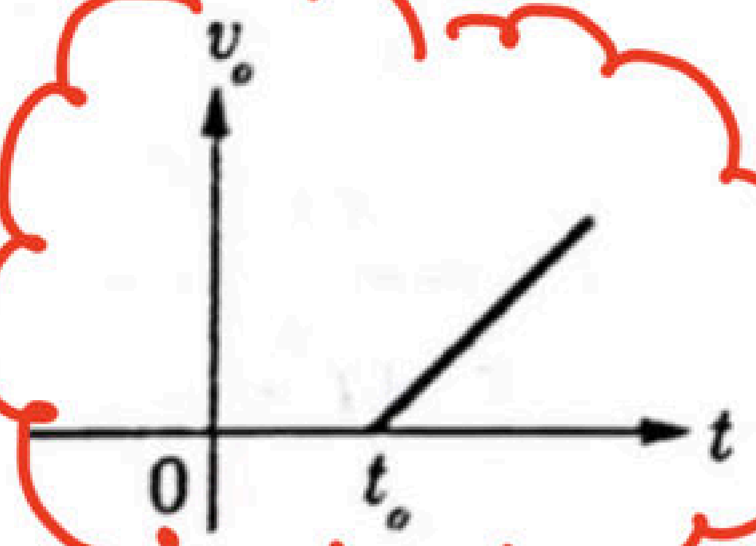
$v_o = -v_c = \boxed{-\frac{1}{C}\int i\,dt}$

The output wave form is

~~(A)~~

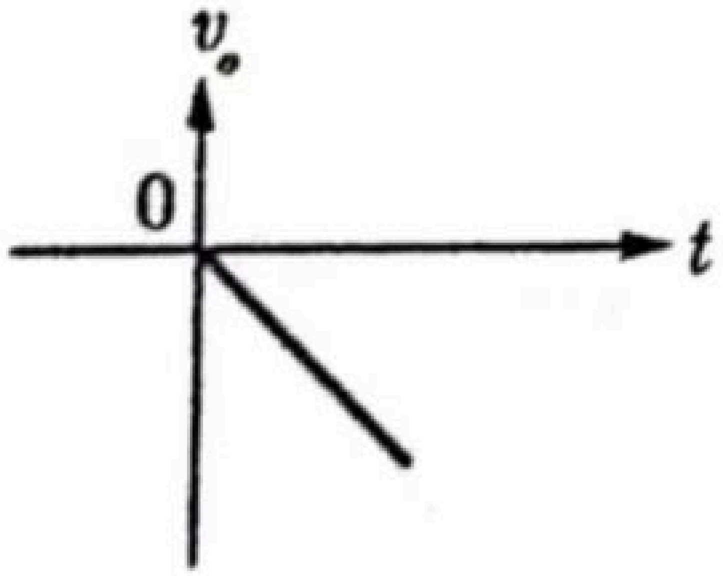



(B)

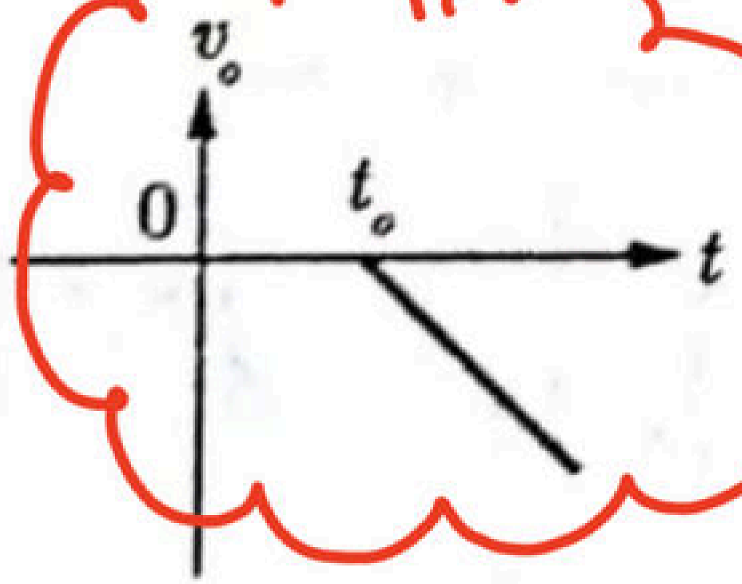



$v_c$

~~(C)~~




(D)




