

CO450 Computer Architectures Week 10 Exercise Handout

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Recap on Truth Tables

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

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

$$\overbrace{\bar{b} \cdot \bar{b}}^{\text{0} \cdot \text{0} = \text{0}} = \text{0}$$

a	b	c	d	\bar{b}	$a \cdot b$	$\bar{b} \cdot (a \cdot b)$	$c \cdot d$	$\bar{c} \cdot \bar{d}$	f
1	1	1	1	0	0	0	1	0	0
1	1	1	0	0	0	0	0	1	0
1	1	0	1	0	0	0	0	0	0
1	1	0	0	0	0	0	0	1	0
1	0	1	1	1	0	0	0	0	0
1	0	1	0	1	0	0	0	1	0
1	0	0	1	1	0	0	0	0	0
1	0	0	0	1	0	0	0	1	0
0	1	1	1	0	0	0	1	0	0
0	1	1	0	0	0	0	0	1	0
0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0
0	0	1	1	1	0	0	0	0	0
0	0	1	0	1	0	0	0	1	0
0	0	0	1	1	0	0	0	0	0
0	0	0	0	1	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0

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

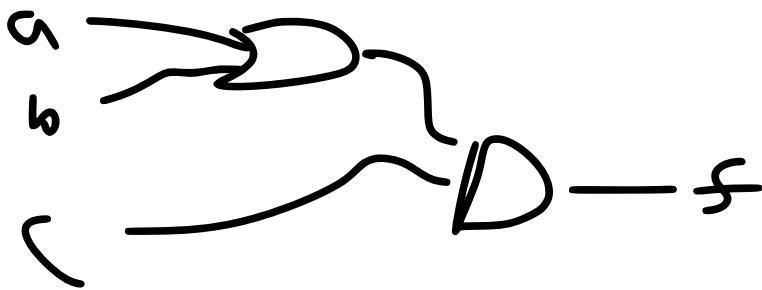
$$f = (\bar{a} + \bar{b}) \cdot (c + \bar{d})$$

a	b	c	d	\bar{a}	$\bar{a} + b$	$\bar{a} + \bar{b}$	\bar{d}	$c + \bar{d}$	f
1	1	1	1	0	1	0	0	1	0
1	1	1	0	0	1	1	1	1	0
1	1	0	1	0	1	1	0	0	0
1	1	0	0	0	1	1	0	1	0
1	0	1	1	0	0	1	0	1	0
1	0	1	0	0	0	1	1	0	0
1	0	0	1	0	0	1	1	1	0
1	0	0	0	0	0	1	0	0	0
0	1	1	1	1	0	0	0	1	0
0	1	1	0	1	0	1	1	1	0
0	1	0	1	1	0	1	0	0	0
0	1	0	0	1	0	1	0	1	0
0	0	1	1	1	1	0	0	1	0
0	0	1	0	1	1	0	1	0	0
0	0	0	1	1	1	0	1	1	0
0	0	0	0	1	1	0	0	0	0

Recap on Building Logic Circuits from Expressions

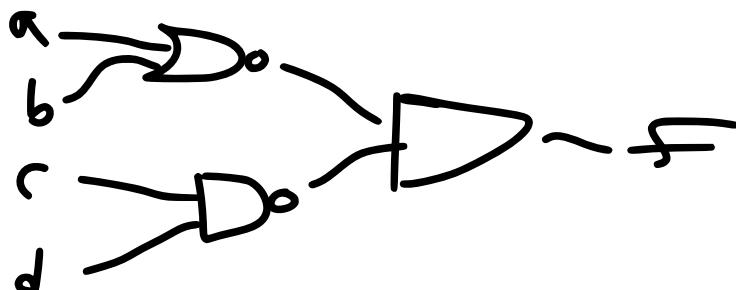
1. Create a Logic Circuit Design for the following logic expression:

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



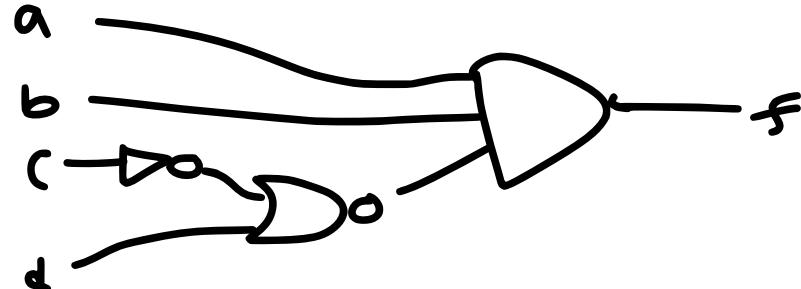
2. Create a Logic Circuit Design for the following logic expression:

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



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

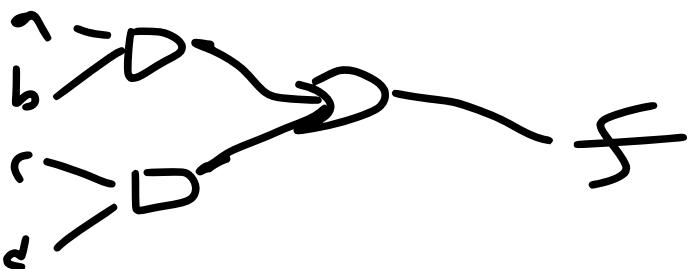
$$f = a \cdot (\overline{c + d}) \cdot b$$



Sum of Products (SoP) Representations

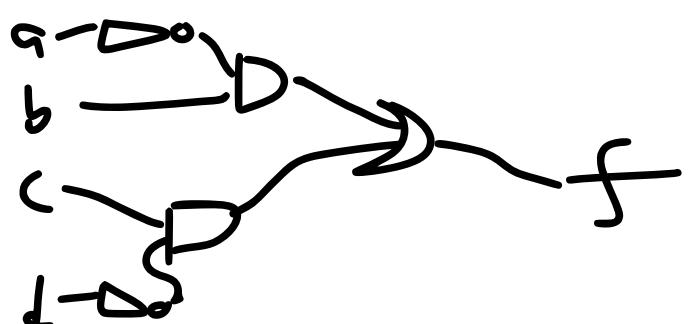
1. Create a Logic Circuit Design for the following SoP logic expression:

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



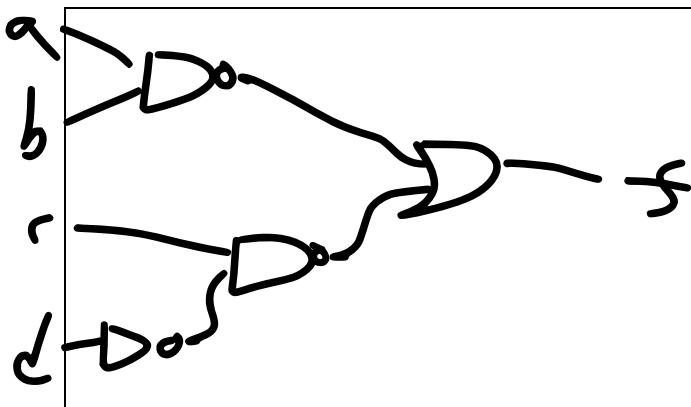
2. Create a Logic Circuit Design for the following SoP logic expression:

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



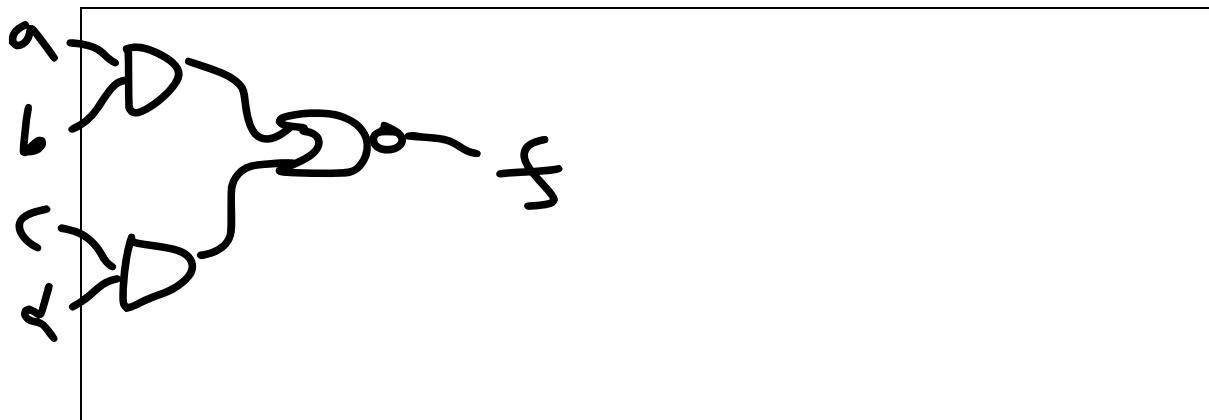
3. Create a Logic Circuit Design for the following SoP logic expression:

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



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

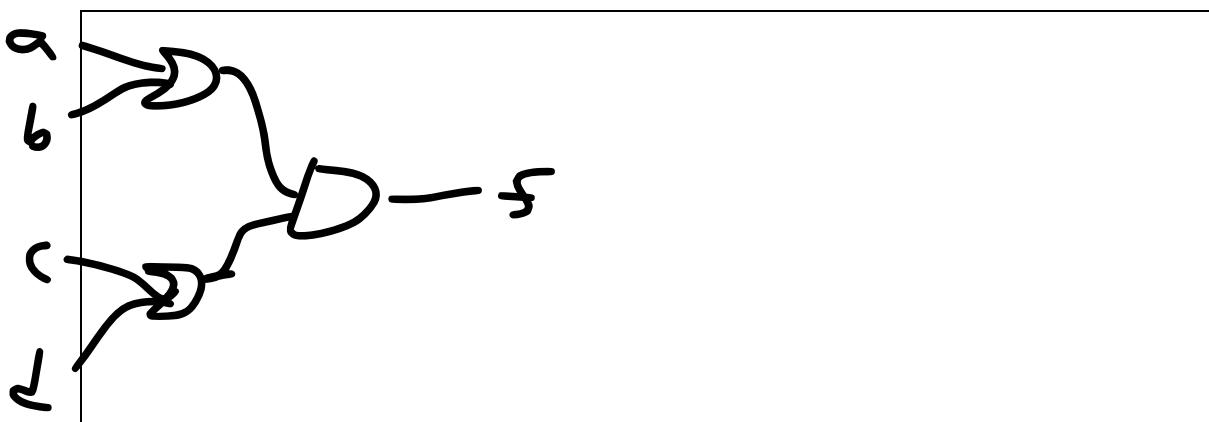
$$f = \overline{(a \cdot b)} + (c \cdot d)$$



Product of Sums (PoS) Representations

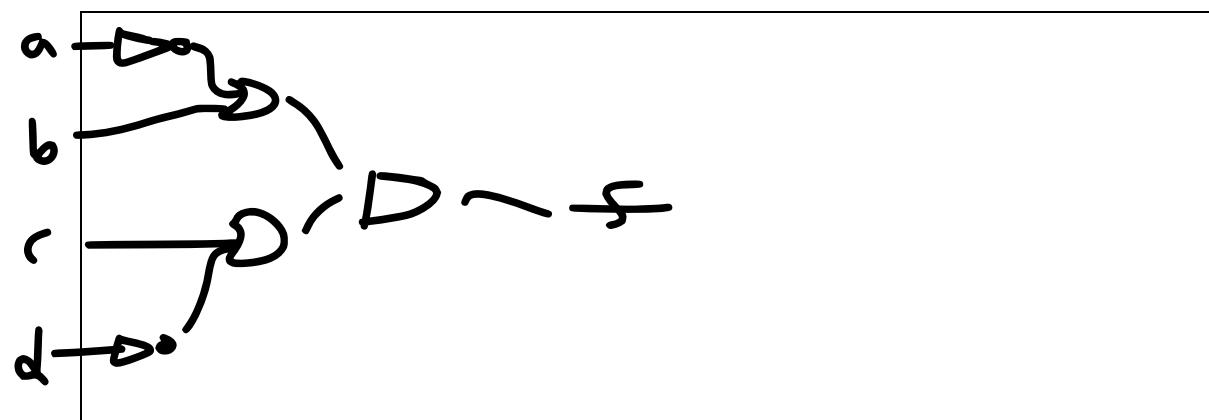
1. Create a Logic Circuit Design for the following PoS logic expression:

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



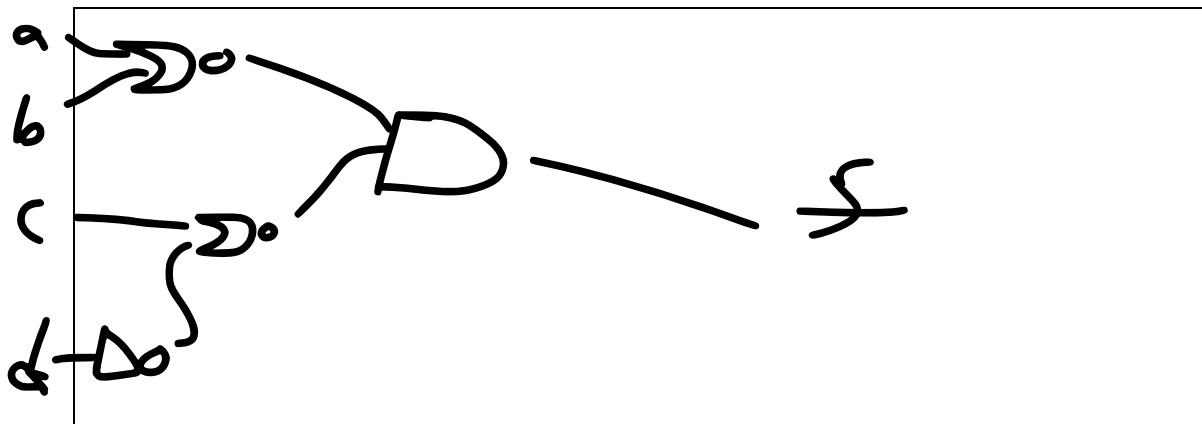
2. Create a Logic Circuit Design for the following SoP logic expression:

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



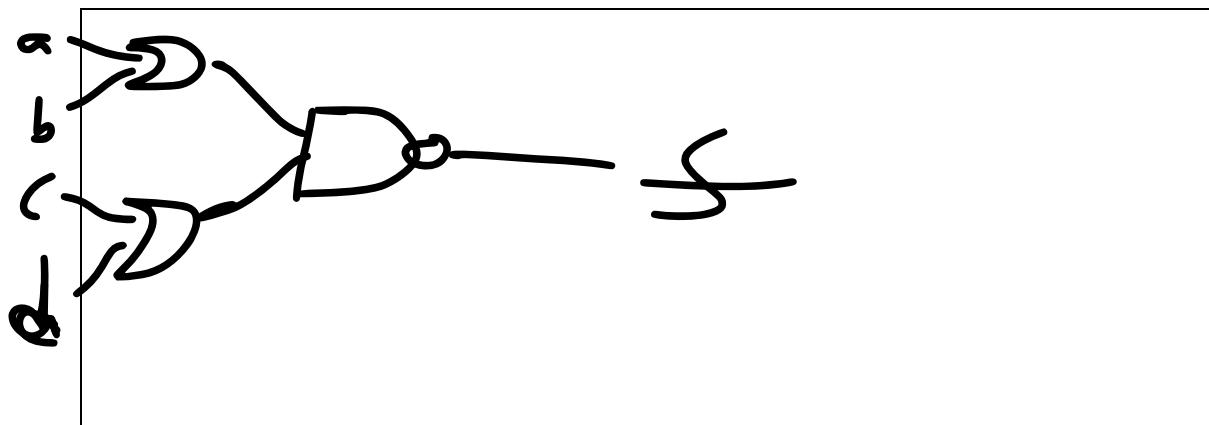
3. Create a Logic Circuit Design for the following SoP logic expression:

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



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

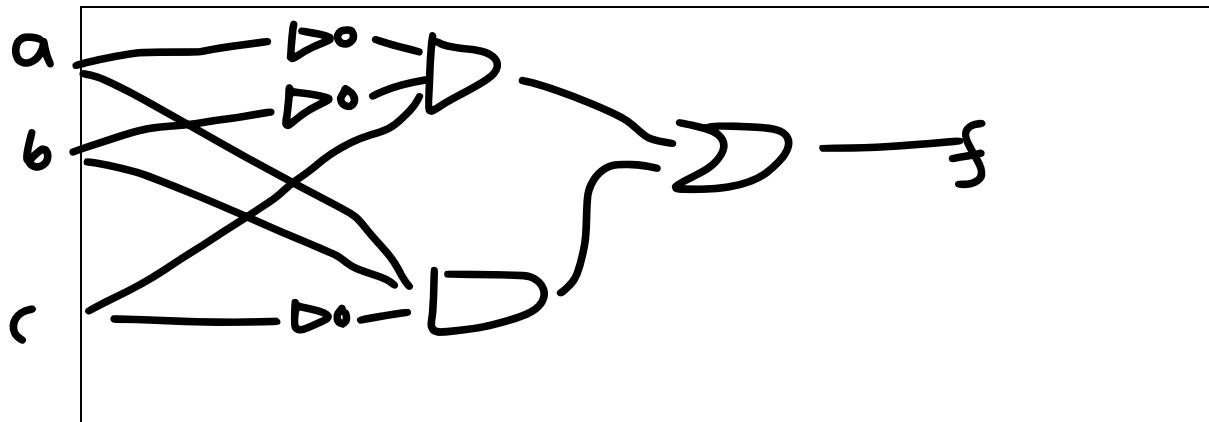
$$f = \overline{(a + b)} \cdot \overline{(c + d)}$$



