Lecture 8: Method of assumed state

Method of assumed state

1) Assume

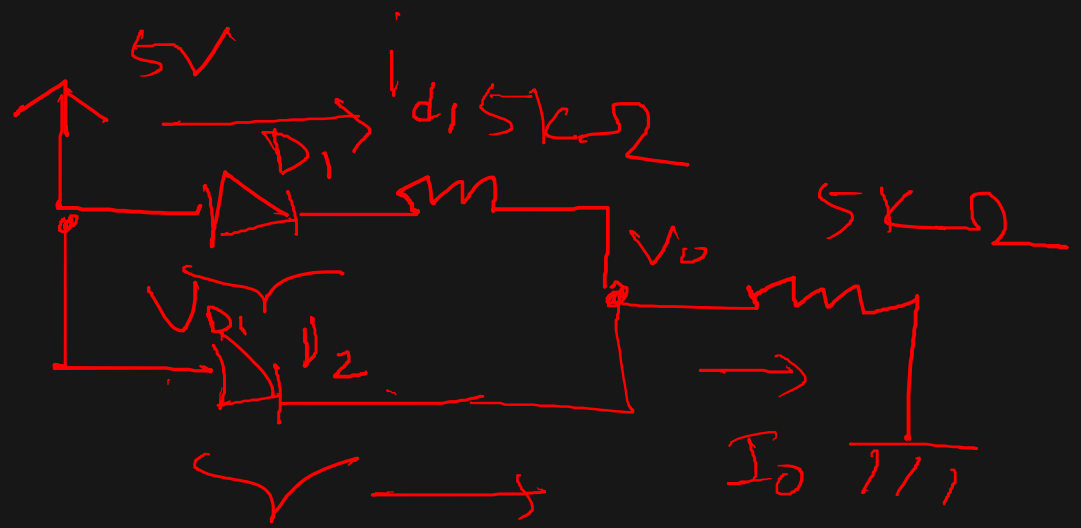
2) Solve → V_D, i_D

3) Verify → ON : $i_D > 0$

→ OFF : $V_D \leq V_{D0}$

$V_D \leq 0$

$V_{D0} = 0.7 / 0.6$ V



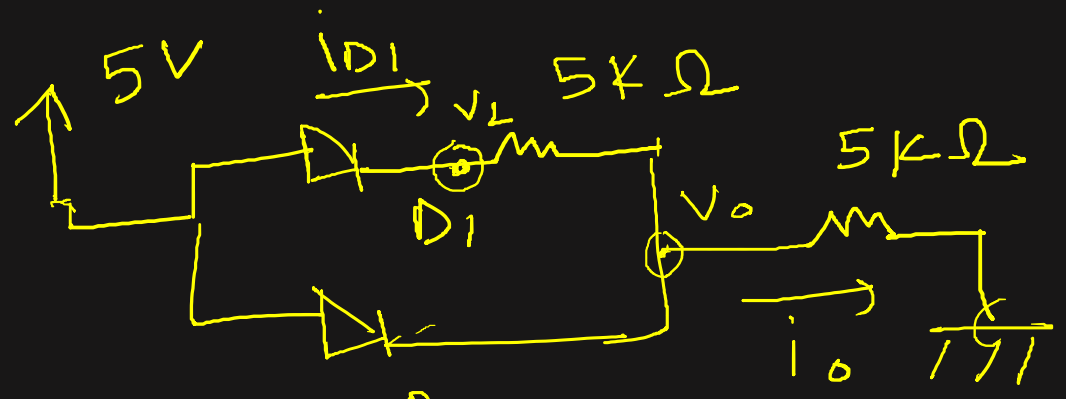
1) D_1, D_2 → ON

2) D_1 → OFF, D_2 → ON

3) D_1 → ON , D_2 → OFF

4) D_1, D_2 → OFF

1)