$v_o = -v_c$

(C) 10 µA

**MCQ 8.1.41** Consider the circuit shown below. Assume op-amp is ideal and input $v_1$, $v_2 > 0$

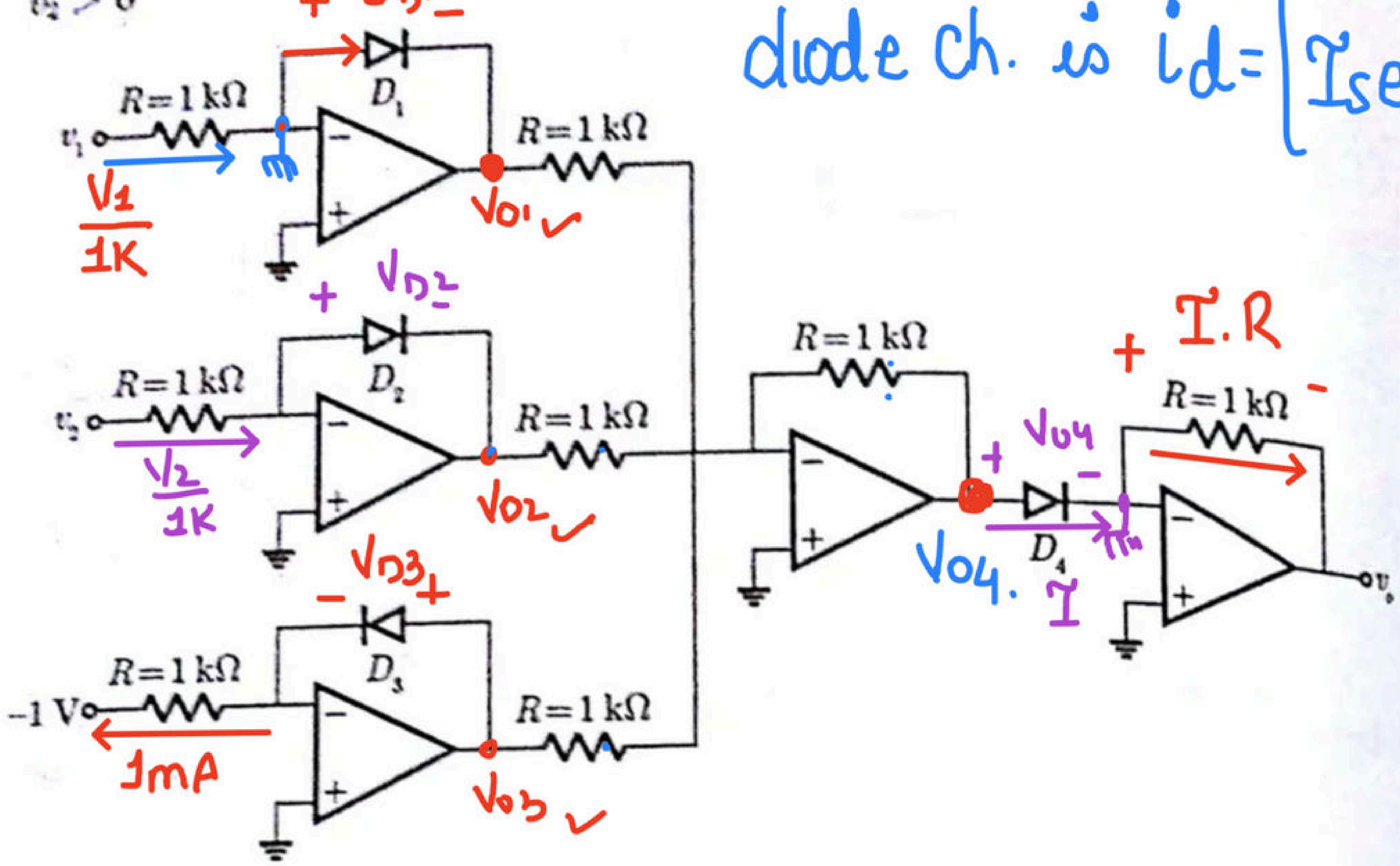
diode ch. is $i_d = \left[I_s e^{V_D/V_T}\right]$

$V_{01} = -V_{D1}$

$i = I_s e^{V_D/V_T}$

$V_D = V_T \ln\left(\frac{i}{I_s}\right)$

$v_{D1} = V_T \ln\left(\frac{V_1}{I_s 1K}\right)$




What is the value of output voltage

(A) $v_1 v_2$

(B) $-v_1 v_2$

(C) $-(v_1 + v_2)$

(D) $v_1 + v_2$

$$V_{O1} = -V_{D1} = -V_T \ln\left[\frac{V_1}{I_s \cdot 1K}\right]$$

$$V_{O2} = -V_{D2} = -V_T \ln\left[\frac{V_2}{I_s \cdot 1K}\right]$$

$$V_{D3} = V_T \ln\left[\frac{1mA}{I_s}\right]$$

$$V_{O3} = V_{D3} = V_T \ln\left(\frac{1mA}{I_s}\right)$$

$$V_{O4} = -V_{O1} - V_{O2} - V_{O3} = V_T \ln\left[\frac{V_1}{I_s \cdot 1k}\right] + V_T \ln\left[\frac{V_2}{I_s \cdot 1k}\right] - V_T \ln\left[\frac{1mA}{I_s}\right]$$

$$V_{o4} = V_T \left[ \ln \left[ \frac{V_1 V_2}{I_s^{\cancel{2}} (1k)^2} \cdot \frac{\cancel{I_s}}{1mA} \right] \right]$$

$$V_{o4} = V_T \ln \left[ \frac{V_1 V_2}{I_s \cdot 1K} \right]$$

Now $I = I_s e^{V_{o4}/V_T} = I_s \, e^{\ln\left[\frac{V_1 V_2}{I_s \cdot 1K}\right]}$

