

Homework #2

CSE 140 – Summer Session 2 – 2016

Instructor: Pietro Mercati

Only a subset of questions will be graded

1. Use K-maps to derive the minimal expression for the following functions. Note that “d” indicates a “don’t care” value.

Derive the minimal POS for the following:

a. $f(a,b,c) = \prod M(2,4,6,7) + \sum d(1)$

		Ab			
C		(0,0)	(0,1)	(1,1)	(1,0)
	0	1	0	0	0
	1	x	1	0	1

$$f = (c + b')(c+a')(a'+b')$$

Derive the minimal SOP for the following:

b. $g(a,b,c) = \sum m(0,1,4) + \sum d(2,3)$

		Ab			
c		(0,0)	(0,1)	(1,1)	(1,0)
	0	1	X	0	1
	1	1	x	0	0

$$g = a' + c'b'$$

2. Given the following function:

$$f(a,b,c) = \prod M(3,4,5) + \sum d(2,7)$$

		Ab			
c		(0,0)	(0,1)	(1,1)	(1,0)
	0	1	X	1	0
	1	1	0	x	0

- List all prime implicants
(a'+b), (a+b'), (b'+c'), (a'+c')
- List essential prime implicants
(a'+b)
- Derive all possible minimal POS (product of sum expressions)

$$f = (a'+b)(a+b') \text{ or } (a'+b)(c'+b')$$

3. A museum has four rooms, each with a motion sensor (m0, m1, m2 and m3) that outputs 1 when motion is detected. At night, the only person in the museum is one security guard who walks from room to room. Create a circuit that sounds an alarm (by setting an output A to 1) if motion is ever detected in more than one room at a time (i.e. in two or three rooms), meaning there must be one or more intruders in the museum

a. Fill out the truth table

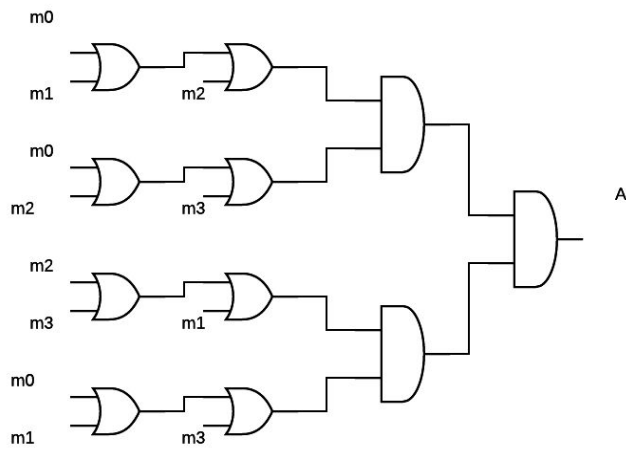
m0	m1	m2	m3	A
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

b. Minimize the expression in POS form using Kmaps

		m0m1			
m2m3		(0,0)	(0,1)	(1,1)	(1,0)
	(0,0)	0	0	1	0
	(0,1)	0	1	1	1
	(1,1)	1	1	1	1
	(1,0)	0	1	1	1

$$A = (m_0 + m_1 + m_2)(m_2 + m_3 + m_0)(m_2 + m_3 + m_1)(m_0 + m_1 + m_3)$$

- c. Draw circuit for minimum implementation obtained in part b



4. Given $f(a, b, c, d) = \sum m(0, 3, 4, 5, 10, 14) + \sum d(1, 7)$:

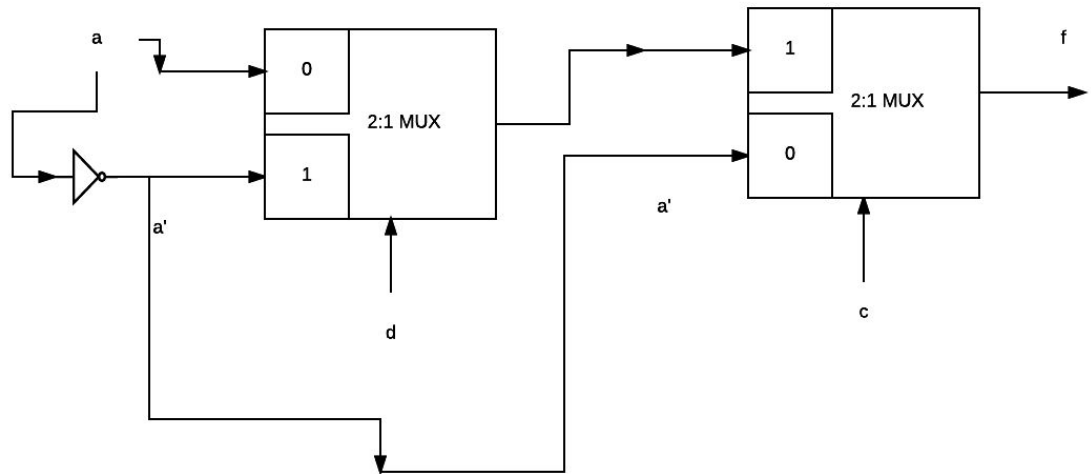
- a. Derive a minimal expression for f with either SOP or POS form