Specified Sum of Products Expressions

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

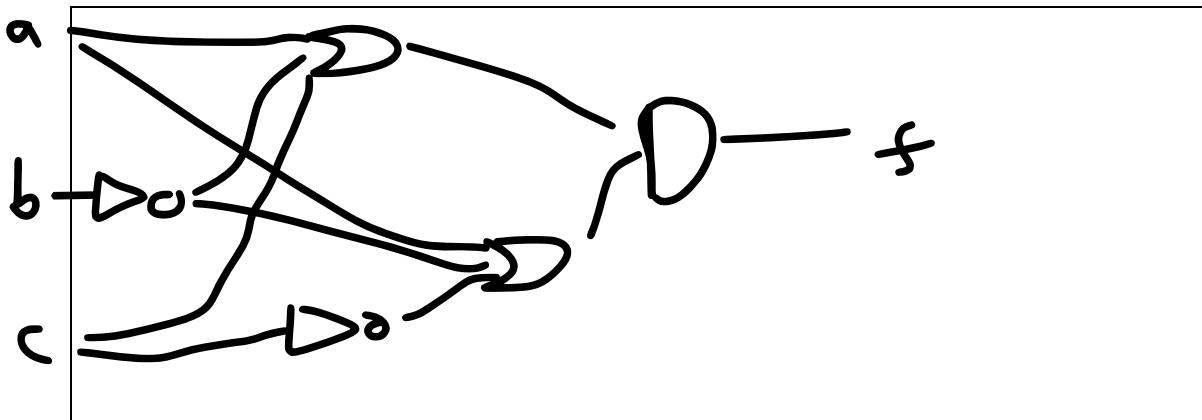
$$f = (\bar{a} \cdot \bar{b} \cdot c) + (a \cdot b \cdot \bar{c})$$



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

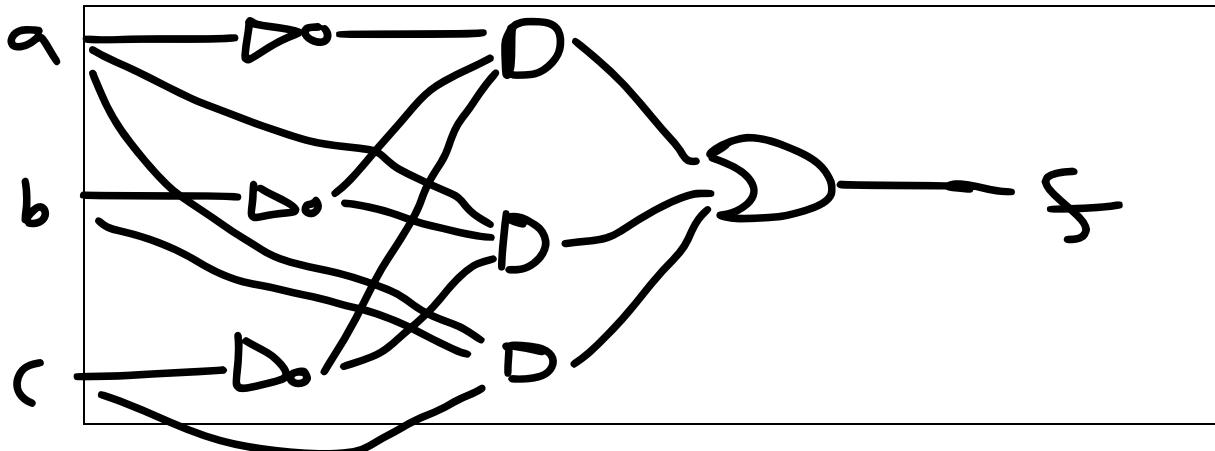
1. What is the fully defined SoP expression for the following specification truth table?

<i>a</i>	<i>b</i>	<i>c</i>	<i>f</i>	Minterms
0	0	0	1	$\bar{a} \cdot \bar{b} \cdot \bar{c}$
1	0	0	1	$a \cdot \bar{b} \cdot \bar{c}$
0	1	0	0	
1	1	0	0	
0	0	1	0	
1	0	1	0	
0	1	1	0	
1	1	1	1	$a \cdot b \cdot c$

The correct fully defined SoP expression is:

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

The Circuit Design is:



PoS Expressions and Circuit Design from a Specification

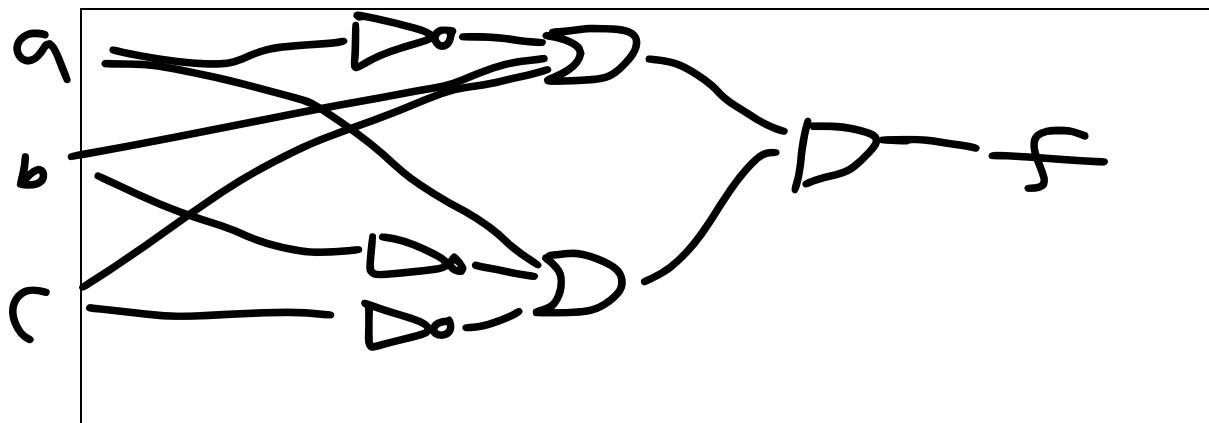
1. What is the fully defined PoS expression and Circuit Design for the following specification truth table?

<i>a</i>	<i>b</i>	<i>c</i>	<i>f</i>	<i>Maxterms</i>
0	0	0	1	$\bar{a} + b + c$
1	0	0	0	
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:

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

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?

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

<i>a</i>	<i>b</i>	<i>c</i>	<i>f</i>
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.

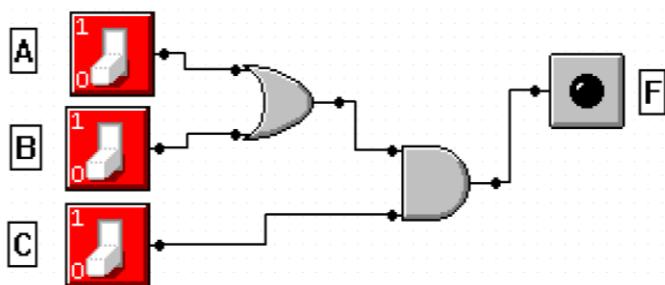
a	b	c	d	\bar{b}	$a \cdot b$	$\bar{b} \cdot (a \cdot b)$	$c \cdot d$	$\bar{c} \cdot \bar{d}$	f
0	0	0	0	1	0	0	0	1	1
1	0	0	0	1	0	0	0	1	1
0	1	0	0	0	0	0	0	1	1
1	1	0	0	0	1	0	0	1	1
0	0	1	0	1	0	0	0	1	1
1	0	1	0	1	0	0	0	1	1
0	1	1	0	0	0	0	0	1	1
1	1	1	0	0	1	0	0	1	1
0	0	0	1	1	0	0	0	1	1
1	0	0	1	1	0	0	0	1	1
0	1	0	1	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.

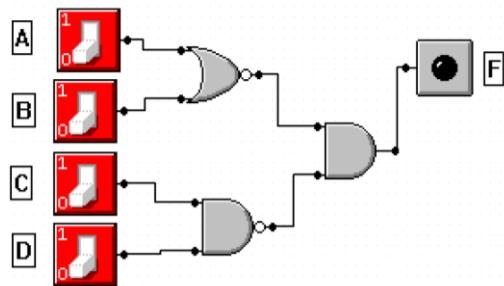
a	b	c	d	\bar{a}	$\bar{a} + b$	$\bar{\bar{a}} + b$	\bar{d}	$c + \bar{d}$	f
0	0	0	0	1	1	0	1	1	0
1	0	0	0	0	0	1	1	1	1
0	1	0	0	1	1	0	1	1	0
1	1	0	0	0	1	0	1	1	0
0	0	1	0	1	1	0	1	1	0
1	0	1	0	0	0	1	1	1	1
0	1	1	0	1	1	0	1	1	0
1	1	1	0	0	1	0	1	1	0
0	0	0	1	1	1	0	0	0	0
1	0	0	1	0	0	1	0	0	0
0	1	0	1	1	1	0	0	0	0
1	1	0	1	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

