Using the ideal parameters

## Negative Logic AND Gate

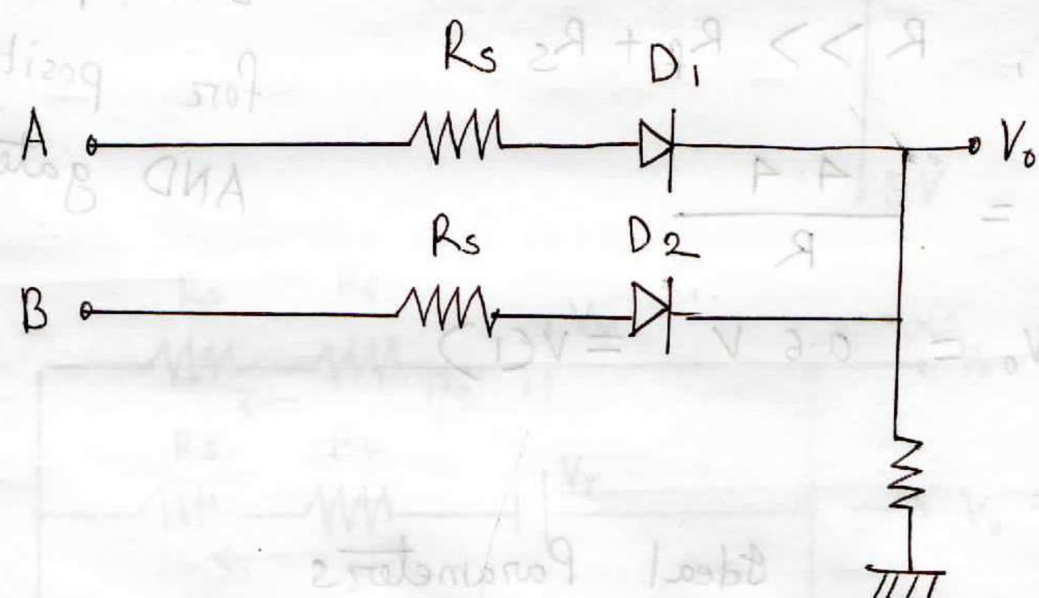
Negative Logic

$V(0) = 5V$

$V(1) = 0V$

AND Gate

| A | B | $V_o$ |
|---|---|---|
| V(0) | V(0) | V(0) |
| V(0) | V(1) | V(0) |
| V(1) | V(0) | V(0) |
| V(1) | V(1) | V(1) |