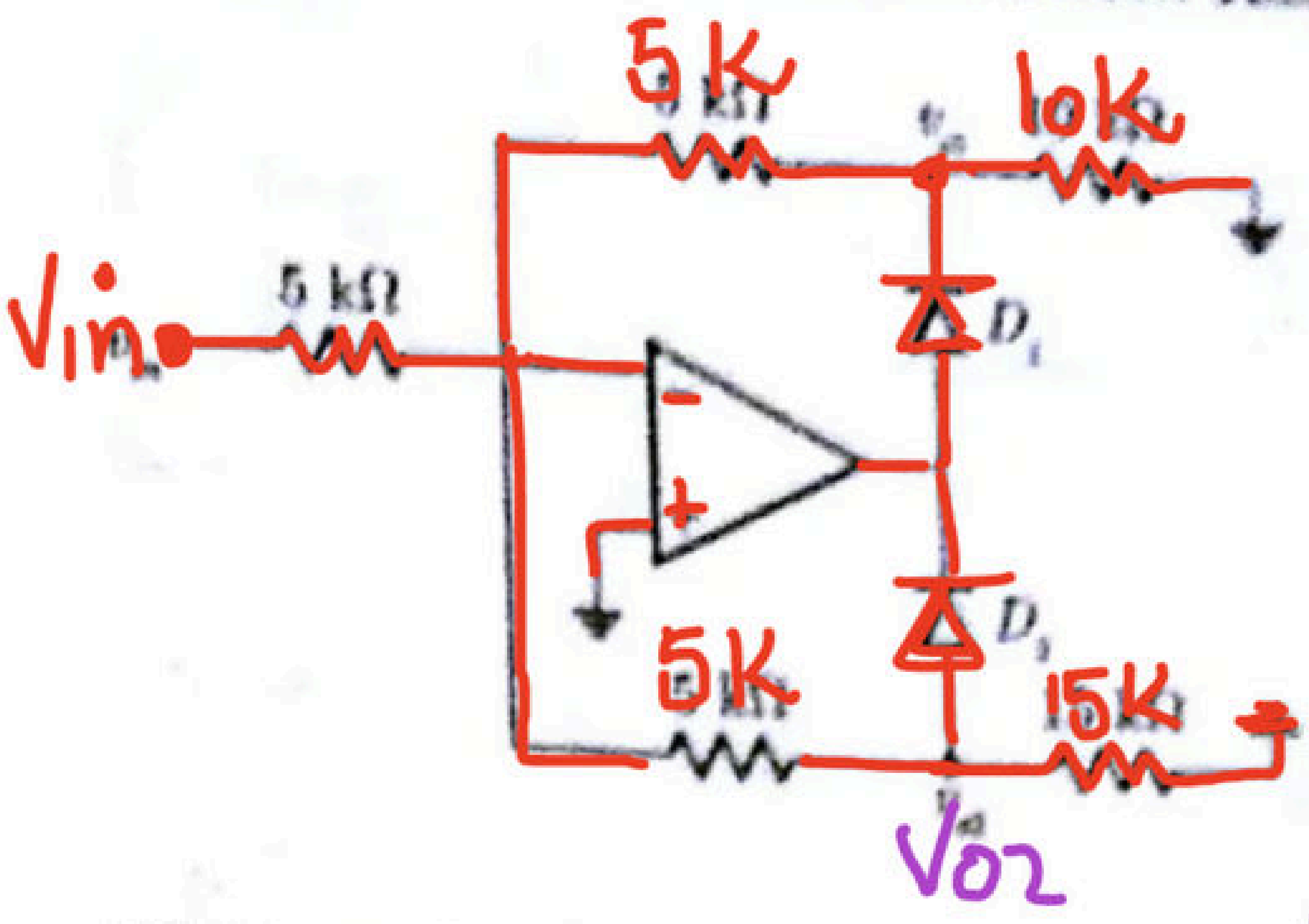
$$\Rightarrow e^{\ln x} = x \Rightarrow I = \cancel{I_s} \cdot \frac{V_1 V_2}{\cancel{I_s} \cdot 1K} = \frac{V_1 V_2}{1K}.$$

$$V_0 = -I \cdot 1K$$

$$= -\frac{V_1 V_2}{\cancel{1K}} \cdot \cancel{1K}$$

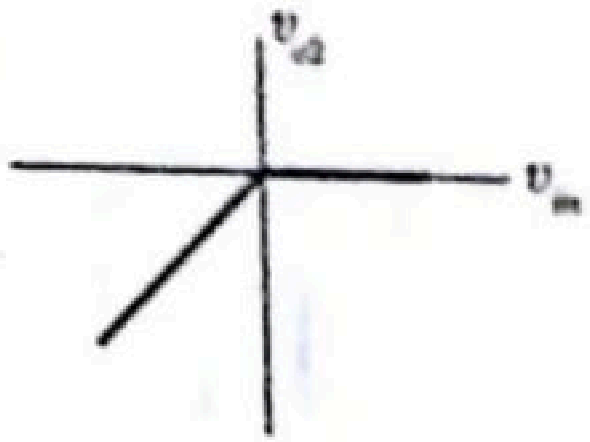
$$\boxed{V_0 = -V_1 V_2}$$

MCQ 8.1.43 Consider the circuit shown in below. Assume diodes and op-amps are ideal.

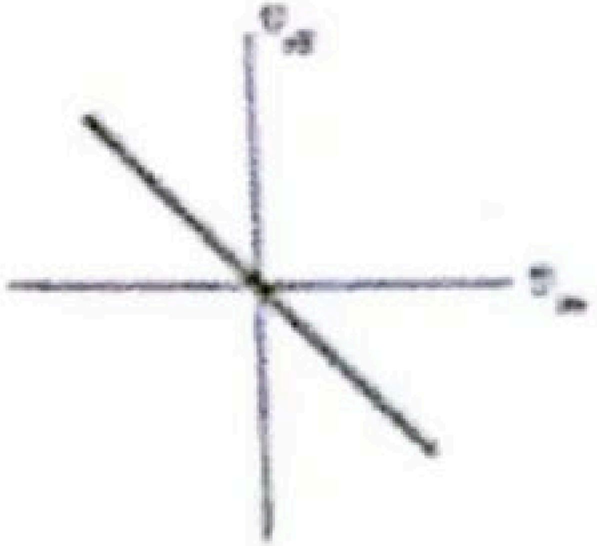



The transfer characteristic $v_{o2}$ versus $v_{in}$ will be

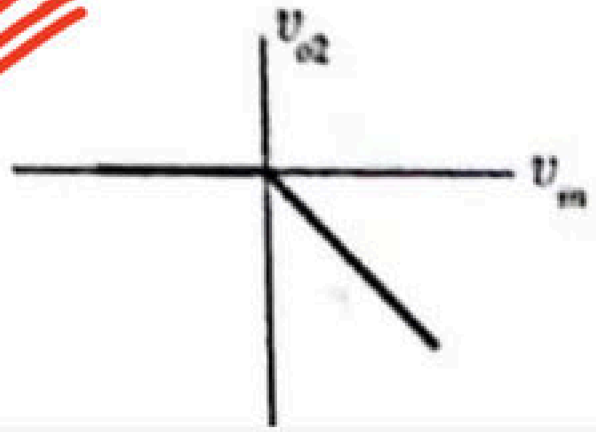
(A)



