CSE251 Assignment [Solution]

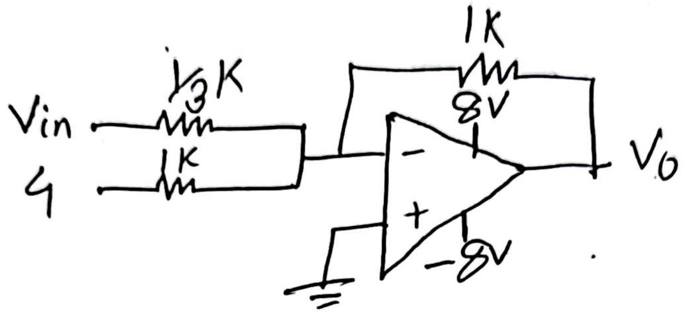
1)

a) $\dfrac{V_{in} - (-4)}{-4} = \dfrac{V_0 - 8}{8+4}$

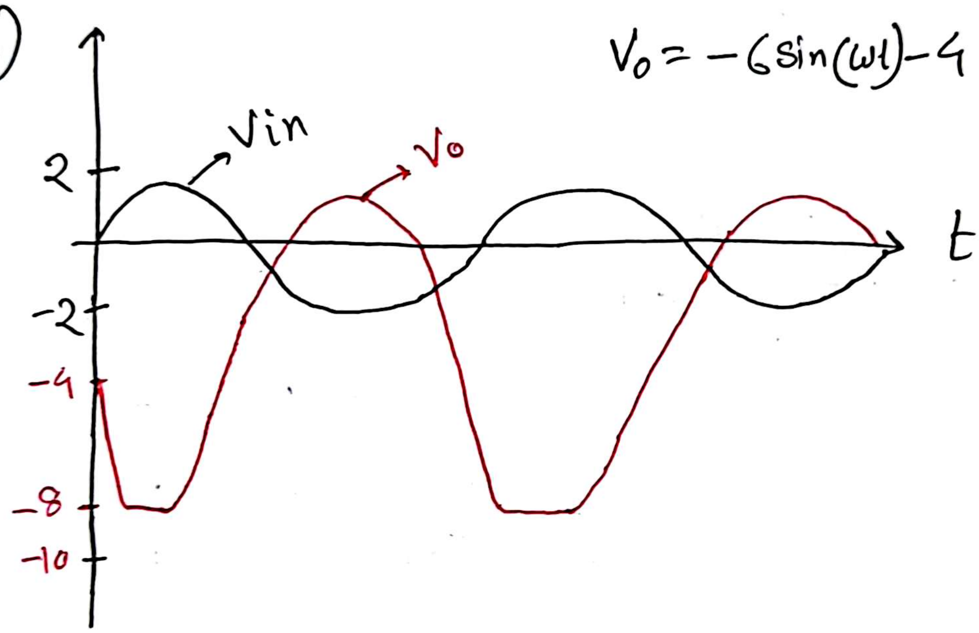
$V_s^+ = 8V$

$V_0 = -3V_{in} - 4$

$V_s^- = -8V$

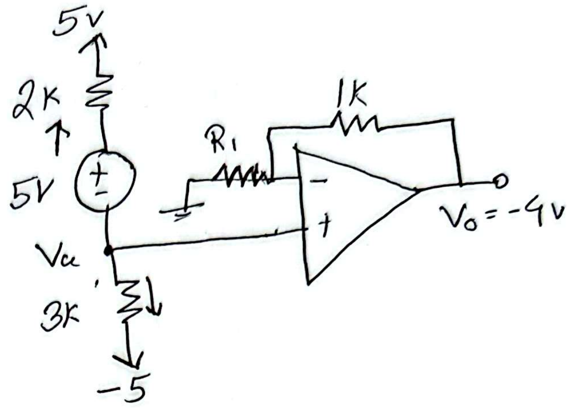


b) $V_0 = -6\sin(\omega t) - 4$



2) a)

KCL at Node V_a



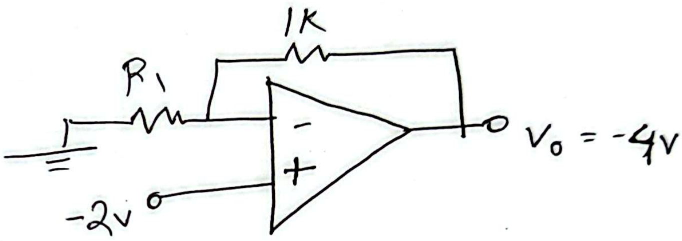
$$\frac{V_a - 5 - (-5)}{2} + \frac{V_a - (-5)}{3} = 0$$

