Apurba Roy

2018-3-60-063

MID-2

[redacted]

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2018-3-60-063

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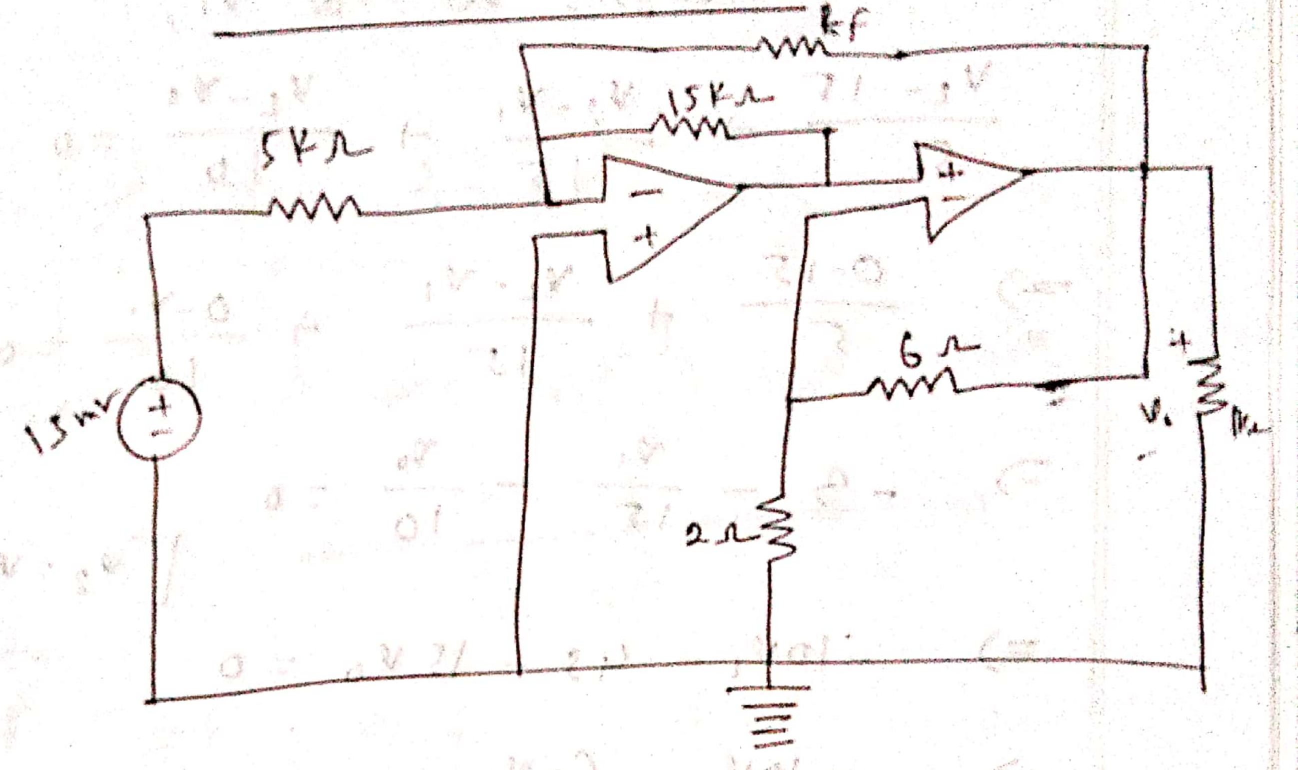
Ans to the q no 1



