XIX

CSE251 - Mid Solve

VICTORUS AUT MORTIS

zarif 31

MID Fall 24

1)

a) Assumption

1) Infinite open loop gain (A_{OL})

2) " Input Resistance (R_{in})

3) Zero Output " (R_{out})

b) $V_{out} = \cancel{\left(1+\frac{R}{}\right)} \; -\frac{1}{R_f C}\int V_{in}\,dt$

c) Non linear because, $I = I_s\left(e^{\frac{qV}{nkT}} - 1\right)$

d) Assumption of CVD Operating gate,

1) Forward biased (ON)

i) $I_D > 0$

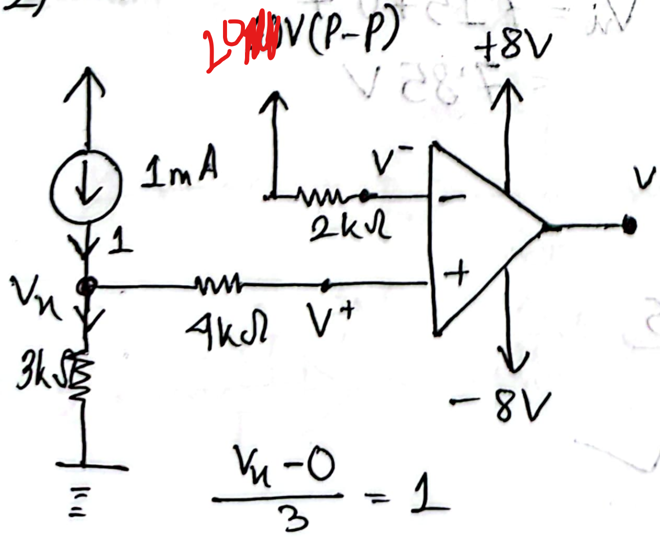
ii) $V_D \approx 0.7$

2) Reverse Biased (OFF)

i) $V_D < 0.7$

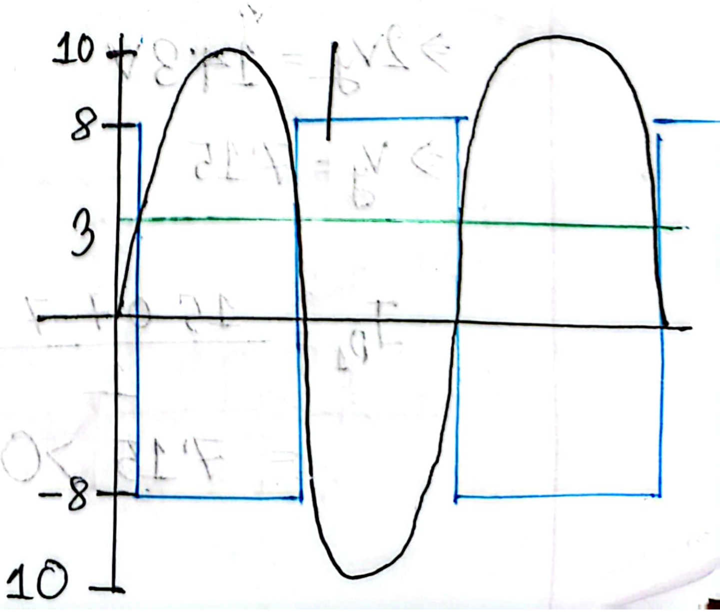
ii) $I_D = 0$

2) a) It would be 10V (P-P) but as I have made the graph (mistakenly) I have assumed it was 20V (P-P)



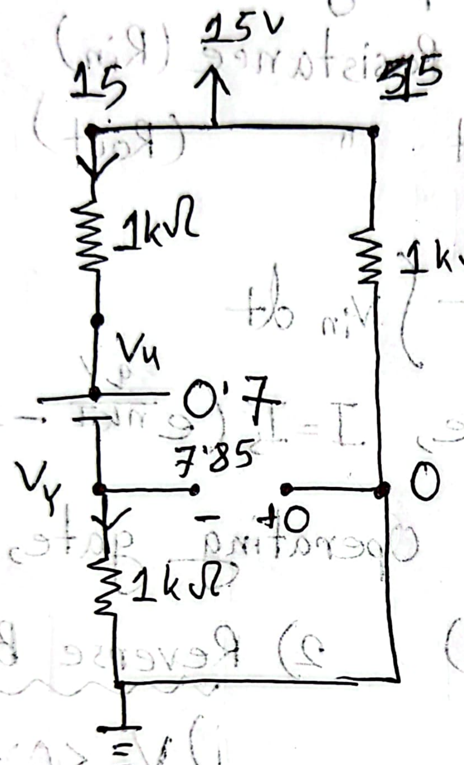
$$\frac{V_n - 0}{3} = 1$$

$$\Rightarrow V_n = 3$$



b)

Assuming D_1 ON, D_2 OFF



$7'85 > 0$

So, D_2 is off ✓

Assumption right

V_y Node

$$\frac{15-0'7-V_y}{1} = \frac{V_y-0}{1}$$

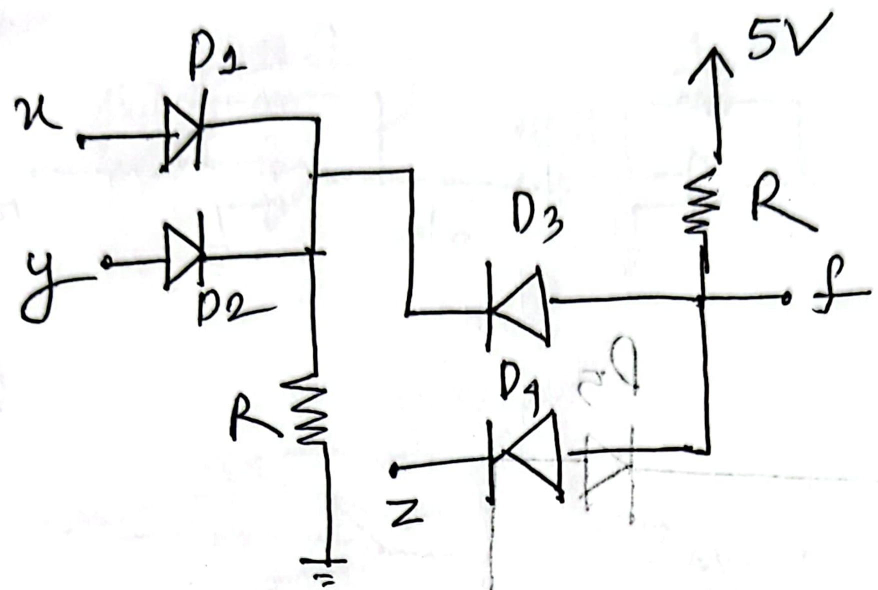
$$\Rightarrow 2V_y = 14'3V$$

$$\Rightarrow V_y = 7'15$$

$$V_u = 7'15 + 0'7 = 7'85\ V$$

$$I_{D_1} = \frac{15-0'7-7'15}{1} = 7'15 > 0 \checkmark$$

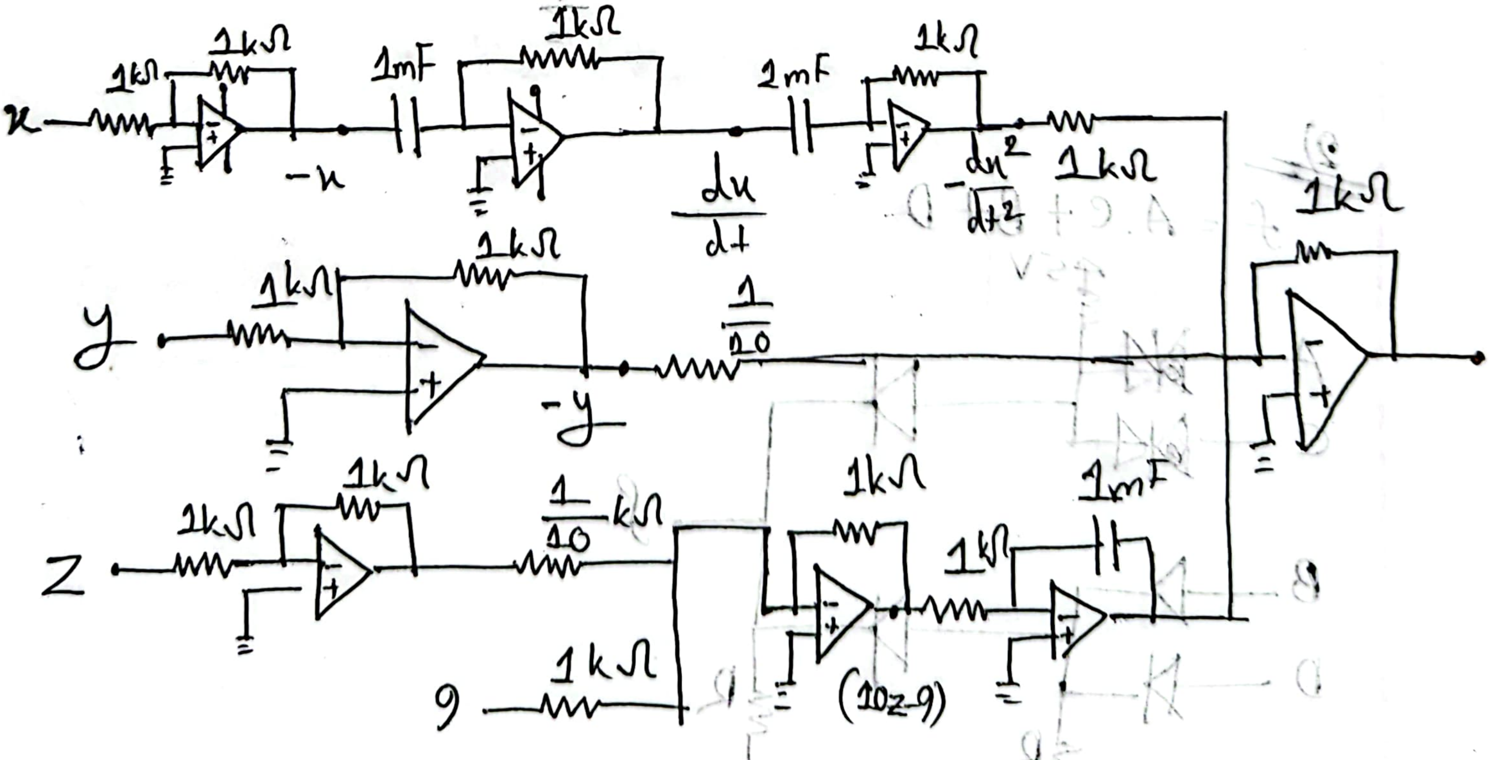
e)