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

$$\Rightarrow 3V_a + 2V_a + 10 = 0$$

$$\Rightarrow 5V_a = -10$$

$$\Rightarrow V_a = -2V$$



Non-Inverting Amplifier

$$V_o = \left(1 + \frac{R_f}{R_1}\right) V_{in}$$

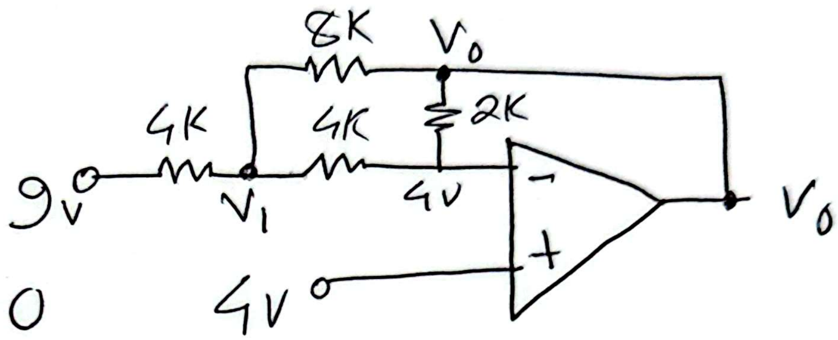
$$\Rightarrow -4 = \left(1 + \frac{R_f}{R_1}\right) \times (-2)$$

$$\Rightarrow 2 = \left(1 + \frac{R_f}{R_1}\right)$$

$$\Rightarrow 1 = \frac{R_f}{R_1}$$

$$\Rightarrow R_1 = 1K\Omega \quad [\because R_f = 1K\Omega]$$

2) b)



KCL at Node V_1

$$\frac{V_1-9}{4}+\frac{V_1-V_0}{8}+\frac{V_1-4}{4}=0$$

$$\Rightarrow 2V_1-18+V_1-V_0+2V_1-8=0$$

$$\Rightarrow 5V_1-V_0=26 \quad \text{--- (i)}$$

KCL at Node 4V

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

$$\Rightarrow 4-V_1+8-2V_0=0$$

$$\Rightarrow V_1+2V_0=12 \quad \text{--- (ii)}$$

Solving eq^N (i) & (ii)

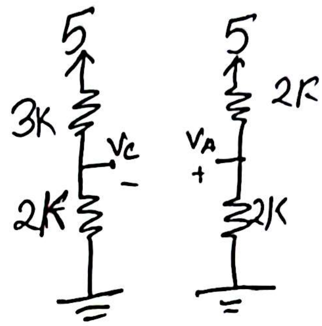
$$V_1 = 5.82V$$

$$\boxed{V_o = 3.09V}$$

CamScanner

3) a) Assuming $D \rightarrow OFF$

$V_{D_0} = 0.6$



$$V_A = \frac{2}{2+2} \times 5 = 2.5\,V$$

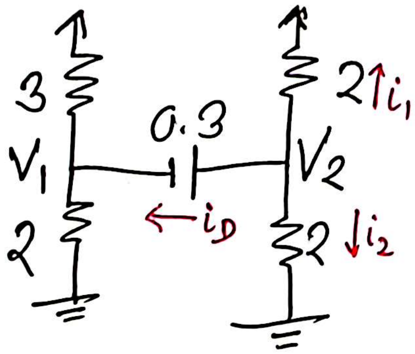
$$V_C = \frac{2}{2+3} \times 5 = 2\,V$$

$$V_D = V_A - V_C = 2.5 - 2 = 0.5 < V_{D_0}$$

Correct Assumption

$$\boxed{\begin{aligned} i_D &= 0 \\ V_D &= 0.5\,V \end{aligned}}$$

b) Assuming $D \rightarrow ON$



$$V_1\left(\frac{1}{2}+\frac{1}{3}\right) + V_2\left(\frac{1}{2}+\frac{1}{2}\right) - \frac{5}{3} - \frac{5}{2} = 0 \quad \text{(i)}$$

$$V_2 - V_1 = 0.3 \quad \text{(ii)}$$

Solving eq^N (i) & (ii)

