# CO450 Computer Architectures Week 10 Exercise Handout

## Recap on Truth Tables

1. Create a Truth Table for the following logic expression:

$f = \bar{b} \cdot (a \cdot b) + (\overline{c \cdot d})$

| $a$ | $b$ | $c$ | $d$ | $\bar{b}$ | $a \cdot b$ | $\bar{b} \cdot (a \cdot b)$ | $c \cdot d$ | $\overline{c \cdot d}$ | $f$ |
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2. Create a Truth Table for the following logic expression:

$f = (\overline{\bar{a} + b}) \cdot (c + \bar{d})$

| $a$ | $b$ | $c$ | $d$ | $\bar{a}$ | $\bar{a} + b$ | $\overline{\bar{a} + b}$ | $\bar{d}$ | $c + \bar{d}$ | $f$ |
|---|---|---|---|---|---|---|---|---|---|
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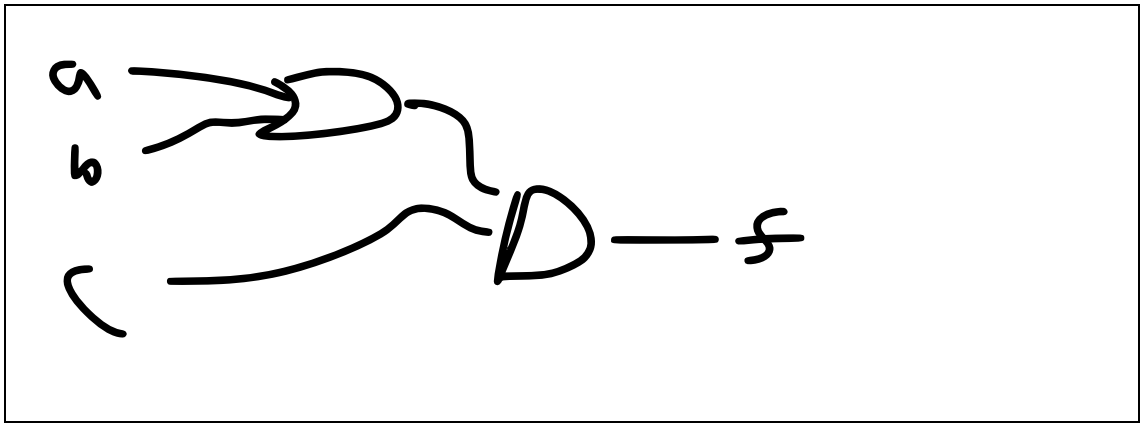
## Recap on Building Logic Circuits from Expressions

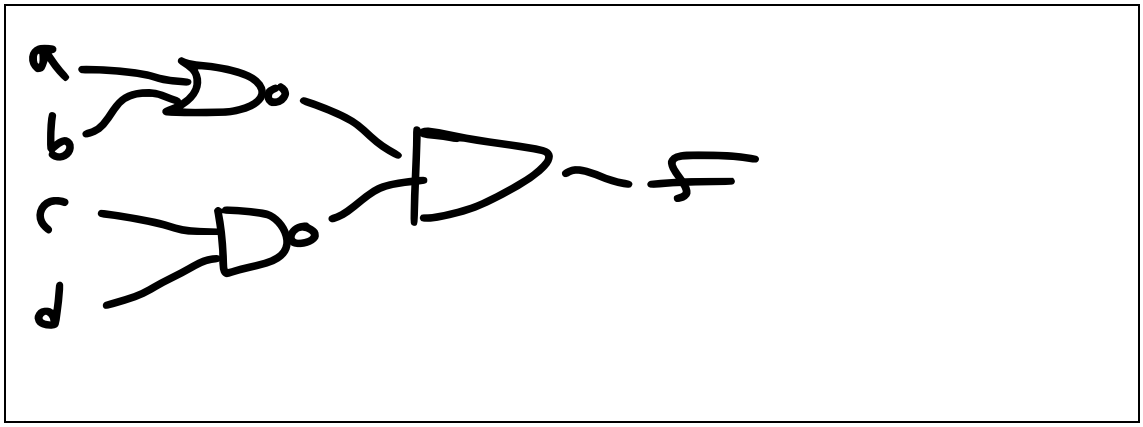
1. Create a Logic Circuit Design for the following logic expression:

$f = (a + b) \cdot c$



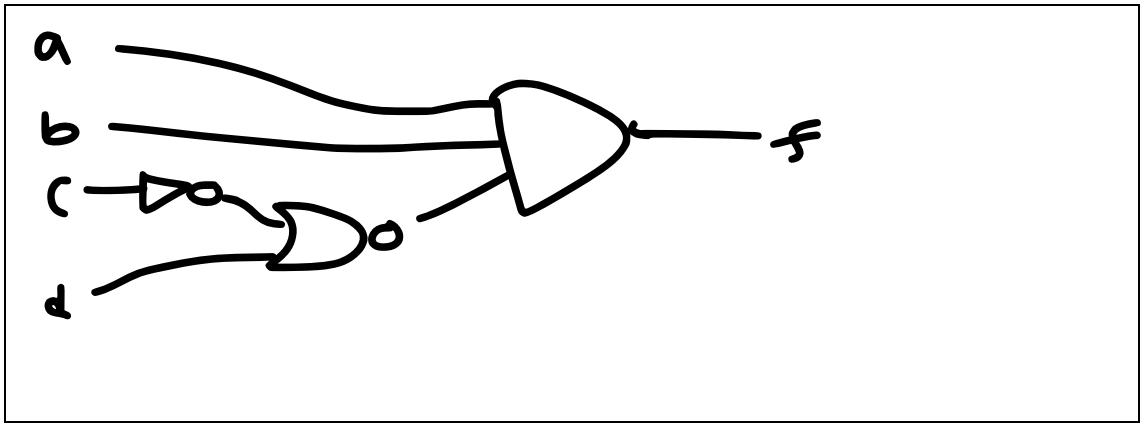

2. Create a Logic Circuit Design for the following logic expression:

$f = (\overline{a + b}) \cdot (\overline{c \cdot d})$




3. Create a Logic Circuit Design for the following logic expression:

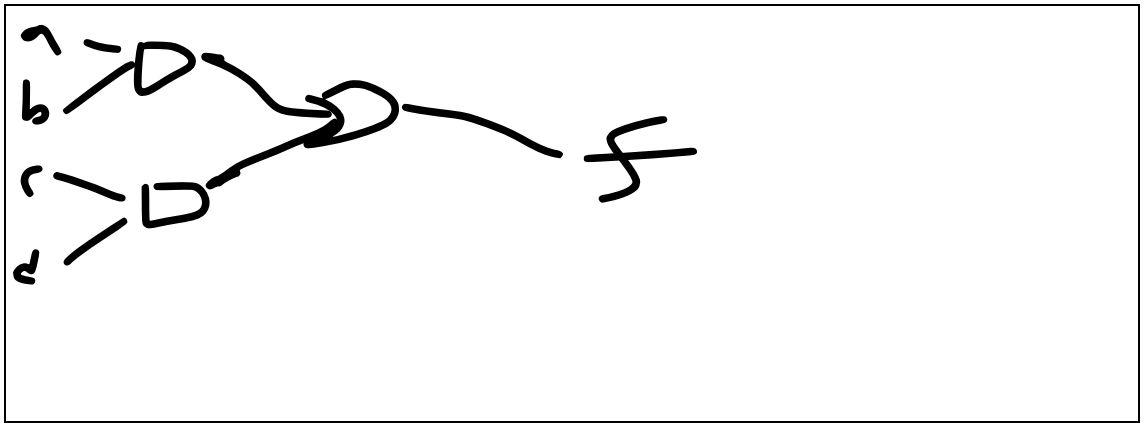
$f = a \cdot (\overline{\bar{c} + d}) \cdot b$



## Sum of Products (SoP) Representations

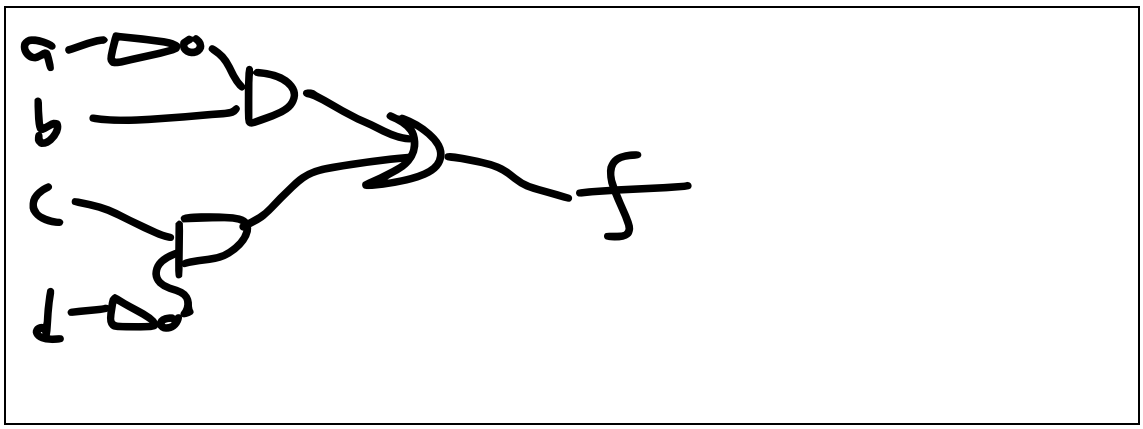
1. Create a Logic Circuit Design for the following SoP logic expression:

$f = (a \cdot b) + (c \cdot d)$



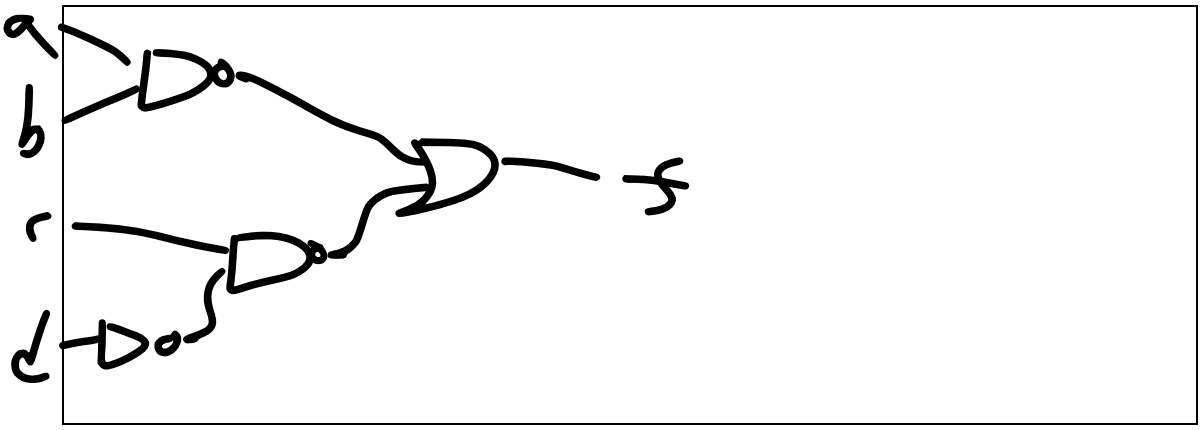

2. Create a Logic Circuit Design for the following SoP logic expression:

$f = (\bar{a} \cdot b) + (c \cdot \bar{d})$



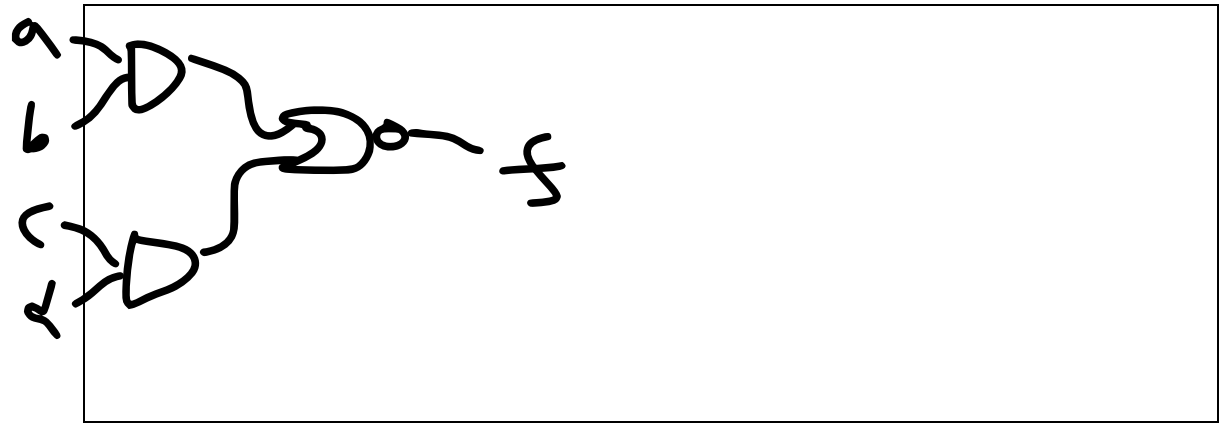

3. Create a Logic Circuit Design for the following SoP logic expression:

$f = (\overline{a \cdot b}) + (\overline{c \cdot \bar{d}})$



4. Create a Logic Circuit Design for the following SoP logic expression:

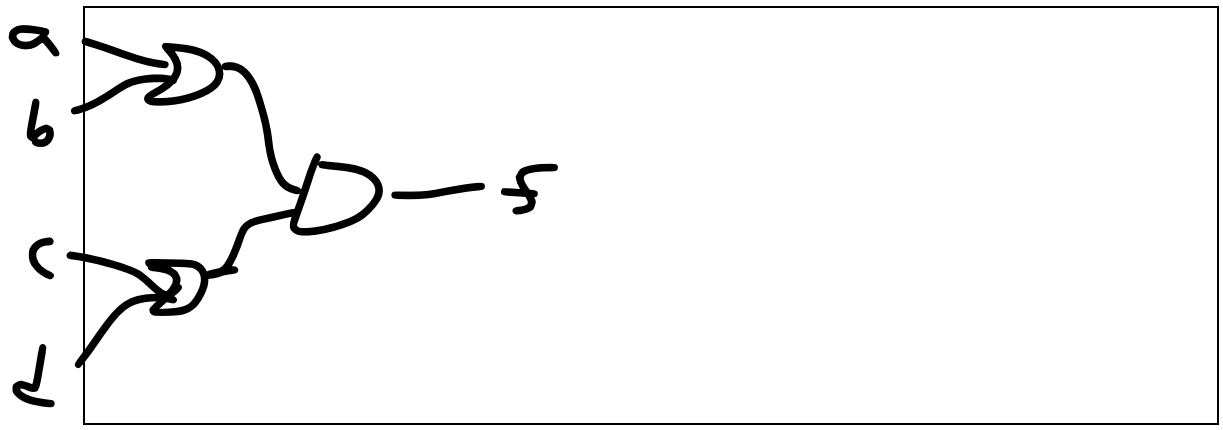
$f = \overline{(a \cdot b) + (c \cdot d)}$