nodal analysis nod V_2,

$$\frac{v_1}{2} + \frac{v_1 - v_0}{6} = 0$$

$$\Rightarrow \frac{v_1}{2} = -\frac{v_1 - v_0}{6}$$

$$\Rightarrow 6v_1 = -2v_1 + 2v_0$$

$$\Rightarrow 8v_1 = 2v_0$$

$$v_1 = \frac{v_0}{4}$$

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nodal analysis at node v_1,

$$\frac{v_2 - 15}{5} + \frac{v_2 - v_1}{15} + \frac{v_2 - v_0}{10} = 0$$

$$\Rightarrow \frac{0 - 15}{5} + \frac{v_2 - v_1}{15} + \frac{0 - v_0}{10} = 0$$

$$\Rightarrow -3 - \frac{v_1}{15} - \frac{v_0}{10} = 0$$

$[v_2 = v_3 = 0]$

$$\Rightarrow -10v_1 - 45 - 15v_0 = 0$$

$$\Rightarrow \frac{-10v_0 - 60v_0}{4} = 45$$

$$\Rightarrow \frac{-70v_0}{4} = 45$$

$$\Rightarrow v_0 = \frac{180}{70}$$

$v_0 = -2.57$ mV

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Ans to the Q no-2

$$-V_{out} = \frac{V_1 - V_2}{3} + \frac{V_3}{2}$$

Sol^n :

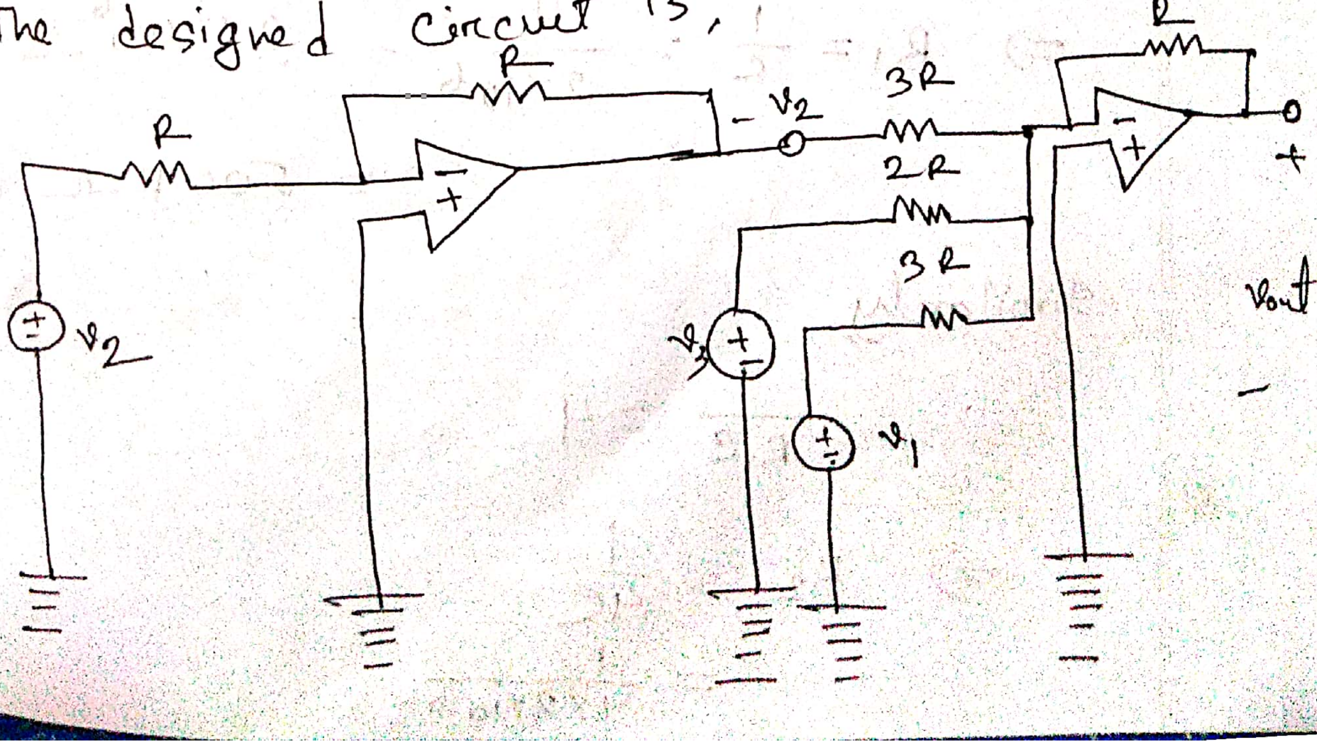
$$-V_{out} = \frac{V_1 - V_2}{3} + \frac{V_3}{2}$$

$$\Rightarrow V_{out} = -\left(\frac{1}{3}V_1 - \frac{1}{3}V_2 + \frac{1}{2}V_3\right)$$

$$\Rightarrow V_{out} = -\left[\frac{1}{3}V_1 + \frac{1}{3}(-V_2) + \frac{1}{2}V_3\right]$$

$$\Rightarrow V_{out} = -\left[\frac{R}{3R}V_1 + \frac{R}{3R}\left(-\frac{R}{R}\right)V_2 + \frac{R}{2R}V_3\right]$$