$V_1 = 2.1\,V$

$V_2 = 2.4\,V$

KCL at V_2

$$i_1 = \frac{2.4-5}{2} = -1.3$$

$$i_2 = \frac{2.4-0}{2} = 1.2$$

$$i_1 + i_2 + i_D = 0$$

$$\Rightarrow i_D = -i_1 - i_2$$

$$= -(-1.3) - 1.2 = 0.1\,mA > 0$$

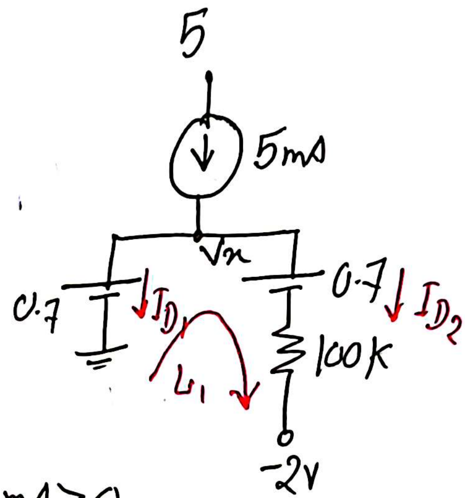
Assumption is correct

$$\boxed{\begin{array}{l} I_D = 0.1 \\ V_D = 0.3 \end{array}}$$

4)

a) $R = 100K$

Assuming D_1 & D_2 ON



KVL at L-1

$$0 = -0.7 + 0.7 + 100 I_{D_2} - 2$$

$$\Rightarrow I_{D_2} = \frac{2}{100} = 0.02\,mA > 0$$

KCL at Vn.

$$5 = i_{D_1} + i_{D_2}$$

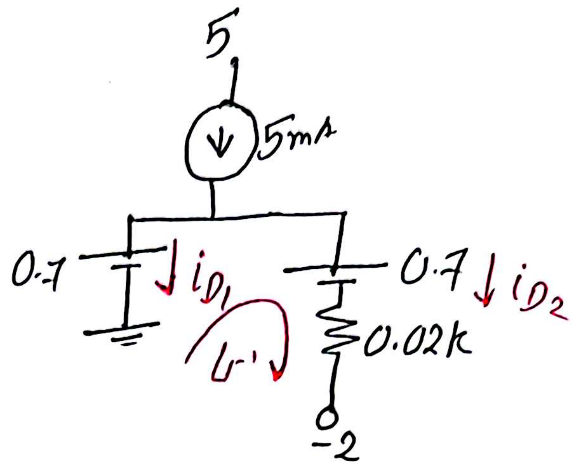
$$\Rightarrow i_{D_1} = 5 - 0.02 = 4.98\,mA > 0$$

Correct assumption

$$\boxed{\begin{array}{l} i_{D_2} = 0.02\,mA \\ i_{D_1} = 4.98\,mA \end{array}}$$

