Assignment 1

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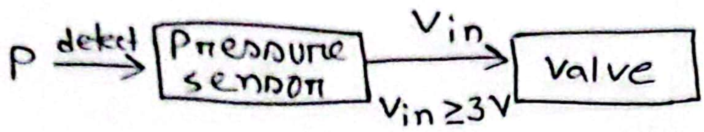
Id : 22201949

Section 09

CSE 251

Ans no 1



Valve open → Vin = low
valve close → Vin = high

$\left.\right\}$ Active low

$p = h\rho g$

$= 10 \times 1000 \times 9.81 = 98100$ Pa

$h \geq 10$

$P \geq 98100$ Pa

101325 Pa $= 1$ atm

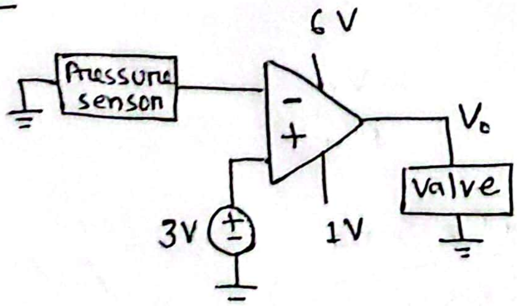
$\therefore 98100 \text{ Pa} = \dfrac{1}{101325} \times 98100 = 0.968$ atm

$P \geq 0.968$ atm → valve open

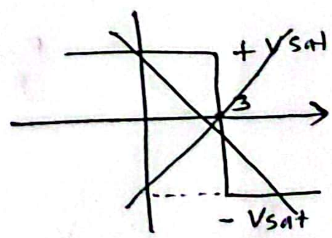
$P \geq 1$ atm → v low

$P \leq 1$ atm → v high

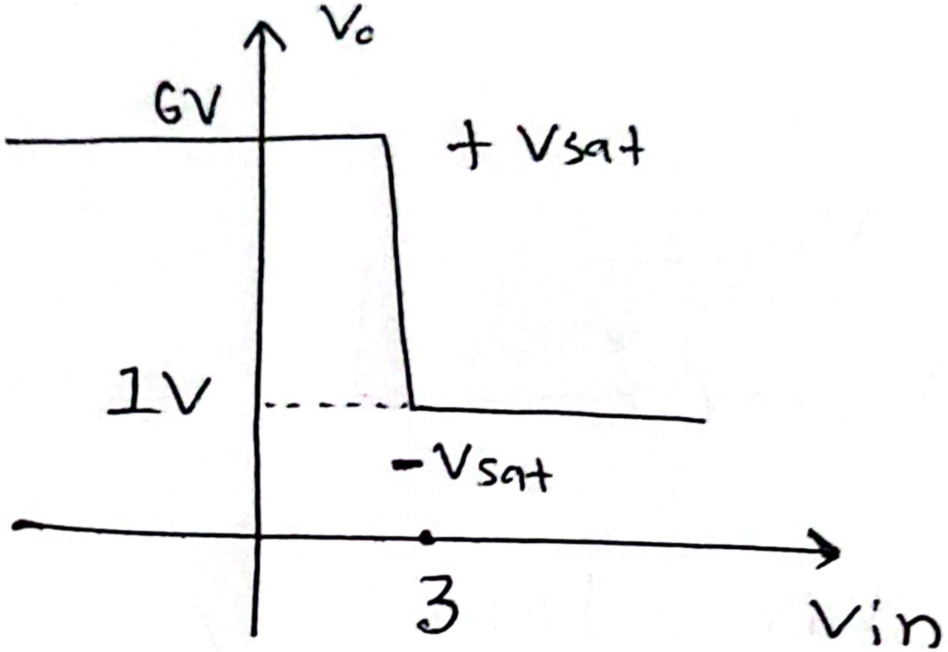
(i)