The designed circuit is,



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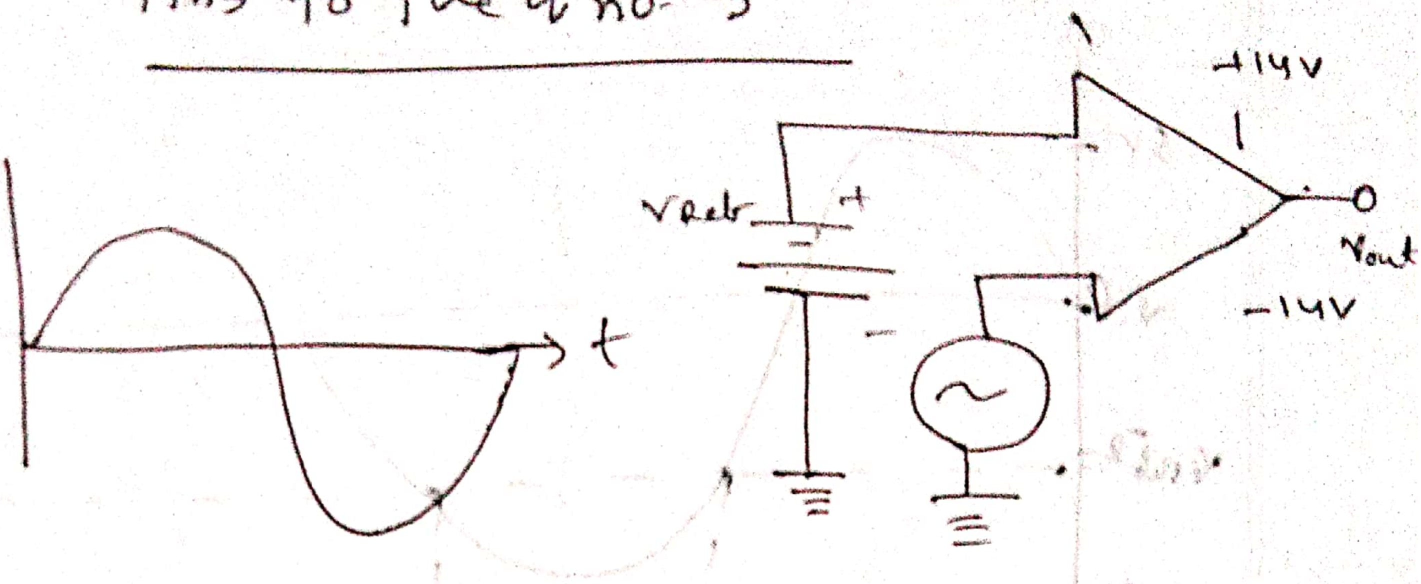
Ans to the q no. 3



