CS 211 Assignment 4 Solutions

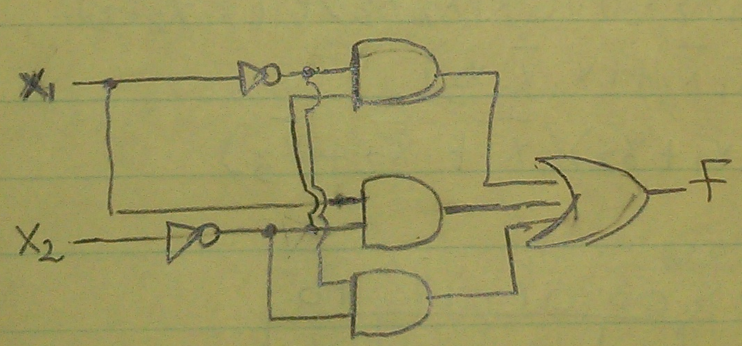
(1)

$$LHS = x_1\overline{x_3} + x_1x_3 + \overline{x_2}\,\overline{x_3} + \overline{x_2}x_3$$
$$= x_1(\overline{x_3} + x_3) + \overline{x_2}(\overline{x_3} + x_3)$$
$$= x_1 + \overline{x_2}$$

$$RHS = \overline{x_1}\,\overline{x_2} + x_1x_2 + x_1\overline{x_2}$$
$$= \overline{x_1}\,\overline{x_2} + x_1(x_2 + \overline{x_2})$$
$$= \overline{x_1}\,\overline{x_2} + x_1 = x_1 + \overline{x_1}\,\overline{x_2} + x_1\overline{x_2}$$
$$= \overline{x_1}\,\overline{x_2} + x_1(1 + \overline{x_2}) = x_1 + \overline{x_2}. \blacksquare$$
$$= x_1 + (\overline{x_1} + x_1)\overline{x_2}$$

(2)

② $F(x_1, x_2) = x_1\overline{x_2} + \overline{x_1}\,\overline{x_2} + \overline{x_1}x_2$



(3)

Minterms: $\overline{x_1}\,\overline{x_2}\,\overline{x_3}$, $\overline{x_1}\,x_2\,\overline{x_3}$, $\overline{x_1}\,x_2\,x_3$, $x_1 x_2 x_3$

Maxterms: $x_1 + x_2 + \overline{x_3}$, $\overline{x_1} + x_2 + x_3$, $\overline{x_1} + x_2 + \overline{x_3}$, $\overline{x_1} + \overline{x_2} + x_3$

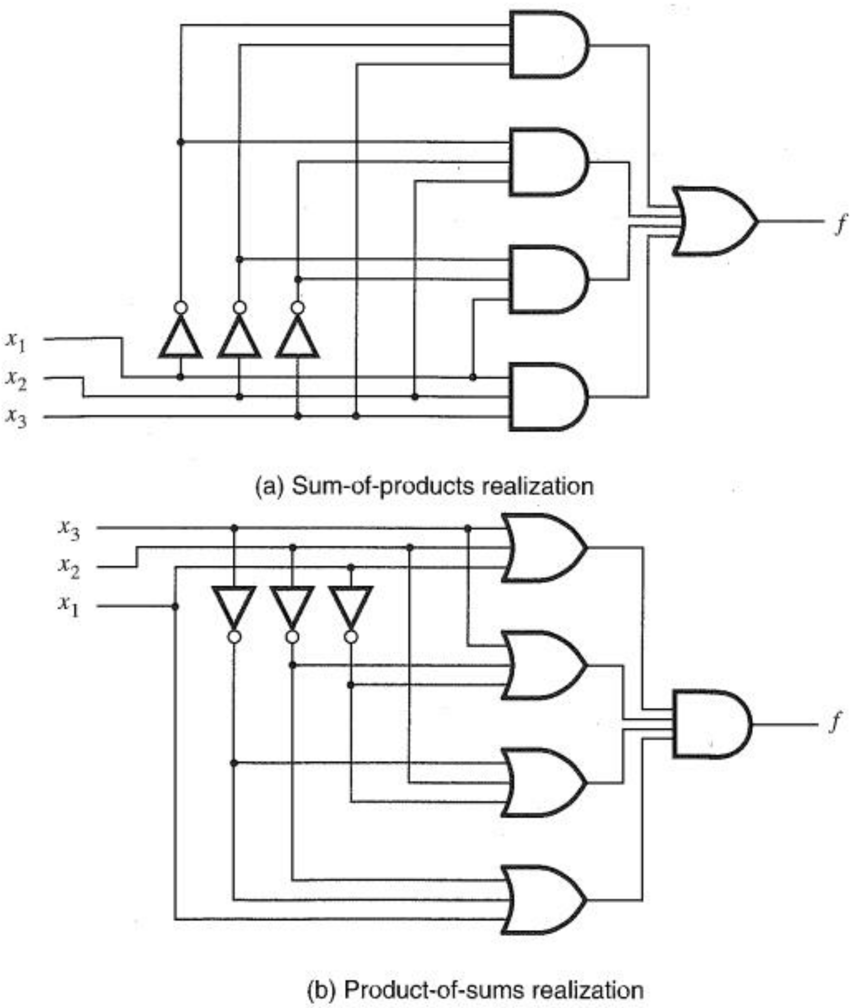
(4)