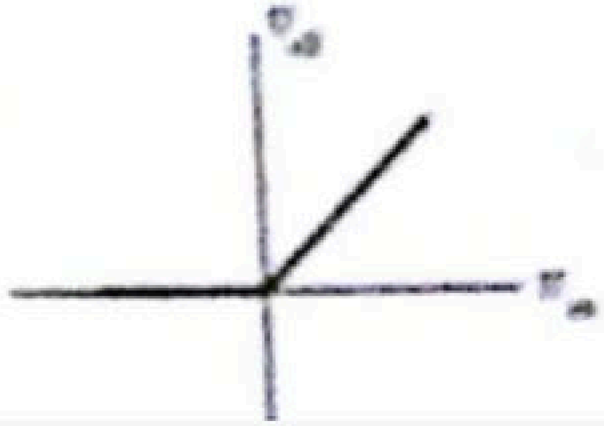

(B)



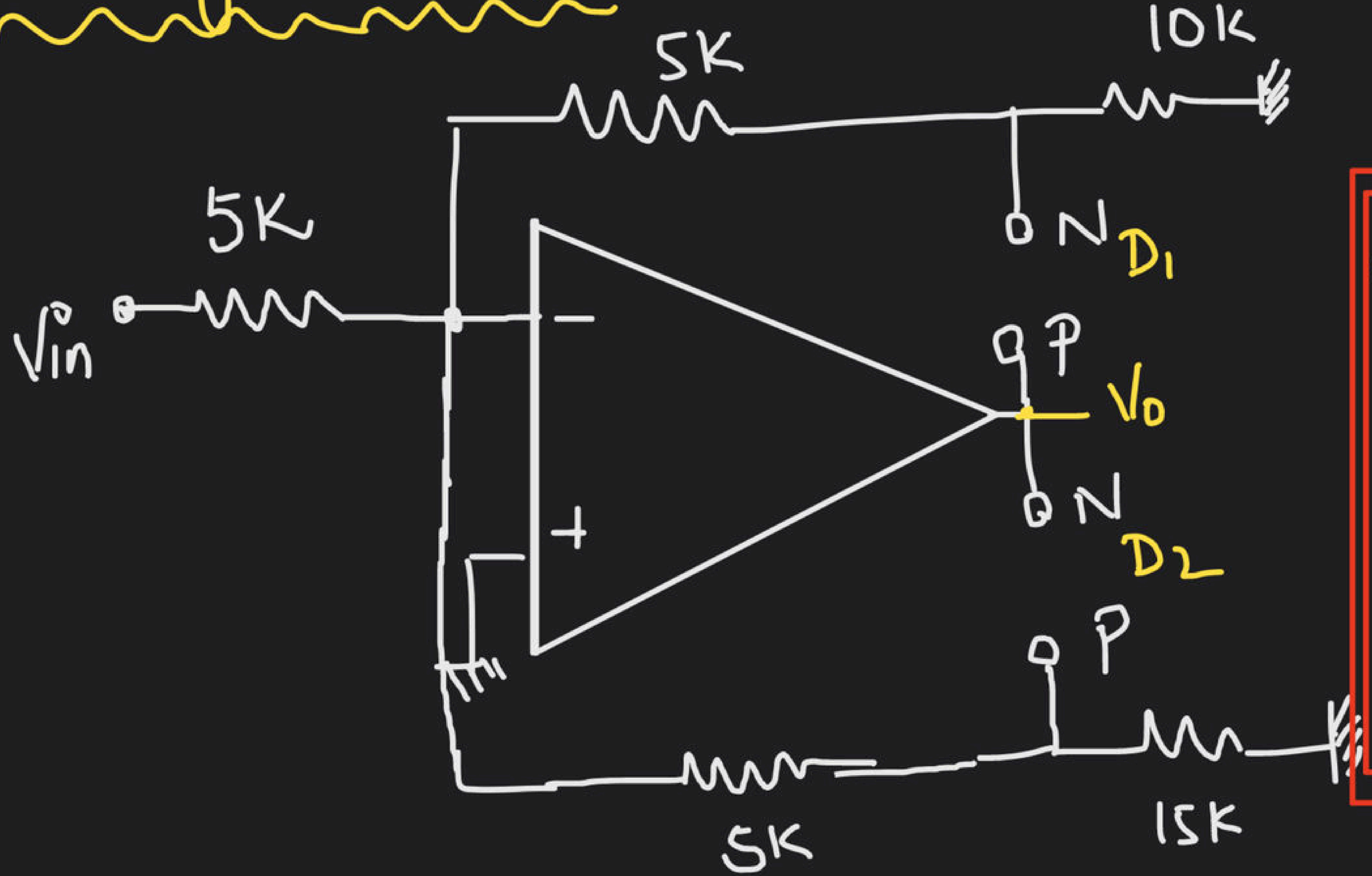

(C)




(D)