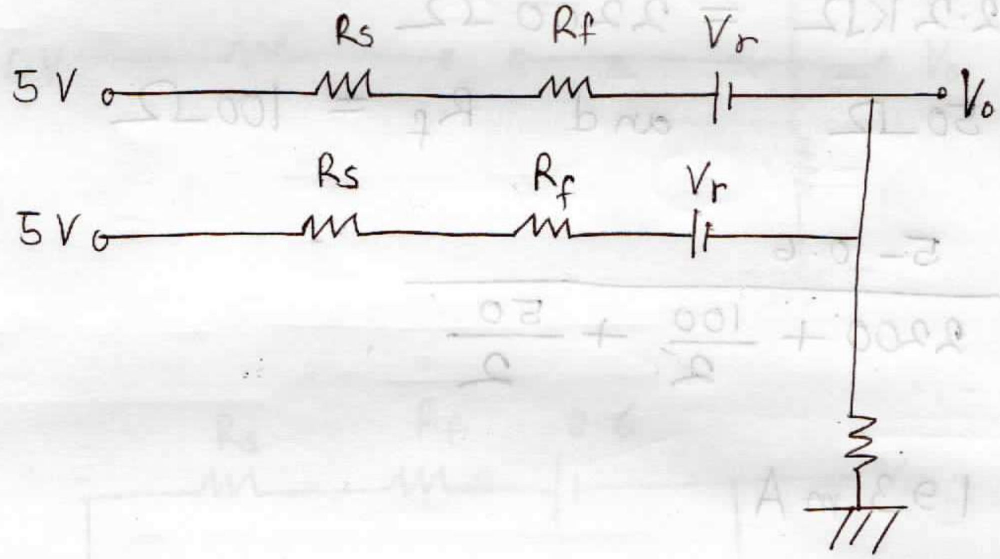


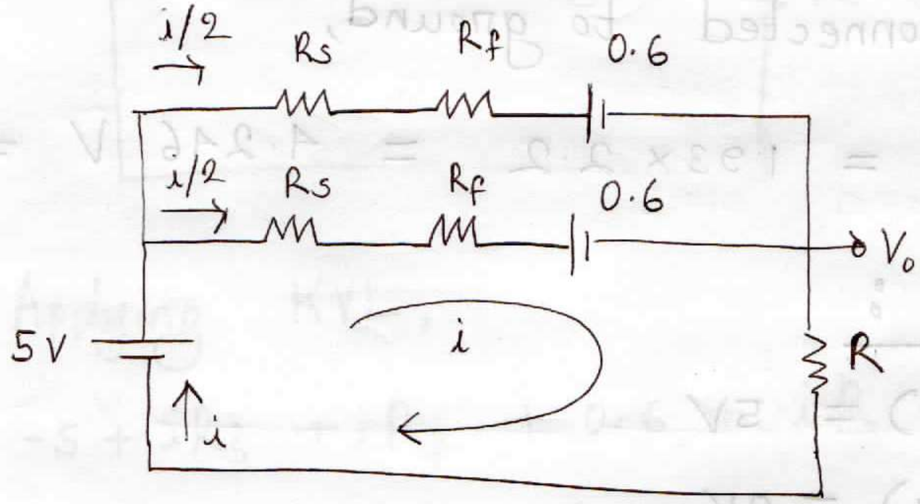

Case 1:

$A = V(0) = 5V$

$B = V(0) = 5V$

Both diodes are in forward bias




Applying KVL,

$$-5 + iR + V_r + \frac{i}{2} R_f + \frac{i}{2} R_s = 0$$

$$i = \frac{5 - V_r}{R + \frac{R_f}{2} + \frac{R_s}{2}}$$

Putting the ideal parameters, i.e

$R = 2.2\,K\Omega = 2200\,\Omega$

$R_s = 50\,\Omega$ and $R_f = 100\,\Omega$

$$i = \frac{5 - 0.6}{2200 + \frac{100}{2} + \frac{50}{2}}$$

$$= 1.93\,mA$$

Since connected to ground,

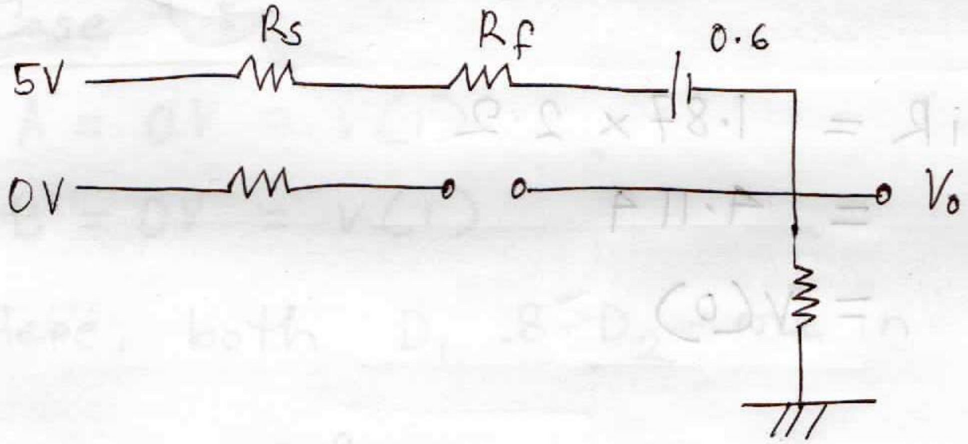
$V_o = iR = 1.93 \times 2.2 = 4.246\ V = V(0$

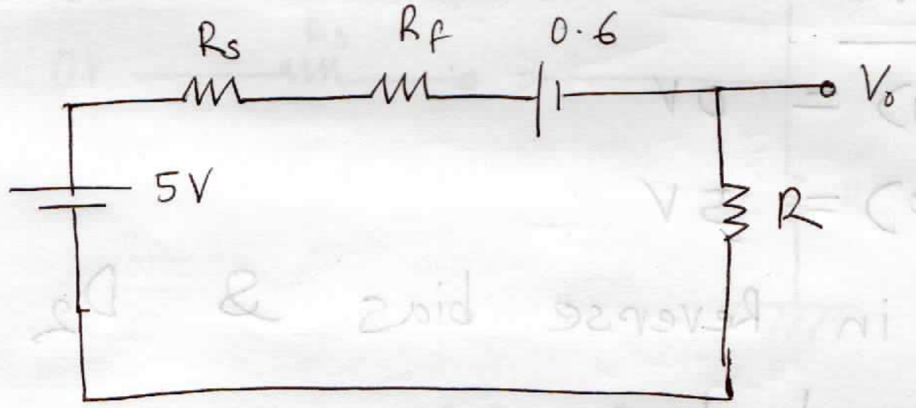
<u>Case 2 :</u>

$A = V(0) = 5V$

$B = V(1) = 0V$

Here, $D_1$ is in forward bias and $D_2$ in reverse bias.