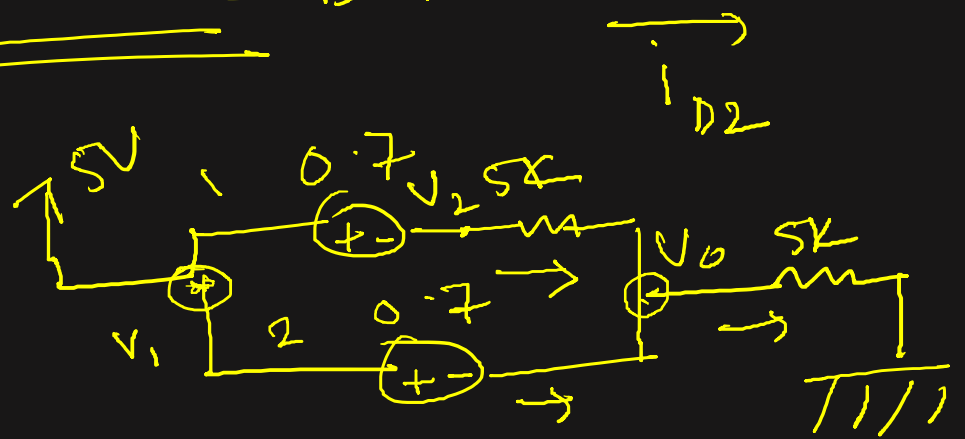


→ CVD model,

$V_{D0} = 0.7V$

→ Find V_o, i_o

ASSUME: Both ON



Solve: $V_1 - V_o = 0.7V$

$\Rightarrow 5 - V_o = 0.7V$

$\Rightarrow V_o = 4.3V$

$i_o = \dfrac{V_o - 0}{5\,K\Omega} = 0.86\,mA$

$5 - V_2 = 0.7\,V$

$\Rightarrow V_2 = 4.3V$

$i_{D1} = \dfrac{V_L - V_o}{5\,K\Omega} = 0\,mA$

KCL: V_o nod

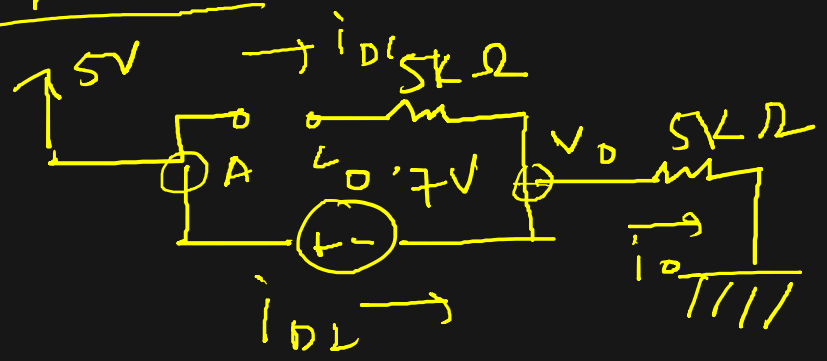
$i_{D1} + i_{D2} = i_o$

$\Rightarrow i_{D2} = 0.8_m$

Verify

Wrong

Assumption 2: D_1 OFF, D_2 ON



$V_{D1} = V_A - V_C$

$= 5 - V_o$

$= 0.7V$

Solve: $i_{D1} = 0$, $i_{D2} = i_o$

$5 - V_o = 0.7V$

$\Rightarrow V_o = 4.3V$

$V_{D1} \leq V_o$

$\therefore D_1$ OFF

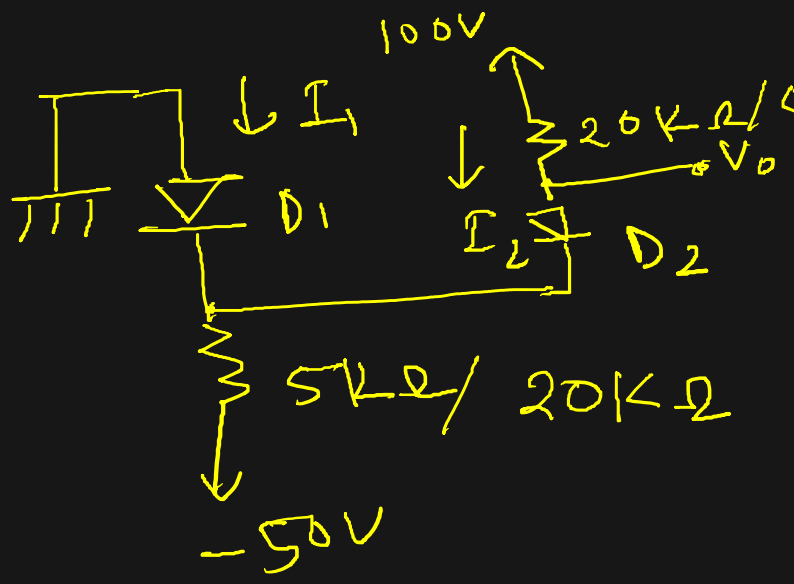