## Product of Sums (PoS) Representations

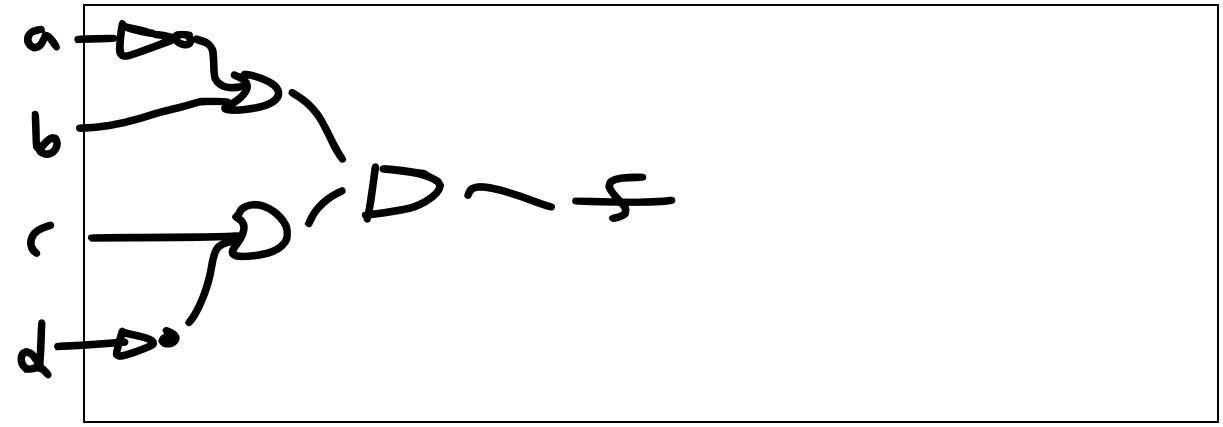
1. Create a Logic Circuit Design for the following PoS logic expression:

$f = (a + b) \cdot (c + d)$



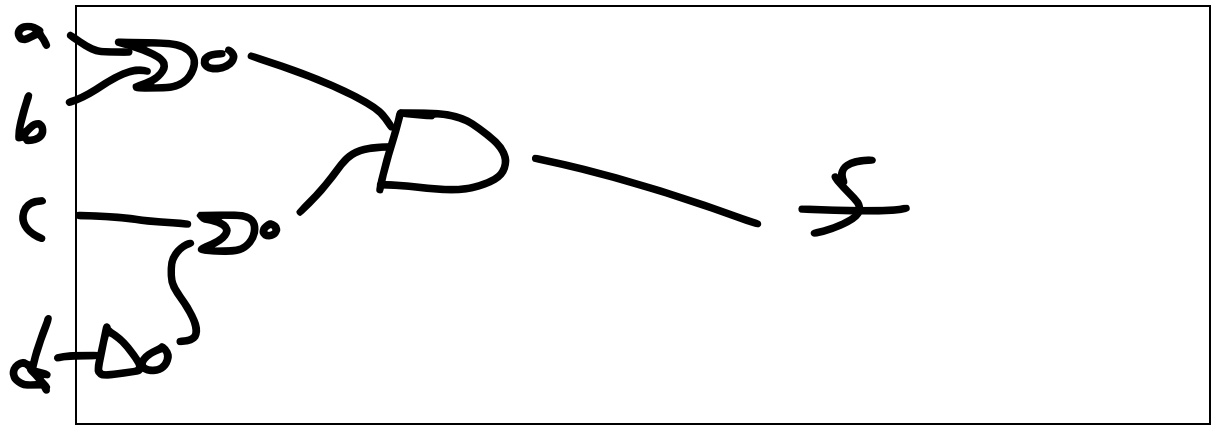

2. Create a Logic Circuit Design for the following SoP logic expression:

$f = (\bar{a} + b) \cdot (c + \bar{d})$



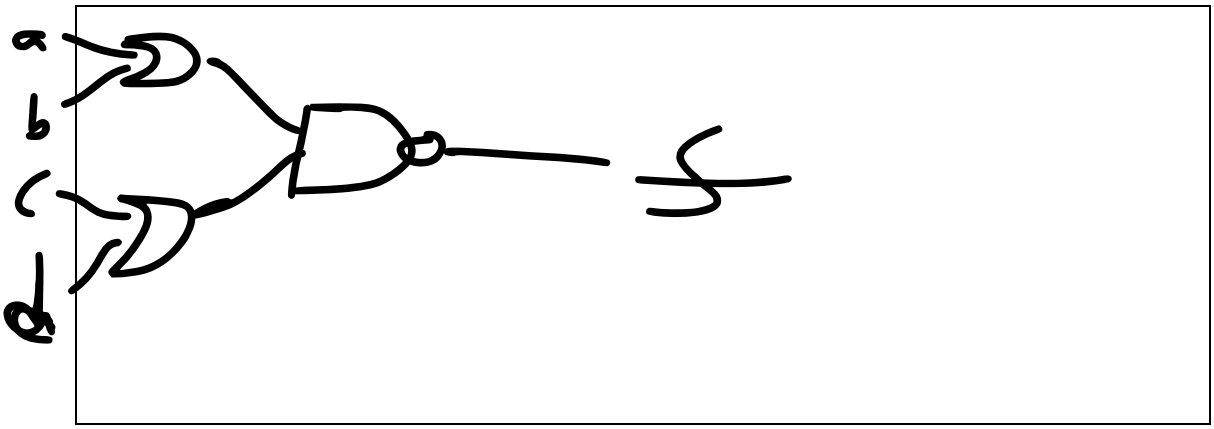
3. Create a Logic Circuit Design for the following SoP logic expression:

$f = (\overline{a + b}) \cdot (\overline{c + \bar{d}})$




4. Create a Logic Circuit Design for the following SoP logic expression:

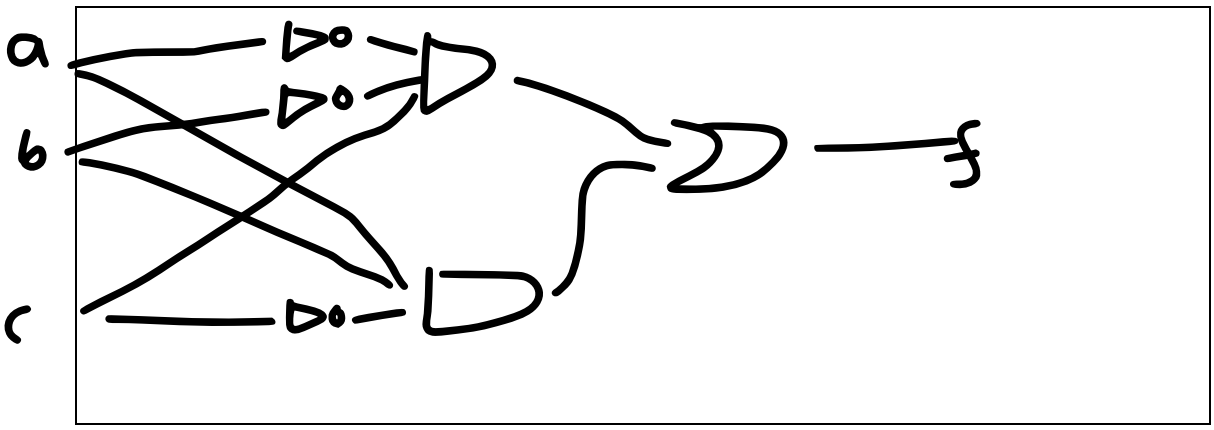
$f = \overline{(a + b) \cdot (c + d)}$




## Specified Sum of Products Expressions

1. Create a Logic Circuit Design for the following specified SoP logic expression:

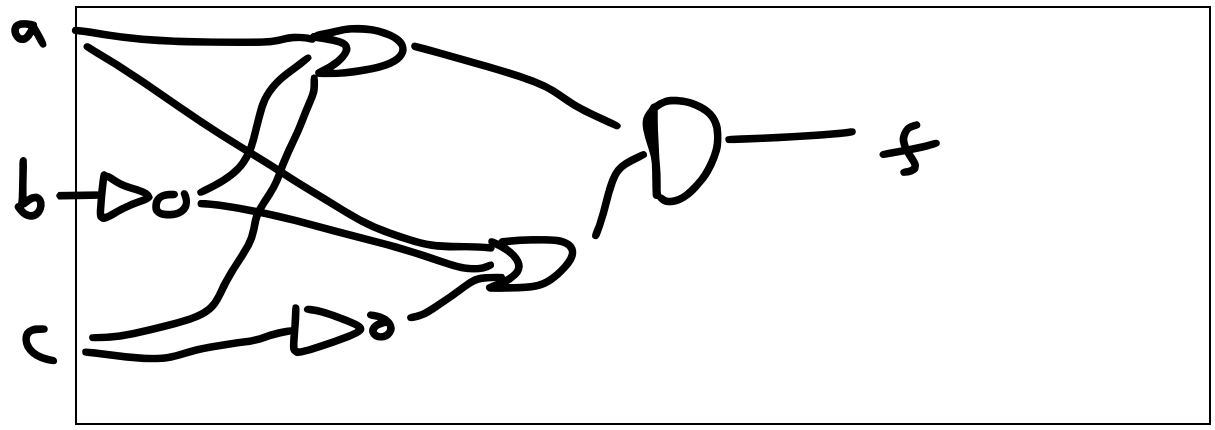
$f = \left(\bar{a} \cdot \bar{b} \cdot c\right) + (a \cdot b \cdot \bar{c})$



## Specified Product of Sums Expressions

1. Create a Logic Circuit Design for the following specified PoS logic expression:

$f = (a + \bar{b} + c) \cdot (a + \bar{b} + \bar{c})$




## SoP Expressions and Circuit Design from a Specification

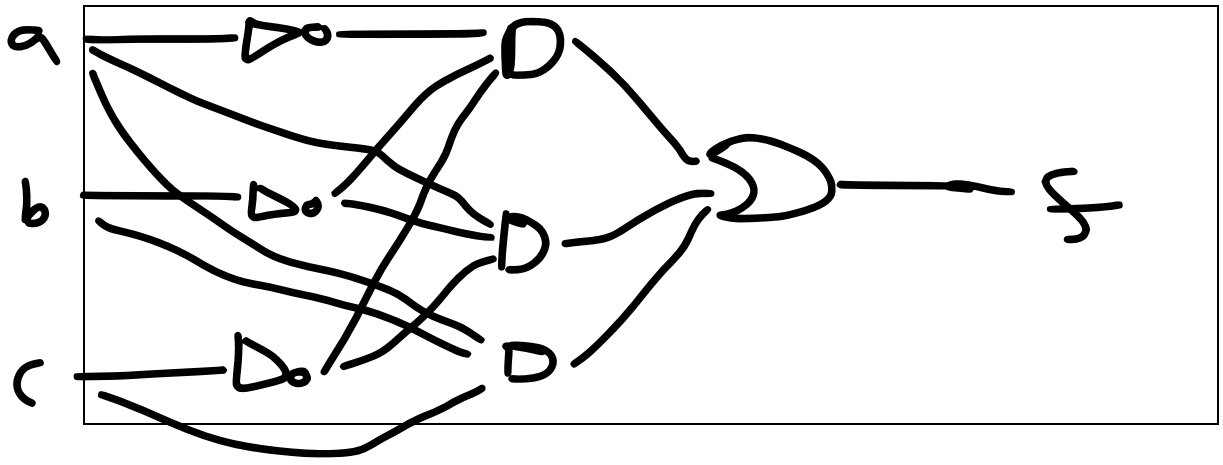
1. What is the fully defined SoP expression for the following specification truth table?

