WPE Fall 2011 Solutions to the Digital Design Problem (Problem 11)

a) (12 pt)

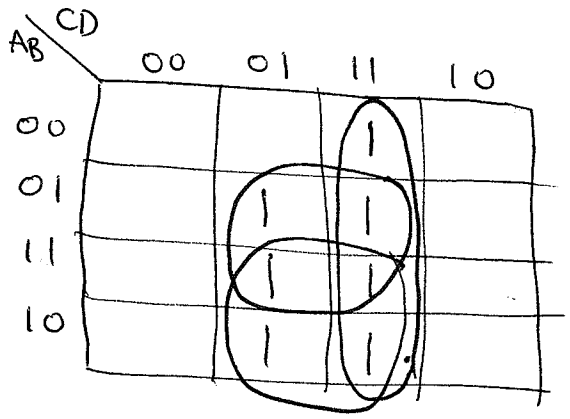
A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	0	← dad has a "no" veto power, not a "yes" veto.
0	0	1	0	0	
0	0	1	1	1	← tie
0	1	0	0	0	
0	1	0	1	1	← tie
0	1	1	0	0	
0	1	1	1	1	
1	0	0	0	0	
1	0	0	1	1	← tie
1	0	1	0	0	
1	0	1	1	1	
1	1	0	0	0	← tie, dad wins
1	1	0	1	1	
1	1	1	0	0	← veto
1	1	1	1	1	

b) (0.1 pt)

$$\bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BCD + A\bar{B}\bar{C}D + A\bar{B}CD + AB\bar{C}D + ABCD$$

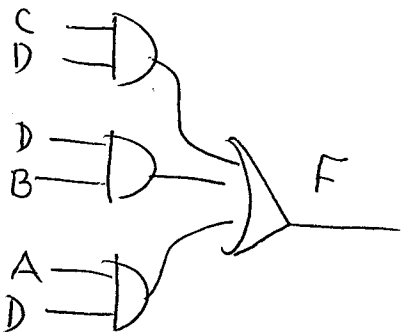
~~logic diagram not drawn~~

c) (0.7 pt)

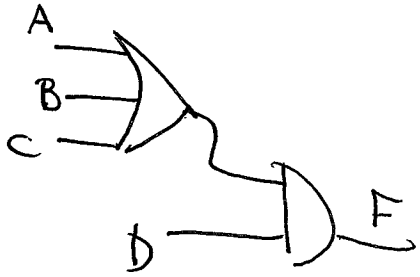


$F = CD + BD + AD$

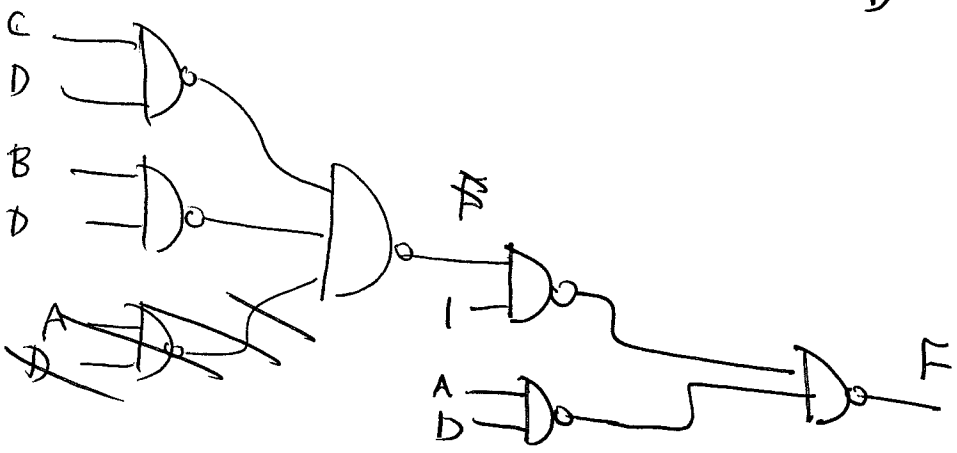
d) (0.3 pt)