$i_o = \dfrac{V_o - 0}{5K\Omega}$

$= 0.86mA$

$= i_{D2}$; D_1 ON

$\therefore$ Assumption Correct

Ex. 2

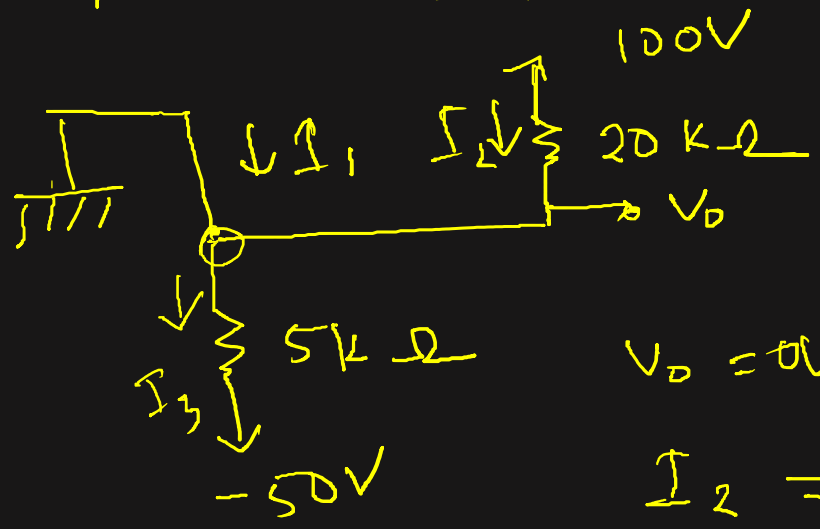


V_o , I_1 , I_2 = ?

Ideal Diode model

Assumption correct

Assumption : Both ON



$V_o = 0V$

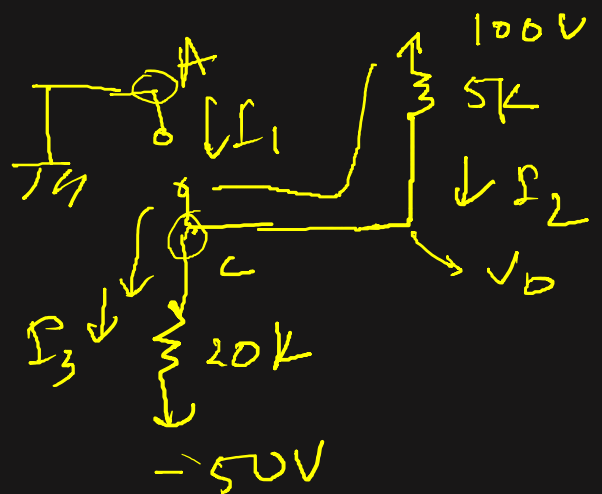
$$I_3 = \frac{V_o - (-50)}{5K\Omega} = 10\,mA$$

$I_1 + I_2 = I_3$; KCL at V_o node

$\Rightarrow I_1 = I_3 - I_2 = 5\,mA$

$$I_2 = \frac{100 - V_o}{20}\,mA = 5\,mA$$

Assumption 2 : $D_1 \rightarrow$ OFF, $D_2 \rightarrow$ ON



$I_1 = 0$

$I_2 = I_3$

KVL :

$$100 - 5I_2 - 20I_3 - 50 = 0$$

$$\Rightarrow 50 - 5I_2 - 20I_2 = 0$$

$$\Rightarrow I_2 = 2\,mA$$

$$V_o = 100 - 5I_2$$

$$= 90V$$

D_1 :

