Robert Dick ECE 303 Spring 2006 final

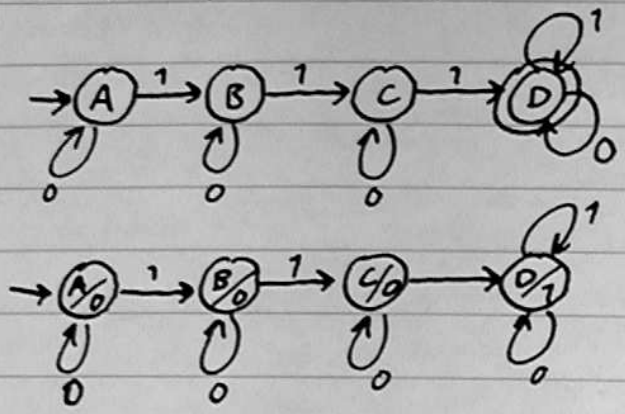
1)a) Synchronous design allows correct operation even in the presence of hazards in state variable networks. Most existing CAD tools target synchronous design.

1)b) Higher power consumption increases temperature, resulting in decreased reliability, increased packaging and cooling cost, and increased leakage power. Higherpower consumption also results in reduced battery life.

1)c) No. $e \propto p \cdot t$, $p \propto f$, $t \propto 1/f$
The decrease in power is offset by the increase in time to complete the task.

2)a) $0^*10^*10^*1(0+1)^*$

2)b)



2)c)

	NS(I)		
CS	0	1	Output
A_{00}	A_{00}	B_{01}	0
B_{01}	B_{01}	C_{11}	0
C_{11}	C_{11}	D_{10}	0
D_{10}	D_{10}	D_{10}	1

2)d)

B	~~BC~~		
C	~~BD~~	~~CD~~	
D	X	X	X
	A	B	C

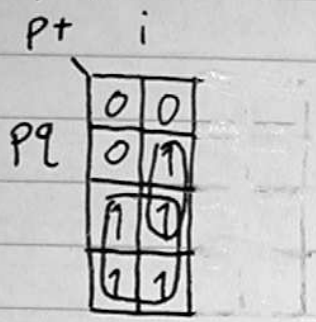
The machine is minimal.

2)e)

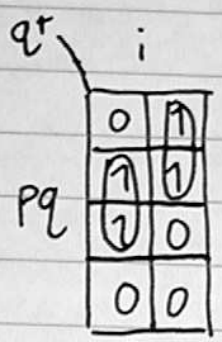
p^0 \ q	0	1
0	A	B
1	D	C

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

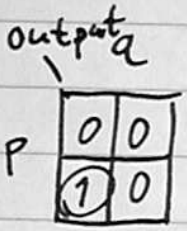
2)f)



$p^+ = p + qi$



$q^+ = q\bar{i} + \bar{p}i$



$output = p\bar{q}$

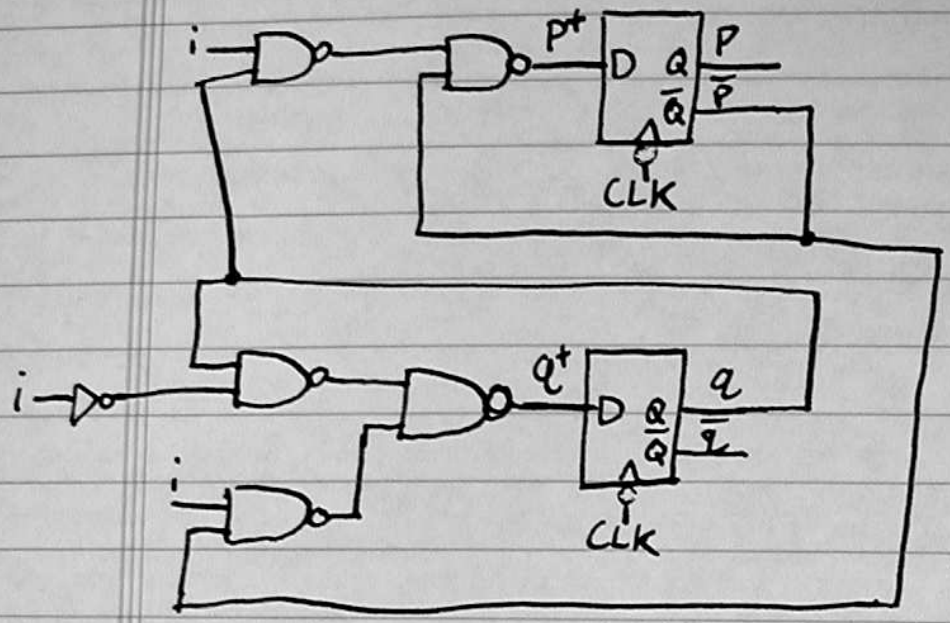
2)g)

