Digital Electronics and Microprocessor Systems (ELEC211)

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Week 7 Q&A

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Week 7 – Lecture 17

Digital Electronics

Introduction to sequential logic

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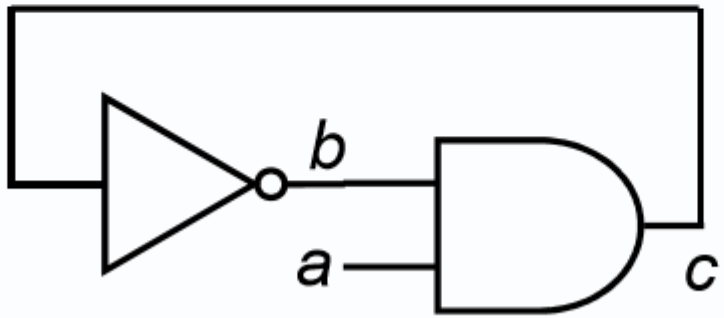
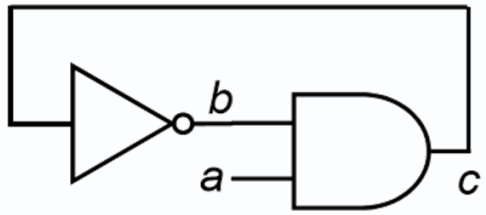
Question

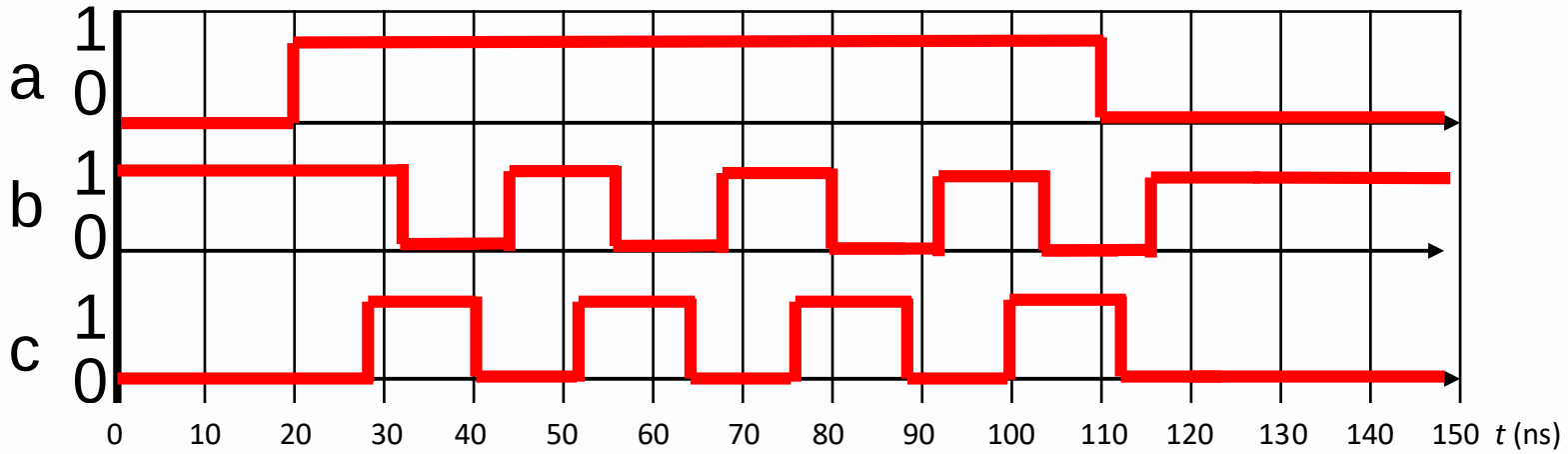
The inverter in the figure has a propagation delay of 4 ns and the AND gate of 8 ns. Draw a timing diagram for the circuit showing a, b, c. a and c are initially equal to 0, b is initially one. After 20 ns a becomes 1 for 90 ns and then 0 again.



Answer

The inverter in the figure has a propagation delay of 4 ns and the AND gate of 8 ns. Draw a timing diagram for the circuit showing a, b, c. a and c are initially equal to 0, b is initially one. After 20 ns a becomes 1 for 90 ns and then 0 again.