$V_A = 0V$

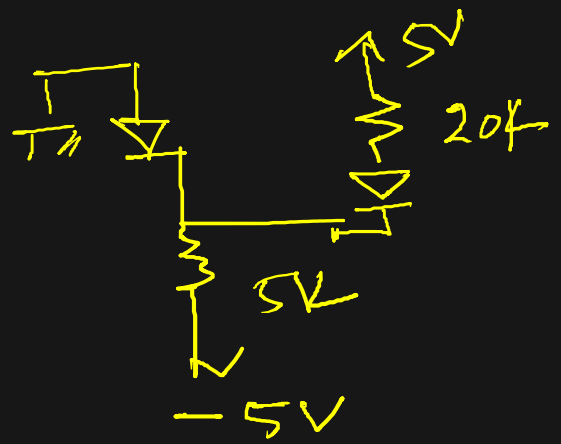
$V_C = 90V$

$V_{D_1} = V_A - V_C$

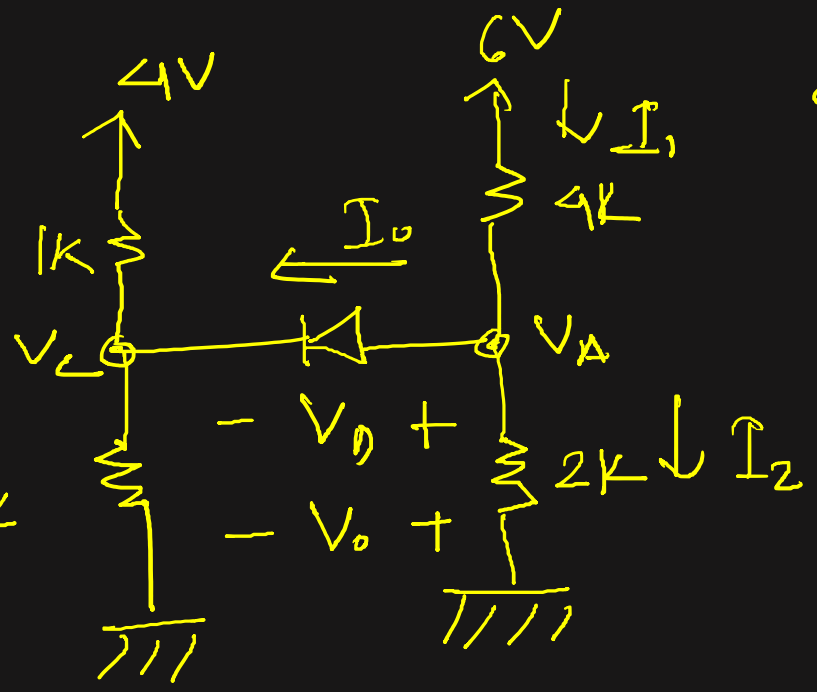
$= -90V$

$V_{D_1} \leq V_{P_0}$

Practice :



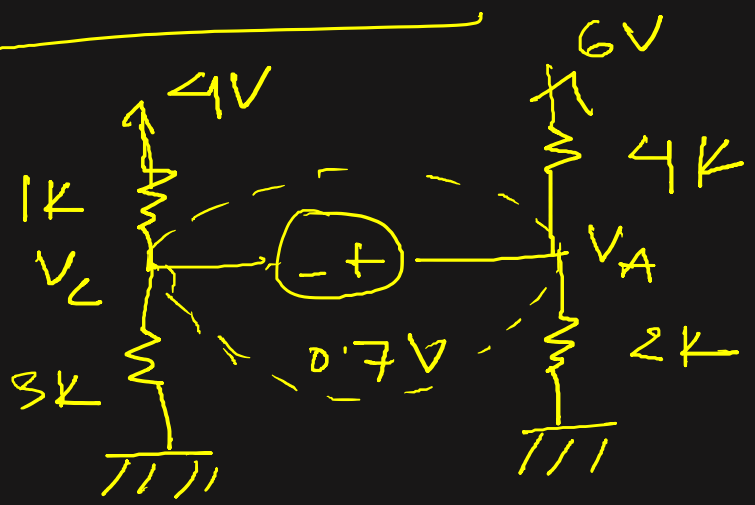
5)