$$f = (x+y)z$$

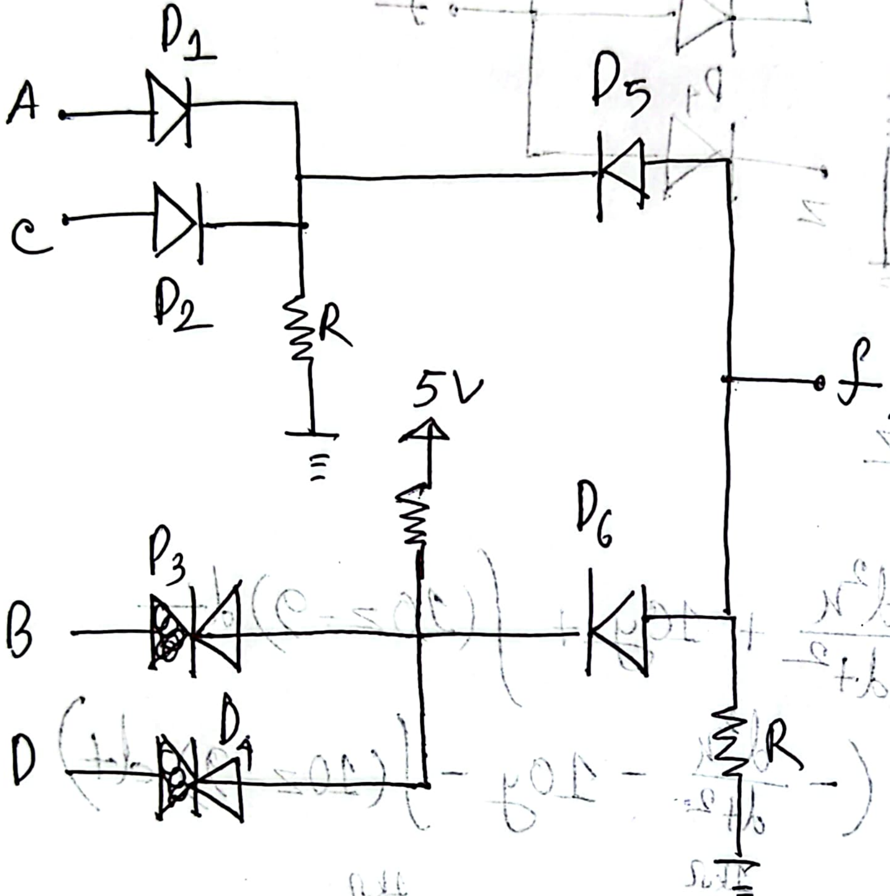
3) a) $$f = \frac{d^2x}{dt^2} + 10y + \int (10z-9)\,dt$$

$$= -\left(-\frac{d^2x}{dt^2} - 10y - \int (10z-9)\,dt\right)$$



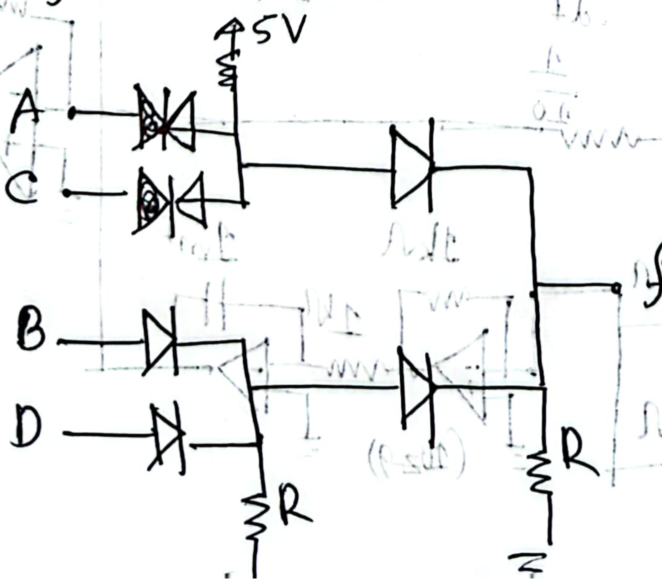
b)

1) $f = A + C + B.D$

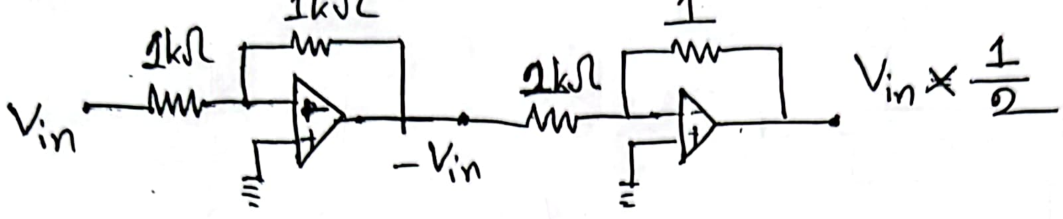


2)

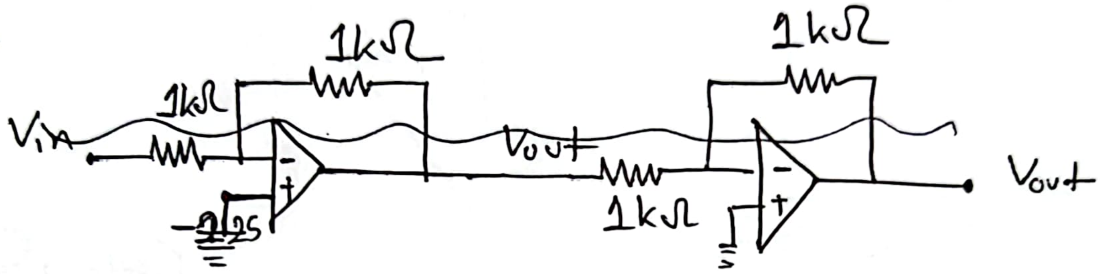
$f = A.C + B + D$



c)



d)



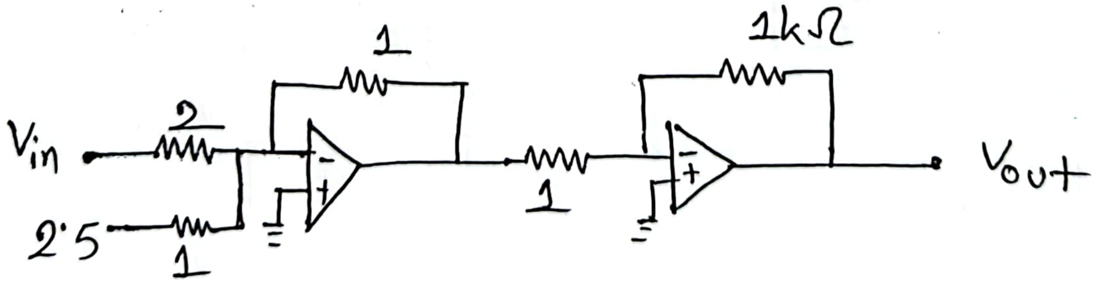
$$\cancel{\frac{V_{in}-(-1.25)}{1} = \frac{-V_{out}-1.25}{1}}$$

$$\Rightarrow \cancel{V_{in}+2.5 = -V_{out}}$$

$$\Rightarrow \cancel{V_{out} = -V_{in}-2.5}$$

~~After inverting,~~

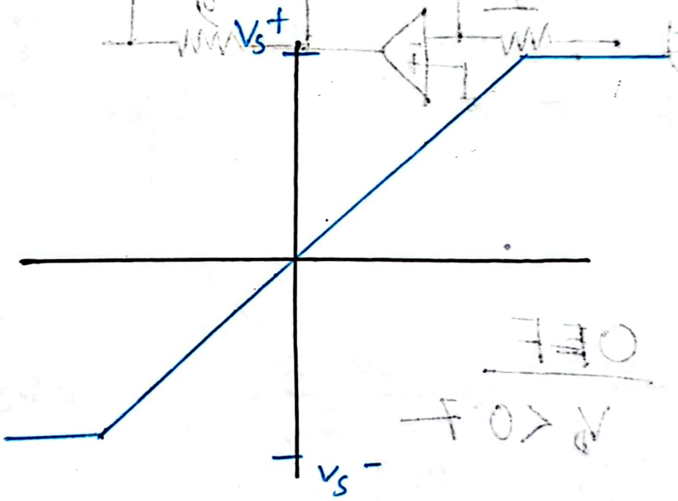
$$\cancel{V_{out} = V_{in}+2.5}$$



1)

a) A virtual ground is a concept used in operation amplifier circuits, referring to a node or point in the circuit that is maintained at approximately zero volts (ground potential), despite not being physically connected to ground.

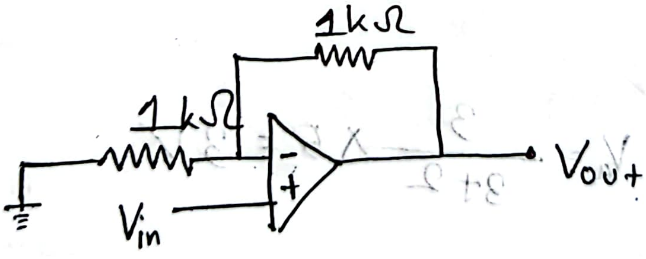
b)



Non-inverting amplifier

slope = 2

c)



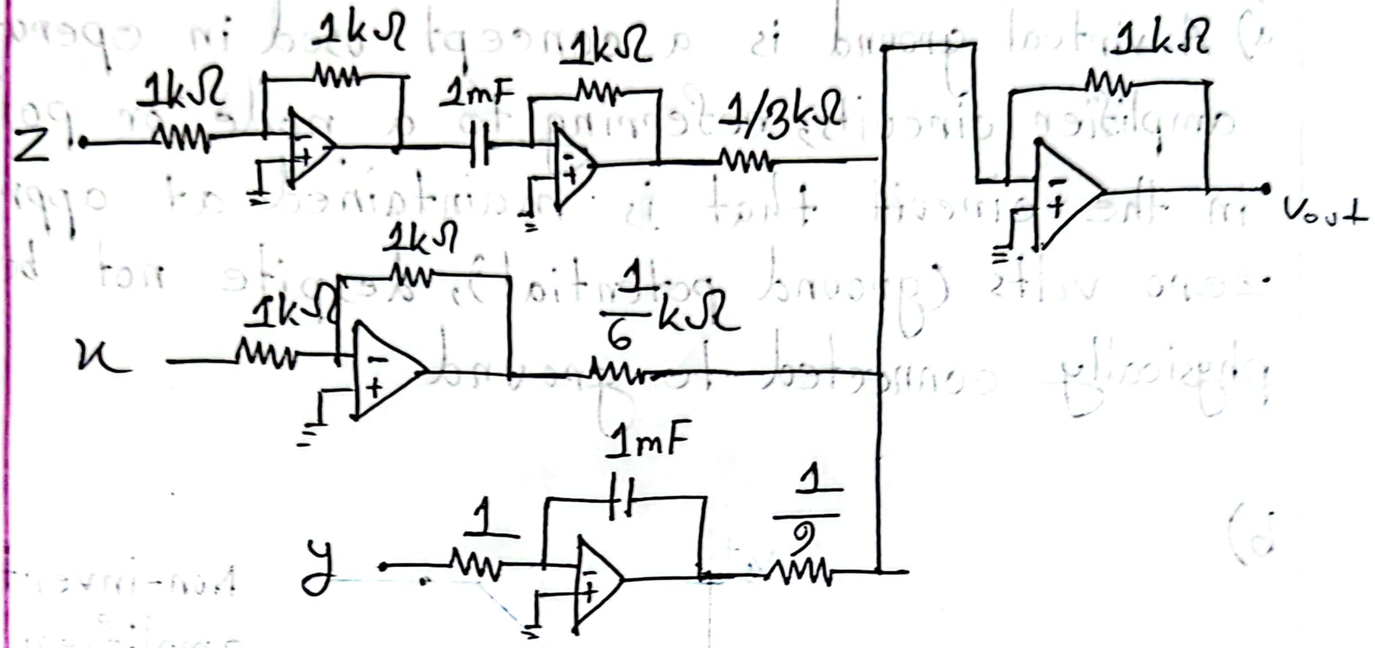
$$\left(1+\frac{R_f}{R_i}\right)=2$$

$$\Rightarrow R_f = R_i$$

d)