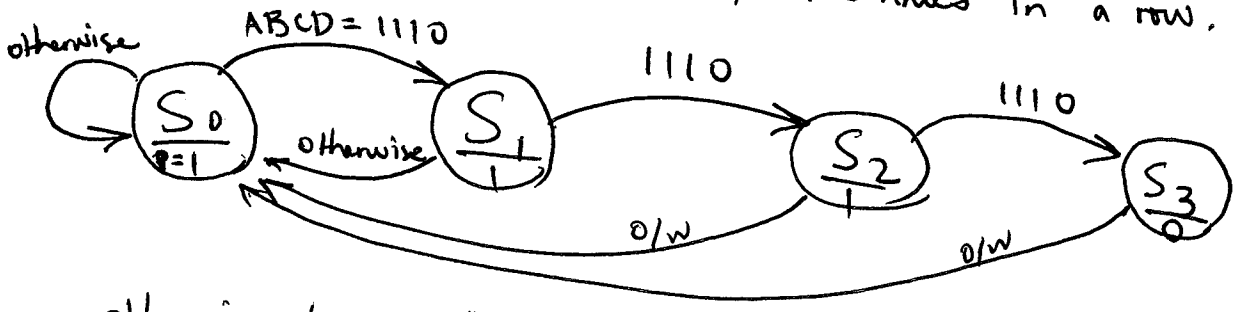
OR



e) (0.2 pt)



f) (1 pt) There are four cases: the father has not vetoed yet, he has vetoed once, twice, three times in a row.

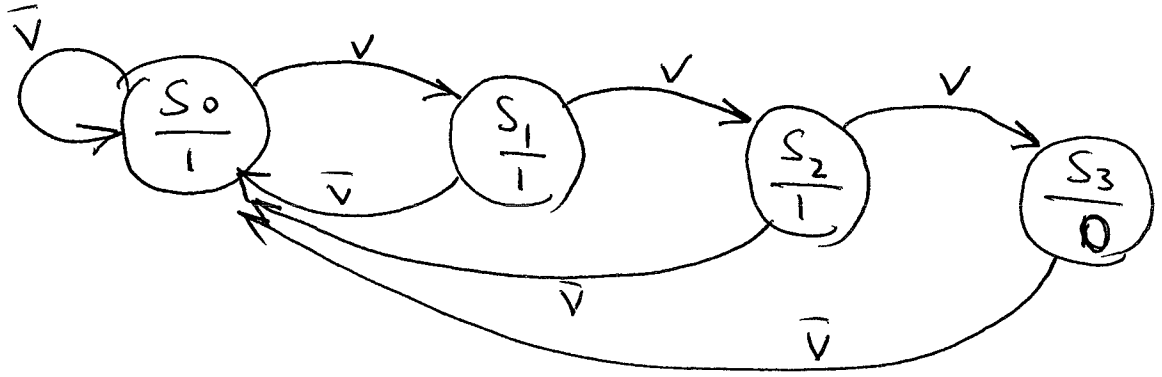


otherwise (or o/w) means $ABCD \neq 1110$

WPE Fall 2011 Problem 11 Digital Design SOLUTIONS

9) (1.5 pt) $S_0 = 00$ S1: 01 S2: 10 S3: 11

We define an intermediate function $V = ABC\bar{D}$, which is one if a veto was used.



The state machine is essentially a counter w/ reset.

Jk excitation table

cur state → next state	J k
0 → 0	0 X
0 → 1	1 X
1 → 0	X 1
1 → 1	X 0

J	k	Q^+
0	0	Q
0	1	0
1	0	1
1	1	$\bar{Q}$

Cur state	next state V=0	next state V=1
S_0	S_0	S_1
S_1	S_0	S_2
S_2	S_0	S_3
S_3	S_0	S_0

Cur state $(Q_1 Q_2)$	next State $(R_1 R_2)$ V=0	V=1
0 0	0 0	0 1
0 1	0 0	1 0
1 0	0 0	1 1
1 1	0 0	0 0

9)) (cont'd)

cur state (Q_1Q_2)	$J_1 k_1$		$J_2 k_2$	
	V=0	V=1	V=0	V=1
00	0X	0X	0X	1X
01	0X	1X	X1	X1
10	X1	X0	0X	1X
11	X1	X1	X1	X1

J_1

V \ Q_1Q_2	00	01	11	10
0	0	0	X	X
1	0	1	X	X

$J_1 = VQ_2$

k_1

V \ Q_1Q_2	00	01	11	10
0	X	X	1	1
1	X	X	1	0

$k_1 = Q_2 + \overline{V}$

J_2

V \ Q_1Q_2	00	01	11	10
0	0	X	X	0
1	1	X	X	1

$J_2 = V$

k_2

V \ Q_1Q_2	00	01	11	10
0	X	1	1	X
1	X	1	1	X

$k_2 = 1$

State output (~~was~~ whether to allow the father to veto)

$\hat{is} = \overline{Q_1} + \overline{Q_2}$