ECE 303 Spring 2003 Final Exam Solutions

1)a) Two-level ensures that dynamic hazards won't occur. It also allows one to eliminate static hazards by covering all 1-1 transitions in SOP or all 0-0 transitions in POS.

1)b) A combination of input values for which the output is irrelevant because the input combination can never occur.

1)c) A PLA has fully general product term selection for its OR array. A PAL only allows a subset of product terms to be used by each OR gate.

1)d) Calculating EFT and LFT.

1)e) Partially specified FSM state minimization
Technology mapping
Phase II of Quine-McCluskey

2)a)

cd \ ab	00	01	11	10
00	0: X	4: 1	12: 1	8: 0
01	1: 1	5: 1	13: 0	9: 1
11	3: X	7: 0	15: 0	11: 0
10	2: X	6: X	14: X	10: 0

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

2)b)

List

0000✓
0001✓
0100✓
0111✓
1001✓
1010✓
0011✓
0101✓
1011✓

0000✓ 0001✓ 0100✓ 1001✓ 1010✓ 0011✓ 0101✓ 0111✓ 1011✓

000X✓ 0X00✓ X001✓ 00X1✓ 0X01✓ 010X✓ 10X1✓ 101X 0X11✓ X011✓ 01X1✓

0X0X ~~0X0X~~ X0X1 ~~X0X1~~ 0XX1 ~~0XX1~~

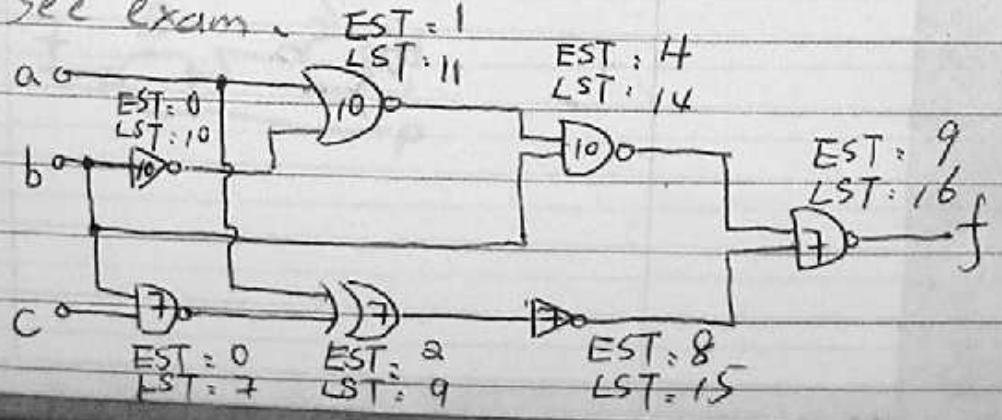
	101X	0X0X	X0X1	0XX1
0000		1		
0001		1	1	1
0100		1		
0111				1
1001			1	
1010	1			

All required

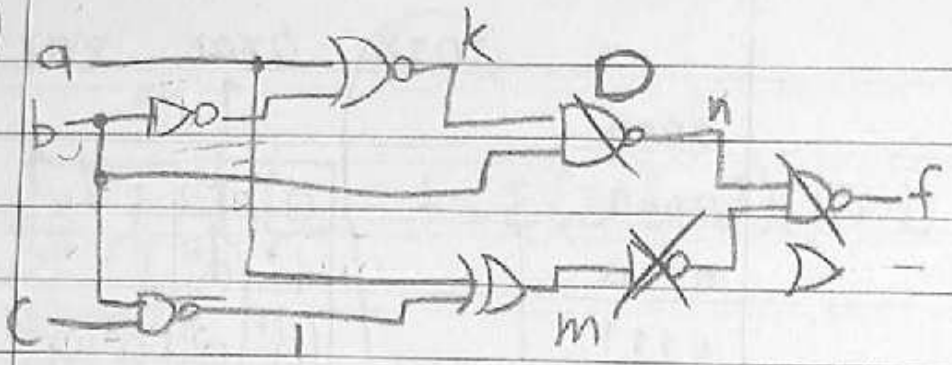
$$f = a\bar{b}c + \bar{a}\bar{c} + \bar{b}d + \bar{a}d$$

3)a) Top path has 10 units of slack
Bottom has 7 units of slack
See exam.