| *a* | *b* | *c* | *f* | *Minterms* |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | $\bar{a}.\bar{b}.\bar{c}$ |
| 1 | 0 | 0 | 1 | $a.\bar{b}.\bar{c}$ |
| 0 | 1 | 0 | 0 | |
| 1 | 1 | 0 | 0 | |
| 0 | 0 | 1 | 0 | |
| 1 | 0 | 1 | 0 | |
| 0 | 1 | 1 | 0 | |
| 1 | 1 | 1 | 1 | $a.b.c$ |

The correct fully defined SoP expression is:

$(\bar{a}\bar{b}\bar{c}) + (a\bar{b}\bar{c}) + (abc) = f$

The Circuit Design is:



## PoS Expressions and Circuit Design from a Specification

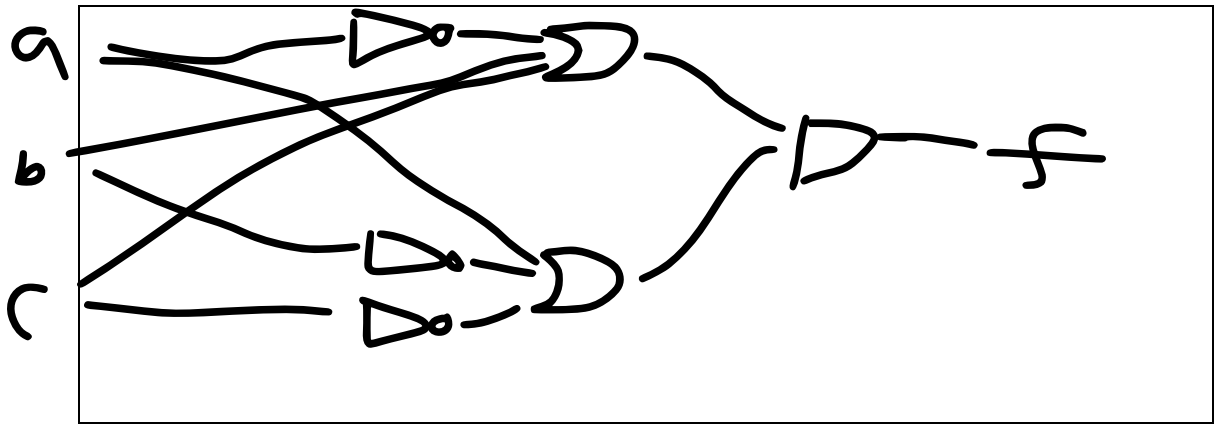
1. What is the fully defined PoS expression and Circuit Design for the following specification truth table?

| *a* | *b* | *c* | *f* | *Maxterms* |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | |
| 1 | 0 | 0 | 0 | $\bar{a}+b+c$ |
| 0 | 1 | 0 | 1 | |
| 1 | 1 | 0 | 1 | |
| 0 | 0 | 1 | 1 | |
| 1 | 0 | 1 | 1 | |
| 0 | 1 | 1 | 0 | $a+\bar{b}+\bar{c}$ |
| 1 | 1 | 1 | 1 | |

The correct fully defined PoS expression is:

$(\bar{a}+b+c)\cdot(a+\bar{b}+\bar{c}) = f$

The Circuit Design is:




## Specified Truth Table from a SoP Expression

1. What was the specified truth table (*f*) that was used to develop the following SoP expression?

$f = (a \cdot b \cdot c) + (\bar{a} \cdot b \cdot \bar{c}) + (\bar{a} \cdot \bar{b} \cdot c)$

| *a* | *b* | *c* | *f* |
|---|---|---|---|
| 0 | 0 | 0 | . |
| 1 | 0 | 0 | . |
| 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | . |
| 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | . |
| 0 | 1 | 1 | . |
| 1 | 1 | 1 | 1 |

## Specified Truth Table from a PoS Expression

1. What was the specified truth table (*f*) that was used to develop the following PoS expression?

$f = (a + \bar{b} + c) \cdot (a + b + \bar{c}) \cdot (\bar{a} + \bar{b} + \bar{c})$

| ***a*** | ***b*** | ***c*** | ***f*** |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 |

## The Answers

Recap on Truth Tables

1.

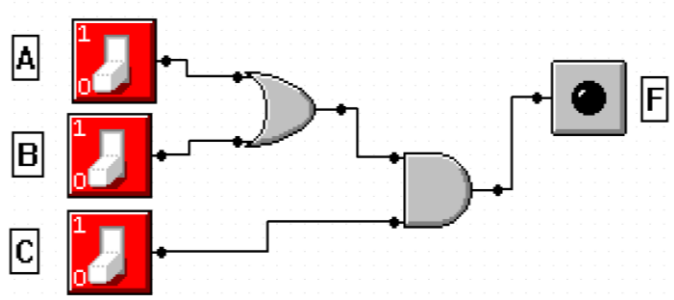
| $a$ | $b$ | $c$ | $d$ | $\overline{b}$ | $a \cdot b$ | $\overline{b} \cdot (a \cdot b)$ | $c \cdot d$ | $\overline{c \cdot d}$ | $f$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |

2.

