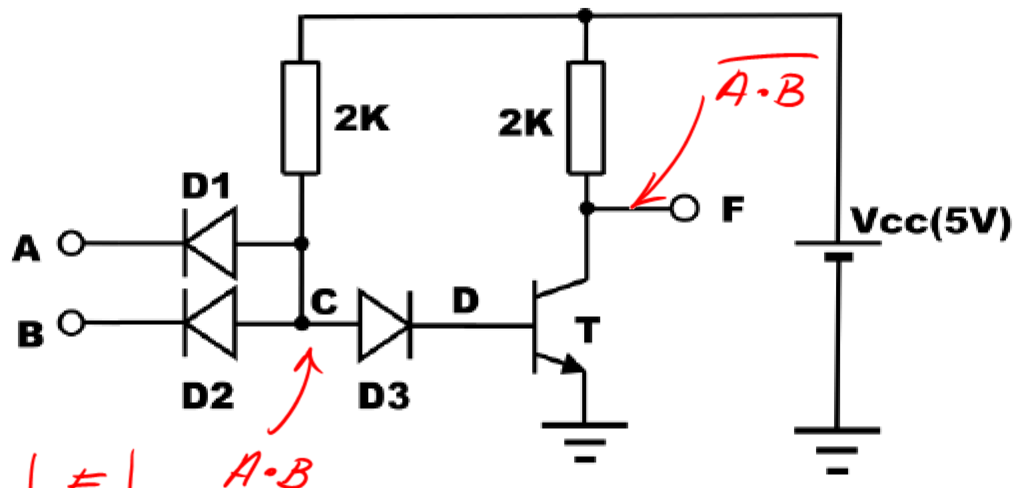
41. The following circuit implements a two-input logic gate: A and B are the inputs and F the output (F):

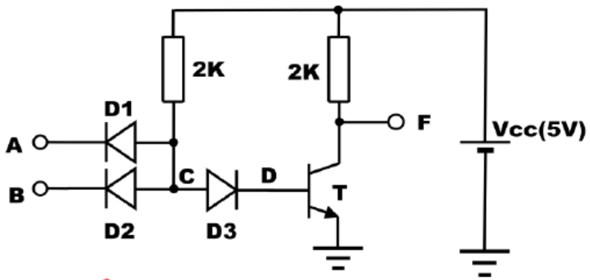
a) Obtain the truth table of the circuit and infer which type of logic gate is. Inputs ("1" -> 5V; "0"-> 0V)
b) Calculate approximately the voltage in the signaled points and the current of all branches, for each combination of inputs.
DATA: $V_{BE(ON)} = 0.7V$; $V_{CE(SAT)} = 0.2V$, $\beta=50$. Diodes: $V\gamma=0.7V$



a)

A B	D_1 D_2	C	T	F
0 0	ON ON	0	OFF	1
0 1	ON OFF	0	OFF	1
1 0	OFF ON	0	OFF	1
1 1	OFF OFF	1	ON	0

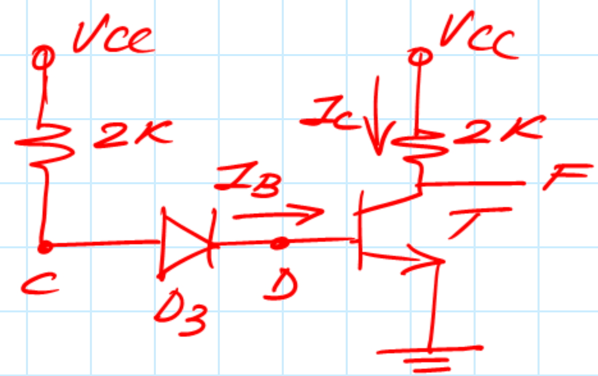
$F = \overline{A\cdot B}$ (NAND)



$\beta = 50$

b1) $A = B = 1$

$\left.\begin{array}{l} D_1 \text{ OFF} \\ D_2 \text{ OFF} \end{array}\right\} \Rightarrow$