$$f = -3\frac{dz}{dt} + 6x + 9\int(y)\,dt$$

$$= -\left(3\frac{dz}{dt} - 6x - 9\int(y)\,dt\right)$$

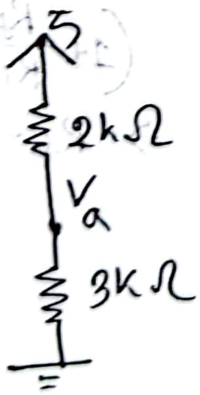


2)

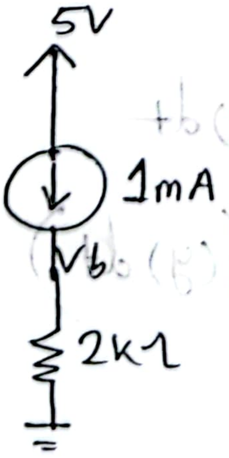
a) ON | OFF

$I_D > 0$ | $V_D < 0.7$

b)



$V_a = \frac{3}{3+2} \times 5 = 3V$

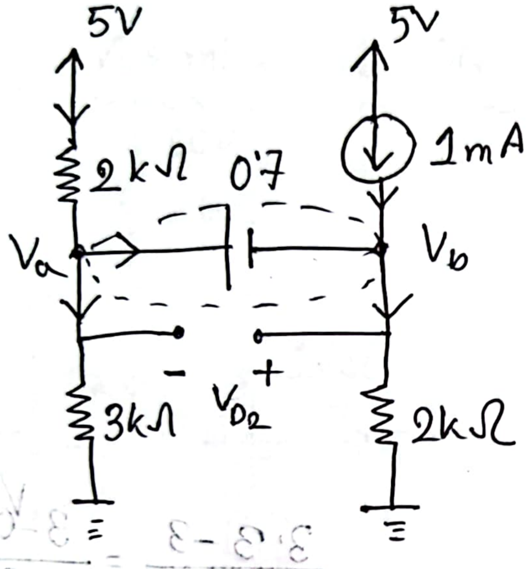


$\frac{V_b - 0}{2} = 1$

$\Rightarrow V_b = 2V.$

c)

Assuming D_1 ON, D_2 OFF



Supernode

$$\frac{5-V_a}{2}+1=\frac{V_a-0}{3}+\frac{V_b-0}{2}$$

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

$$\Rightarrow 15-3V_a+6=2V_a+3V_b$$

$$\Rightarrow 5V_a+3V_b=21$$

$$V_a-V_b=0.7$$

$V_a=2.89V$

$V_b=2.187V$

$$\frac{5-V_a}{2}+\frac{0-V_a}{3}=I_{d_1}$$

$$\Rightarrow \frac{5-2.89}{2}+\frac{-2.89}{3}=I_{d_1}$$

$$\Rightarrow I_{d_1}=0.092>0$$

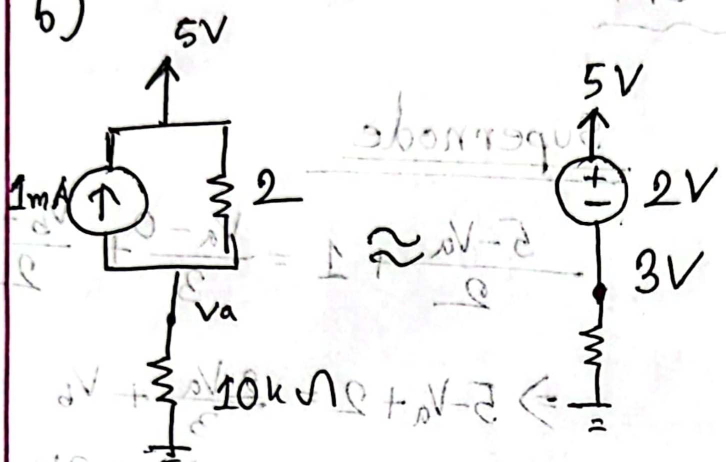
$V_b<V_a$,

So, d_2 in reverse bias

d) Both off, $I_{ab}=0$

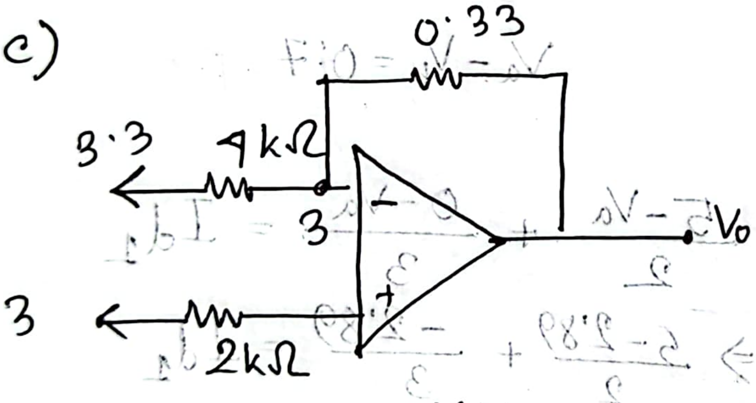
3) a) $V_{out} = -\frac{R_f}{R_i} V_{in}$

b)



$\therefore V_a = V_+ = 5 - 2 = 3V$

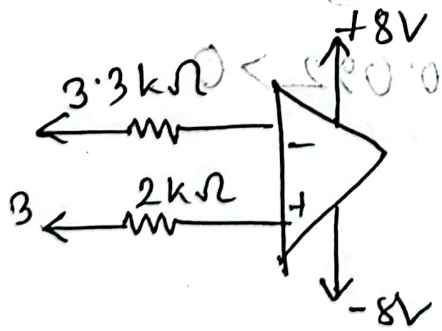
c)



$$\frac{3.3 - 3}{4} = \frac{3 - V_0}{0.33}$$

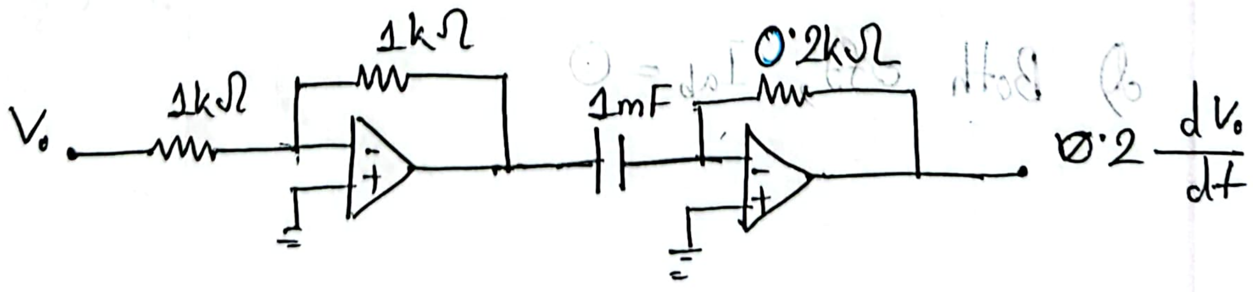
$\Rightarrow V_0 = 2.97525\ V$

d)

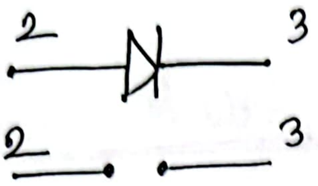


$3.3 > 3$ so, $V_{out} = -8V$

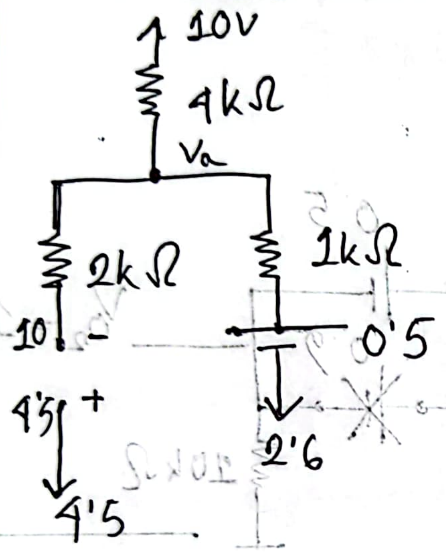
e)



Q) a)



b) Assuming D_2 ON, D_1 OFF



$I_{D_2} = \dfrac{4'48 - 3'1}{1} = 1'38\,mA > 0$

$10 > 4'5$, D_1 in reverse Bias

$I_{D_2} = 0$

$\dfrac{10 - V_a}{4} = \dfrac{V_a - 3'1}{1}$

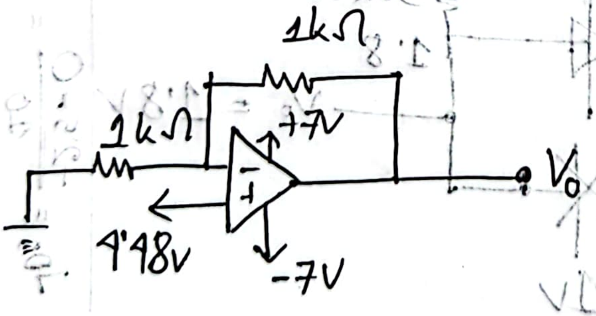
$\Rightarrow 10 - V_a = 4V_a - 12'4$

$\Rightarrow 5V_a = 10 + 12'4$

$\Rightarrow V_a = 4'48V$

$V_u = V_a$

c)



