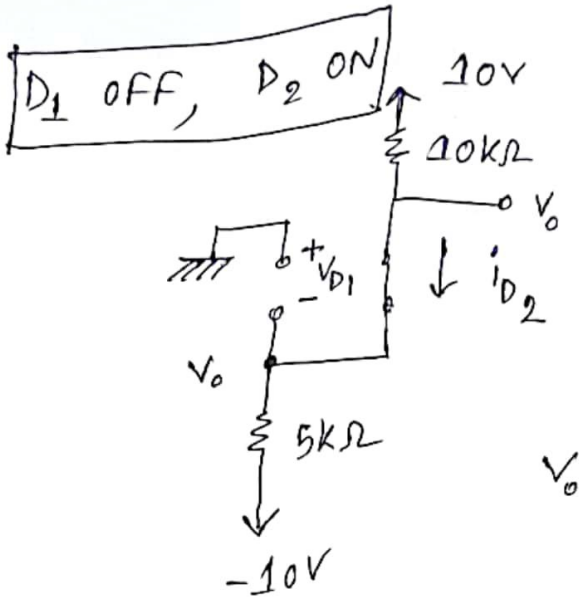
1 (i)

D_1 OFF, D_2 ON



$$i_{D_2} = \frac{10-(-10)}{10+5}$$

$$= \frac{20}{15}$$

$$= 1.33\ mA > 0$$

$$V_o = 10 - 10 \times i_{D_2}$$

$$= 10 - 10 \times \frac{20}{15}$$

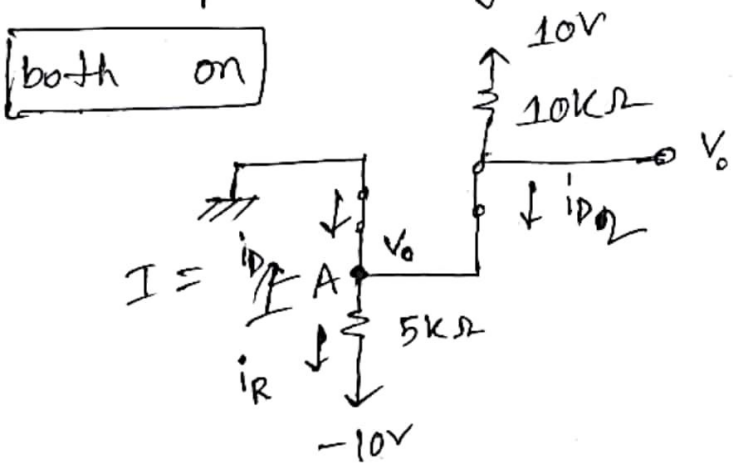
$$= -3.33\ V$$

$$i_{D_1} = I = 0$$

$$V_{D_1} = V_A - V_c = 0 - V_o = 0 + 3.33 \not< 0$$

assumption wrong.

both on



Here, $V_o = 0\ V$

[the node is connected to ground]

$$i_{D_2} = \frac{10 - V_o}{10} = \frac{10}{10} = 1\ mA > 0$$

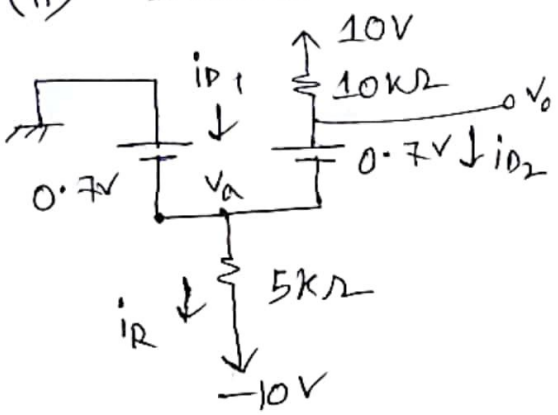
$$i_R = \frac{0-(-10)}{5} = 2\ mA$$

at node A, $i_{D_2} + i_{D_1} = i_R$

$$\Rightarrow i_{D_1} = i_R - i_{D_2} = 2 - 1 = 1\ mA > 0$$

$\therefore$ assumption verified.