3)b) See exam.



3)c)



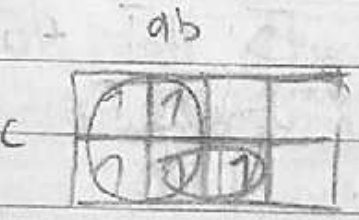
$k = \overline{\bar{a} + \bar{b}} = \bar{a}b$

$l = \overline{bc} = \bar{b} + \bar{c}$

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

$n = \bar{a}bb = \bar{a}b$

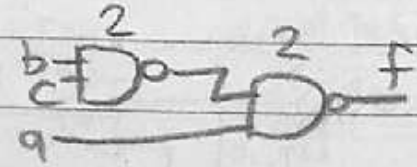
$f = abc + \bar{a}\bar{b} + \bar{a}\bar{c} + \bar{a}b = abc + \bar{a}$



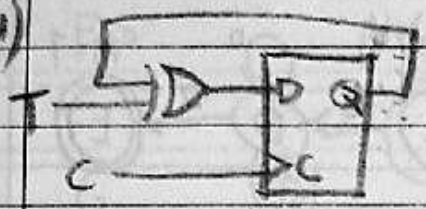
$= \bar{a} + bc$

$= \overline{\overline{\bar{a} + bc}}$

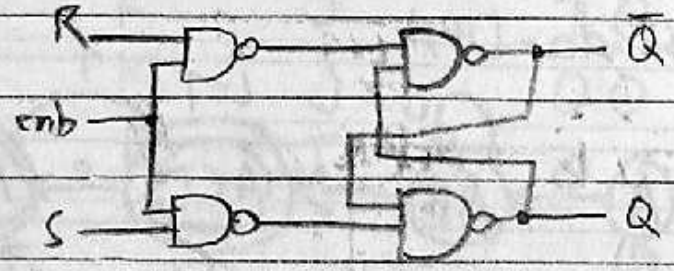
$= \overline{a(\overline{bc})}$



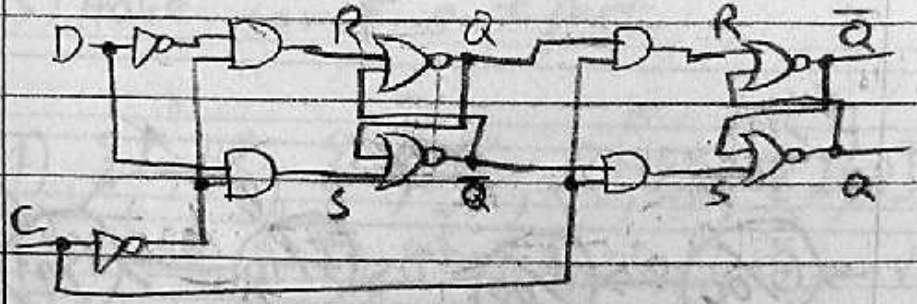
4)a)



4)b)

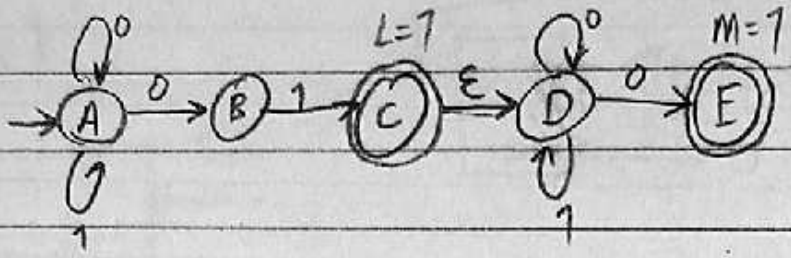


4)c)