~~(ii)~~

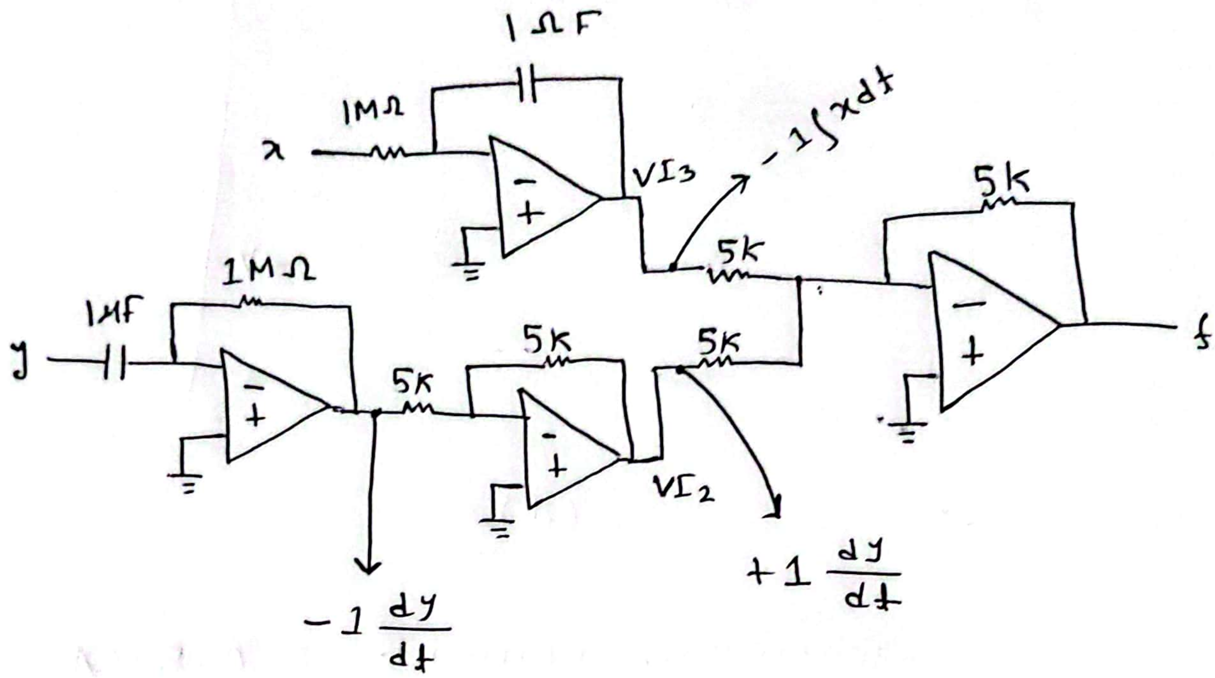


(ii)



Ans no 3

(a)

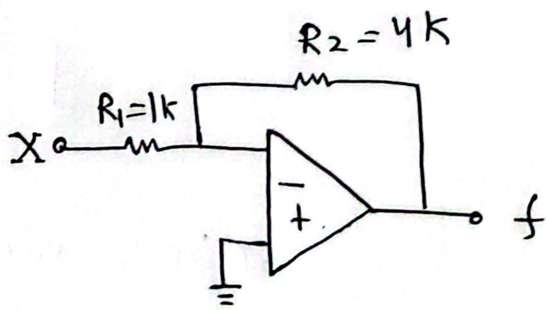


$$\therefore\ f = -\left(-1\int x\,dt + 1\frac{dy}{dt}\right)$$

$$= \int x\,dt - \frac{dy}{dt}$$

(b)

$$k = -4 = -\frac{R_f}{R_i}$$



$$\Rightarrow \frac{R_f}{R_i} = \frac{R_2}{R_1} = \frac{4}{1}$$

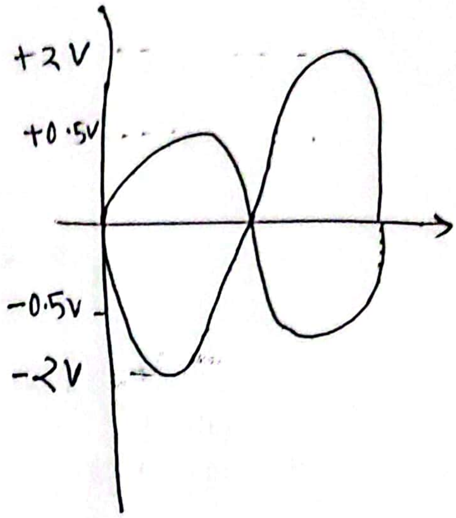
$$\therefore\ R_1 = 1\,k\Omega$$

$$R_2 = 4\,k\Omega$$

(c)