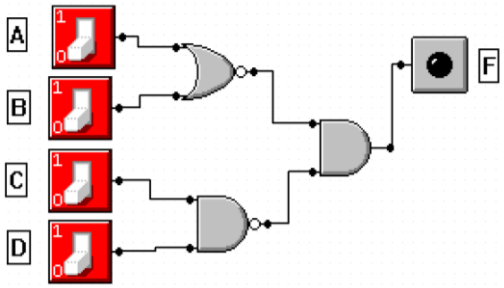
| $a$ | $b$ | $c$ | $d$ | $\overline{a}$ | $\overline{a} + b$ | $\overline{\overline{a} + b}$ | $\overline{d}$ | $c + \overline{d}$ | $f$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |

Recap on Building Logic Circuits from Expressions

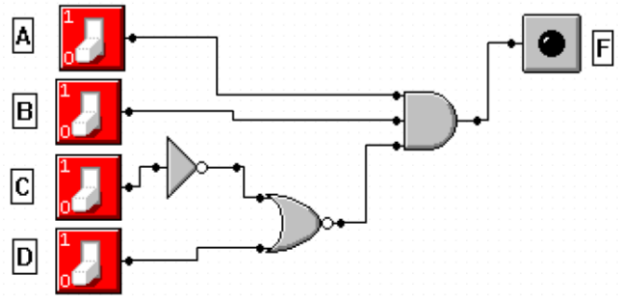
1. $f = (a + b) \cdot c$




2. $f = (\overline{a + b}) \cdot (\overline{c \cdot d})$

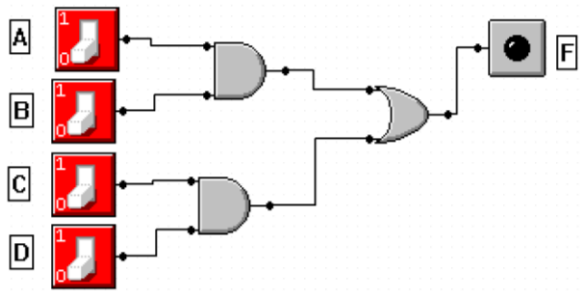



3. $f = a \cdot (\overline{\bar{c} + d}) \cdot b$

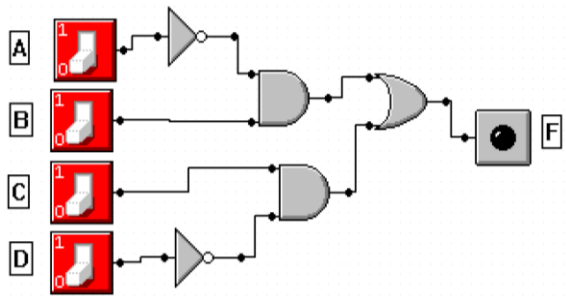



Sum of Products (SoP) Representations

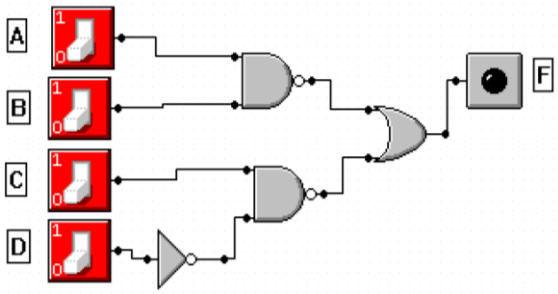
1. $f = (a \cdot b) + (c \cdot d)$



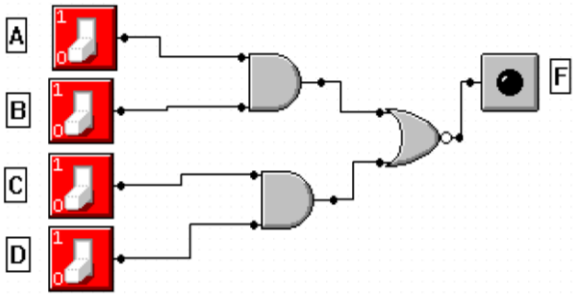
2. $f = (\bar{a} \cdot b) + (c \cdot \bar{d})$