(ii) assume both ON.



for D1, $-V_a + 0 = 0.7$

$\therefore V_a = -0.7V$

for D_2, $V_o - V_a = 0.7$

$\Rightarrow V_o = 0.7 + V_a$

$= 0\ V$

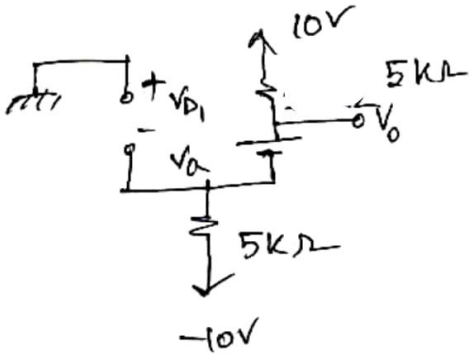
$i_D = \frac{10 - V_o}{10} = \frac{10}{10} = 1mA > 0$

$i_R = \frac{V_a + 10}{5} = \frac{-0.7 + 10}{5} = 1.86mA$

$i_{D_1} + i_{D_2} = i_R \Rightarrow i_{D_1} = i_R - i_{D_2} = 1.86 - 1 = 0.86\ mA > 0$

assumption verified.

(iii) D_1 off, D_2 ON



at node V_o, $\frac{V_o - 10}{5} + \frac{V_a + 10}{5} = 0$, here $V_o - V_a = 0.7$

$\Rightarrow \frac{V_o - 10}{15} + \frac{(V_o - 0.7) + 10}{5} = 0 \Rightarrow V_o = 0.35\ V$

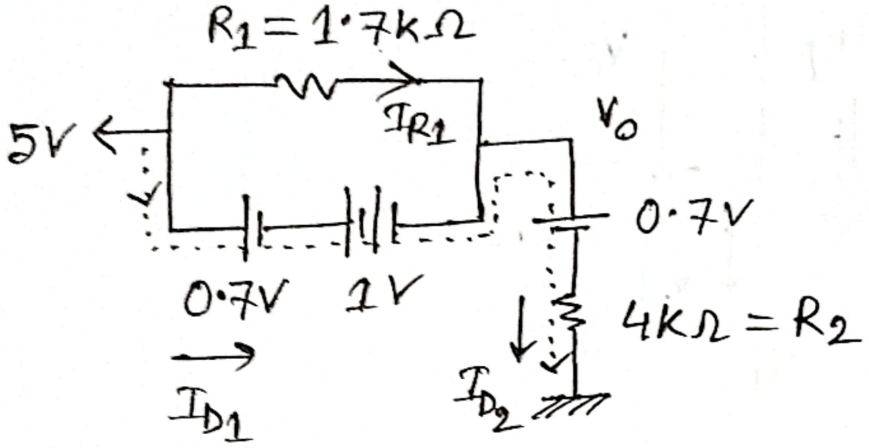
$\therefore i_{D_2} = \frac{10 - V_o}{5} = \frac{10 - 0.35}{5} = 1.93mA > 0$

$V_{D_1} = V_A - V_c = 0 - V_a = 0 - (V_o - 0.7) = 0.35V < 0.7$

$\therefore$ assumptions are correct.

(2)

Assumption: D_1, D_2 both ON.