Week 7 – Lecture 18

Digital Electronics

CPLDs & FPGAs

Shannon's expansion

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Question

Shannon's expansion (decomposition)

Decompose the following function into 2 functions, one for a' and the other for a.

$$f(a,b,c,d) = a'c'd' + abd + bcd + b'cd' + acd'$$

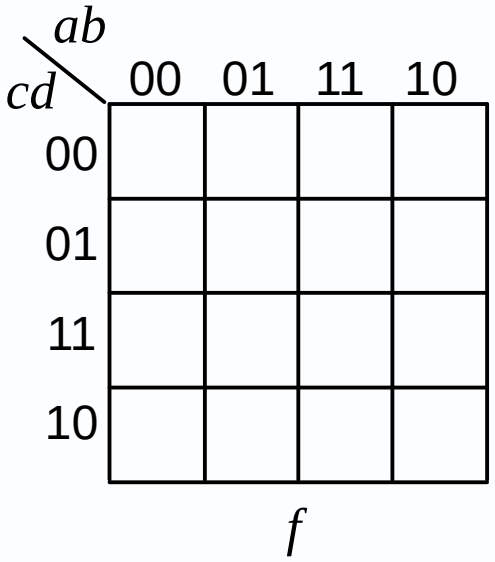
$$= a'f_0 + af_1$$

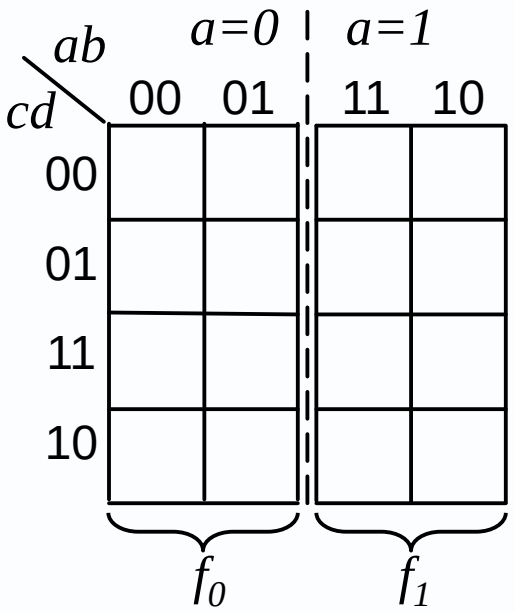
(4 to 3 variable example)

Method

$$f(a,b,c,d) = a'c'd' + abd + bcd + b'cd' + acd'$$

$$= a'c'd' + abd + (a + a')bcd + (a + a')b'cd' + acd'$$





(4 to 3 variable example)

$$= a'(\ldots) + a(\ldots)$$

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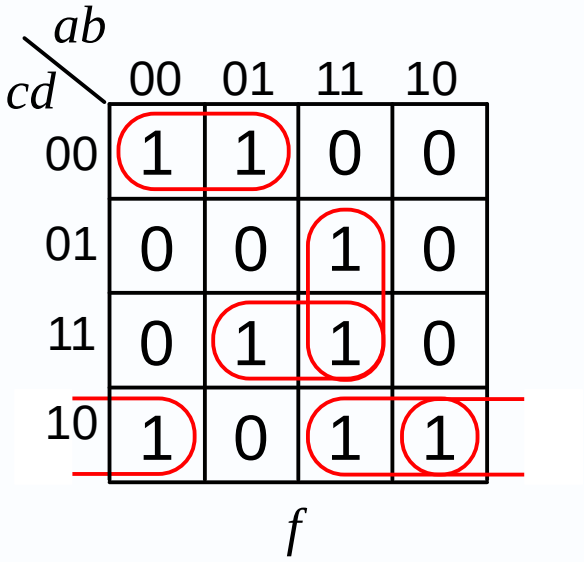
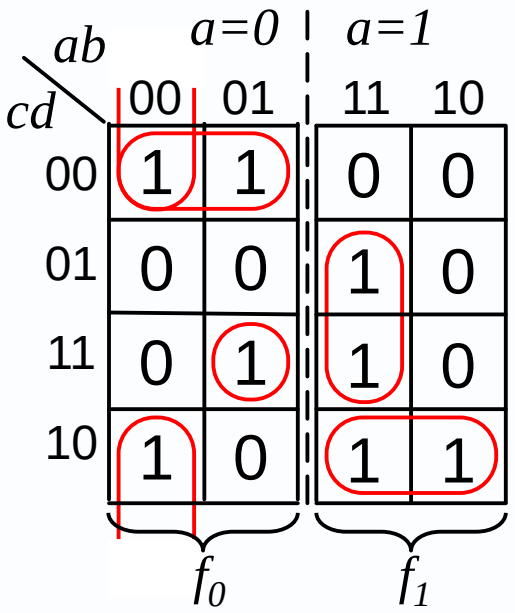
Answer

$$f(a,b,c,d) = a'c'd' + abd + bcd + b'cd' + acd'$$

$$= a'c'd' + abd + (a + a')bcd + (a + a')b'cd' + acd'$$





(4 to 3 variable example)

$$f = a'(c'd' + b'd' + bcd) + a(cd' + bd)$$ (answer)

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Question

Decompose the following function into 2 functions, one for a' and the other for a.