Non inverting

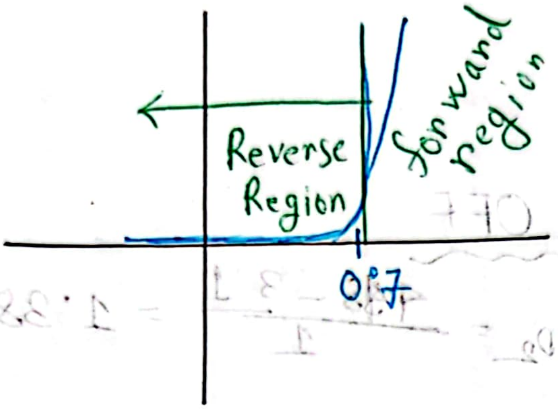
$V_o = \left(1 + \dfrac{R_f}{R_i}\right) \times V_{in}$

$= \left(1 + \dfrac{1}{1}\right) \times 4'48$

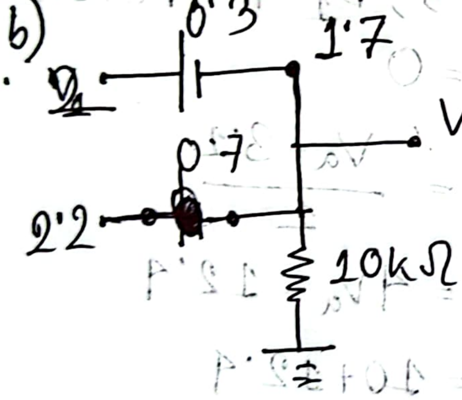
$= 9'6V$

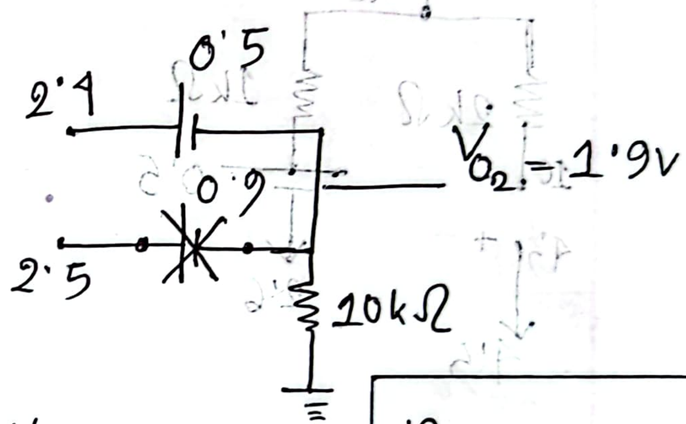
5)

a)

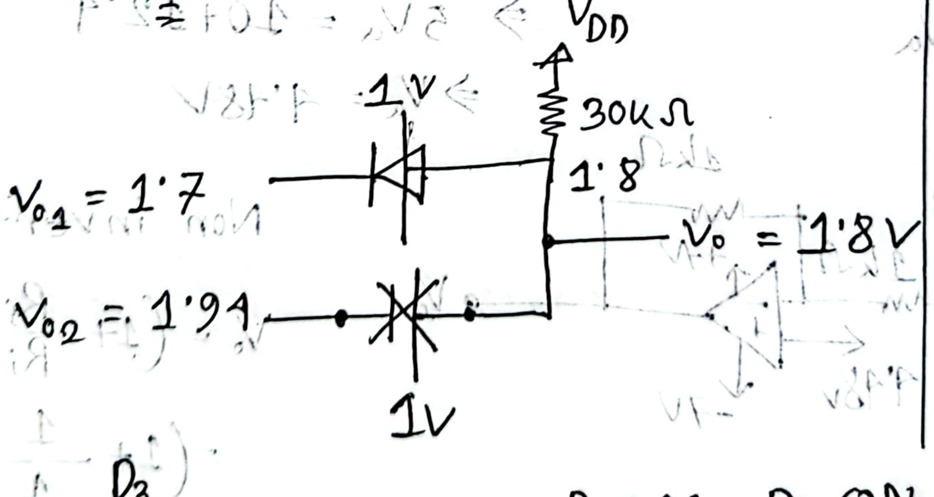


b)





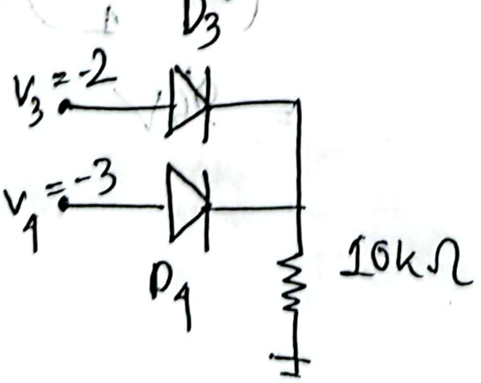
c)



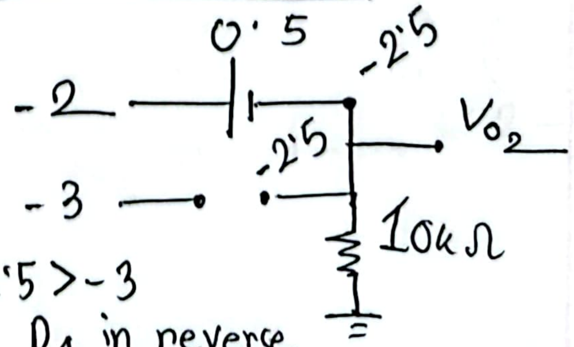
$I_{D_3} = \frac{-2.5-0}{10} = -0.25 < 0$

D_3 in reverse bias

d)



D_1 Off D_3 ON

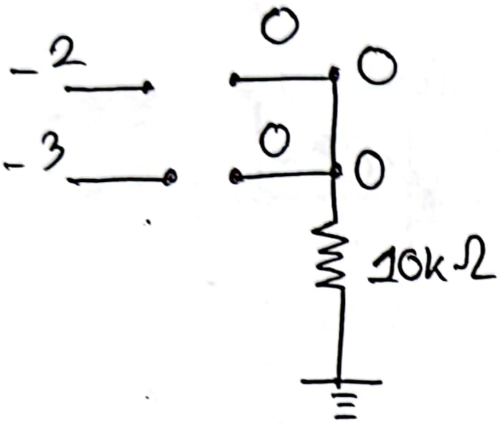


$-2.5 > -3$

D_1 in reverse

So,

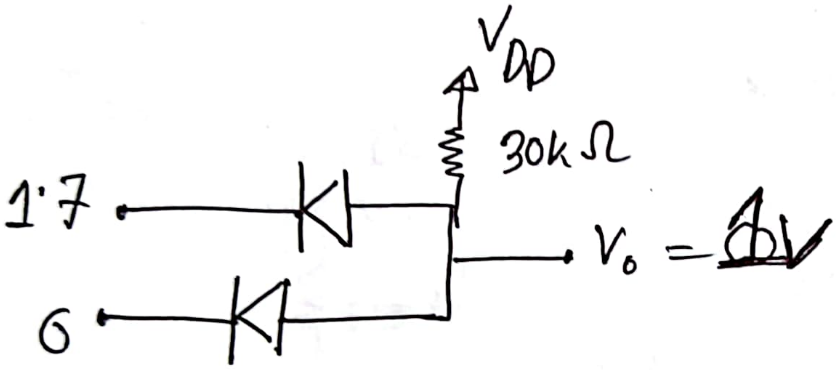
D_1 off D_3 Off



$0 > -2 > -3$

So, both in reverse

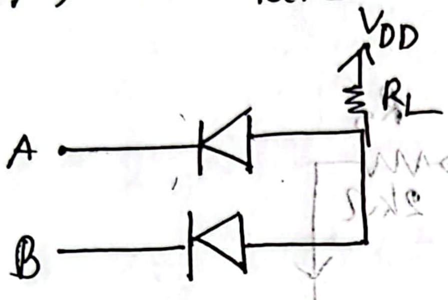
$I_{D_1} = I_{D_2} = 0$



Mid Spring

~~Summer~~ 24

1) a) AND Gate

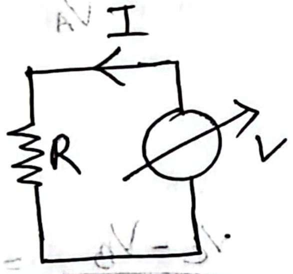


b) $V_A = 4V$

$V_B = 5V$

$V_A < V_B$ So, $f = V_A$

c)

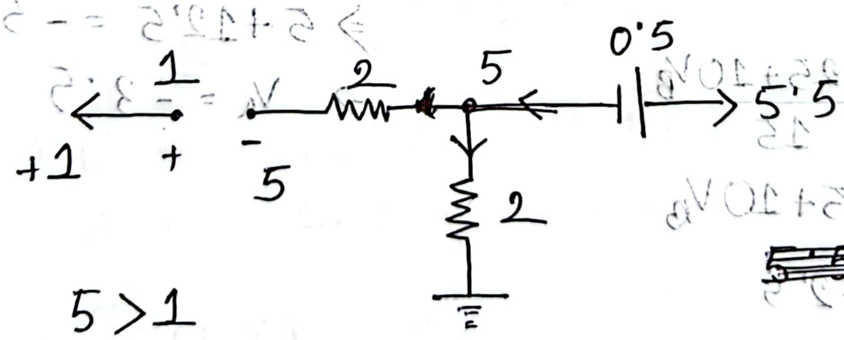


$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.5 - 0}{1 - 0} = 0.5$$

$R = 2$

d)