3. $f = \overline{(a \cdot b)} + \overline{(c \cdot \bar{d})}$

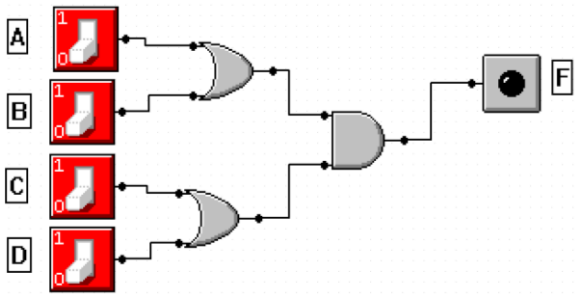



4. $f = \overline{(a \cdot b) + (c \cdot d)}$

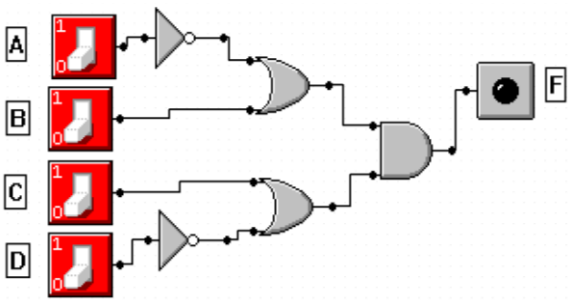



Product of Sums (PoS) Representations

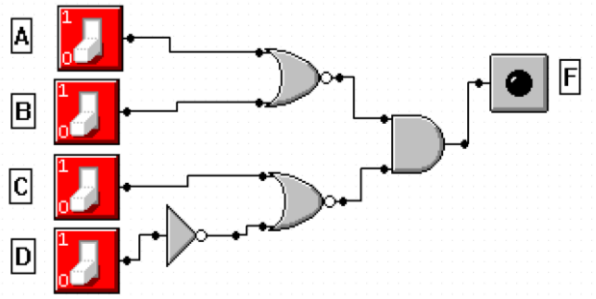
1. $f = (a + b) \cdot (c + d)$



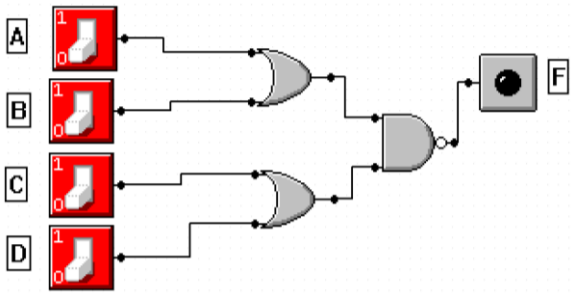

2. $f = (\bar{a} + b) \cdot (c + \bar{d})$



3. $f = (\overline{a + b}) \cdot (\overline{c + \bar{d}})$

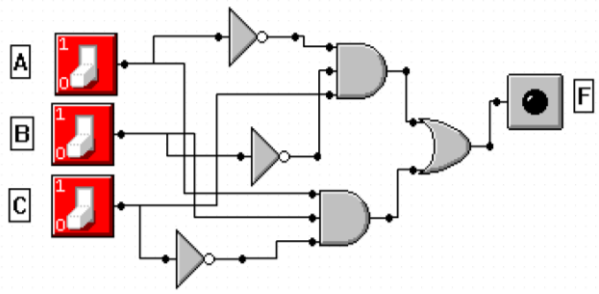



4. $f = \overline{(a + b) \cdot (c + d)}$



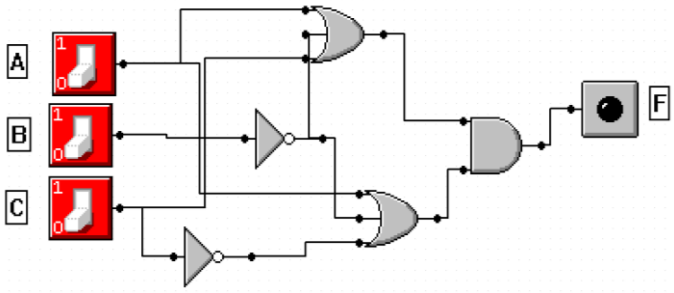

Specified Sum of Products Expressions

1. $f = (\bar{a} \cdot \bar{b} \cdot c) + (a \cdot b \cdot \bar{c})$



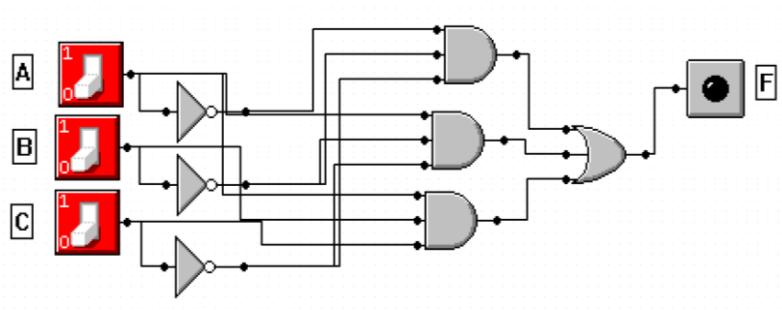

Specified Product of Sums Expressions

1. $f = (a + \bar{b} + c) \cdot (a + \bar{b} + \bar{c})$



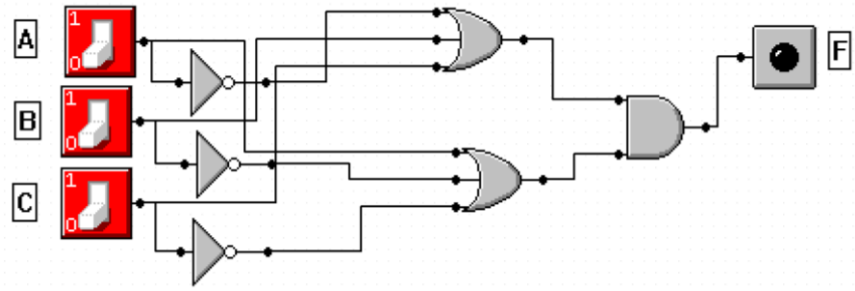
SoP Expressions and Circuit Design from a Specification

1. $f = (\bar{a} \cdot \bar{b} \cdot \bar{c}) + (a \cdot \bar{b} \cdot \bar{c}) + (a \cdot b \cdot c)$




PoS Expressions and Circuit Design from a Specification

1. $f = (\bar{a} + b + c) \cdot (a + \bar{b} + \bar{c})$




Specified Truth Table from a SoP Expression

1. $f = (a \cdot b \cdot c) + (\bar{a} \cdot b \cdot \bar{c}) + (\bar{a} \cdot \bar{b} \cdot c)$

| ***a*** | ***b*** | ***c*** | ***f*** |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 |

Specified Truth Table from a PoS Expression

1. $f = (a + \bar{b} + c) \cdot (a + b + \bar{c}) \cdot (\bar{a} + \bar{b} + \bar{c})$

| ***a*** | ***b*** | ***c*** | ***f*** |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 |