CVD, $V_{D_0} = 0.7V$

I_D, V_o = ?

Assume : ON



$V_A - V_C = 0.7V$ — (i)

Nodal

$$\frac{V_A - 6}{4} + \frac{V_A - 0}{2} + \frac{V_C - 4}{1} + \frac{V_C - 0}{3} = 0 \quad \ldots\ldots (ii)$$

$V_A = 3.09V$, $V_C = 2.39V$

$$I_1 = \frac{6 - V_A}{4}\ mA \approx \frac{3}{4}\ mA$$

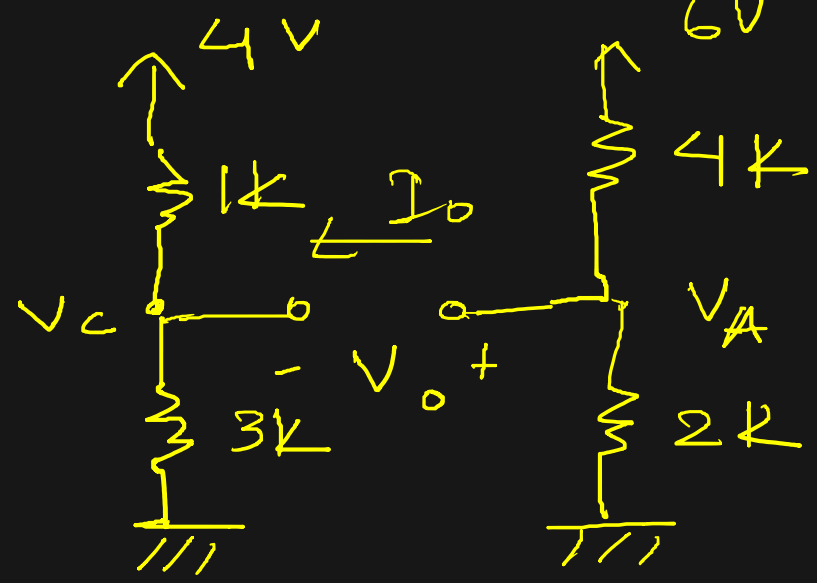
$$I_2 = \frac{V_A - 0}{2}\ mA = \frac{3.09}{2}\ mA$$

$$I_0 + I_2 = I_1$$

$$\Rightarrow I_0 \approx -\frac{3}{4}\ mA$$

Assumption Wrong!

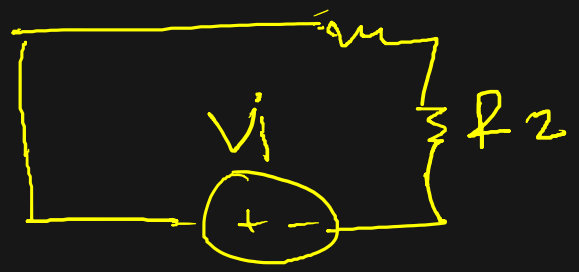
Assumption 2 : D → OFF



$I_o = 0\,mA$

$$V_A = 6 \times \frac{2}{2+4} V = 2V$$

$$V_c = 4 \times \frac{3}{3+1} V = 3V$$



$$V_{R_1} = V_i \times \left(\frac{R_1}{R_1+R_2}\right)$$

$$V_{R_2} = V_i \times \left(\frac{R_2}{R_1+R_2}\right)$$

$$V_o = V_A - V_c$$

$$= (2-3)V$$

$$= -1\,V$$

$$V_o \leq V_{D_0}$$