$$A_1$$
Assignment 1

CS 3482; Professor Tang

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1 Question

Draw the circuit in LogicWorks to implement the Boolean function:

$$f(a, b, c, d) = (a' + b)'c + d(b' + ac)$$
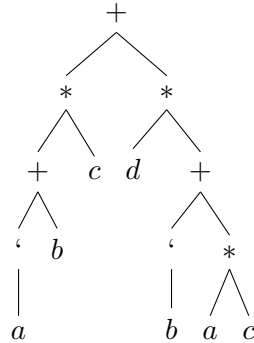
Figure 1: Given boolean function f

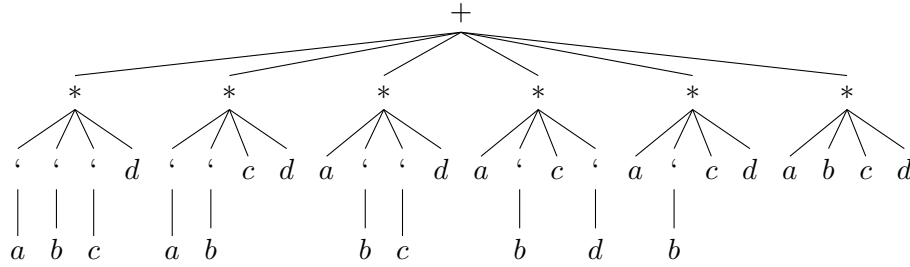Figure 2: Parse tree of figure 1

(a) Figure 2 shows the structure of a naive circuit implementation.

(b) The longest path from a to f is 5 gates. At a 2ns delay per gate, $2\text{ns} * 5 = 10\text{ns}$.

2 Question

Simplify the same Boolean function in figure 1 to be the sum of its minterms by obtaining is truth table first.

(a) Figure 1 shows the truth table for the function.

(b) $f_{\text{minterm}} = a'b'c'd + a'b'cd + ab'c'd + ab'cd' + ab'cd + abcd$

a	b	c	d	a'	$a'+b$	$(a'+b)'$	$(a'+b)'c$	ac	b'	$b'+ac$	$d(b'+ac)$	f
0	0	0	0	1	1	0	0	0	1	1	0	0
0	0	0	1	1	1	0	0	0	1	1	1	1
0	0	1	0	1	1	0	0	0	1	1	0	0
0	0	1	1	1	1	0	0	0	1	1	1	1
0	1	0	0	1	1	0	0	0	0	0	0	0
0	1	0	1	1	1	0	0	0	0	0	0	0
0	1	1	0	1	1	0	0	0	0	0	0	0
0	1	1	1	1	1	0	0	0	0	0	0	0
1	0	0	0	0	0	1	0	0	1	1	0	0
1	0	0	1	0	0	1	0	0	1	1	1	1
1	0	1	0	0	0	1	1	1	1	1	0	1
1	0	1	1	0	0	1	1	1	1	1	1	1
1	1	0	0	0	1	0	0	0	0	0	0	0
1	1	0	1	0	1	0	0	0	0	0	0	0
1	1	1	0	0	1	0	0	1	0	1	0	0
1	1	1	1	0	1	0	0	1	0	1	1	1

Table 1: Truth table for f as described in figure 1

Figure 3: Parse tree of minterms of f

(c) Figure 3 shows the parse tree and thusly the gate implementation of the minterms of f.

(d) The delay is set to 2ns and the longest gate path is 3 gates (as is with any sum of minterms circuit). Thusly, the delay is $2\text{ns} * 3 = 6\text{ns}$.

3   Question

(a) Figure 4 shows the trees of a 2-to-4 decoder with an active-high enable E

4   Question

(a) Five, one for the first two bits, and four for each of the four minterms of the first two bits.

(b) Figure 5 shows the parse trees of a 4-to-16 decoder built only using 2-to-4 decoders. The parse tree describes the gate diagram.
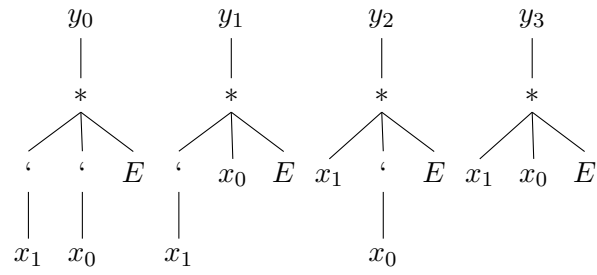
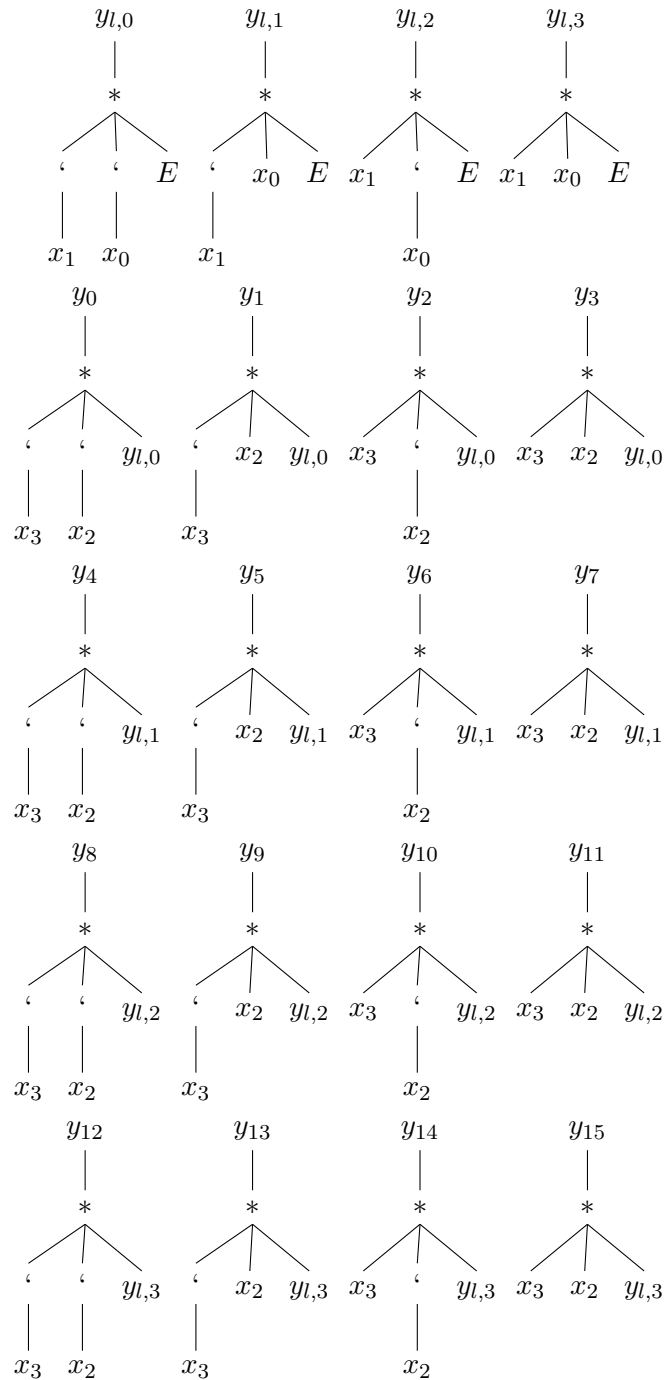Figure 4: Parse trees of 2-to-4 decoder with an active-high enable E

Figure 5: Parse trees of 4-to-16 decoder with an active-high enable E