		Ab			
cd		(0,0))	(0,1)	(1,1)	(1,0)
	(0,0)	1	1	0	0
	(0,1)	X	1	0	0
	(1,1)	1	X	0	0
	(1,0)	0	0	1	1

$$\text{SOP: } f = c'a' + da' + acd'$$

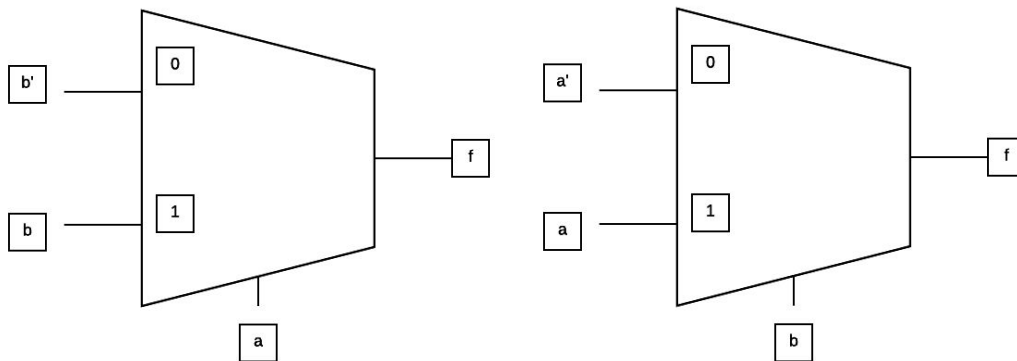
$$\text{POS: } f = (c+a')(d'+a')(a+c'+d)$$

- b. Implement the function using a minimal network of 2:1 multiplexers and minimum number of inverters. Do not use any other logic gate

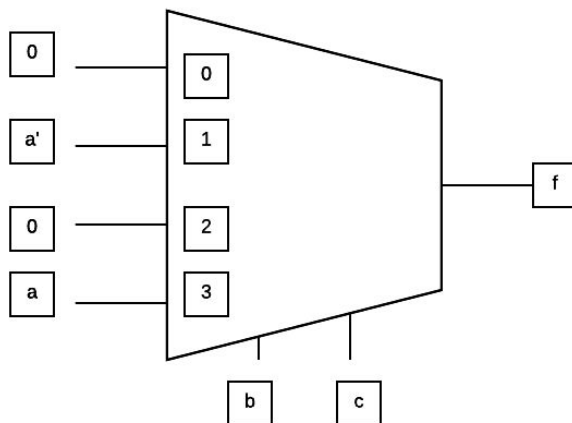
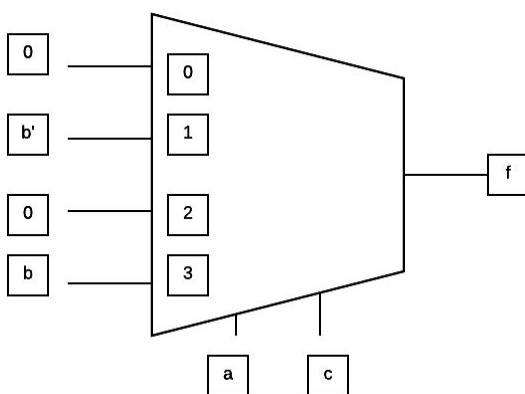
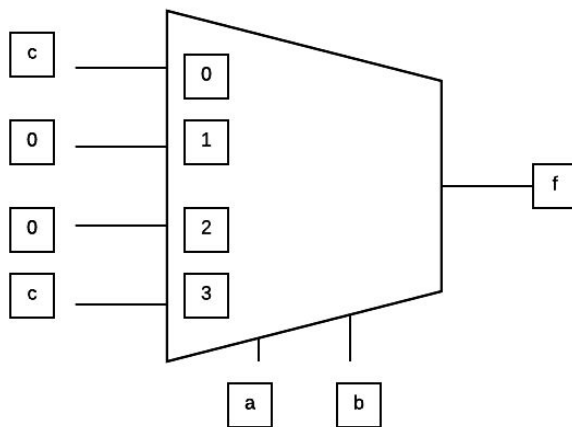


5. Implement the following functions using multiplexers. You can simplify the function using theorems whenever it is possible. If you do so, report the simplification steps.

a. Implement $F(a,b) = ab + a'b'$ with a 2:1 MUX



b. Implement $H(a,b,c) = abc + b'ca'$ with a 4:1 MUX



6. Use decoders specified below and a minimum number of other gates to output a 1 for any prime number less than 16 using the minimum number of 2:4 decoders.