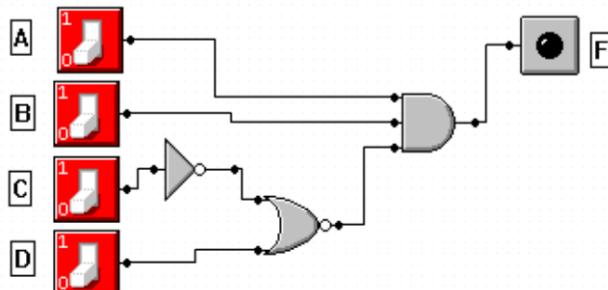
$$1. f = (a + b) \cdot c$$



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

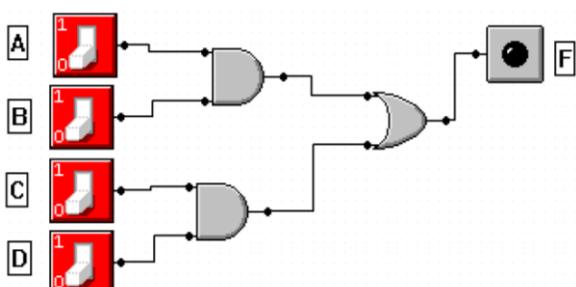


$$3. f = a \cdot (\overline{c + d}) \cdot b$$

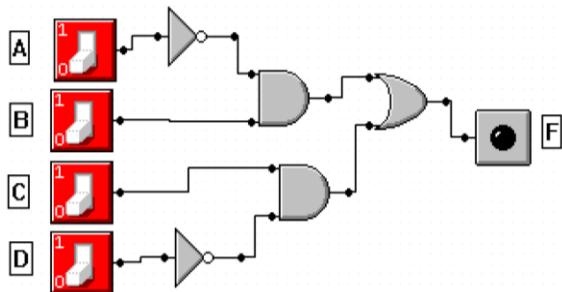


Sum of Products (SoP) Representations

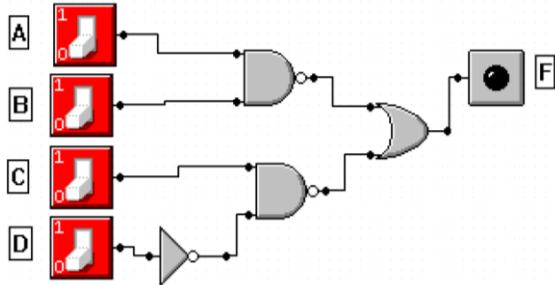
$$1. f = (a \cdot b) + (c \cdot d)$$



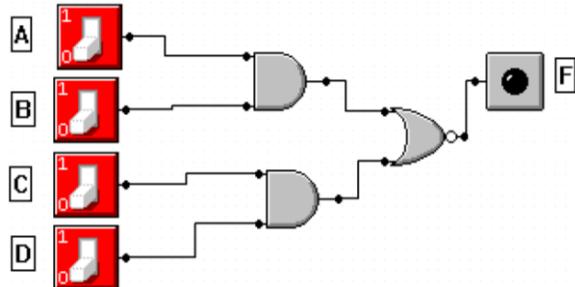
2. $f = (\bar{a} \cdot b) + (c \cdot \bar{d})$