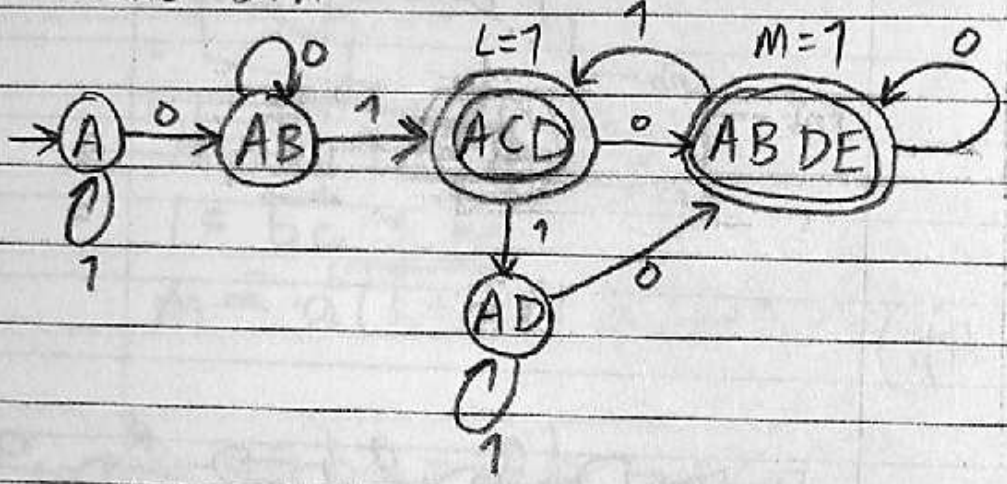


5)a)

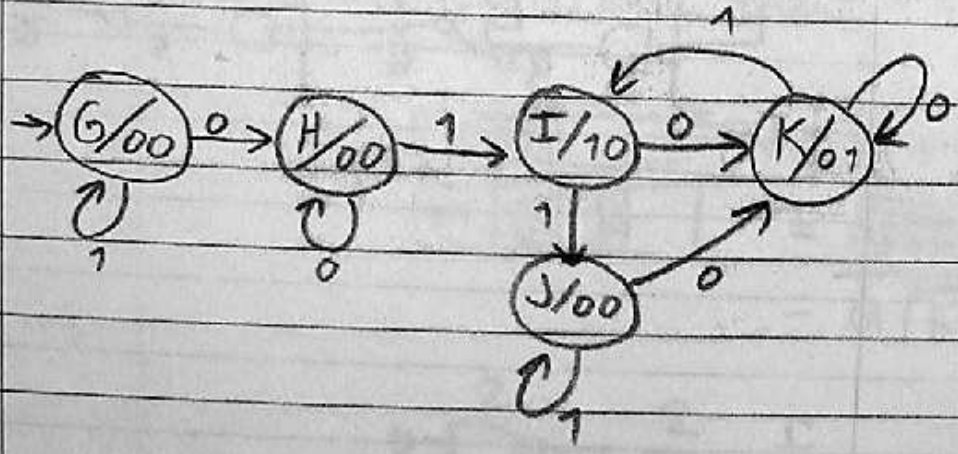
Pseudo-NFA



Pseudo-DFA



FSM



5)b)

PS	NS i=0	NS i=1	LM
G	H	G	00
H	H	I	00
I	K	J	10
J	K	J	00
K	K	I	01

5)c) 1) Share same child (input)
2) Share same parent
3) Have same output

5)d) 1) ~~{G,H}~~, ~~{H,K}~~, ~~{J,K}~~, ~~{I,J}~~ (H, I, K, J)
2) ~~{G,H}~~, ~~{H,I}~~, ~~{J,K}~~, ~~{J,K}~~, {I,K} cont (G, H, I, K)
3) {G,H,J} decent. can't do output w.o. splitting

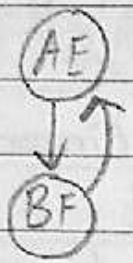
ab

c		G	H	I
	-		K	J

5)e)

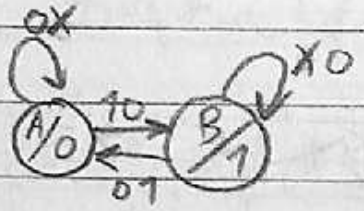
6)