b) $R = 0.02K$

Assuming D_1 & D_2 ON



$$0 = -0.7 + 0.7 + 0.02\, i_{D_2} - 2$$

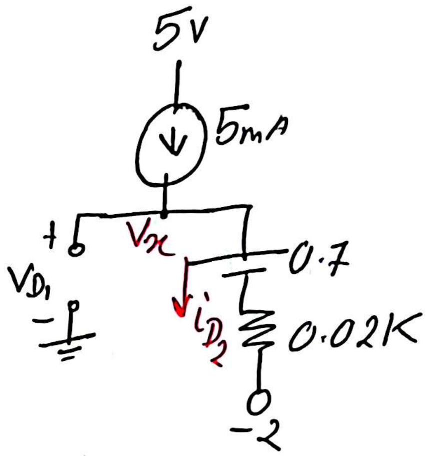
$$\Rightarrow i_{D_2} = 100\text{mA}$$

$$5 = i_{D_1} + i_{D_2}$$

$$\Rightarrow i_{D_1} = -95\text{mA} \not> 0$$

invalid assumption

Assuming D_1 OFF , D_2 ON



$$i_{D_2} = 5\text{mA} > 0$$

$$V_x = 0.7 + 0.02 i_{D_2} - 2$$

$$= -1.2$$

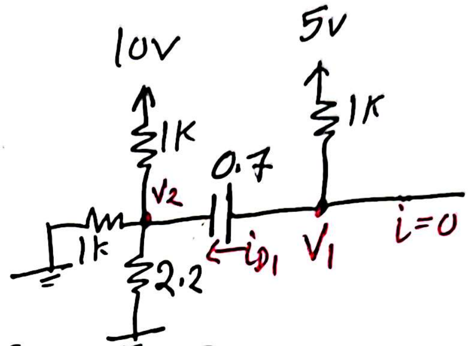
$$V_{D_1} = V_x - 0 = -1.2 < 0.7$$

assumption is Correct

$$\boxed{\begin{array}{l} i_{D_1} = 0\text{mA} \\ i_{D_2} = 5\text{mA} \end{array}}$$

6)

a) Assuming D_1 ON



KCL at Super Node

$$\frac{V_1-5}{1}+\frac{V_2-10}{1}+\frac{V_2}{1}+\frac{V_2}{2.2}=0 \quad \text{.... (i)}$$

$$V_1-V_2=0.7 \quad \text{.... (ii)}$$

Solving eqN (i) & (ii)

$$V_1=4.84$$

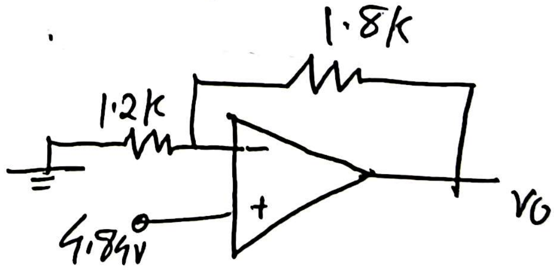
$$V_2=4.14$$

$$i_{D_1}=\frac{5-4.84}{1}=0.16mA>0$$

Assumption is correct

$$\boxed{D_1 \rightarrow \text{Forward bias}}$$

b) $V_a=V_1=4.84V$

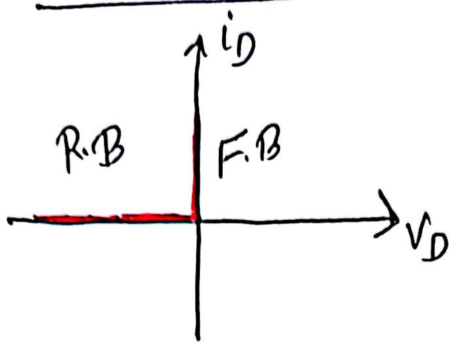


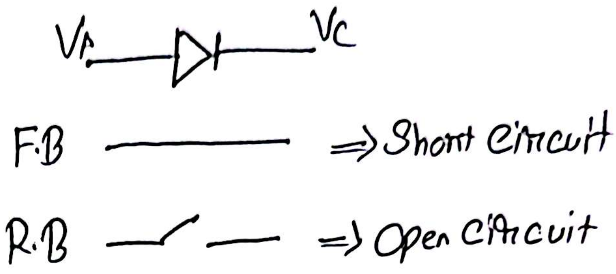
$$V_o=\left(1+\frac{1.8}{1.2}\right)\times 4.84$$

$$=12.1>10$$

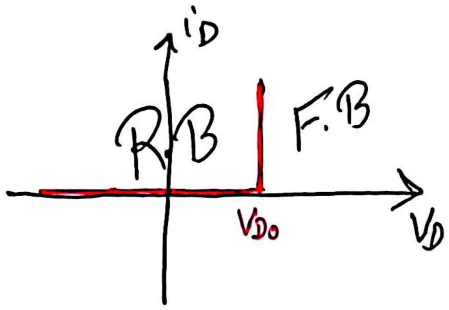
$$\boxed{\therefore V_o=10V}$$

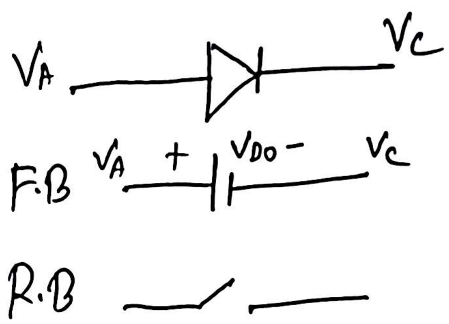
7) Ideal Model





CVD Model





CVD+R Model