Robert Dick, Fall '07 Final

1) $\bar{f} = \Sigma(0,1,2,5,6,7)$

Σ_0	000 ✓	00X
Σ_1	001 ✓	0X0
	010 ✓	X01
Σ_2	101 ✓	X10
	110 ✓	1X1
Σ_3	111 ✓	11X

all PIs

$\bar{f} = \bar{a}\bar{b} + b\bar{c} + ac$

$\bar{\bar{f}} = \overline{\bar{a}\bar{b} + b\bar{c} + ac}$

$f = \overline{\bar{a}\bar{b}} \cdot \overline{b\bar{c}} \cdot \overline{ac}$

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

	00X	0X0	X01	X10	1X1	11X
000	1	1				
001	1		1			
010		1		1		
101			1		1	
110				1		1
111					1	1

Where to start? Consider two alternatives, after which all subsequent steps are obvious.

Each new column covers at most two rows. Therefore, at least 3 columns required for 6 rows. {00X, X10, 1X1} and {0X0, X01, 11X} equally good.

2) NP-completeness is the property of problems for which solutions can be checked in polynomial time (in terms of the input size) by a deterministic, i.e. Turing-equivalent abstract machine but which are as hard as the hardest such problem. It is conjectured that P ≠ NP and that optimally solving an NP-complete problem takes exponential time using a deterministic machine.

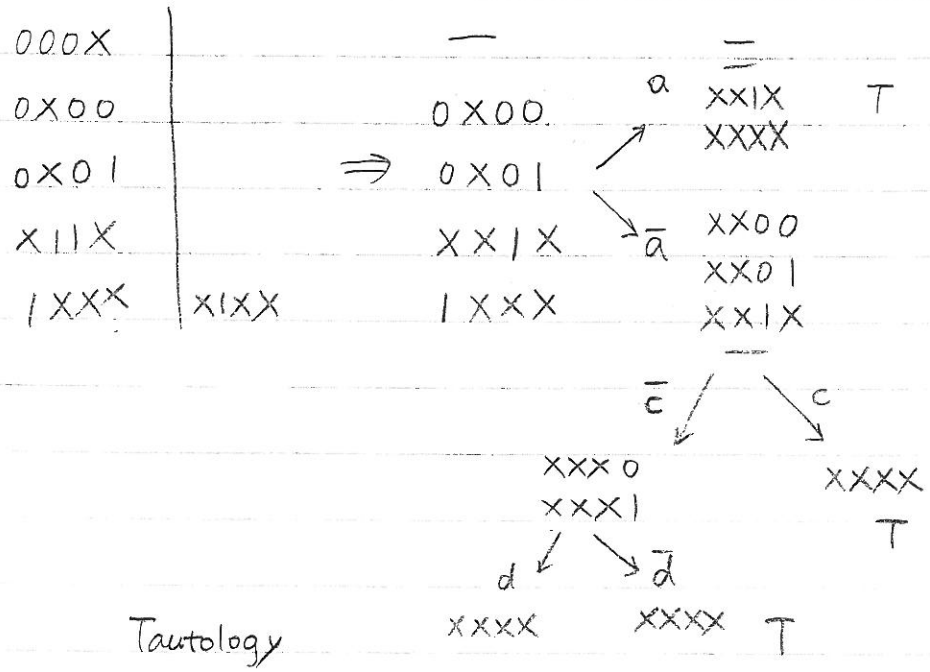
3) a) Develop a P-time algorithm
+ best solution
- probably impossible
b) Live w. an exponential-time algorithm
+ optimal results
- only finishes for small problem instances
c) Develop an approximation algorithm
+ bounded deviation from optimality
- can be very difficult
d) Identify previously-unknown constraints on problem instances of interest to allow P-time algorithm
+ optimal and fast
- doesn't always work
e) Develop a fast heuristic
+ may work pretty well much of the time
- generally hard to bound deviation from optimality

4. Consider whether each cube is relatively essential by cofactoring other cubes by it and checking for tautology.

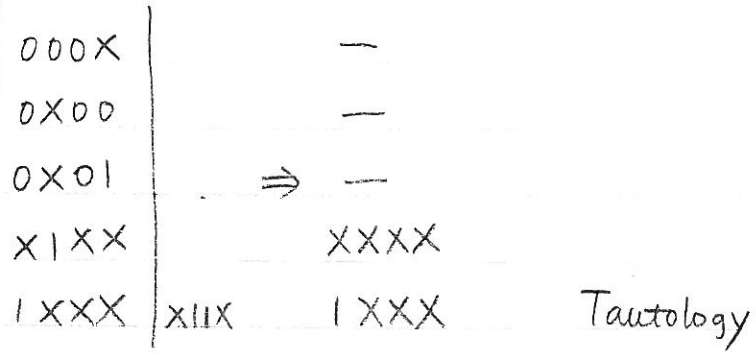
0X00		XXX0	→ $\bar{d}$	XXXX
0X01		XXX1	→ d:	XXXX
X1XX	⇒	—		
X11X		—		Tautology
1XXX	000X	—		

