DTL - logic gates tutorial. Prof. M.-C. Brunet

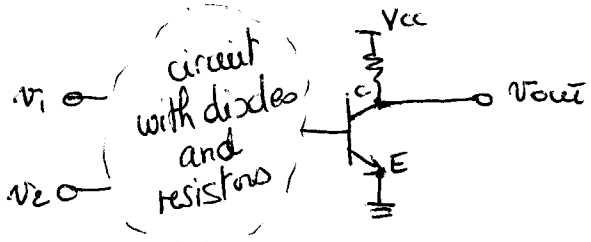
- Example of a 2-input gate:

The truth table is a summary of all possible input combinations and the corresponding output value. To low voltage corresponds a logic 0; to high voltage corresponds a logic 1.

Truth table

v_1	v_2	v_{out}
0	0	?
0	1	?
1	0	?
1	1	?

- In most DTL gates v_{out} is V_{CE} (the output voltage of the Transistor in the circuit).

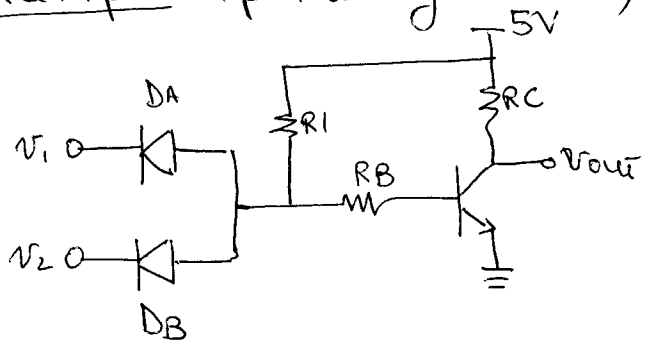


- Finding the truth table for v_{out}: To analyze what the gate is doing consider an input 0V for Logic 0, and V_{cc} (typically 5V) for Logic 1. In addition:

① if v_{out} = low, the BJT is saturated (ON)
② if v_{out} = high, the BJT is off (no current i_B, i_C)
} (*)

One strategy: For each input combination assume
→ a state for the BJT (① or ②)
→ a state for each diode in the circuit (ON or OFF)
Then compute all node voltages in the circuit and currents.
If there is a contradiction → try other assumptions
If there is no contradiction → the BJT state defines v_{out} (see (*))

- **Example** (partially solved)

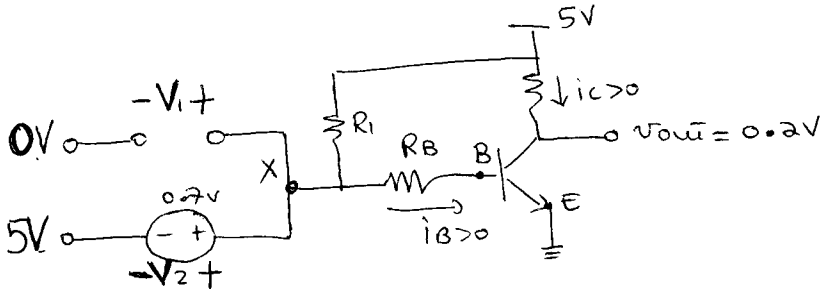


Look at one input combo:

v_1	v_2	v_{out}
0	0	
→ 0	1	? ←
1	0	
1	1	

- v_1 is 0 : take 0V ; v_1 is 1 : take 5V

(A1) we assume that BJT is ON (saturated), DA is OFF, DB is ON



(be careful with notations: v_1 and V_1, v_2 and V_2 are not the same!)

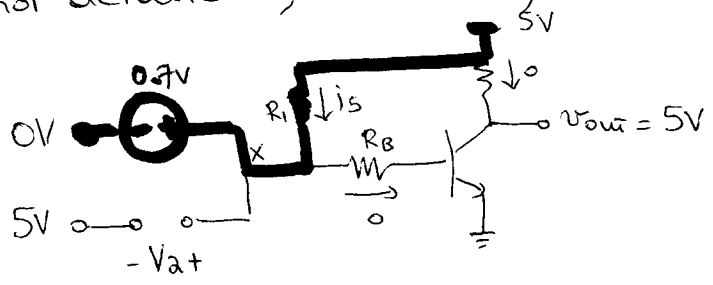
1) BJT is ON $\Rightarrow V_{BE} = V_{BEON} = 0.7V$

$i_B > 0 \Rightarrow V_X > 0.7V$ ← so far no contradiction...

2) DB is ON ($V_2 = 0.7V$) and $V_X - 5 = V_2 \Rightarrow V_X = 5.7V$ ←

3) DA is OFF; $V_1 = V_X - 0V = 5.7V$ not possible !! (for any diode $v_d \leq V_{ON}$)

(A2) Assume that BJT is OFF, DA is ON, DB is OFF - This works!! (not detailed ; see below).



— current path

$V_X = 0.7V$

$V_2 = 0.7 - 5 = -4.3V$ (off)

$i_S = \frac{5 - V_X}{R_1} = \frac{4.3}{R_1}$

$v_{out} = 5V$

Truth table:

v_1	v_2	v_{out}
0	0	
→ 0	1	1 ←
1	0	
1	1	