Solutions to Quiz 3

Question 1

The table(s) below shows part of the datasheet for a 74LS-series IC. What are the high- and low-level noise margins?

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE

		Min	Max	
VIH	Input HIGH Voltage	2.0		V
VIL	Input LOW Voltage		0.8	V
VOH	Output HIGH Voltage	2.7		V
VOL	Output LOW Voltage		0.5	V

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE

		Min	Max	
VIH	Input HIGH Voltage	2.2		V
VIL	Input LOW Voltage		0.8	V
VOH	Output HIGH Voltage	2.7		V
VOL	Output LOW Voltage		0.4	V

Answers

The high and low-level noise margins are (note the corrections to the min/max notation for the equations in Lecture 7):

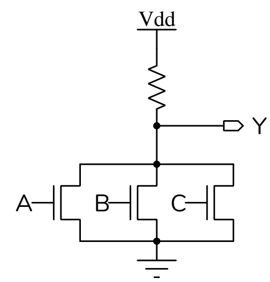
- noise margin(low) = $V_{IL(max)}$ - $V_{OL(max)}$
- noise margin(high) = $V_{OH(min)}$ - $V_{IH(min)}$

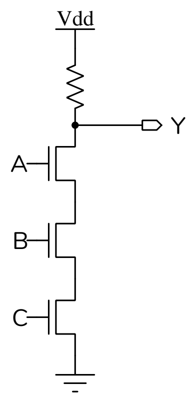
For the first example the high-level noise margin is $2.7 - 2.0 = \boxed{0.7\text{ V}}$ and the low-level noise margin $0.8 - 0.5 = \boxed{0.3\text{ V}}$.

For the first example the high-level noise margin is $2.7 - 2.2 = \boxed{0.5\text{ V}}$ and the low-level noise margin $0.8 - 0.4 = \boxed{0.4\text{ V}}$.

Question 2

What logic function is implemented by the circuit on the right? Give your answer as a Boolean logic expression for Y involving A, B and C.





Answers

For the first circuit, if any of the transistors are turned on the output is pulled low. Thus the logic function is a 3-input NOR gate: $\boxed{Y = \overline{A+B+C}}$.

For the second circuit, all of the transistors must be turned on for the output to be pulled low. Thus the logic function is a 3-input NAND gate: $\boxed{Y = \overline{A \cdot B \cdot C}}$.

Question 3

You are designing a circuit with an open-collector output. The rise-time time constant must be less than 100 μs. The total capacitance to ground on this output is 35 (or 60) pF. What is the highest resistance that you can use for the pull-up resistor?

Answers

The time constant of the circuit is $\tau = RC$ and C is given as 35 pF (or 60 pF). To keep the time constant to less than 100 µs the resistance must be kept to less than $R = {}^{100\,\mu s}/_{35\,pF} = {}^{100\times10^{-6}}/_{35\times10^{-12}} \approx \boxed{2.9\,M\Omega}$ (or $\boxed{1.7\,M\Omega)}$.