Assuming D_2 ON, D_1 Off



~~5.5~~ $I_{D_2} = \frac{5-0}{2}$

$= 2.5A > 0$

$5 > 1$

So, D_1 is in reverse Bias

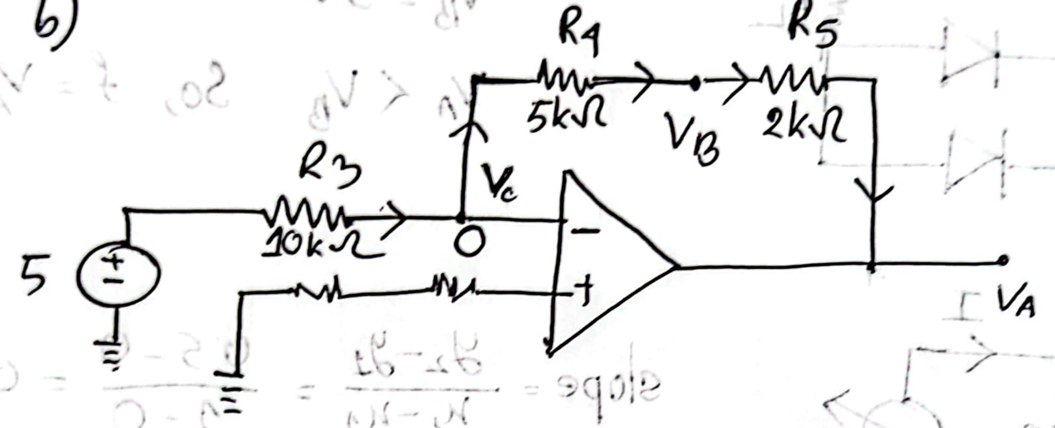
$I_{D_1} = 0$

$V_x = 5$

$V_y = 5V$

3)a) $I^- = I^+ = 0$

b)



$$\frac{5 - V_c}{10} = \frac{V_c - V_B}{5}$$

$\Rightarrow 25 - 5V_c = 10V_c - 10V_B$

$\Rightarrow 25 + 10V_B = 15V_c$

$\Rightarrow V_c = \dfrac{25 + 10V_B}{15}$

$\Rightarrow 0 = 25 + 10V_B$

$\Rightarrow V_B = -2.5$

$$\frac{V_c - V_B}{5} = \frac{V_B - V_a}{2}$$

$\Rightarrow 2V_c - 2V_B = 5V_B - 5V_a$

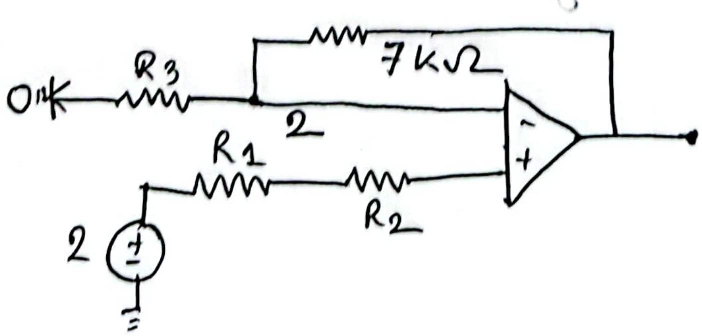
$\Rightarrow -2\times(-2.5) = 5\times(-2.5) = -5V_a$

$\Rightarrow 5 + 12.5 = -5V_a$

$\Rightarrow V_a = -3.5$

ⓒ $V_B > V_A$ So, V_{sat}^{+}

ⓓ



$$\frac{0-2}{R_3} = \frac{2-5.13}{7}$$

5.13 $\Rightarrow R_3 = 4.47$

ⓔ

$$\frac{2-V_B}{5} = \frac{V_B - 5'13}{2}$$

$$\Rightarrow 4 - 2V_B = 5V_B - 25'65$$

$$\Rightarrow 7V_B = 29'65$$

$$\Rightarrow V_B = 4'24$$

4)

a) $V_s(G) = 6G^2 + 7G$

$\cancel{V_s(16) = 6 \times (16)^2}$

$V_s(0'186) = 6 \times (0'186)^2 + 7 \times 0'186$

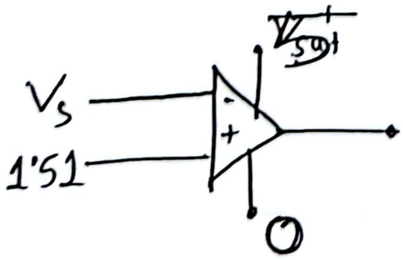
$= 1'51\,V$

b) Before 16:00 $V_s > 1'51$

After 16:00 $V_s < 1'51$

c) Inverting comparator to satisfy "lamp on at lower V_s"

d)



(e)

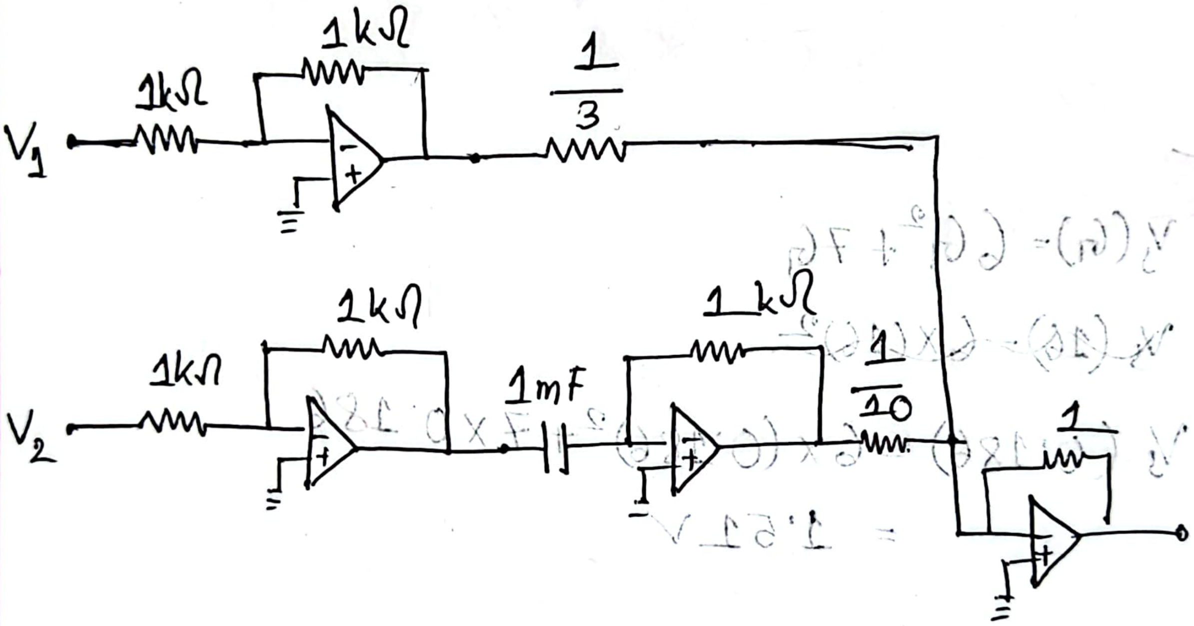
$$V_o = X_1 V_1 - X_2 \int V_2\, dt$$

$$= 3V_1 - 10 \int V_2\, dt$$

$$= -\left(-3V_1 + 10 \int V_2\, dt\right)$$

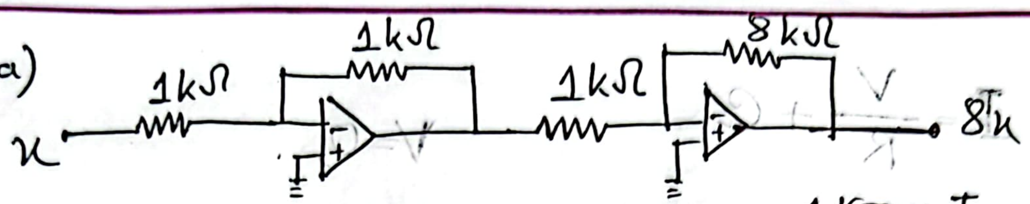
$$X_1 = 1+2 = 3$$

$$X_2 = 1+9 = 10$$

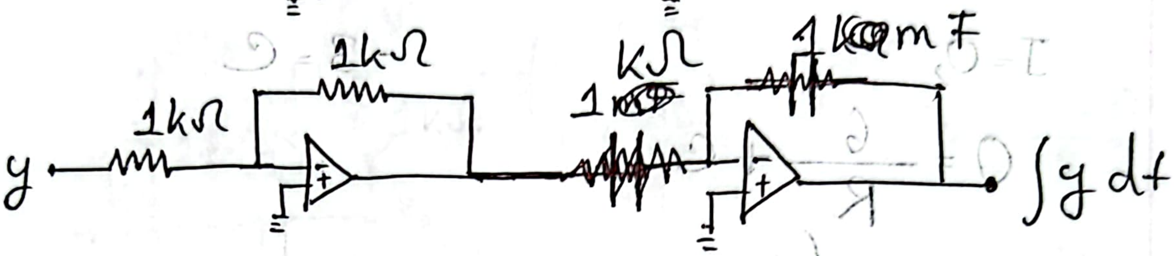


Summer 23

1) a)



b)



c)

$$f = -4x - \int y\,dt + 2\frac{dz}{dt}$$

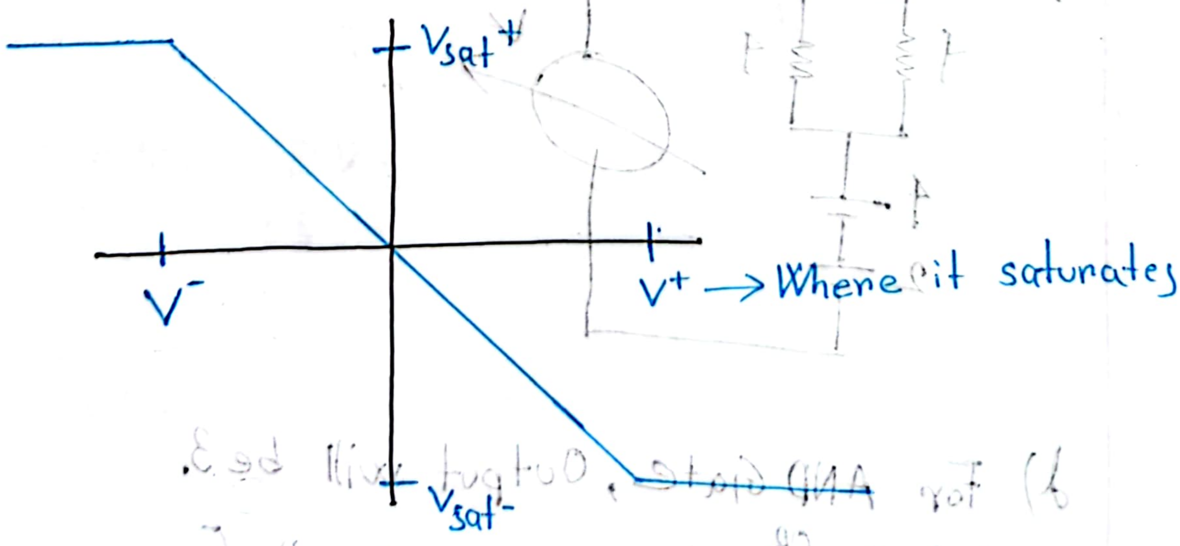
d)

$$f = -4\times 1 - \int 8\cos(30t)\,dt + 2\times \frac{d(\sin(4t))}{dt}$$

$$= -4 - \frac{8\sin(30t)}{30} + 2\times 4\cos(4t)$$

$$= -4 - \frac{4}{15}\sin(30t) + 8\cos(4t)$$

e)