$$p^+ = \overline{\overline{p+qi}} = \overline{\bar{p}\bar{q}i}$$

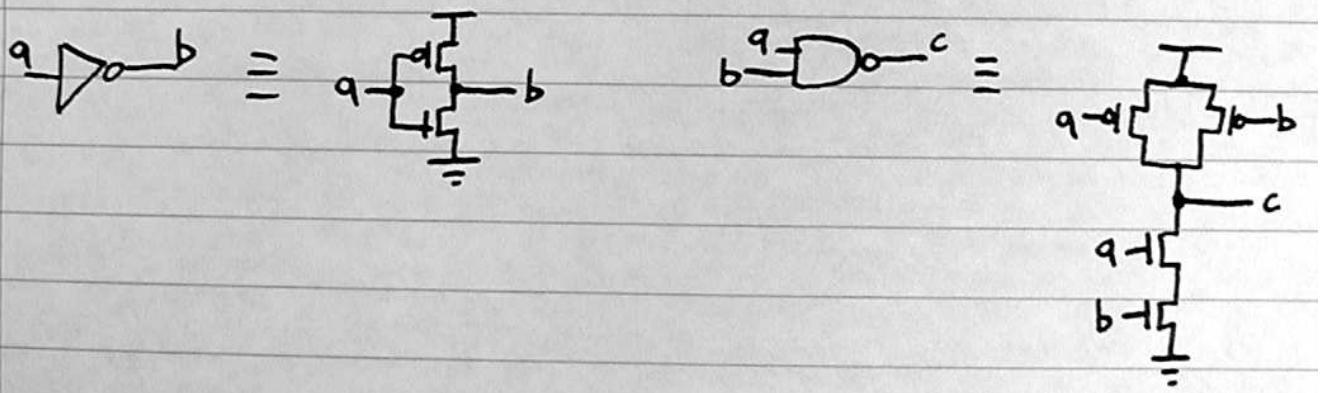
$$q^+ = \overline{\overline{q\bar{i}+\bar{p}i}} = \overline{\overline{q\bar{i}} \cdot \overline{\bar{p}i}}$$

$$output = \overline{\overline{p\bar{q}}} = \overline{\bar{p}+q}$$

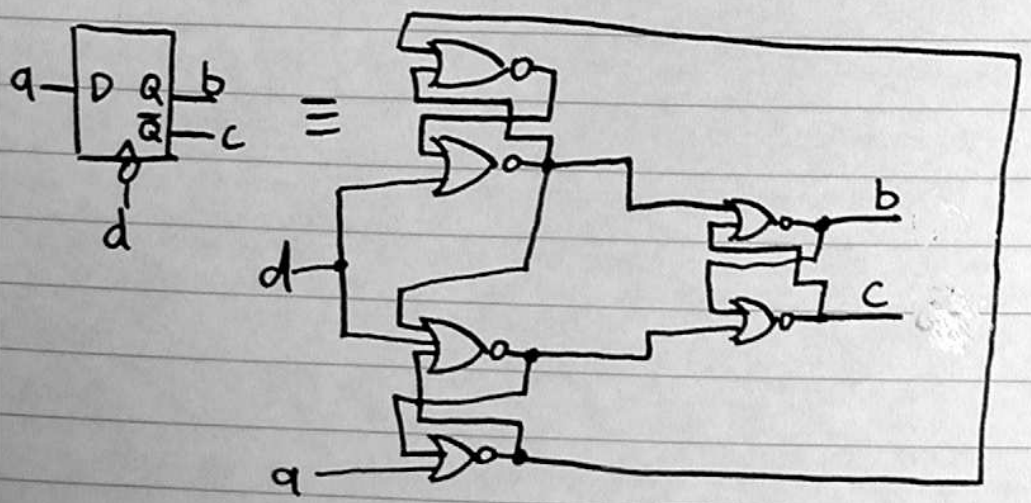
2)h)