at the dotted line,

$$5 - 0{\cdot}7 - 1 - 0{\cdot}7 - 4I_{D_2} = 0$$

$$\Rightarrow I_{D_2} = 2{\cdot}6/4 = 0{\cdot}65\,mA > 0$$

$$V_o = 5 - 0{\cdot}7 - 1 = 3{\cdot}3V$$

$$I_{R_1} = \frac{5 - V_o}{R_1} = \frac{5 - 3{\cdot}3}{1{\cdot}7} = 1\,mA$$

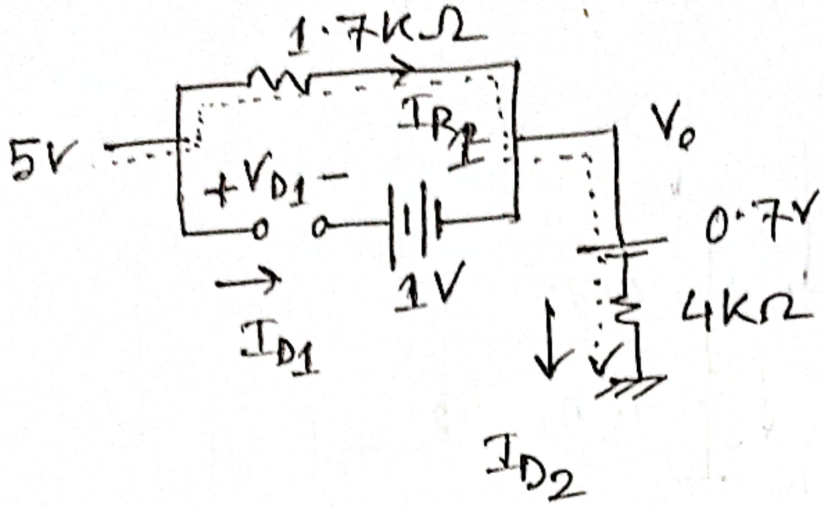
at node V_o, using KCL, $I_{D_2} = I_{D_1} + I_{R_1}$

$$\Rightarrow I_{D_1} = I_{D_2} - I_{R_1}$$
$$= 0{\cdot}65 - 1$$
$$= -0{\cdot}35\,mA < 0$$

$\therefore$ D_1 ON is a wrong assumption

D_2 ON is a correct assumption ($\because I_{D_2} > 0$)

let's assume D_1 is off, D_2 is ON



From the figure, $I_{D1} = 0$

$\therefore I_{D_2} = I_{R_1}$

along the dotted line,

$$5 - 1{\cdot}7 I_{R_1} - 0{\cdot}7 - 4 I_{D_2} = 0$$

$$\Rightarrow 4{\cdot}3 = 1{\cdot}7 I_{D_2} + 4 I_{D_2} \quad [\because I_{D_2} = I_{R_1}]$$

$\therefore I_{D_2} = 0{\cdot}7544 \text{ mA} > 0$ $\therefore D_2$ is ON

$= I_{R1}$

and,

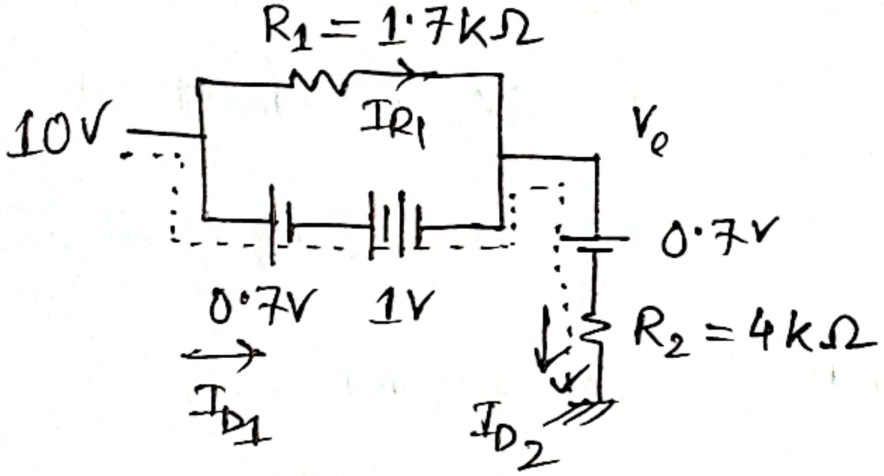
$$V_o = 5 - 1{\cdot}7 I_{R_1} = 3{\cdot}718 \text{ V}$$

Here, $V_{D_1} = 5 - (V_o + 1) = 5 - 4{\cdot}718 < 0{\cdot}7\text{V}$

$\therefore D_1$ is OFF

(b) now, $V_1 = 10V$

we'll assume both D_1 and D_2 is ON.



Here, $V_o = 10 - 0.7 - 1 = 8.3V$

$$I_{R_1} = \frac{10 - V_o}{R_1} = 1mA$$

along the dotted line,

$$10 - 0.7 - 1 - 0.7 - 4I_{D_2} = 0$$

$$\Rightarrow I_{D_2} = 1.9mA$$

at node V_o, $I_{D_2} = I_{D_1} + I_{R_1}$

$$\therefore I_{D_1} = 1.9 - 1 = 0.9mA$$

Since both $I_{D_1} > 0$ and $I_{D_2} > 0$,

the assumptions are correct.

For problem 3 and 4, see the solutions of previous semester's term questions.