4)

x_1	x_2	x_3	$f(x_1, x_2, x_3)$
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

SOP = $\overline{x_1}\,\overline{x_2}\,x_3 + \overline{x_1}\,x_2\,\overline{x_3} + x_1\,\overline{x_2}\,\overline{x_3} + x_1 x_2 x_3$

POS = $(x_1 + x_2 + x_3)(x_1 + \overline{x_2} + \overline{x_3})(\overline{x_1} + x_2 + \overline{x_3})(\overline{x_1} + \overline{x_2} + x_3)$



(a) Sum-of-products realization

(b) Product-of-sums realization

Figure 2.21 Implementation of the function in Figure 2.20.

(5)

5) $F(x_1,x_2,x_3) = \Sigma m(1,2,4,7) =$

$\bar{x}_1\bar{x}_2x_3 + \bar{x}_1x_2\bar{x}_3 + x_1\bar{x}_2\bar{x}_3 + x_1x_2x_3$

x_3 \ x_1x_2	00	01	11	10
0		1		1
1	1		1	

$x_1\ x_2\ x_3$	F
000	0
001	1
010	1
011	0
100	1
101	0
110	0
111	1

this is the simplest form possible, no simplifications available

(6)

6) $F(x_1, x_2, x_3) = \prod M(0,2,5) = (x_1+x_2+x_3)(x_1+\bar{x}_2+x_3)(\bar{x}_1+x_2+\bar{x}_3)$

$\Rightarrow F(x_1, x_2, x_3) = (\bar{x}_1\bar{x}_2\bar{x}_3) + (\bar{x}_1 x_2 \bar{x}_3) + (x_1 \bar{x}_2 x_3)$

$\Rightarrow F(x_1, x_2, x_3) = (\bar{x}_1 \bar{x}_3) + (x_1 \bar{x}_2 x_3)$

$= (x_1 + x_3)(\bar{x}_1 + x_2 + \bar{x}_3)$

K-map for F

$x_3 \backslash x_1x_2$	00	01	11	10
0	0	1	1	0
1	1	0	1	1

thus K-map for $\bar{F}$

$x_3 \backslash x_1x_2$	00	01	11	10
0	1	0	0	1
1	0	1	0	0

thus: $\bar{F}$

$\bar{F} = \bar{x}_1\bar{x}_2 + x_1\bar{x}_2x_3 = (x_1+x_3)(\bar{x}_1+x_2+\bar{x}_3)$