Applying KVL,

$$-5 + iR_s + iR_f + 0.6 + iR = 0$$

$$\Rightarrow i(R_s + R_f + R) = 5 - 0.6$$

$$\Rightarrow i = \frac{5-0.6}{R_s + R_f + R}$$

$$= \frac{5-0.6}{1000 + 50 + 2200}$$

$$\therefore i = 1.87 \text{ mA}$$

So,

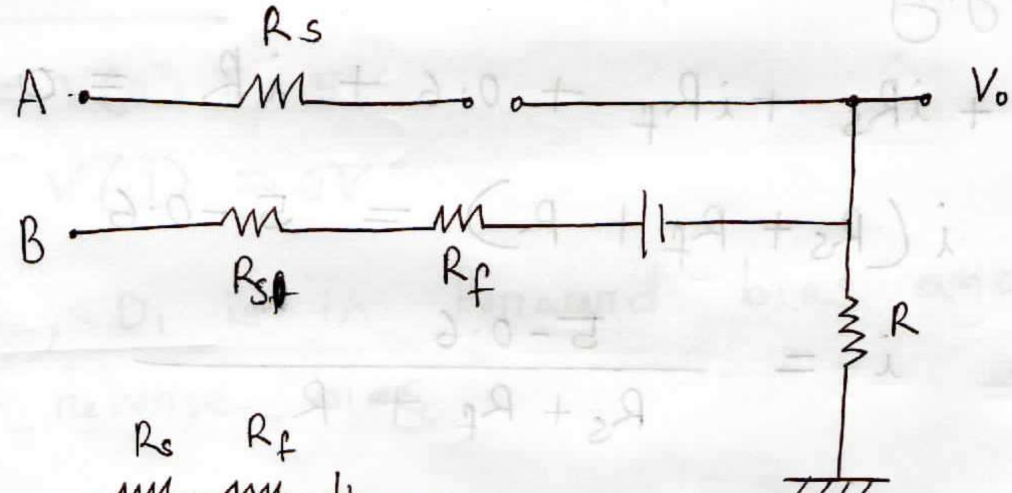
$$V_o = iR = 1.87 \times 2.2$$
$$= 4.114$$
$$= V(0)$$

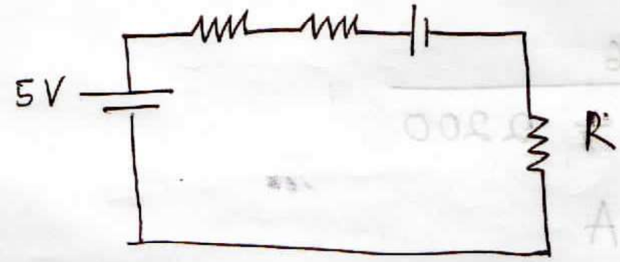
Case 3 :

$A = V(1) = 0V$

$B = V(0) = 5V$

$D_1$ is in Reverse bias & $D_2$ is in Forward bias



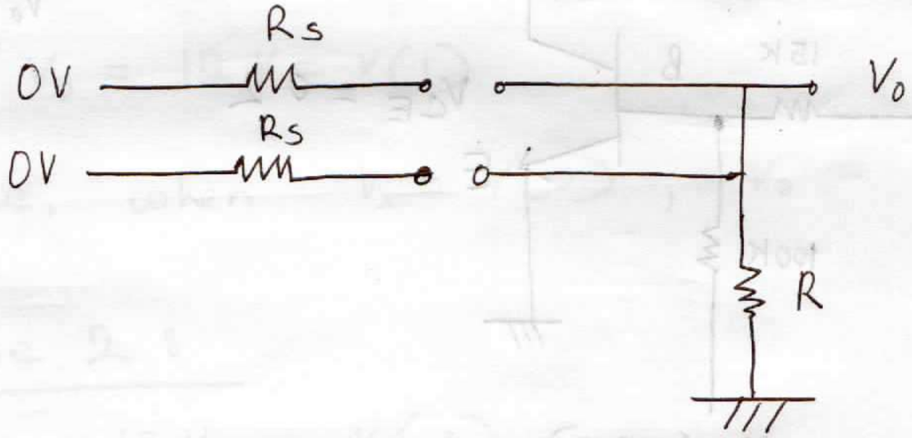



## Case 4 :

$A = 0V = V(1)$

$B = 0V = V(1)$

Here, both $D_1$ & $D_2$ are in reverse bias.




$\therefore V_0 = 0V = V(1)$