Truth Table

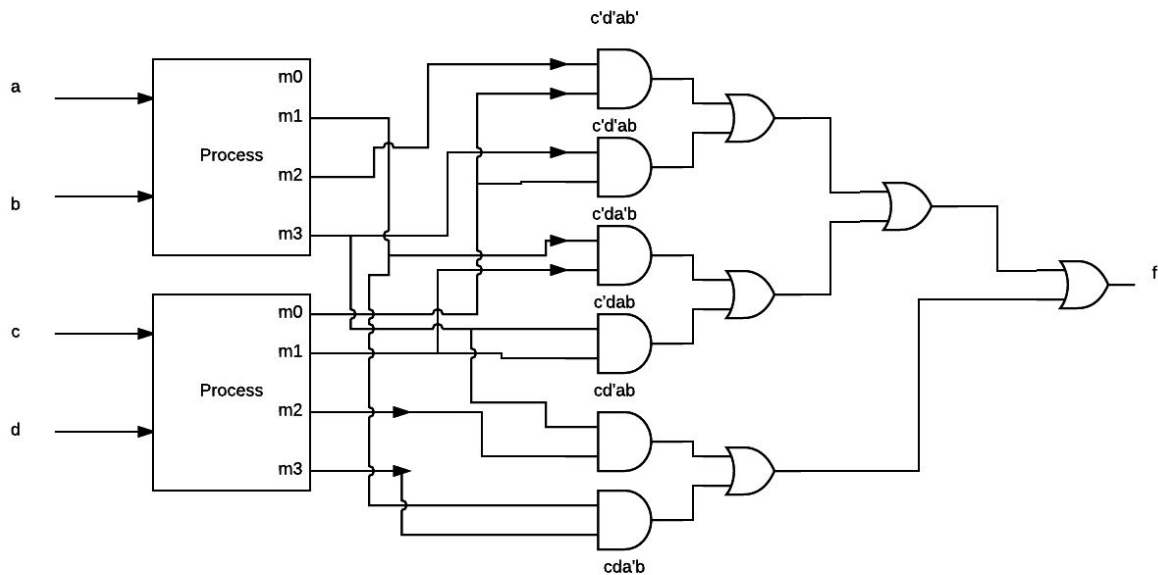
a	B	C	D	f
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1

0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

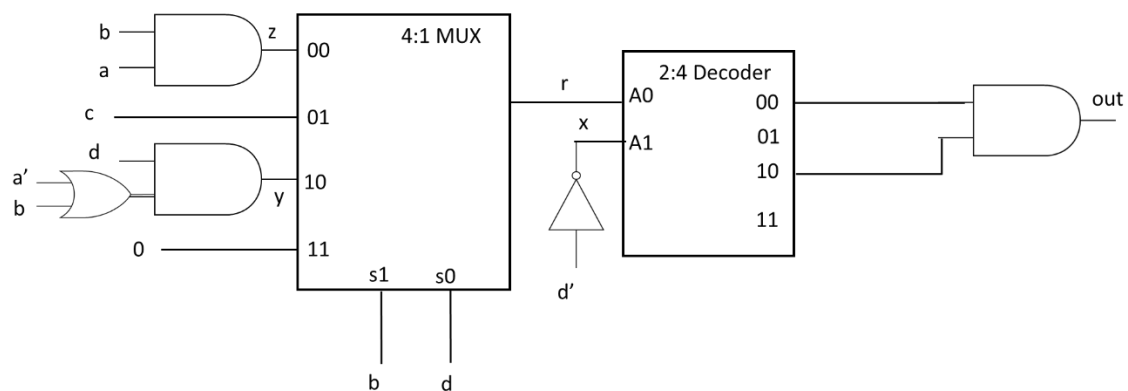
$$f = \sum m(2,3,5,7,11,13)$$

	Ab				
		(0,0)	(0,1)	(1,1)	(1,0)
cd	(0,0)	0	0	0	0
	(0,1)	0	1	1	0
	(1,1)	1	1	0	1
	(1,0)	1	0	0	0

$$f = ca'b' + b'cd + da'b + bc'd$$



7. Analyze the following circuit and answer below.



a. Write the function for the following signals, in terms of the arguments specified between parenthesis:

$$\text{out}(r,x) = (r'x').(rx') = 0$$

$$x(d) = d$$

$$r(z,c,y,b,d) = b'd'z + b'dc + bd'y$$

$$z(a,b) = a.b$$

$$y(a,b,d) = d.(a'+b)$$

b. Write the expression for the function $\text{out}(a,b,c,d)$.

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out(a,b,c,d) = 0
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