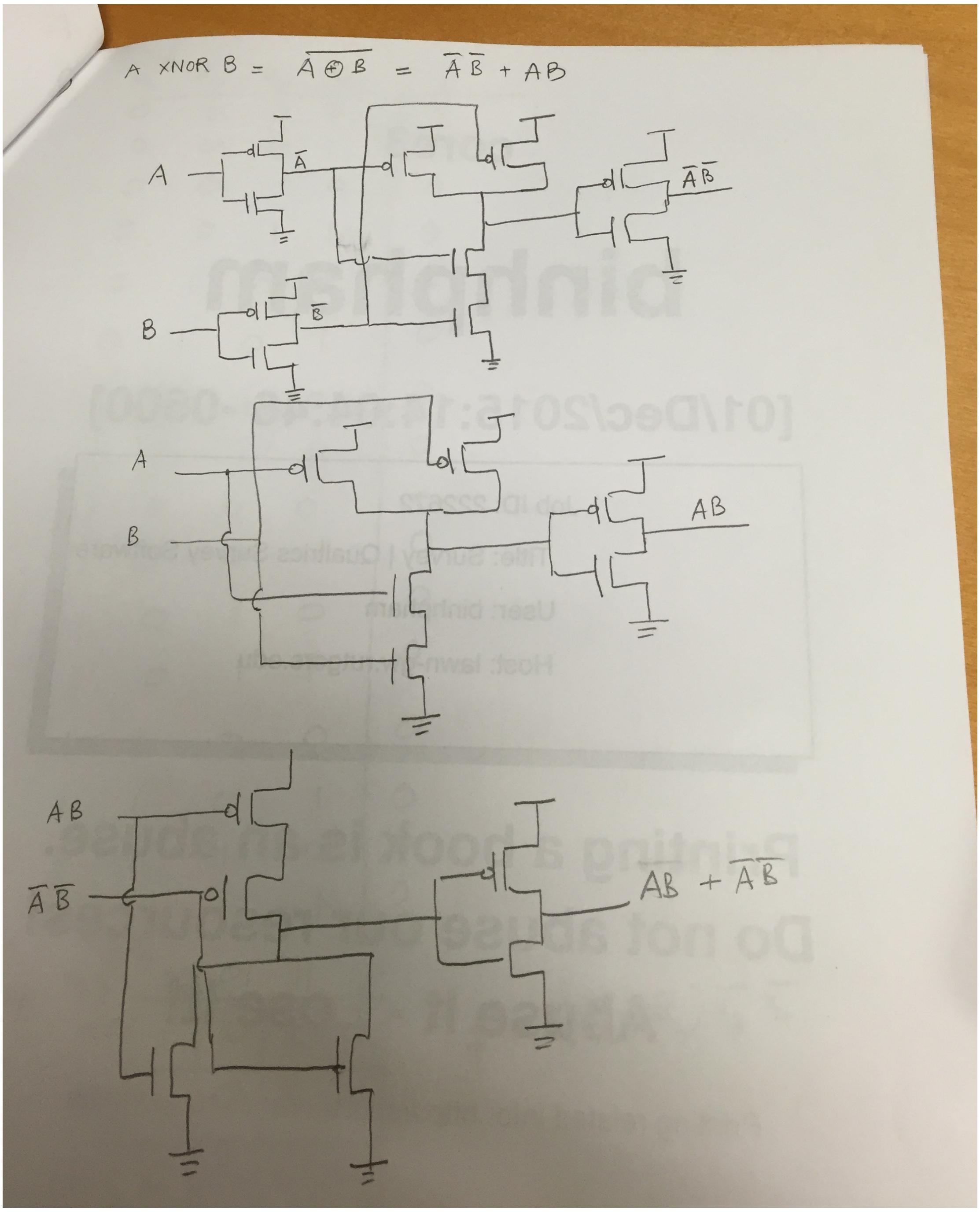
(7)

x_1	x_2	x_3	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

$x_1 \backslash x_2x_3$	00	01	11	10
0	1	1	1	1
1	1			

$f = \bar{x}_1 + \bar{x}_2\bar{x}_3$

(8)



(9)

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

Thus, it's a XOR gate.

(10)

x_1	x_2	x_3	x_4	F
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

x_1x_2 \ x_3x_4	00	01	11	10
00	1	0	0	0
01	1	0	0	0
11	0	0	0	0
10	1	0	0	0

$$F = \overline{x_3}\,\overline{x_4}\left(\overline{x_1} + \overline{x_2}\right)$$

(11)

x_1	x_2	x_3	h	g
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Thus, the two circuits are equivalent.