Amplitude $= \cancel{2V} - \frac{4}{1} \times 0.5$

$= -2$



(d)

maximum current $= 0.5\mu A$

so,

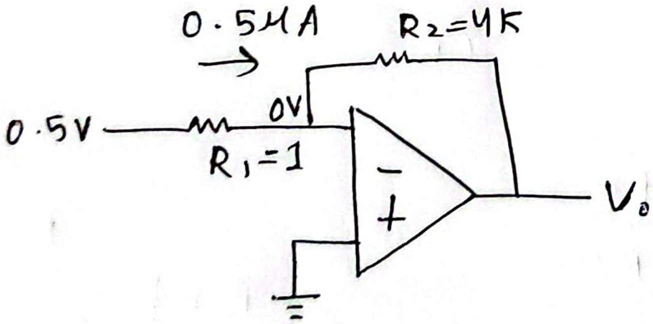
$$0.5\mu = \frac{0.5-0}{R_1}$$

$\therefore R_1 = 1M\Omega$

gain $= -4$

$\Rightarrow -\frac{R_2}{R_1} = -4$

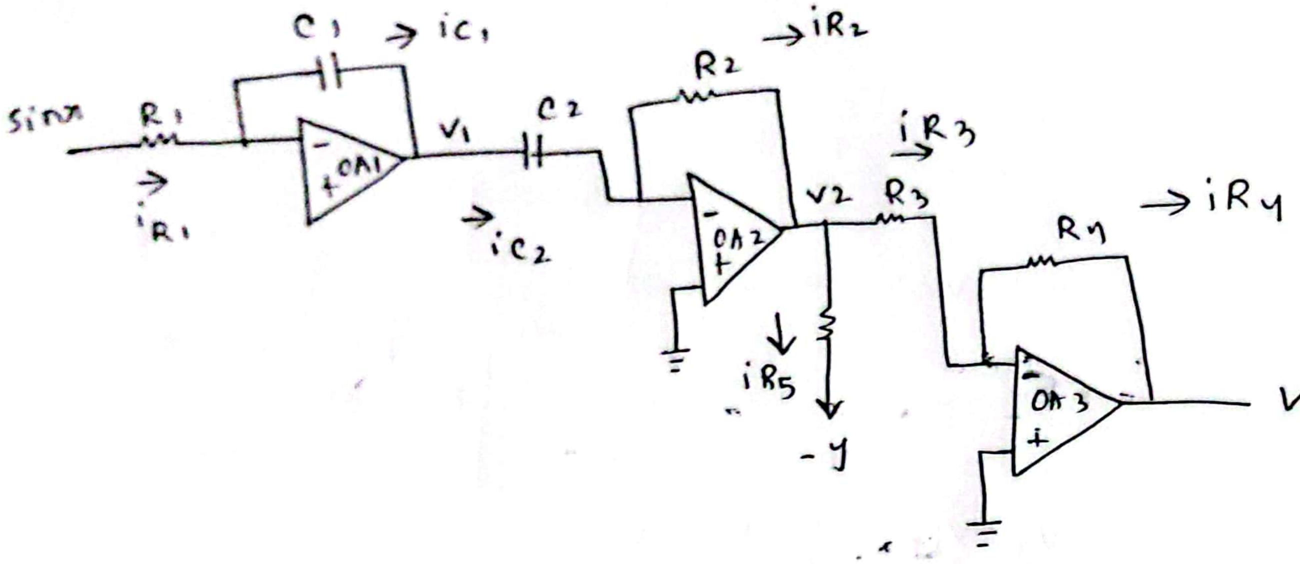
$\therefore R = 4R_1 = 4M\Omega$



so we need to set, $R_1 = 1M\Omega$ and

$R_2 = 4\ M\Omega$.

Ans no 2



$$V_1 = -\frac{1}{RC}\int \sin x\,dt$$

$$V_2 = -RC\frac{d}{dt}(V_1) = -RC\frac{d}{dt}\left(-\frac{1}{RC}\int \sin x\,dt\right)$$

$$= \sin x$$

Applying KCL,

$$i_{R_2} = i_{R_5} + i_{R_3}$$

$$\Rightarrow i_{R_1} = i_{R_5} + i_{R_3} \quad [i_{R_1} = i_{C_1} = i_{C_2} = i_{R_2}]$$