D_3 ON, T ON, as

$V_{CC} > V_{\gamma D3} + V_{BE(ON)T}$

$$I_B = \frac{V_{CC} - V_{\gamma D3} - V_{BE(ON)}}{2K} = \frac{5 - 0.7 - 0.7}{2K} = 1.8\,mA$$

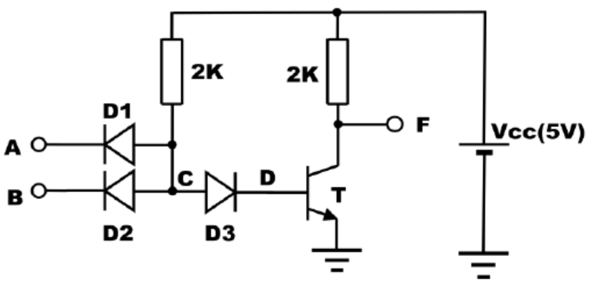
Assume T saturated $\Rightarrow I_{C(SAT)} = \dfrac{V_{CC} - V_{CE(SAT)}}{2K} = \dfrac{5 - 0.2}{2}$

$I_{C(SAT)} = 2.4\,mA$

as $\beta I_B = 50 \cdot 1.8 > I_{C(SAT)} = 2.4\,mA \Rightarrow$ T is SATURATED

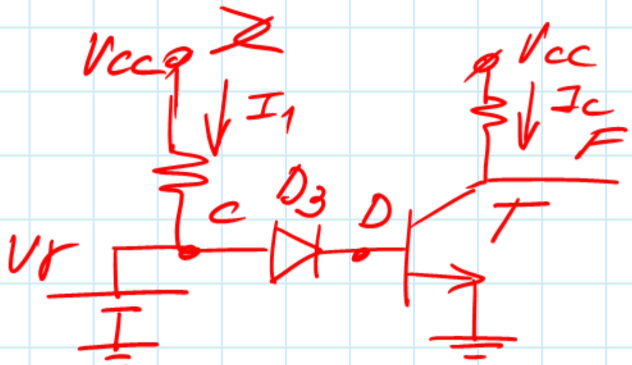
and $\boxed{V_F = V_{CE(SAT)} = 0.2V}$

$$\boxed{\begin{array}{l} V_C = V_\gamma + V_{BE(ON)} = 1.4V \\ V_D = V_{BE(ON)} = 0.7V \end{array}}$$



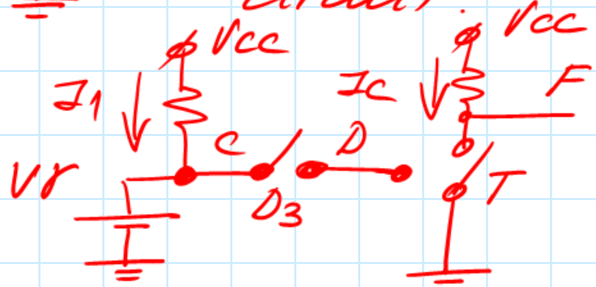
b2) $\left.\begin{array}{l} A=0;\ B=1 \\ A=1;\ B=0 \\ A=0;\ B=0 \end{array}\right\}$ In these cases, at least ONE diode is ON $\Rightarrow$

$$\boxed{V_C = V_\gamma = 0.7V}$$



As $V_C < V_\gamma + V_{BE(ON)} \Rightarrow \left\{\begin{array}{l} D_3 \text{ OFF} \\ T \text{ OFF} \end{array}\right.$

Then we have the (new) equivalent circuit:



$$\boxed{V_F = V_{CC}}$$

$\boxed{V_D < V_C}$ (in fact, D is open, a floating voltage between $(0 - V_C)$)

$$I_1 = \frac{V_{CC} - V_\gamma}{2K} = \underline{2.15\,mA}$$

$$I_C = \underline{0\,mA}$$