i
P+
D
Q
P
$\bar{Q}$
$\bar{P}$
CLK
i
Q+
D
Q
q
$\bar{Q}$
$\bar{q}$
CLK
i

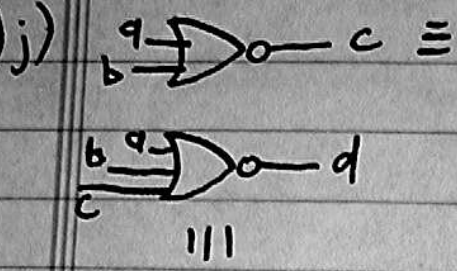
2)i)


a
b
≡
a
b
a
b
c
≡
a
b
c
a
b

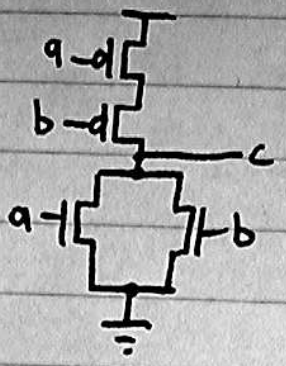
2)j)

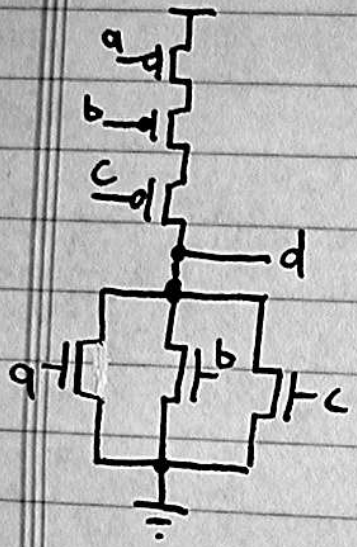

a
D
Q
b
$\bar{Q}$
c
d
≡
d
b
c
a

2) j)

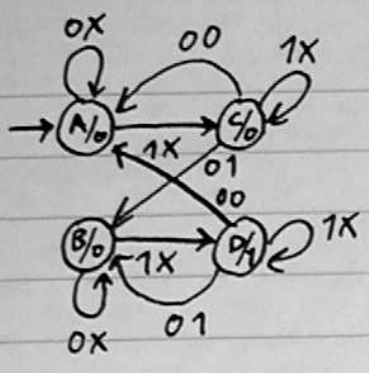


≡





3)a)



3)b)

NS(CLK, i)

CS	00	01	10	11	Output
A 00	A 00	A 00	C 01	C 01	0
B 11	B 11	B 11	D 10	D 10	0
C 01	A 00	B 11	C 01	C 01	0
D 10	A 00	B 11	D 10	D 10	1

3)c)

B ~~XX~~

C ~~X~~ ~~X~~

D X X X

A B C

The machine is minimal.

3)d)

P \ q	0	1
0	A	C
1	D	B

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

3)e)

P+

P \ CLK, i	00	01	11	10
0	0	0	0	0
1	0	1	0	0
q	1	0	1	1
$\bar{q}$	0	1	1	1

$P^+ = q \cdot \overline{CLK} \cdot i + p \cdot q + p \cdot i + p \cdot CLK$

q+

P, q \ CLK, i	00	01	11	10
0 0	0	0	1	1
0 1	0	1	1	1
1 1	1	0	0	0
1 0	0	1	0	0

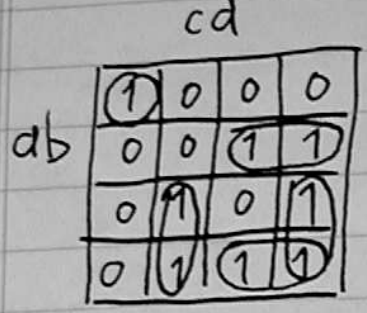
$q^+ = \bar{p} \cdot CLK + \bar{p} \cdot q \cdot i + q \cdot \overline{CLK} \cdot i + p \cdot q \cdot \overline{CLK} + p \cdot \overline{CLK} \cdot i$

output q

P \ q	0	1
0	0	0
1	1	0

$output = p \cdot \bar{q}$

4)