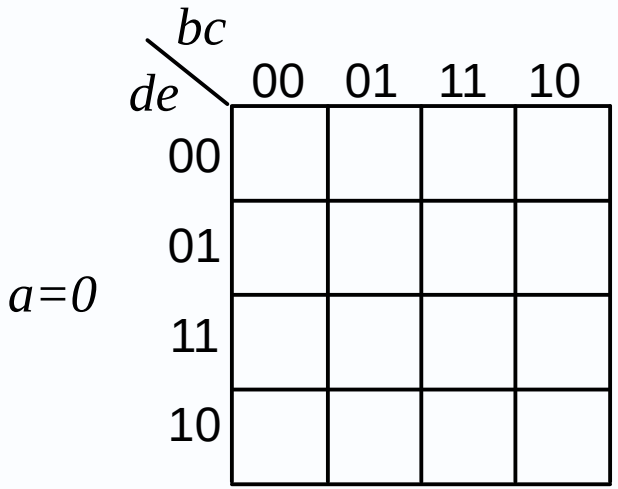
$$f(a,b,c,d,e) = b'c'd' + a'be + b'cde' + ab'd' + bcde$$
$$= a'f_0 + af_1$$

(5 to 4 variable example)

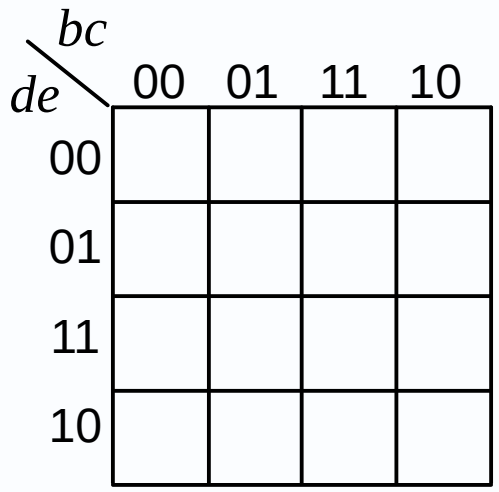
Method

$$f(a,b,c,d,e) = b'c'd' + a'be + b'cde' + ab'd' + bcde)$$

$$= (a + a')b'c'd' + a'be' + (a + a')cde' + ab'd' + (a + a')bcde$$



$a=0$



$a=1$

(5 to 4 variable example)

$$= a'(\ldots) + a(\ldots)$$

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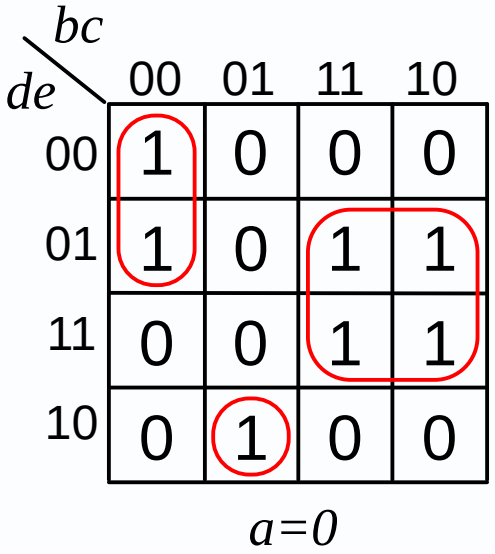
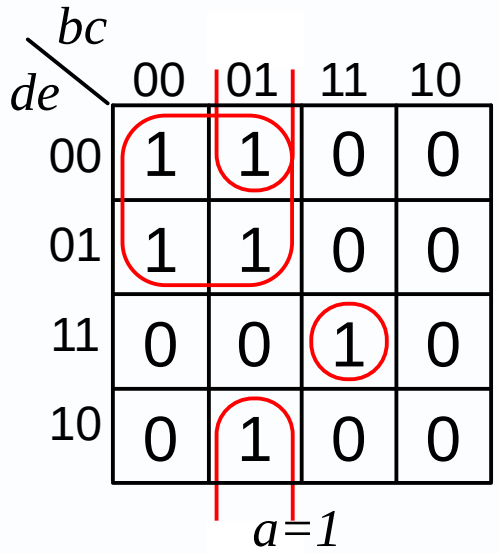
Answer

$$f(a,b,c,d,e) = b'c'd' + a'be + b'cde' + ab'd' + bcde`$$

$$= (a + a')b'c'd' + a'be' + (a + a')cde' + ab'd' + (a + a')bcde$$





(5 to 4 variable example)

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$$f = a'(b'c'd' + be + b'cde') + a(b'd' + b'ce' + bcde)$$ (answer)