Initially diode off :-




$V_{in}$ +ve, $V_0 = -V_{bias}$

D2 on

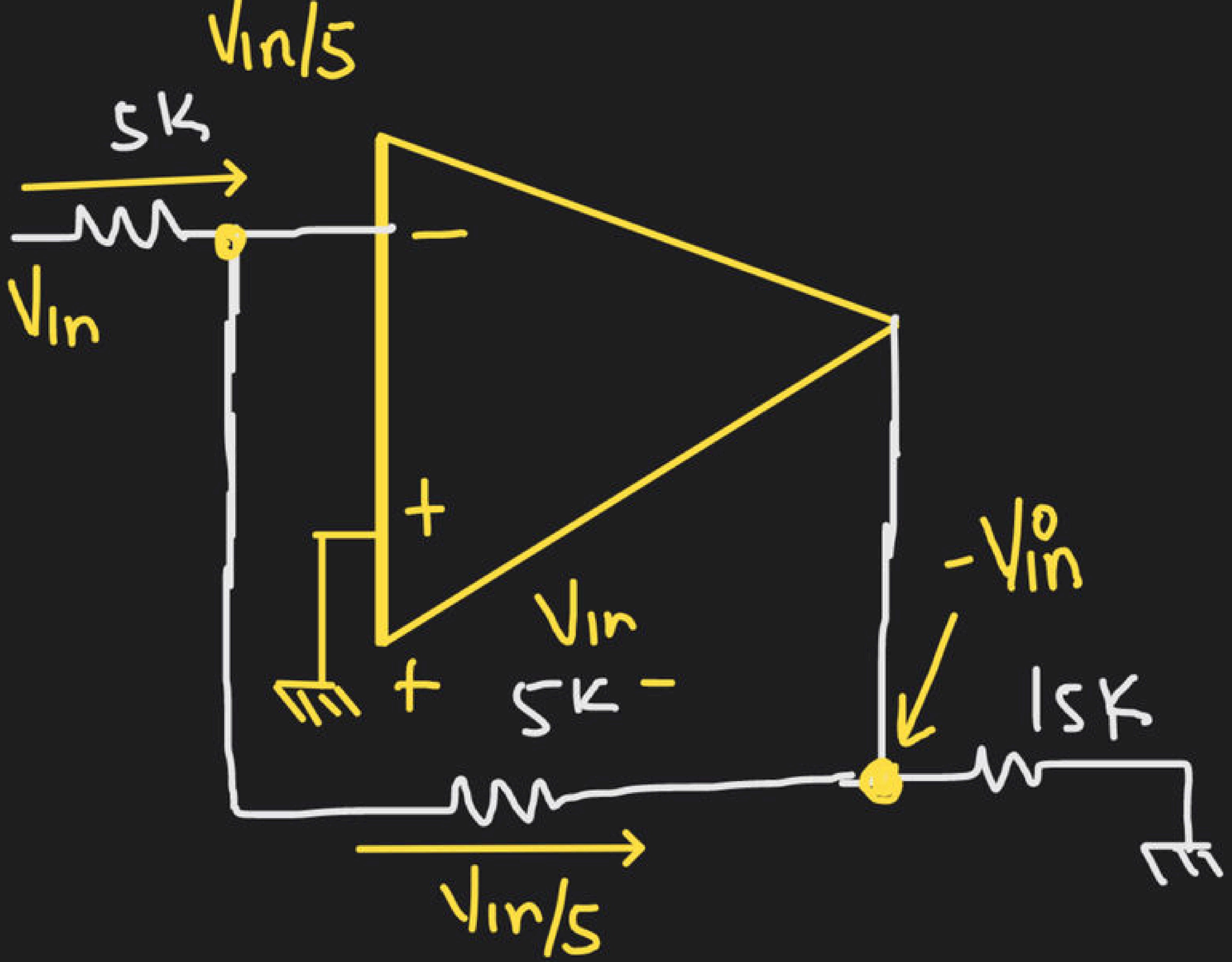
D1 OFF

$V_{in}$ -ve D2 OFF

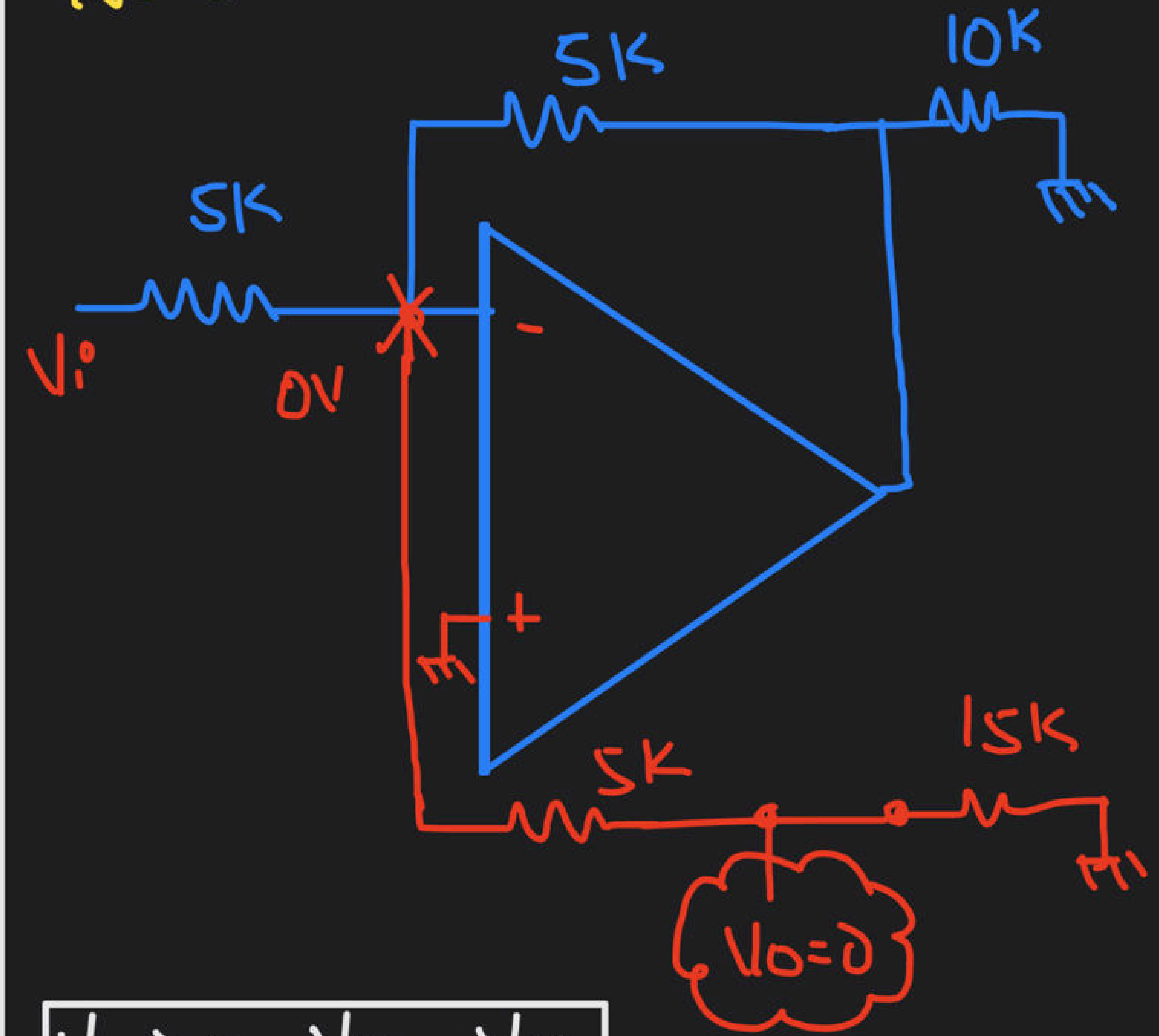
D1 on.