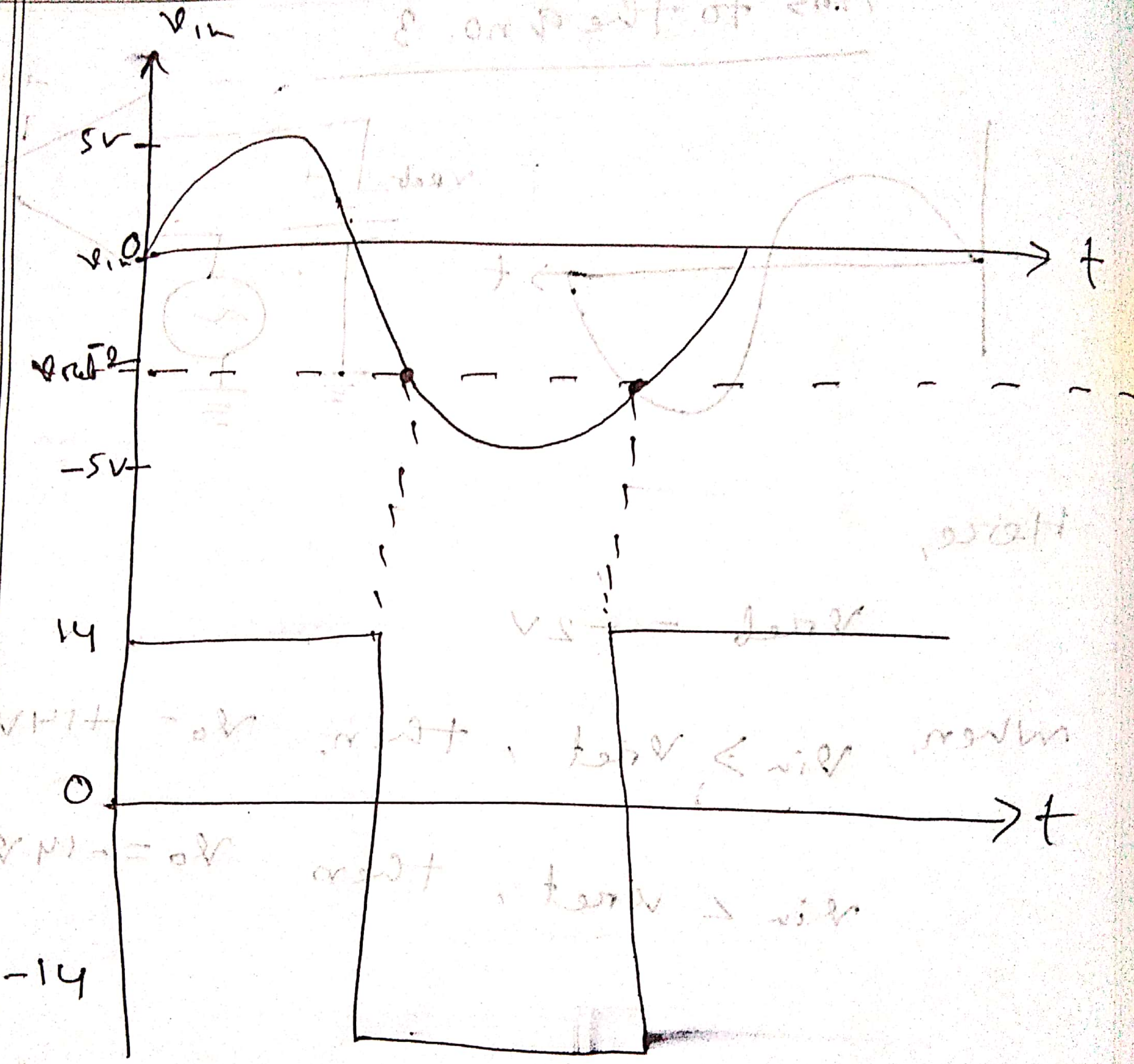
Here,

$V_{ref} = -2V$

when, $V_{in} > V_{ref}$, then $V_o = +14V$

$V_{in} < V_{ref}$, then $V_o = -14V$

P.T.O


v_{in}
5V
v_{in} 0
Vref 2
-5V
t
14
0
-14
t

Ans to the q no - 4

Sol^n: using a single op amp the integrator circuits is output with three input signals

$$v_o = -\left[\frac{1}{R_1C}\int v_1\,dt + \frac{1}{R_2C}\int v_2\,dt + \frac{1}{R_3C}\int v_3\,dt\right] \quad \text{(i)}$$

Given,

$$v_o = -\int_0^t [v_1 + 4v_2 + 10v_3]\,dt \quad \text{(ii)}$$

Comparing (i) with (ii) we have,

$$\frac{1}{R_1C} = 1$$

$$\Rightarrow R_1 = \frac{1}{C} = \frac{1}{2\times10^{-6}} = 0.5\times10^6\,\Omega$$

$$= 500\,K\Omega$$

Similarly,

$$\frac{1}{R_2C} = 4$$

$$\Rightarrow R_2 = \frac{1}{4C}$$

$$= \frac{1}{4\times2\times10^{-6}}$$

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$= 0.125 \times 10^6 \Omega$