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

16 literals at start

cube	kernel	gain
$\bar{a}$	$\bar{b}\bar{c}\bar{d}+bc$	1
a	$\bar{c}d+\bar{b}c+c\bar{d}$	2
$\bar{b}$	$\bar{a}\bar{c}\bar{d}+ac$	1
b	~~$a\bar{c}$~~	
$\bar{c}$	$\bar{a}\bar{b}\bar{d}+ad$	1
c	$\bar{a}b+a\bar{b}+a\bar{d}$	2
$\bar{d}$	$\bar{a}\bar{b}\bar{c}+ac$	1
d	~~$a\bar{c}$~~	
ac	$\bar{b}+\bar{d}$	2

Use $\bar{b}+\bar{d} = k_1$

$f = ack_1 + \bar{a}\bar{b}\bar{c}\bar{d} + a\bar{c}d + \bar{a}bc$

cube	kernel	gain
$\bar{a}$	$\bar{b}\bar{c}\bar{d}+bc$	1
a	$ck_1+\bar{c}d$	1
$\bar{c}$	$\bar{a}\bar{b}\bar{d}+ad$	1
c	$ak_1+\bar{a}b$	1

Use $\bar{b}\bar{c}\bar{d}+bc = k_2$

$f = ack_1 + \bar{a}k_2 + a\bar{c}d$

4) $f = ack_1 + \bar{a}k_2 + a\bar{c}d$

cube	kernel	gain
a	$ck_1 + \bar{c}d$	1

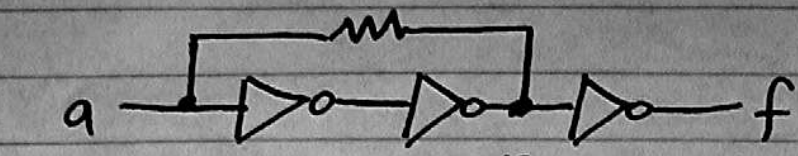
use $ck_1 + \bar{c}d = k_3$

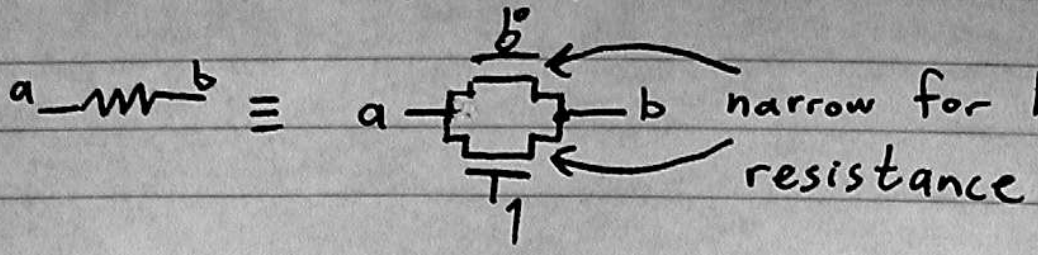
$f = ak_3 + \bar{a}k_2$

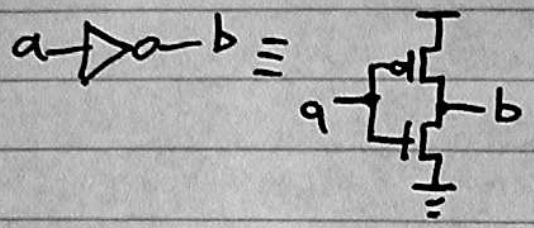
$f = a(c(\bar{b}+\bar{d}) + \bar{c}d) + \bar{a}(\bar{b}\bar{c}\bar{d} + bc)$

12 literals

5)







6)a) lag-flop

6)b) a = asynchronous preset
b = asynchronous clear
c = clock
d = input
e = output