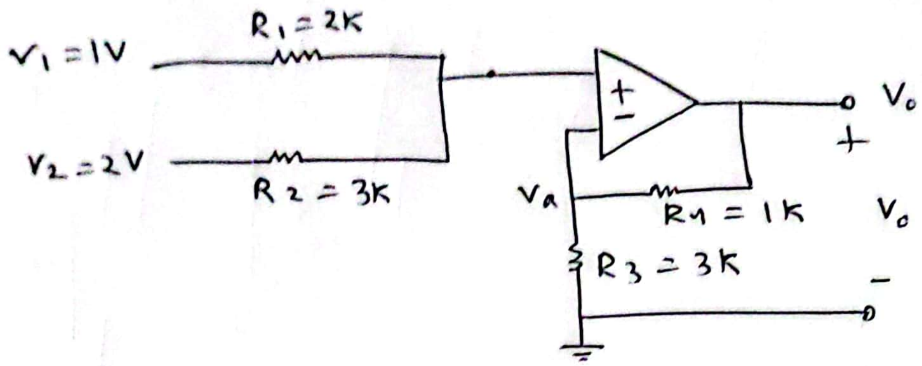
$$\Rightarrow \frac{\sin x - 0}{R_1} = \frac{V_2 - (-y)}{R_5} + i_{R_4} \quad [i_{R_3} = i_{R_4}]$$

$$\Rightarrow \frac{\sin x}{R_1} = \frac{\sin x + y}{R_5} + \frac{0 - V_0}{R_4}$$

$$\Rightarrow \frac{\sin x}{R_1} - \frac{\sin x + y}{R_5} = \frac{-V_0}{R_4}$$

$$\therefore V_0 = -\left(\frac{R_4}{R_1}\sin x - \frac{R_4}{R_5}(\sin x + y)\right)$$

Ans no 4



$$\frac{V_1 - V_{in}}{R_1} + \frac{V_2 - V_{in}}{R_2} = 0 \quad \cdots (i)$$

$$V_a = \frac{R_3}{R_3 + R_4} V_o \quad \cdots (ii)$$

(i), (ii) $\Rightarrow$

$$V_1 - V_a + \frac{R_1}{R_2} V_2 - \frac{R_1}{R_2} V_a = 0$$

$$\Rightarrow V_a \left(1 + \frac{R_1}{R_2}\right) = V_1 + \frac{R_1}{R_2} V_2$$

$$\Rightarrow \frac{R_3 V_o}{R_3 + R_4} \left(1 + \frac{R_1}{R_2}\right) = V_1 + \frac{R_1}{R_2} V_2$$

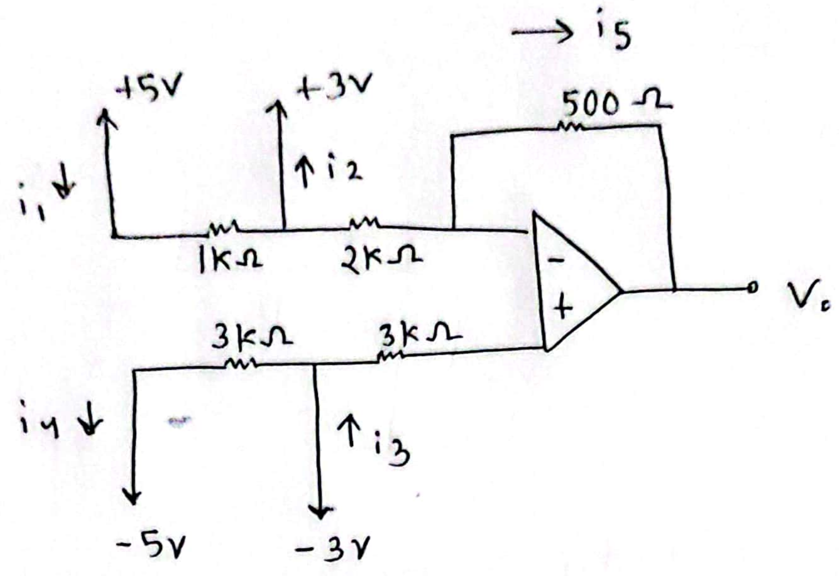
$$\Rightarrow V_o = \frac{R_3 + R_4}{R_3\left(1 + \frac{R_1}{R_2}\right)} \left(V_1 + \frac{R_1}{R_2} V_2\right)$$