(12)

$S_0 \sim S_{n-1}$: n XORs $G_0 \sim G_{n-1}$: n ANDs

$P_0 \sim P_{n-1}$: nORs C_n: 1OR, nANDs

(13)

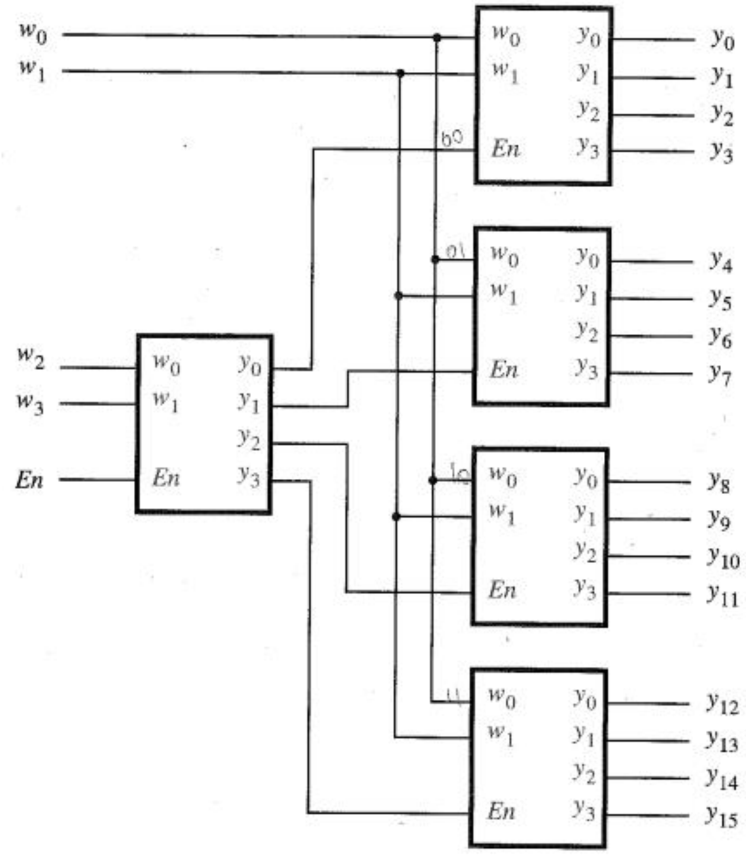


Figure 6.18 A 4-to-16 decoder built using a decoder tree.

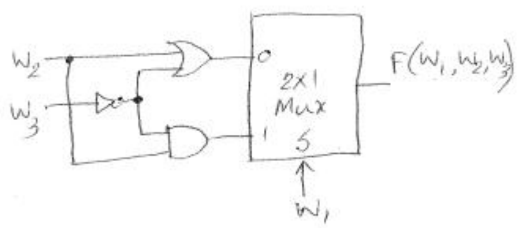
(14)

$$F(w_1, w_2, w_3) = \Sigma m(0,2,3,6)$$

$$= \overline{w}_1\overline{w}_2\overline{w}_3 + \overline{w}_1 w_2 \overline{w}_3 + \overline{w}_1 w_2 w_3 + w_1 w_2 \overline{w}_3$$

$$= \overline{w}_1 (w_2 w_3 + \overline{w}_3) + w_1 (w_2 \overline{w}_3)$$

$$= \overline{w}_1 (w_2 + \overline{w}_3) + w_1 (w_2 \overline{w}_3)$$



(15)

Truth Table

M	N	Q_{t+1}
0	0	0
0	1	1
1	0	$\overline{Q_t}$
1	1	$\overline{Q_t}$

Excitation Table

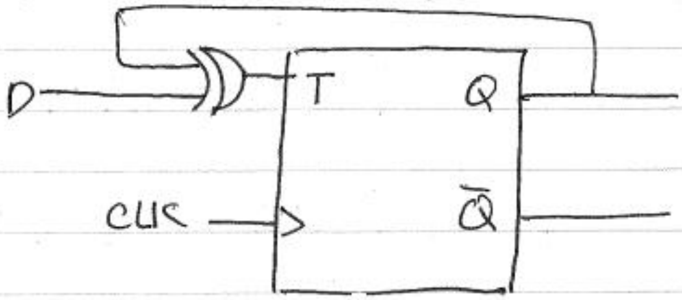
Q_t	Q_{t+1}	M	N
0	0	0	0
0	1	0	1
0	1	1	X
1	0	0	0
1	0	1	X
1	1	0	1

(16)

Excitation table:

Q_t	Q_{t+1}	D	T
0	0	0	0
0	1	1	1
1	0	0	1
1	1	1	0

$$T = Q_t' D + Q_t D' = Q_t \oplus D$$



(17)

A	B	Q	Comment
0	0	1	set
0	1	Q	hold
1	0	0	reset
1	1	Q	hold

(18)

State table:

Prev State Q_2	Q_1	Q_0	Next State $Q_2'(t+1)$	$Q_1'(t+1)$	Q_0'	T's Excitation T_2	T_1	T_0
0	0	0	0	0	1	0	0	1
0	0	1	0	1	0	0	1	1
0	1	0	0	1	1	0	0	1
0	1	1	1	0	0	1	1	1
1	0	0	1	0	1	0	0	1
1	0	1	0	0	0	1	0	1
1	1	0	X	X	X	X	X	X
1	1	1	X	X	X	X	X	X

T_2's KMap:

$Q_2 \backslash Q_1Q_0$	00	01	11	10
0	0	0	1	0
1	0	1	X	X

$$T_2 = Q_2Q_0 + Q_1Q_0$$

T_1's KMap:

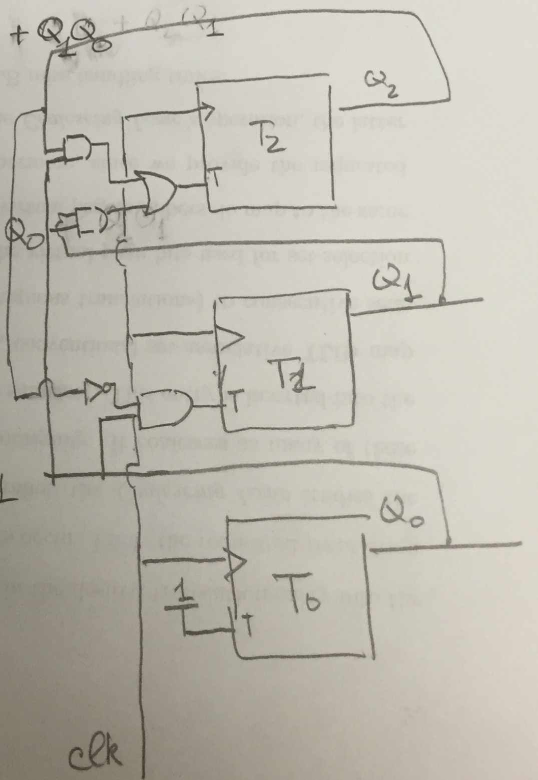
$Q_2 \backslash Q_1Q_0$	00	01	11	10
0	0	1	1	0
1	0	0	X	X

$$T_1 = \overline{Q_2}Q_0$$

T_0's KMap:

$Q_2 \backslash Q_1Q_0$	00	01	11	10
0	1	1	1	1
1	1	1	X	X

$$T_0 = 1$$



(19)

Output of flip-flop charges only on clock. On the other hand, latch reacts immediately with change in input.

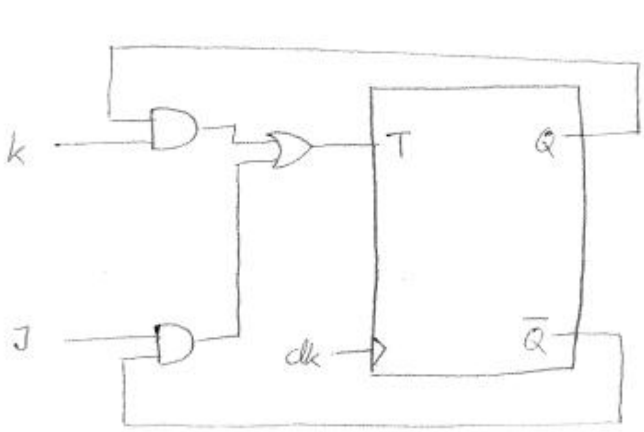
(20)

Excitation Table

Q_t	Q_{t+1}	J	k	T
0	0	0	x	0
0	1	1	x	1
1	0	x	1	1
1	1	x	0	0

So, $f_T(J,k,Q_t) = \Sigma M(3,5,6,7)$

Jk \ Q_t	0	1
00		
01		1
11	1	1
10	1	



$$f_T = J\overline{Q_t} + kQ_t$$