3)a) $I = \frac{V}{R} + C$

$V = 0$

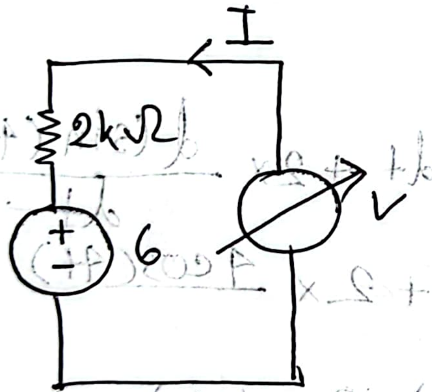
$I = 0$, $-3 = C$

$0 = \frac{6}{R} + C$

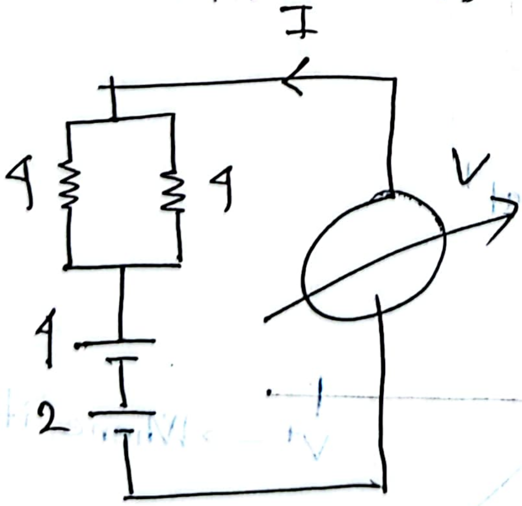
$\Rightarrow -C = \frac{6}{R}$

$\Rightarrow R = \frac{6}{-C} = \frac{6}{3} = 2$

b)



c)

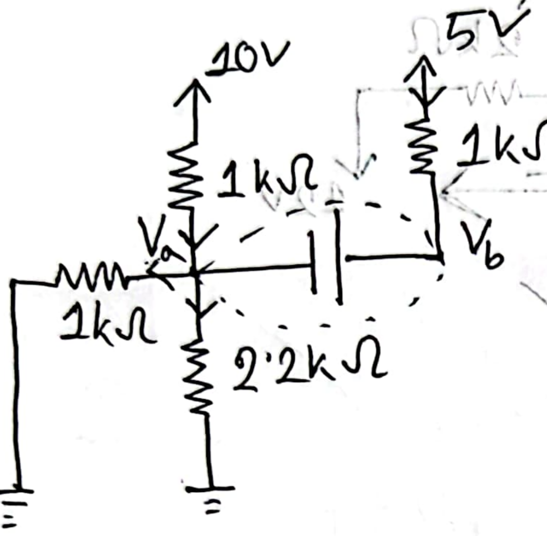


d) For AND Gate, Output will be 3.

And for OR Gate, " " " 5.

4)

a) Assuming D1 ON



$V_b - V_a = 0.7$

$$\frac{10-V_a}{1} + \frac{5-V_b}{1} = \frac{V_a-0}{2.2} + \frac{V_a-0}{1}$$

$\Rightarrow \cancel{10 - V_a + 5 - V_a = 0.45V_a + V_a}$

$\Rightarrow \cancel{3.45V_a = 15}$

$\Rightarrow \cancel{V_a = 4.35}$

$$10 - V_a + 5 - V_b = 0.45V_a + V_a$$

$\Rightarrow 15 = 2.45V_a + V_b$

$V_a = 4.14V$

$V_b = 4.84V$ (Ans.)

$$I_{D_1} = \frac{4.14-10}{1} + \frac{4.14}{1} + \frac{4.14}{2.2}$$

$= 0.262 > 0$

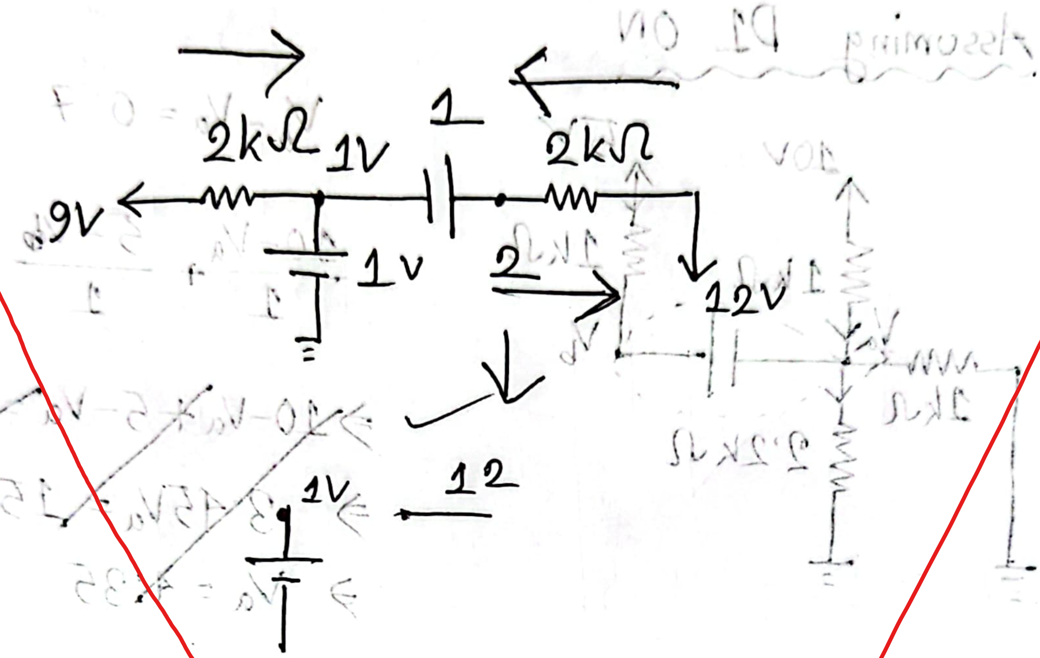
Assumption right

b) i) $V_+ = 4.84V$

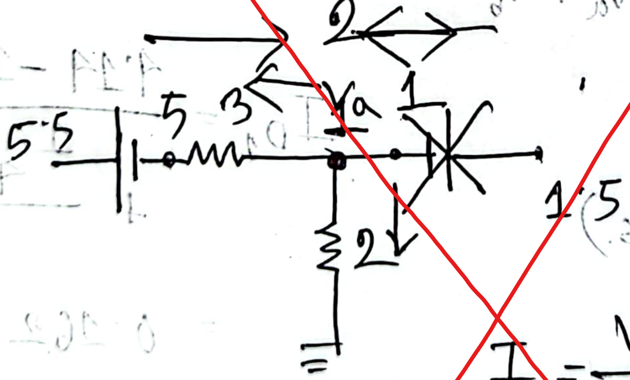
ii) $V_- = 4.84V$

c) $V_0 = \left(1 + \frac{1.8}{2.2}\right) \times 4.84$

$= 12.1V$



$$\frac{9-1}{2} + \frac{12-1}{2} = 9.5$$



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

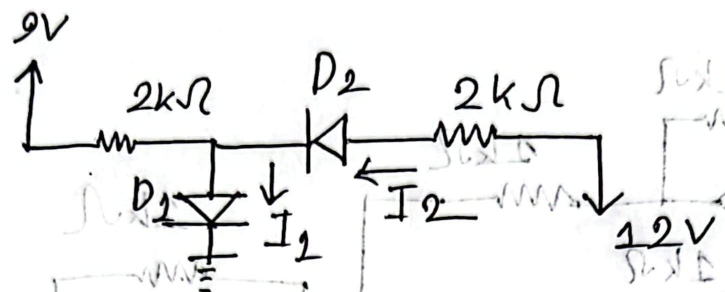
$$= \frac{2(V_a-5)+3V_a}{6}$$

$$= \frac{2(1-5)+3\times 1}{6}$$

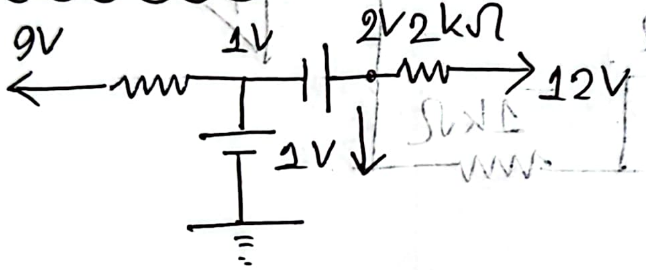
Spring 2023

1)

a)



b) Assuming D_1, D_2 ON



$V_x = 1V$

$I_1 = 9mA$

$I_2 = 5mA$

$V_y = 2V$

$$ID_1 = \frac{9-1}{2} + \frac{12-2}{2} = 9 > 0$$

Assumption right

c) $P_{D_1} = V \times I = 1 \times 9A$ = (Consuming)

$= 9$ watts

2) a) $I = \frac{V}{R} + C$

$I = 0,$ $V = 0,$

$-1 = C$

$R = \frac{5}{-C}$

$= 5k\Omega$

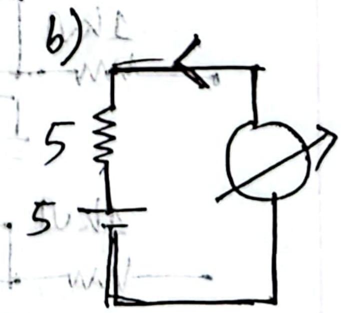
$x = 5V$

$y = 5k\Omega$

X Voltage source

Y resistor

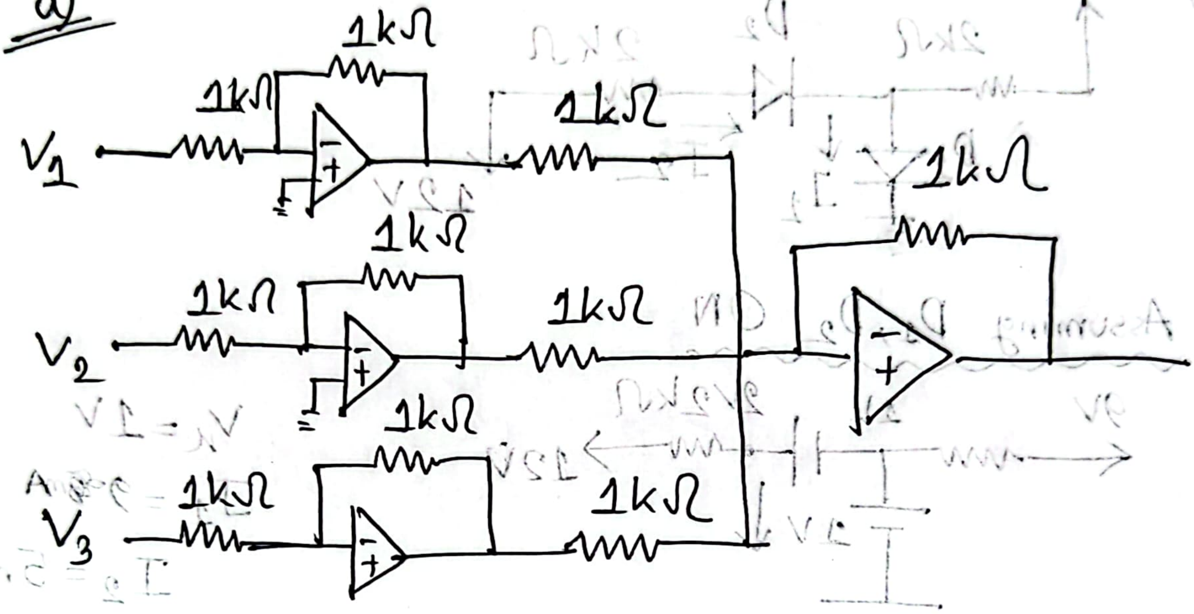
b)



c) Thienvin

3)