$= 125 K\Omega$

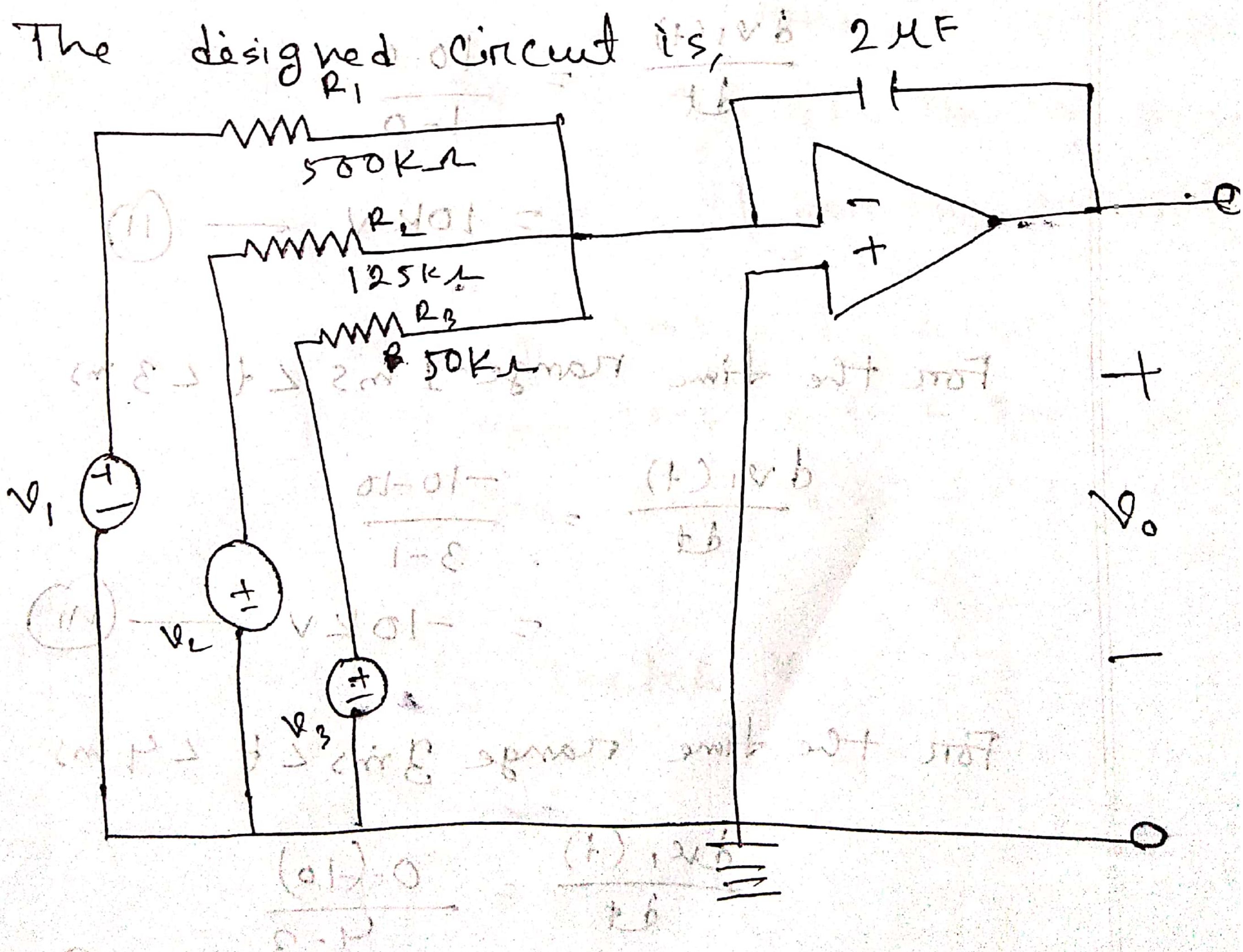
and,

$$\frac{1}{R_3 C} = 10$$

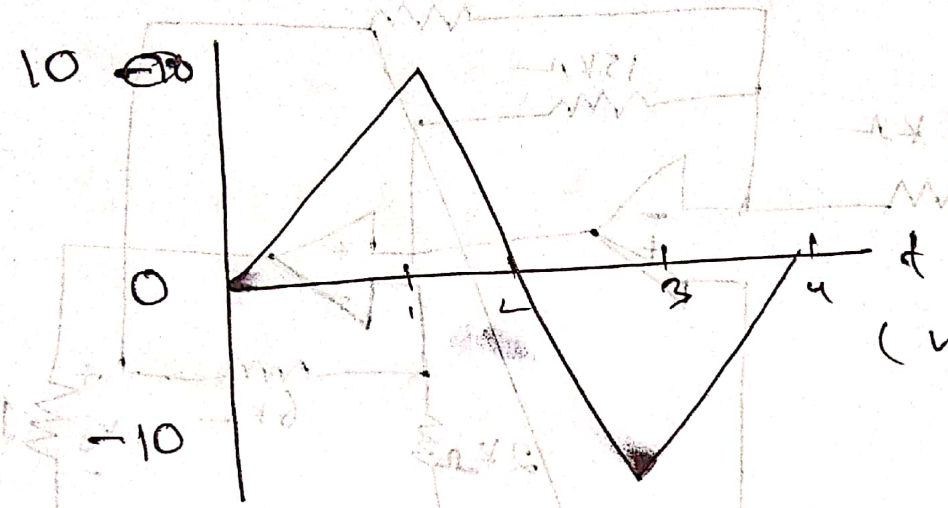
$$\Rightarrow R_3 = \frac{1}{10 \times 