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

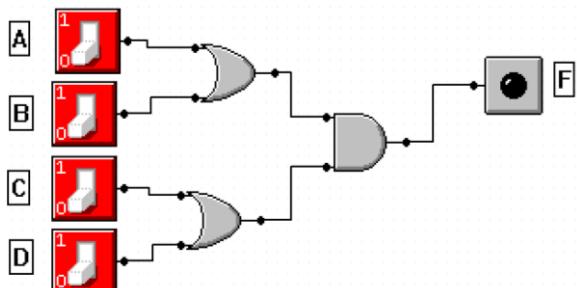


4. $f = \overline{(a \cdot b) + (c \cdot d)}$

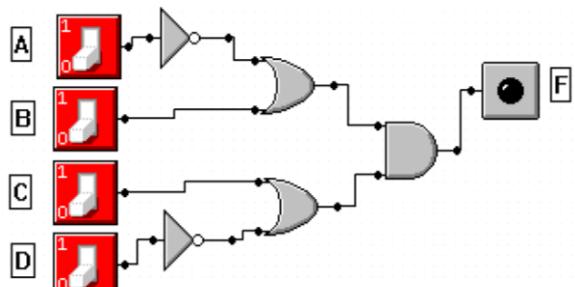


Product of Sums (PoS) Representations

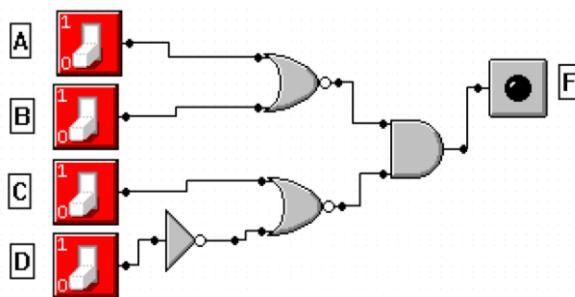
1. $f = (a + b) \cdot (c + d)$



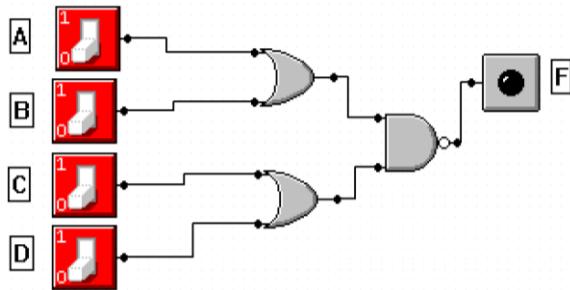
2. $f = (\bar{a} + b) \cdot (c + \bar{d})$



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

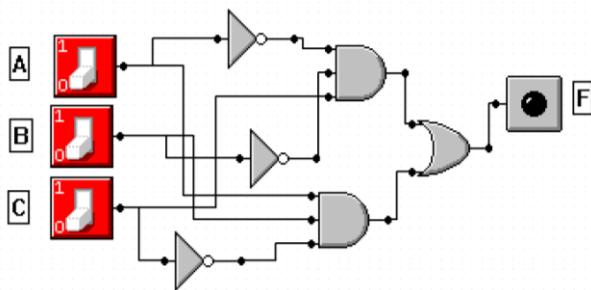


$$4. f = \overline{(a + b) \cdot (c + d)}$$



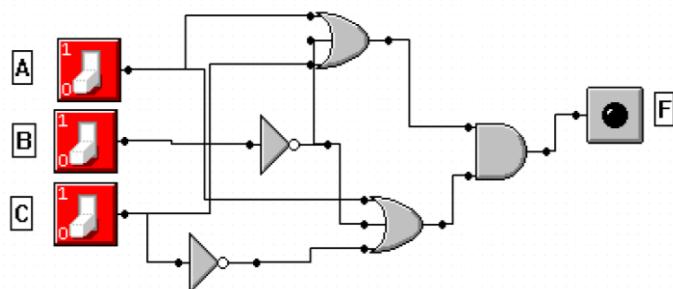
Specified Sum of Products Expressions

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



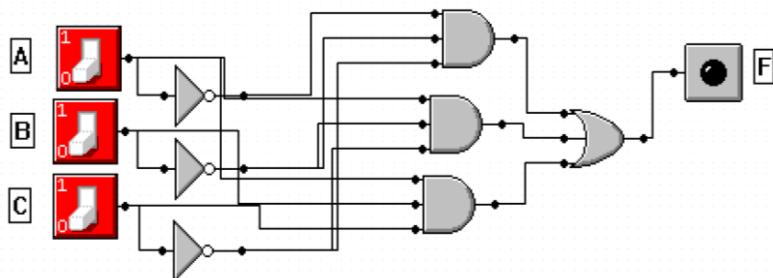
Specified Product of Sums Expressions

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



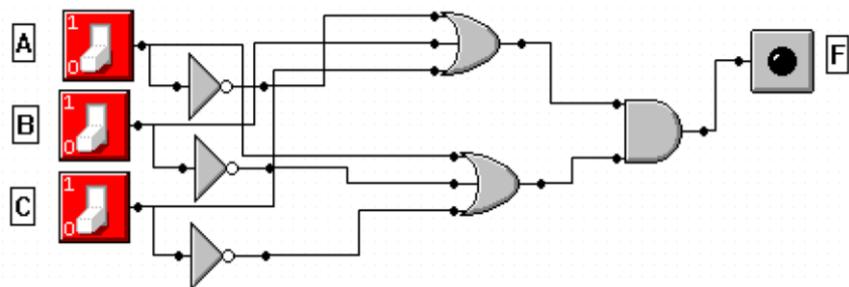
SoP Expressions and Circuit Design from a Specification

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



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