$$\Rightarrow V_o = \frac{R_3 + R_4}{R_3(R_1 + R_2)} (V_1 R_2 + V_2)$$

$$= \frac{3 + 1}{3(2+3)} (1 \times 3 + 2)$$

$$= 1.33 V$$

Ans no 5



$$i_1 = \frac{5-3}{1} = 2\ mA$$

$$i_3 = i_4 = \frac{-3-(-5)}{4} = 0.5\ mA$$

At inventing terminal

$$\frac{-3-V_o}{0.5} = \frac{3-(-3)}{2}$$

$$\Rightarrow\ -V_o = 3 \times 0.5 + 3$$

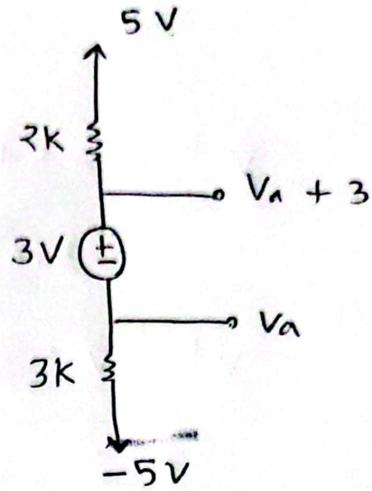
$$\therefore\ V_o = -4.5\ V$$

$$i_5 = \frac{-3+4.5}{0.5} = 3\ mA$$

$$i_2 = i_1 - i_5 = 2 - 3 = -1\ mA$$

Ans no 6

Nodal at V_a & $(V_a + 3)$:



$$\frac{V_a + 5}{3} + \frac{V_a + 3 - 5}{2} = 0$$

$\therefore \cancel{V_a = 0}$

$$\Rightarrow \frac{2V_a + 10 + 3V_a + 9 - 15}{6} = 0$$

$$\Rightarrow 5V_a + 4 = 0$$

$$\therefore V_a = -0.8\ V$$

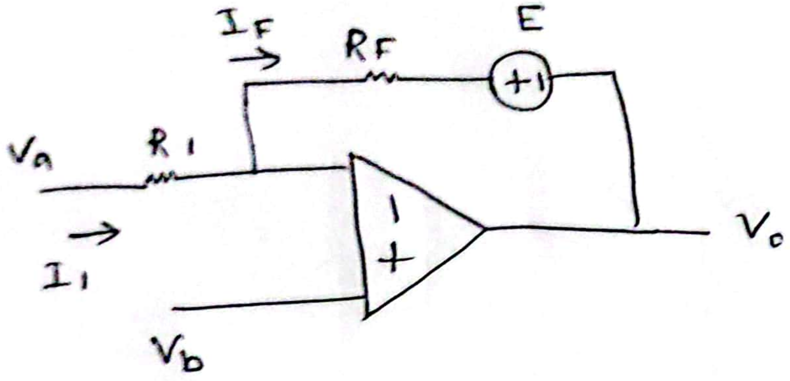
Here, V_a is connected to a non-inverting amplifier

$$\therefore V_o = -2 = V_a\left(1 + \frac{1.8}{R_1}\right)$$

$$\Rightarrow -2 = -0.8\left(1 + \frac{1.8}{R_1}\right)$$

$$\Rightarrow R_1 = 1.2\ k\Omega$$

Ans no 7



$$I_1 = \frac{V_a - V_b}{R_1}$$

$$I_F = \frac{V_b - V_o - E}{R_F}$$

$$I_1 = I_F$$

$$\Rightarrow \frac{V_a - V_b}{R_1} = \frac{V_b - V_o - E}{R_F}$$

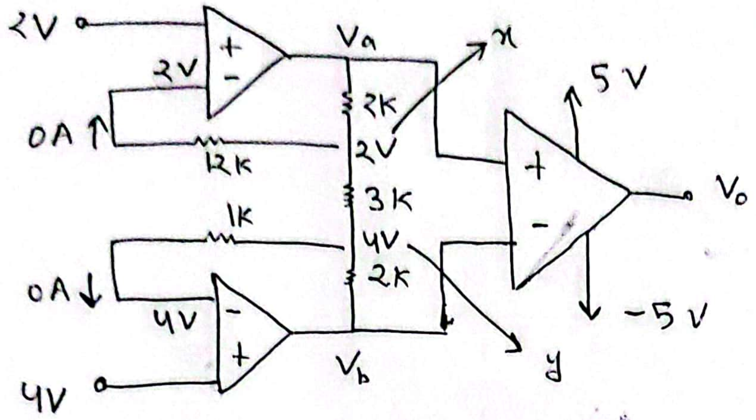
$$\Rightarrow R_F (V_a - V_b) = R_1 (V_b - V_o - E)$$

$$\Rightarrow R_F V_a - R_F V_b = R_1 V_b - R_1 V_o - R_1 E$$

$$\Rightarrow R_1 V_o = R_1 V_b - R_1 E - R_F V_a + R_F V_b$$

$$\therefore V_o = \frac{R_1 V_b - R_1 E - R_F V_a + R_F V_b}{R_1}$$

Ans no 8



Applying nodal on x :