2 \times 10^{-6}} = 0.5 \times 10^5 \Omega$$

$$= 50 K\Omega$$

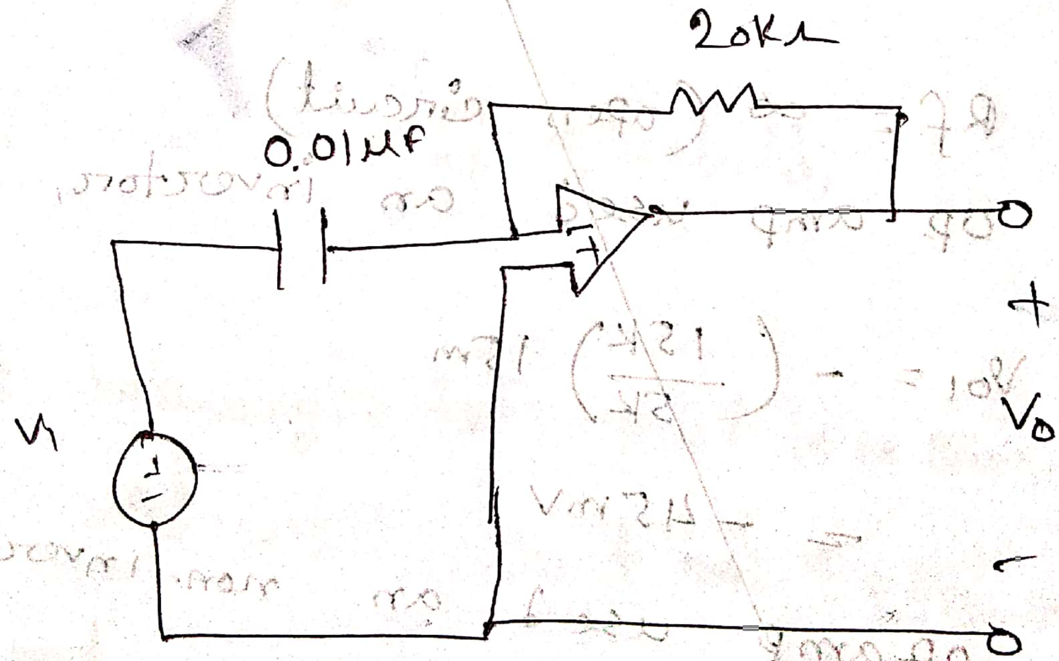
The designed circuit is,



Ans to the qns 5



(a)



(b)

