0.1 Exercise 1: Design and Implementation of NOT Gates Using Transistors

High-Level and Low-Level Input Voltages

The high-level input voltage (V_{IH}) es the minimum input voltage that is considered as high, while the low-level input voltage (V_{IL}) is the maximum input voltage that is considered as low.

High-Level and Low-Level Output Voltages

The high-level output voltage (V_{OH}) is the minimum output voltage that the circuit provides as a high, while the low-level output voltage (V_{OL}) is the maximum output voltage that the circuit provides as a low.

Noise Margin

The high noise margin (NM_H) is the gap between the high-level input voltage and the high-level output voltage, while the low noise margin (NM_L) is the gap between the low-level output voltage and the low-level input voltage.

$$NM_H = V_{OH} - V_{IH}$$

$$NM_L = V_{IL} - V_{OL}$$

Propagation Delays

For this assignment's meassures, when the input changes from low to hight and the output from high to low, the high-to-low propagation delay is considered as the time between the moment in which the input voltage reaches the 90% of its maximum high value, until the moment in which the output voltage reaches the 10% of its maximum high value.

$$t_{pHL} = t_{10\%V_{maxO}} - t_{90\%V_{maxI}}$$

In the case in which the input goes from high to low and the output from low to high, the low-to-high propagation delay is considered as the time between the moment in which the input voltage reaches the 10% of its maximum high value, until the moment in which the output voltage reaches the 90% of its maximum high value.

$$t_{pLH} = t_{90\%V_{maxO}} - t_{10\%V_{maxI}}$$

Transition Times

The high-to-low transition time or fall time (t_f) is the time that it takes the output voltage to go from its high maximum value to its low minimum value, while the low-to-high transition time or rise time (t_r) is the time that it takes for it to change from its low minimum value to tis high maximum value.

Maximum Output Current

0.1.1 Using a BJT NPN 337 Transistor

Without Load Connected to the Output

$V_{IH} = 0,9V$
$V_{IL} = 0,5V$
$V_{OH} = 4,96V$
$V_{OL} = 100mV$

$NM_H = 4,06V$
$NM_L = 0,4V$

$t_{pHL} = 87ns$
$t_{pLH} = 2,94\mu s$

$t_f = 69,5ns$
$t_r = 505ns$

$MaximumOutputCurrent =$

With a $1nF$ Capacitor Connected to the Output

0.1.2 Using a BJT PNP 327 Transistor

Without Load Connected to the Output

$V_{IH} = 4,5V$
$V_{IL} = 4,2V$
$V_{OH} = 4,77$
$V_{OL} = 50mV$

$NM_H = 0,27V$
$NM_L = 4,15V$

$t_{pHL} = 2,72\mu s$
$t_{pLH} = 73ns$

$t_f = 575ns$
$t_r = 83ns$

$MaximumOutputCurrent =$

With a $1nF$ Capacitor Connected to the Output