000X		X0XX	→ $\bar{b}$:	XXXX
0X01		—		
X1XX	⇒	X1XX	→ b:	XXXX
X11X		—		Tautology
1XXX	0X00	—		

000X		X0XX	→ $\bar{b}$:	XXXX
0X00		—		
X1XX	⇒	X1XX	→ b:	XXXX
X11X		—		Tautology
1XXX	0X01	—		



Tautology



Tautology

000X		—	
0X00		—	
0X01	⇒	—	
X1XX		X1XX	$\overline{b}$: —
X11X	1XXX	X11X	not tautology

1XXX is relatively essential

Relatively essential {1XXX}

Determine which redundant cubes covered by relatively essential cubes.

000X | 1XXX = null

0X00 | 1XXX = null

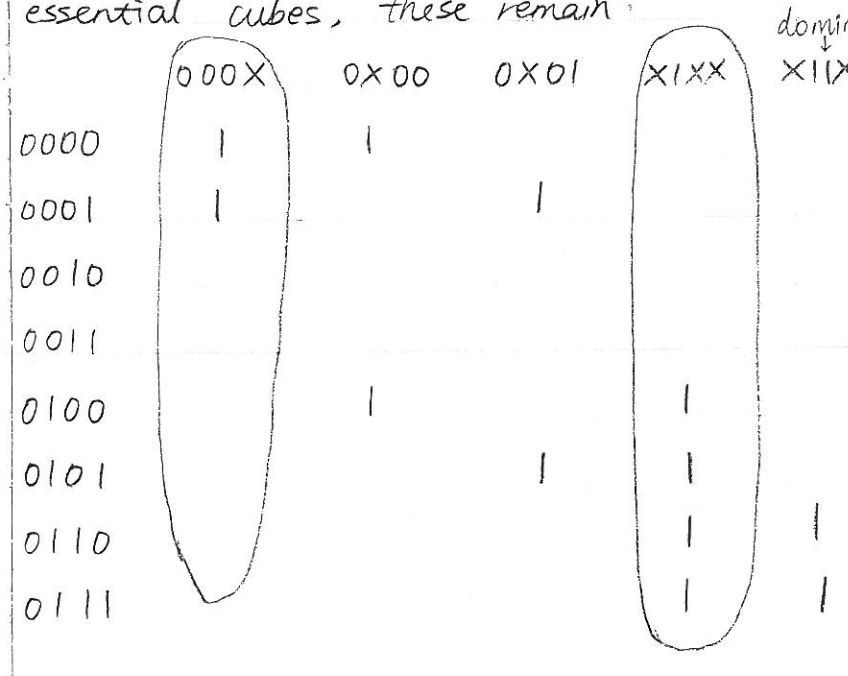
0X01 | 1XXX = null

X1XX | 1XXX = X1XX not tautology

X11X | 1XXX = X11X not tautology

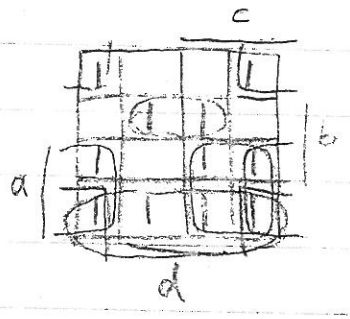
None is covered, all are partially redundant

After removing minterms covered by relatively-essential cubes, these remain:



minimal covering: 1XXX, X1XX, 000X

5.