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Sol^n: The output voltage of the differentiator is given by,

$$V_0 = -R_e \frac{dv_1(t)}{dt} \quad \text{—} (1)$$

Then,

For the time range $0\,ms < t < 1\,ms$

$$\frac{dv_1(t)}{dt} = \frac{10-0}{1-0}$$

$$= 10K\,V \quad \longleftarrow (ii)$$

For the time range $1\,ms < t < 3\,ms$

$$\frac{dv_1(t)}{dt} = \frac{-10-10}{3-1}$$

$$= -10KV \quad \longleftarrow (iii)$$

For the time range $3\,ms < t < 4\,ms$

$$\frac{dv_1(t)}{dt} = \frac{0-(-10)}{4-3}$$

$$= 10KV \quad \text{———} (iv)$$

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From (i), (ii), (iii) and (iv),

$$\frac{dv_i(t)}{dt} = \begin{cases} 10kV & \text{for } 0ms < t < 1ms \\ -10kV & \text{for } 1ms < t < 3ms \\ 10kV & \text{for } 3ms < t < 4ms \end{cases} \quad \text{--- (v)}$$

Substitute with (v). When, $R = 20k\Omega$, $C = 0.01\mu F$

$$v_o(t) = -20 \times 10^3 \times 0.01 \times 10^{-6} \times \begin{cases} 10kV & \text{For } 0ms < t < 1ms \\ -10kV & \text{For } 1ms < t < 3ms \\ 10kV & \text{For } 3ms < t < 4ms \end{cases}$$

$$v_o(t) = \begin{cases} -2V & \text{for } 0ms < t < 1ms \\ 2V & \text{for } 1ms < t < 3ms \\ -2V & \text{for } 3ms < t < 4ms \end{cases} \quad \text{--- (vi)}$$

Then, From (vi), sketch $v_o(t)$

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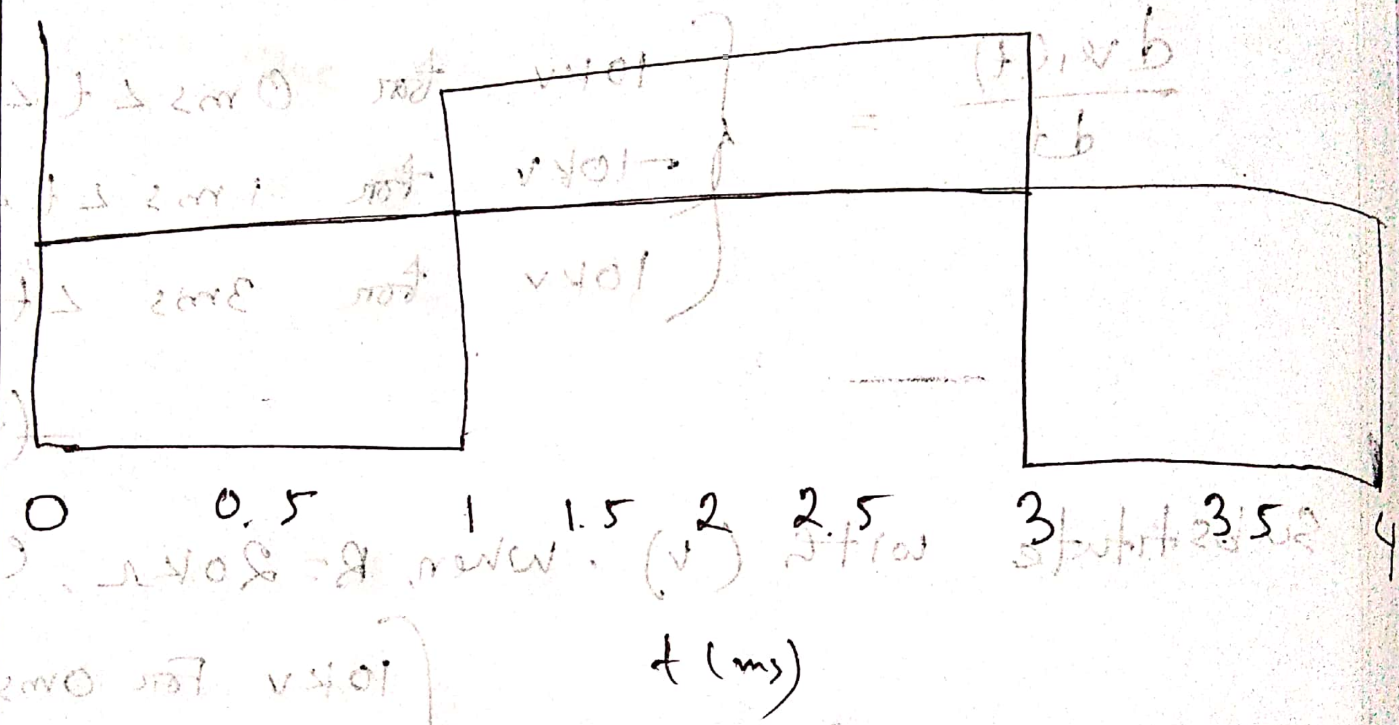