B ~~X~~				
C X	~~A=D~~			
D ~~B=D~~	X	X		
E B=F	X	X	~~A=E~~	
F X	A=E	~~A=E~~	X	X
A	B	C	D	E



{AE}, {BF}, C, D

7)a)i)



7)a)ii) A=0, B=1

7)a)iii)

PS	NS(a,b)				Z
	00	01	10	11	
0	0	0	1	X	0
1	1	0	1	X	1

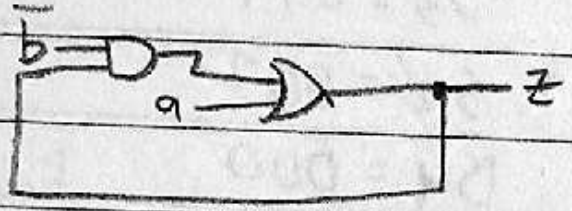
7)a)iv)

q \ q^+	ab = 00	01	11	10
0	0	0	X	1
1	1	0	X	1

$q^+ = a + \bar{b}q$

$z = q$

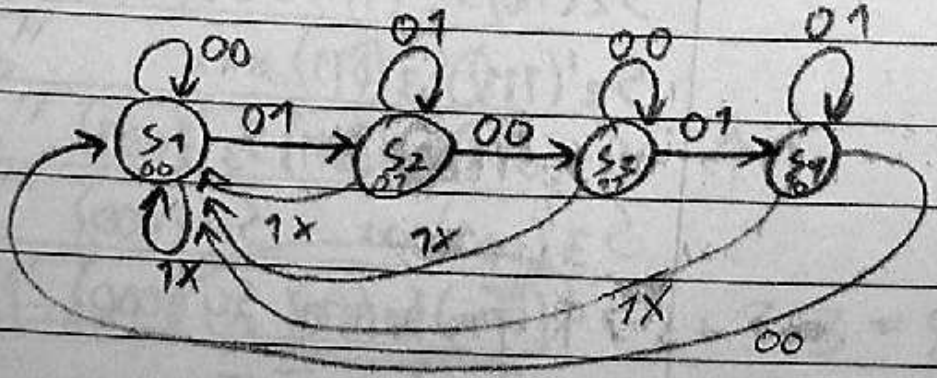
7)a) v)



7)a) vi) SR latch

7)b)i) Moore

7)b)ii)



7)b)iii)

c \ ab	00	01	11	10
0	S_4	S_1	S_2	
1	S_3'	S_3	S_2'	

$S_1 = 010$

$S_2 = 110$

$S_2' = 111$

$S_3 = 011$

$S_3' = 001$

$S_4 = 000$

7)b)iv)

PS	NS (ab) 00	01	10	11	$Z_1 Z_2$
$S_1(010)$	$S_1(010)$	$S_1(010)$	$S_2(110)$	"	00
$S_2(110)$	$S_2(110)$	$S_2'(111)$	$S_2(110)$	"	01
$S_2'(111)$	$S_3(011)$	xxx	"	"	01
$S_3(011)$	$S_3(011)$	$S_3(011)$	$S_3'(001)$	"	11
$S_3'(001)$	xxx	$S_4(000)$	"	"	11
$S_4(000)$	$S_1(010)$	$S_4(000)$	"	"	10

8) see exam

		a	b	c	d	e	f
I/O	d+f				1		1
	e+f					1	1
	b+f		1				1
gates	i				1		1
	j				1		1
	k					1	1
	l					1	1
	m	1			1		1
	n			1		1	1
	o		1				1
	$\bar{d}+b$		1		0		
	$\bar{e}+b$		1			0	
	$\bar{a}+b$	0	1				
	$\bar{c}+b$		1	0			
	$\bar{b}+a+d+c+e$	1	0	1	1	1	

options $\bar{a}\,b\,\bar{c}\,d\,e\,\bar{f}$ $2+3+3=8$

$\bar{a}\,\bar{b}\,\bar{c}\,d\,\bar{e}\,f$ 9

9)a) dsgn = 2:1 MUX
a = I_0
b = I_1
c = select
d = output

9)b) dsgn = rising edge T flip-flop
a = preset (AH)
b = clear (AH)
c = clock
d = toggle