## For Vin +ve

$V_o = -V_{in}$



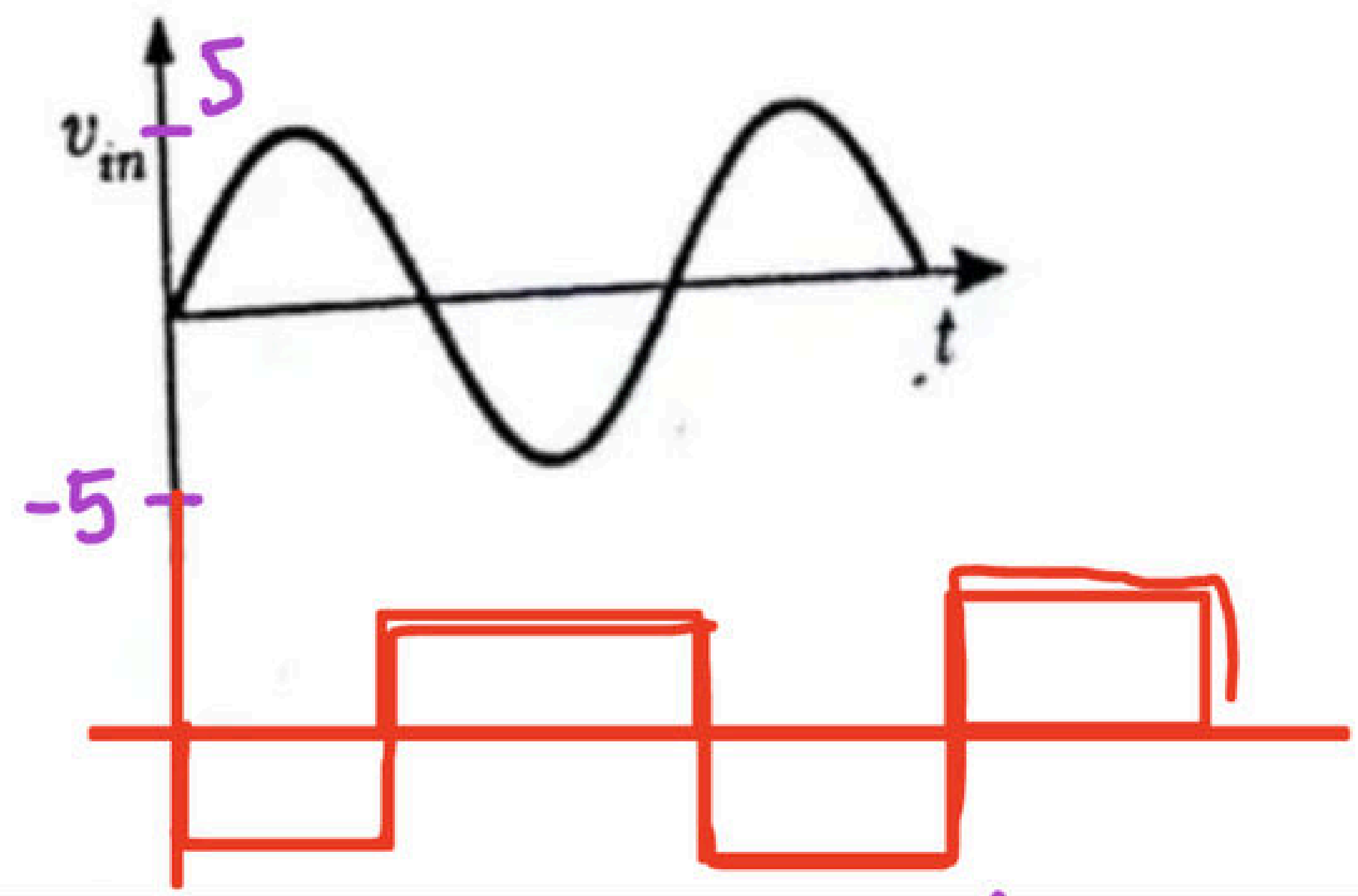

## For Vin −ve

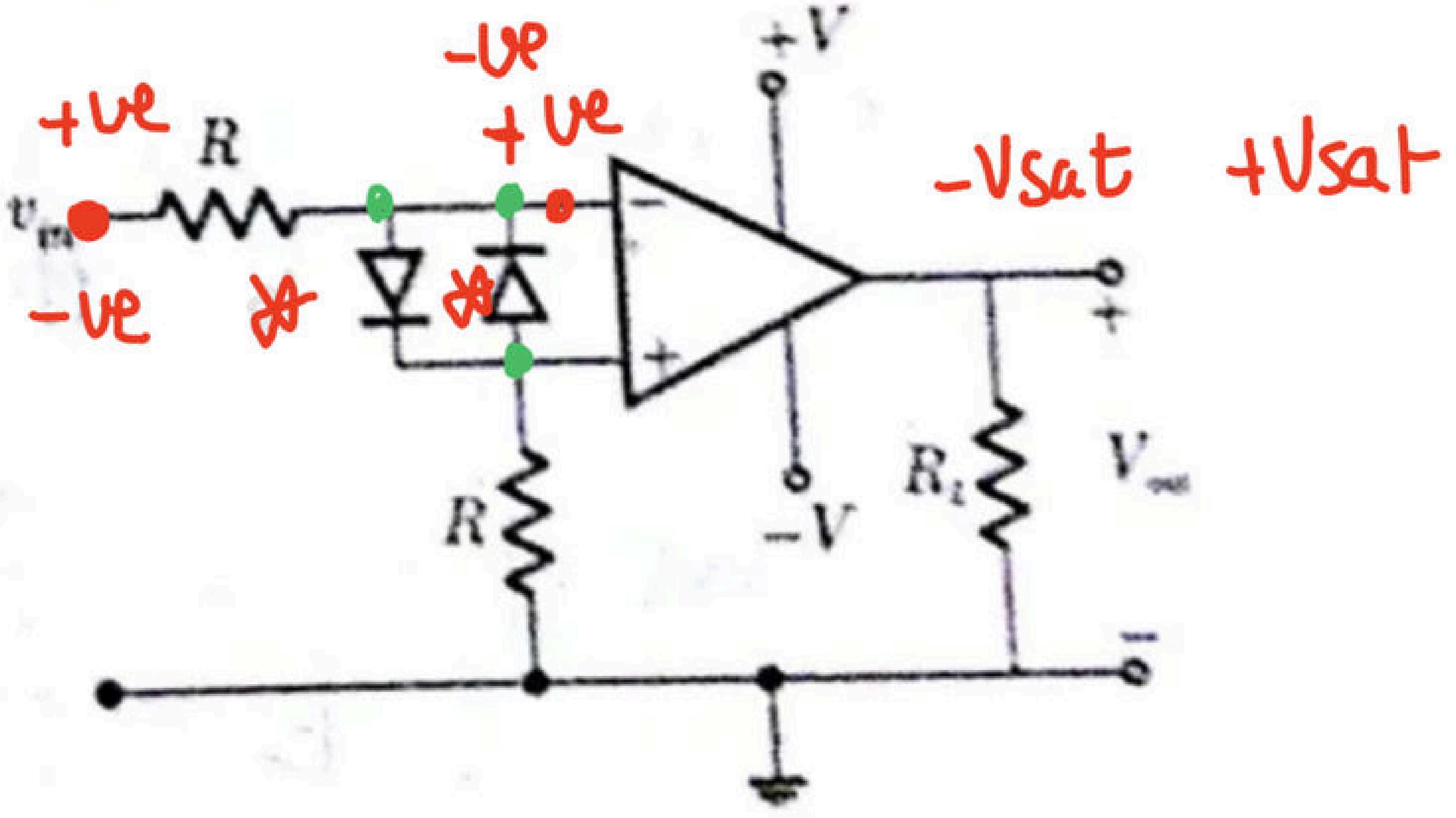



| | |
|---|---|
| $V_{in} > 0$ | $V_o = -V_{in}$ |
| $V_{in} < 0$ | $V_o = 0$ |

MCQ 8.1.29 In the given figure, if the input is a sinusoidal signal, the output will appear as