$f = \bar{b}\bar{d} + \bar{a}cd + a\bar{b} + a\bar{d} + ac$

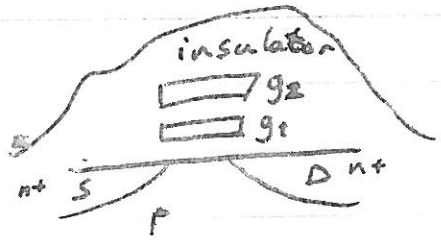
c: $b\bar{d}$

		kernel	gain
a	$\bar{b} + \bar{d} + c$	K_1	2
b	$\bar{a}d$		
c	a		
d	$\bar{a}b$		
$\bar{a}$	bd		
$\bar{b}$	$\bar{d} + a$	K_2	1
$\bar{d}$	$\bar{b} + a$	K_3	1
bd	$\bar{a}$		

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

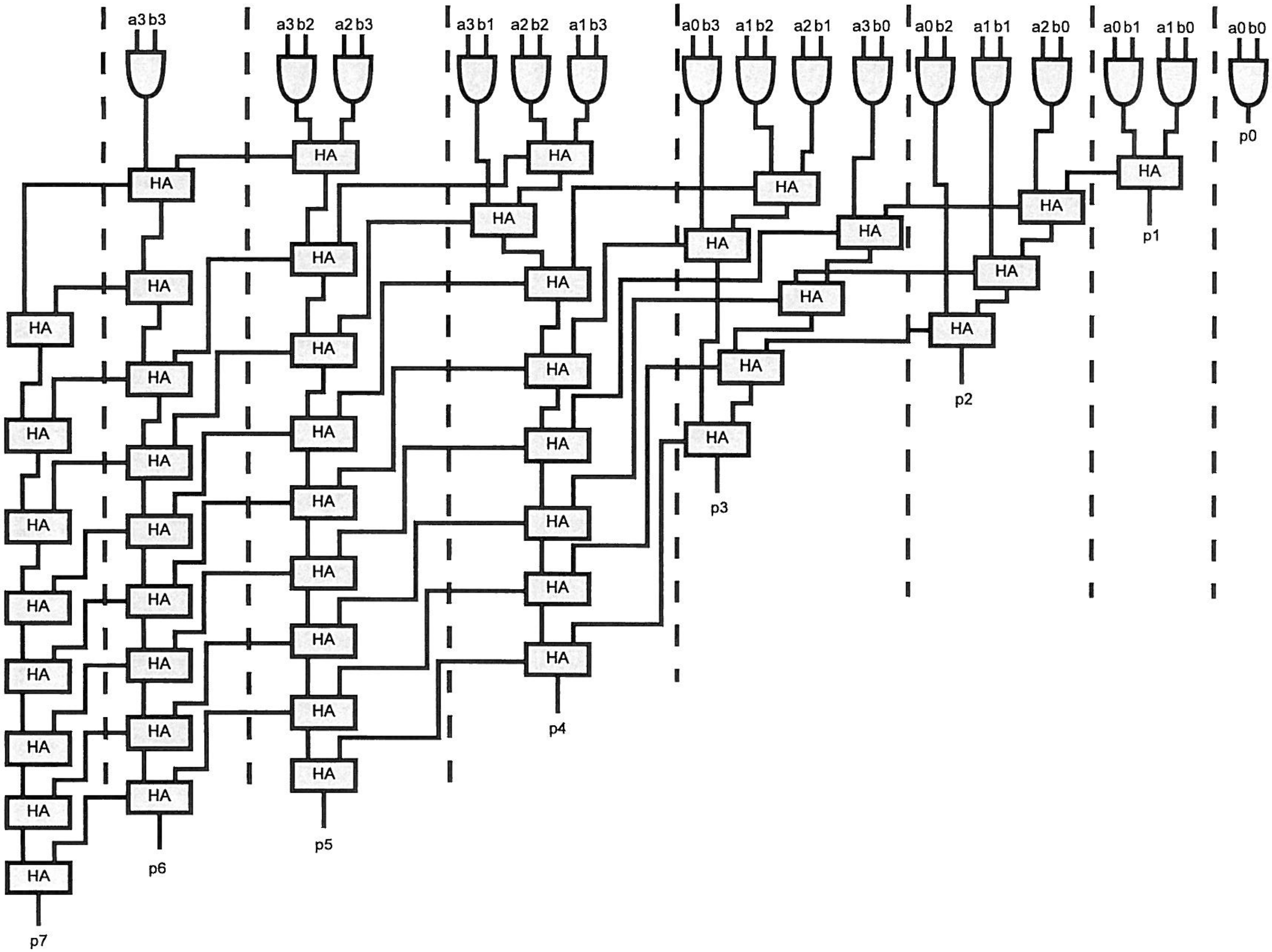
6) High-k dielectric allows gate thickness to be increased while still forming a channel w. the same V_{g2}. This reduces gate (tunneling) leakage, which would have otherwise been a big problem in 45 nm processes.