$$\frac{x - Va}{2} + \frac{x - y}{3} = 0$$

$$\Rightarrow \frac{2 - Va}{2} + \frac{2 - 4}{3} = 0$$

$\therefore Va = 0.67\ V$

again on y node :

$$\frac{y - V_b}{2} + \frac{y - x}{3} = 0$$

$$\Rightarrow \frac{4 - V_b}{2} + \frac{4 - 2}{3} = 0$$

$$\Rightarrow \frac{4 - V_b}{2} = -\frac{2}{3}$$

$\therefore V_b = 5.33\ V$

$Va < V_b$

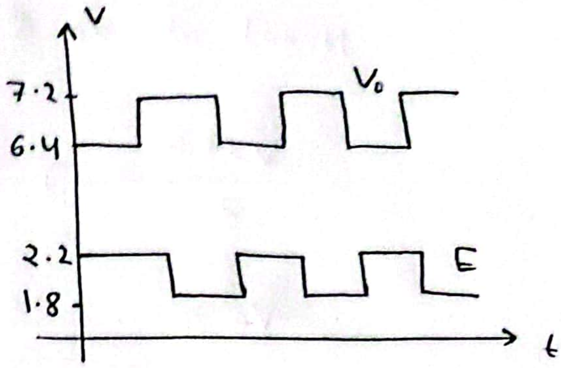
$\Rightarrow v^+ < v^-$ $\quad \therefore V_o = -5V$

Ans no 9

$v^+ = -3 + (2.2 * 3)$

$= 3.6\,V$

$v^+ = v^- = 3.6\,V$



In case of $E = 2.2V$,

we can do nodal analysis at v^-:

$(v^- - V_o)/4 + (v^- - 2.2)/2 = 0$

$\therefore V_o = 6.4\,V$

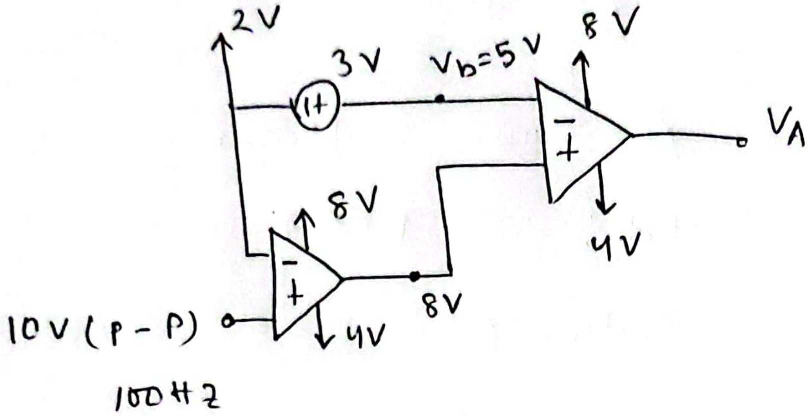
In case of $E = 1.8V$,

again nodal analysis at v^-:

$(v^- - V_o)/4 + (v^- - 1.8)/2 = 0$

$\therefore V_o = 7.2\,V$

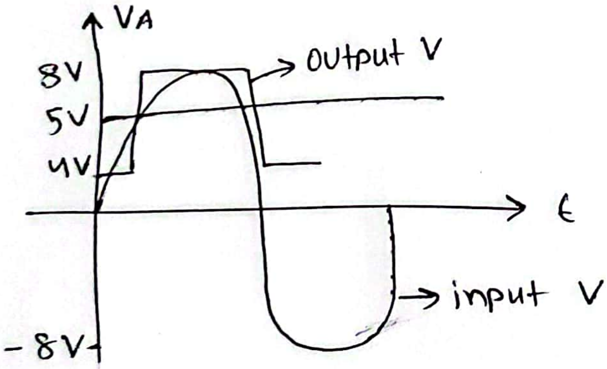
Ans 10

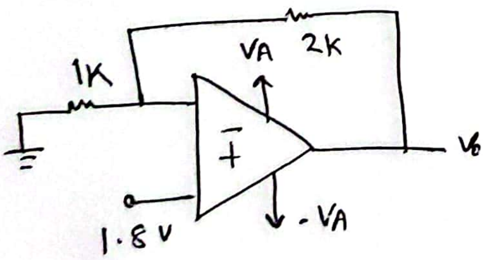


$V_b - 2 = 5 - 2 = 3V$

$\Rightarrow V_b = 5V$

$\therefore V_A = +V_{sat} = 8V$





$V_o = \left(1 + \frac{2}{1}\right) \times 1.8$

$= 5.4V$