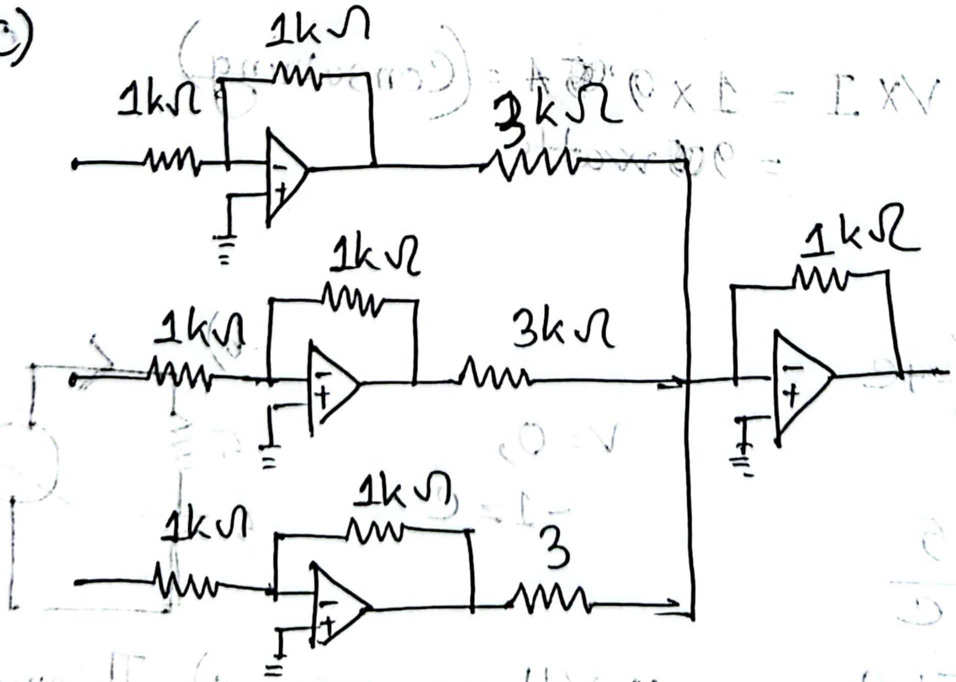
a)



b) $15 \times \frac{1}{k} = 5$

$\Rightarrow k = 3$

c)



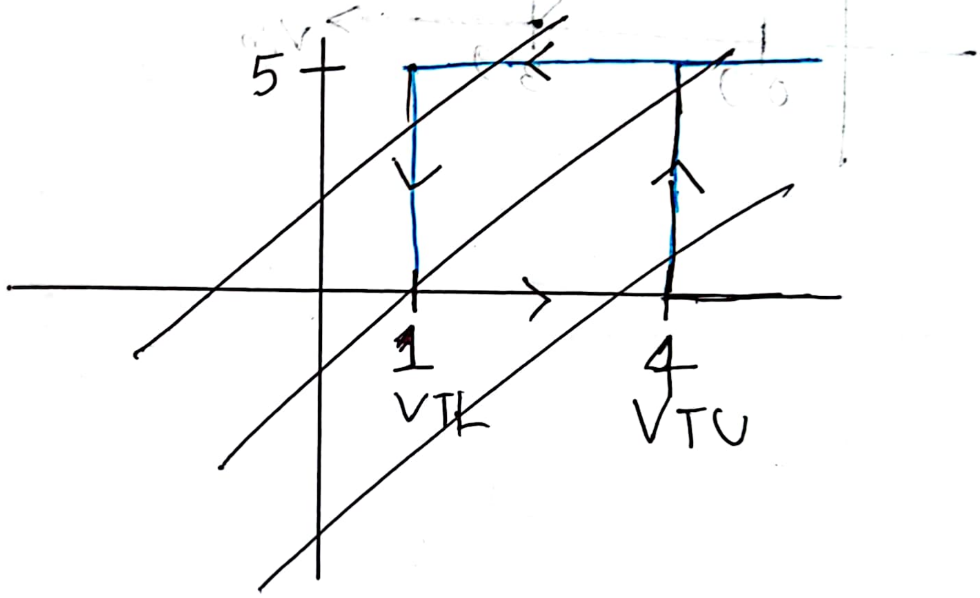
d)

$$\frac{V_{in}-2.5}{3}=\frac{2.5-V_{out}}{5}$$

$$V_{in}=\frac{19.5-3V_o}{5}$$

$$V_{TL}=\frac{19.5-3\times5}{5}=0.9V$$

$$V_{TU}=\frac{19.5-0}{5}=3.9V$$

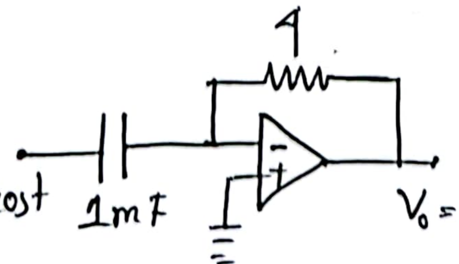


4) a) $f=(a.b)+c$

b) $V_i=1-0.5\cos t$

$V_o=2\sin t$

c)

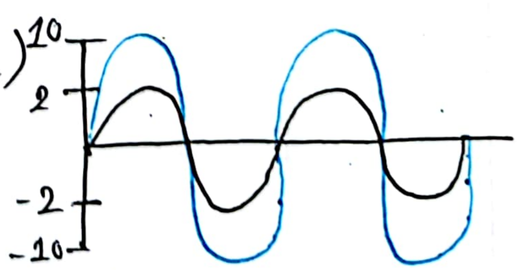


$$V_o=-4\frac{d(1-0.5\cos t)}{dt}$$
$$=2\sin t$$

c) $V_y=\left(1+\frac{20}{5}\right)\times 2\sin t$

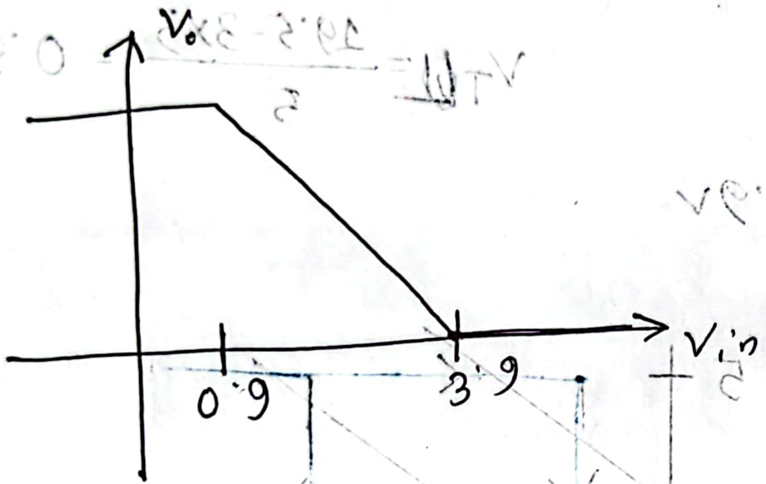
$=10\sin t$

d)



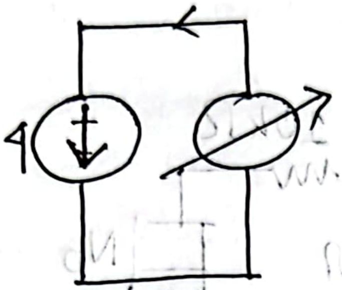
d) VTC

$$V_o = \left(-\frac{5}{3}\right) V_{in} + \frac{19.5}{3}$$

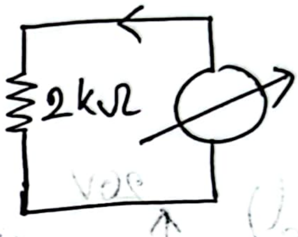


Summer-22

a) $V = -4$



$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4+4}{2+2} = 2$$

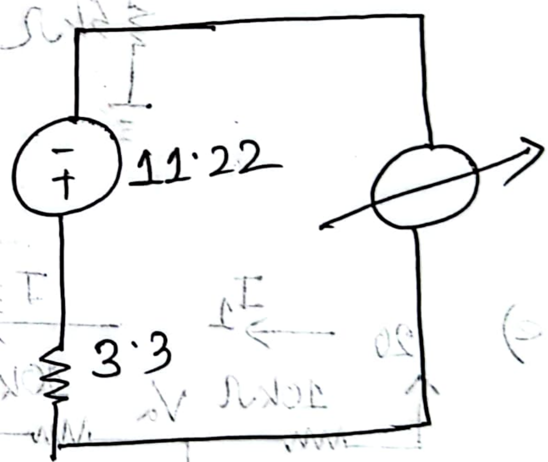


$R = 3.3$

$$I = \frac{V}{R} + C$$

$$\Rightarrow 4 = \frac{2}{3.3} + C$$

$$\Rightarrow C = 3.4$$



$V = 0$,

$I = 3.4$

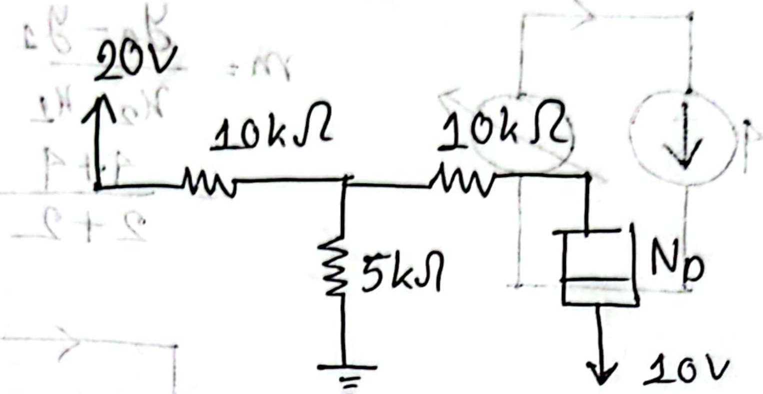
$I = 0$,

$$V = \cancel{+\frac{V}{R}} - CR = -3.4 \times 3.3 = -11.22$$

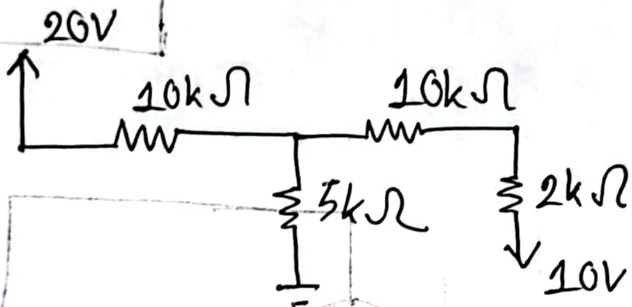
$= \cancel{-3.4}$

b) CD. $I = \frac{\cancel{11}\ 3}{3.3} + 3.4 = 4.31\ mA$

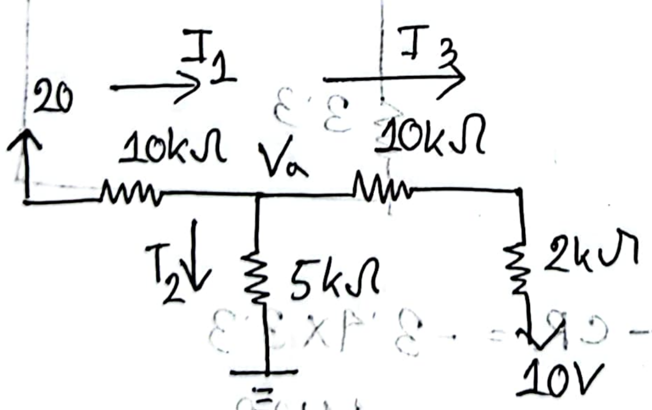
c)



d)



e)