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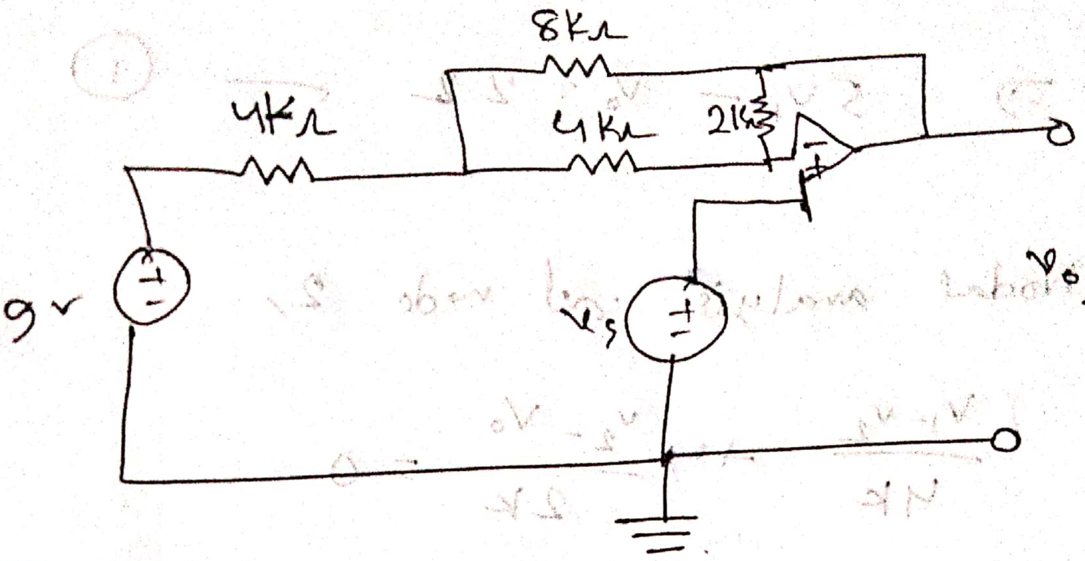
Ans to the q no 6



given,

$v_s = 2v$

so, $v_s = v_2 = v_3 = 2v$

At node 1 doing nodal analysis,

$$\frac{v_1 - v_o}{8k} + \frac{v_1 - 9}{4k} + \frac{v_1 - v_2}{4k} = 0$$

$$\Rightarrow \frac{v_1 - v_o}{2k} + v_1 - 9 + v_1 - 2 = 0$$

$$= \frac{v_1 - v_o}{2k} + 2v_1 - 11 = 0$$

$$\Rightarrow \frac{V_1 - V_0 + 4V_1}{2k} = 11$$

$$\Rightarrow 5V_1 - V_0 = 22 \quad \text{--- (i)}$$

Nodal analysis at node 2,

$$\frac{V_1 - V_2}{4k} + \frac{V_2 - V_0}{2k} = 0$$

$$\Rightarrow \frac{V_1 - 2}{4k} + \frac{2 - V_0}{2k} = 0$$

$$\Rightarrow V_1 - 2V_0 = -6 \quad \text{--- (ii)}$$

Combining equation (i) and (ii)

$$V_0 = \frac{8}{11} \text{ V}$$

So, closed loop voltage gain

$$= \frac{V_o}{V_s}$$

$$= \frac{8/11}{2}$$

$$= \frac{8}{11} \times \frac{1}{2}$$

$$= \frac{4}{11}\ V$$

$$= 0.3636\ V$$

Ans.