7)

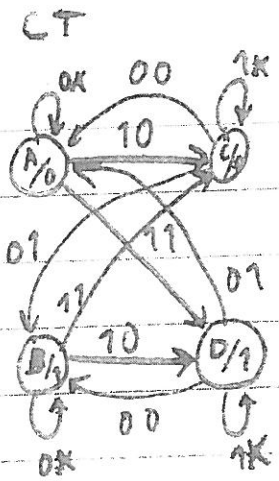


High V_{g2}s forms channel only when g_1 does not have excess electrons. Very high V_{g2}s can be used to tunnel electrons from S to g_1. Very low V_{g2}s or ultra violet light can be used to remove electrons from g_2.

8)


a3 b3
a3 b2
a2 b3
a3 b1
a2 b2
a1 b3
a0 b3
a1 b2
a2 b1
a3 b0
a0 b2
a1 b1
a2 b0
a0 b1
a1 b0
a0 b0
HA
p0
p1
p2
p3
p4
p5
p6
p7

9)

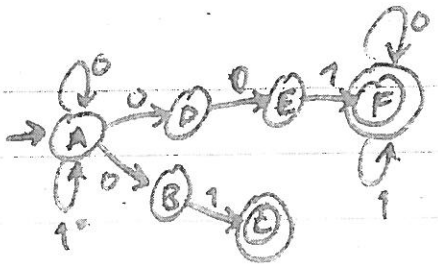


P

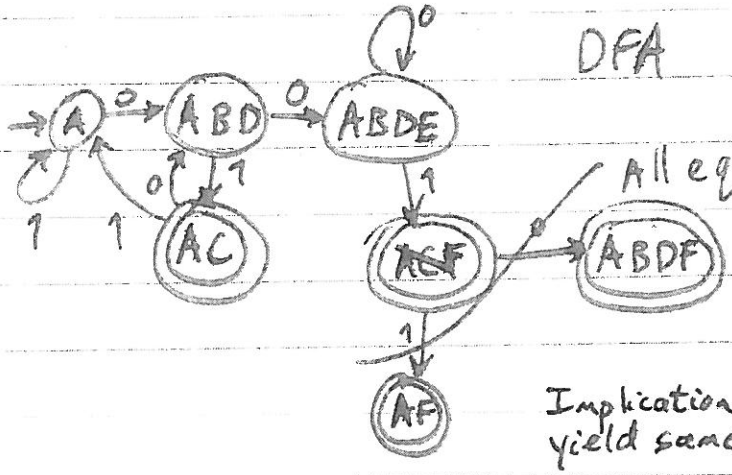
Q	A	C
	D	B

A = 00
B = 11
C = 10
D = 01

10) $(0+1)^*001(0+1)^* + (0+1)^*01$



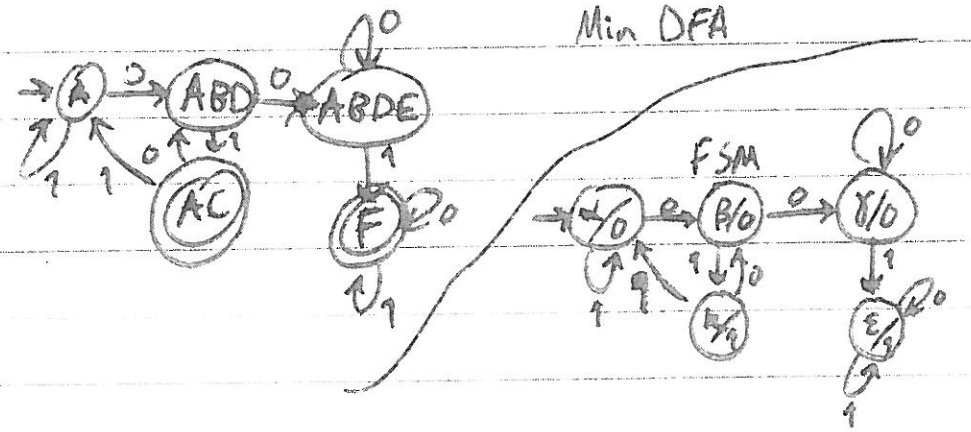
NFA



DFA

All equiv. After this point, always produce 1 output.

Implication chart would yield same result.



11) Two out of three majority vote logic. Carry of full adder.

12) Yes. It wouldn't change the timing diagram much because address was driven a cycle before data. The components on the bus might need to internally latch the address, however.