$I_1 = 1'26mA$

$I_2 = 1'48mA$

$I_3 = -0'22mA$

$$\frac{20-V_a}{10} = \frac{V_a-0}{5} + \frac{V_a-10}{12}$$

$\Rightarrow 2-0'1V_a = 0'2V_a + 0'083V_a - 0'83$

$\Rightarrow 0'383V_a = 2'83$

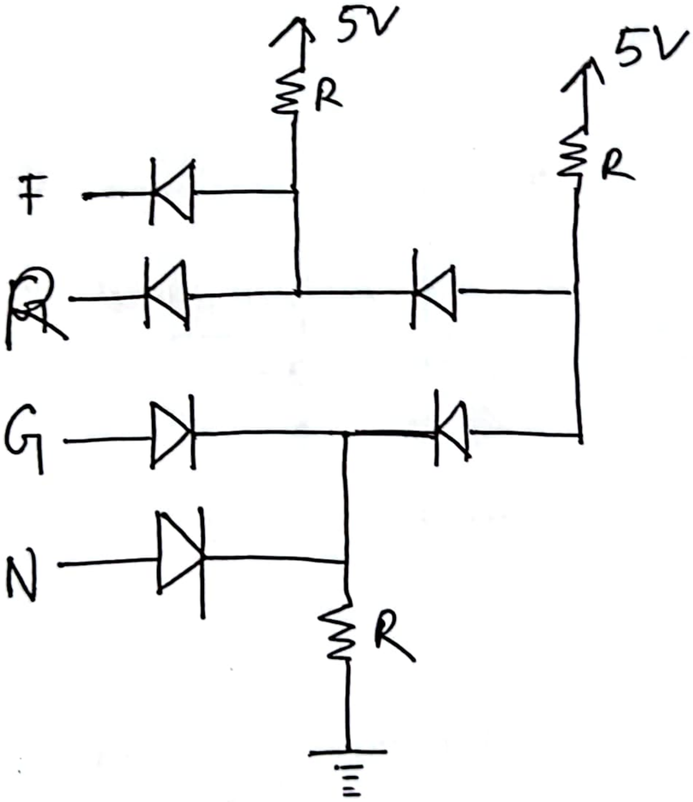
$\Rightarrow V_a = 7'4V$

2) a) ckt-1 $w.x$ ckt-2 $y+z$

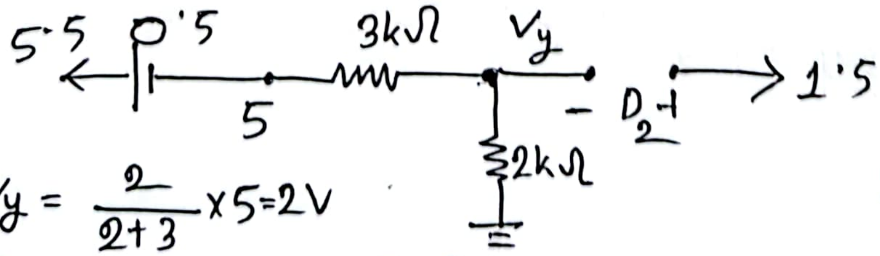
b) $f = (w.x)+(y+z)$

c) $f = (1.2).(3+4)$
$= (F.R).(G+N)$

d)



3) Assuming. D_1 ON, D_2 OFF



$V_y = \frac{2}{2+3} \times 5 = 2V$

$V_x = 5$

$I_{D_1} = \frac{5-2}{3} = 1mA > 0$

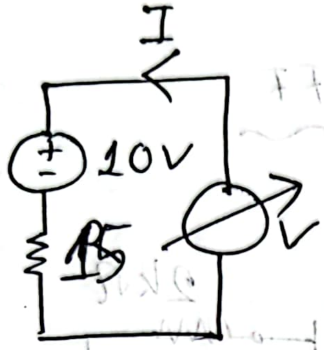
$2 > 1.5$

So, D_2 in reverse bias

Fall

Mid ~~Summer~~ 2022

1) a)



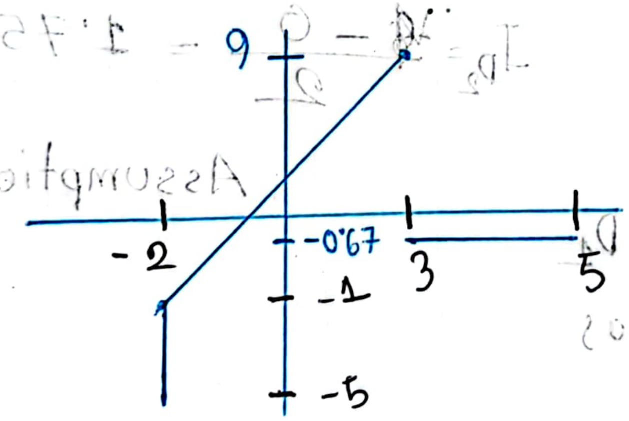
$10 + 15I - V = 0$

$\Rightarrow 10 - V = -15I$

$\Rightarrow V - 10 = 15I$

$\Rightarrow I = \dfrac{V-10}{15}$

b)



$I_D = 2 \times V_D + c$

$\Rightarrow -1 = -4 + c$

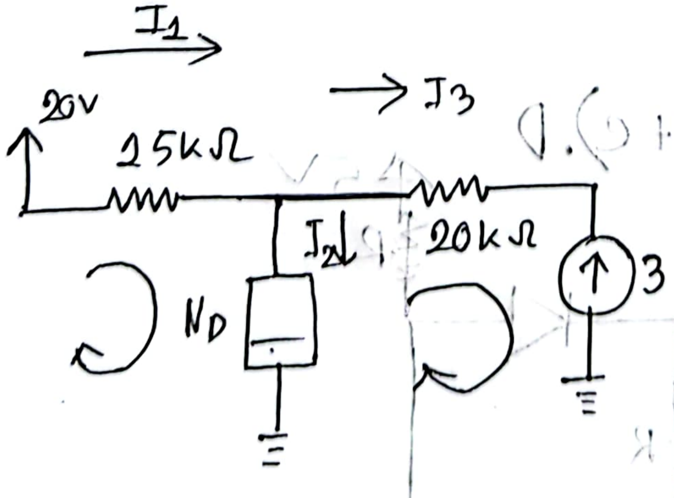
$\Rightarrow c = 3$

$I_D = 2 \times V_D + 3$

$= 2 \times 3 + 3$

$= 9\,mA$

c)



KCL,

$I_1 = I_2 + I_3$

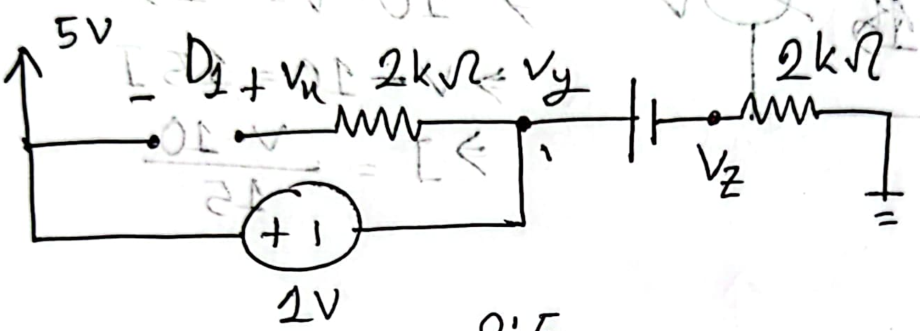
KVL,

$-20 + 15I_1 + N_D I_2 = 0$

$-I_2 N_D + 20I_3 + V = 0$

2)

Assuming, D_2 ON, D_1 OFF



$V_y = 4$

$V_x = 4$

$4 < 5$, So, D_1 Reverse Bias

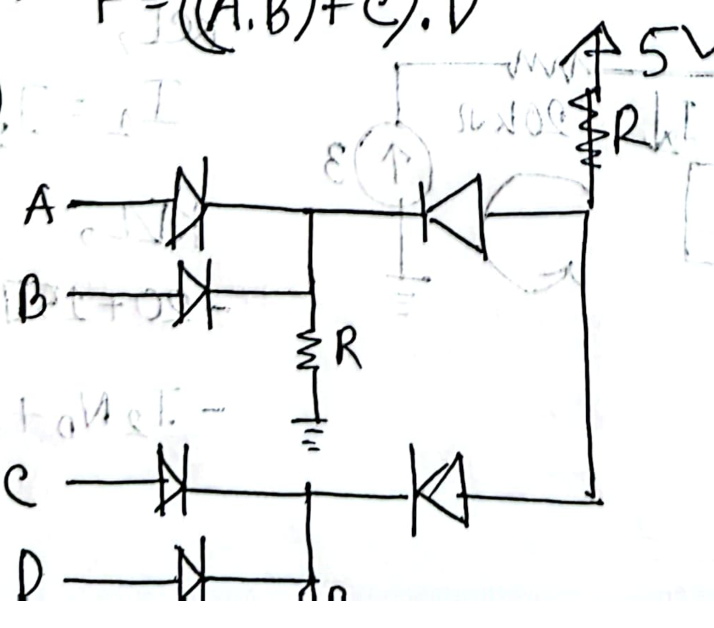
$V_z = 3'5$

$$I_{D_2} = \frac{\cancel{4}\,3'5 - 0}{2} = 1'75\,mA > 0$$

Assumption right

3) a) $F = ((A.B)+C).D$

b)



c)