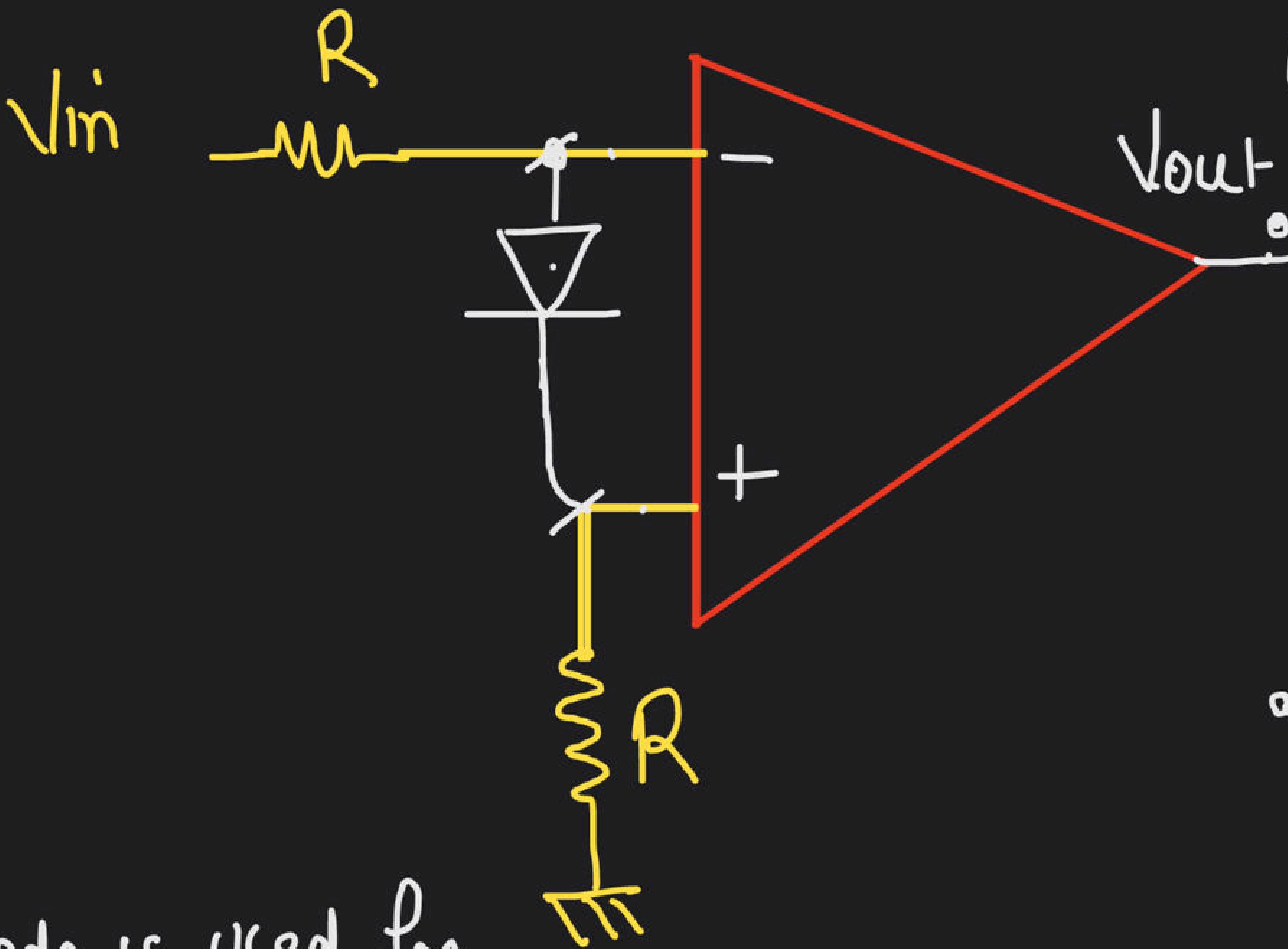
• Cut in .2V •




$V_0 \Rightarrow$ a) Sine wave b) triangular wave c) Square wave with zero avg

d) Square wave with nonzero avg.




diode Cut in = ·2

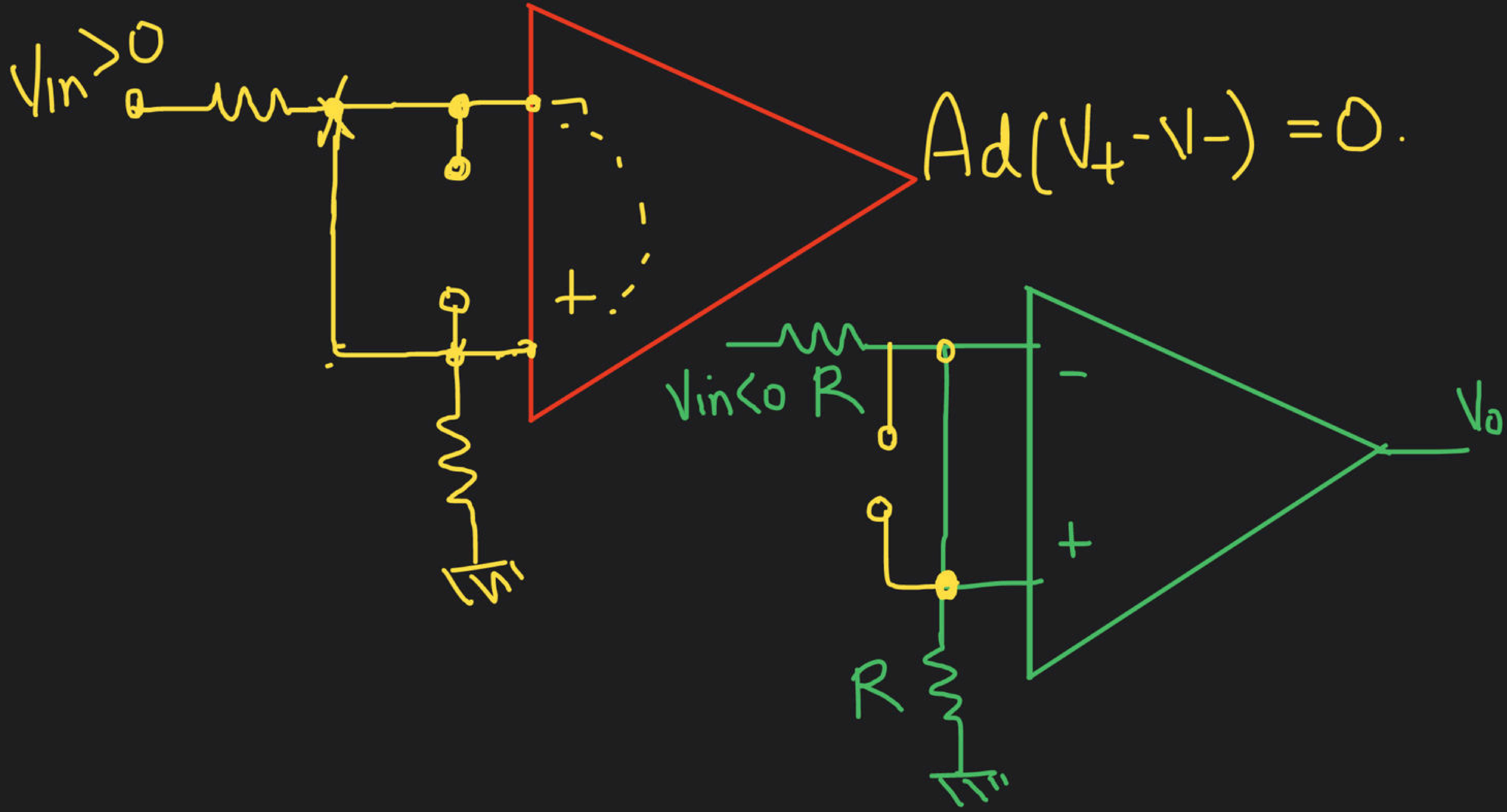
$0 < V_{in} < \cdot 2$ diode OFF

$V_{out} = -V_{sat}$

- $V_{in} > \cdot 2$ then diode on

$V_{out} = \underline{\underline{-V_{sat}}}$

diode is used for Protection :- input b/w terminals shd not be large Value



Vin>0
+
Ad(V+ - V-) = 0.
−
Vin<0 R
+
Vo
R