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LE4.2

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Calculator

LE4.2.1: AND of many inputs

3/3 points (ungraded)

Suppose we wanted to build a circuit to compute the AND of 1024 separate inputs. There's good news and bad news. The bad news is that we only have 2-input AND gates (called AND2) to use when implementing the circuit. The good news is that we have as many AND2 devices as we need.

The AND2 device has a contamination delay t_{CD} of 1 ns and a propagation delay t_{PD} of 4 ns.

What is the minimum number of AND2 devices needed to implement the circuit?

Minimum number of AND2 devices needed: ✓ Answer: 1023

Considering all possible implementations, what is the smallest achievable t_{CD} ?

Smallest achievable t_{CD} (in ns): ✓ Answer: 1

Considering all possible implementations, what is the smallest achievable t_{PD} ?

Smallest achievable t_{PD} (in ns): ✓ Answer: 40

Explanation
Both the chain and tree implemenations require 1023 AND2 devices -- think about the number of "." operators in a product term with 1024 elements.
A chain has the smallest achievable t_{CD} of 1 gate delay: consider the path from the input connected to the final gate in the chain to the output.
A tree has the smallest achievable t_{PD} of 10 gate delays since $\log_2(1024) = 10$. Each of the ten AND2 devices along the path from inputs to output has a t_{PD} of 4 ns.

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