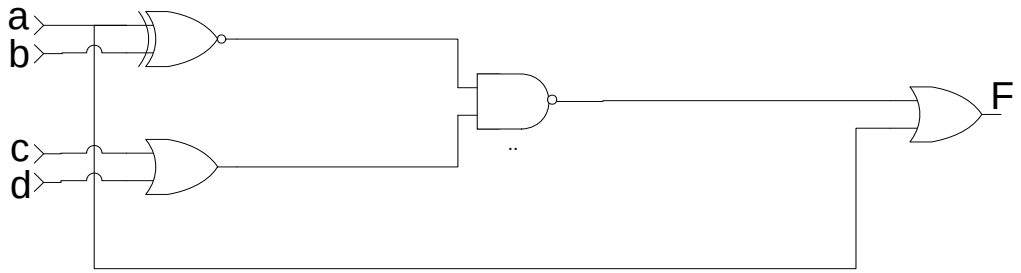
DIGITAL DESIGN COEN 312 Lecturer: A. J. Al-Khalili,
Answer All Questions. Time Allowed 1 hr 10min. Midterm exam. July 14th, 2010

Question 1 (**Use Boolean Algebra for Question 1**)

1.a Simplify to obtain minimum SOP (2 marks)
F(A, B, C, D) = A'B'CD'+AC'D'+ABC'+AB'C+AB'C+BC'D

1.b Simplify to obtain minimum SOP (2 marks)
F(A, B, C, D) = A'B'(1 +C')' + A + (0 + D')+D

1.c Minimize the following circuit, Give minimum circuit in **NAND-NAND** Form. (3 marks)



Question2

a) Give **minimal POS** for F(a,b,c,d) given by the following K-map.
Identify the prime Implicants clearly. Identify the Essential Prime Implicants.
Give the minimum AND-OR-NOT implementation. (4 marks).

cd \ ab	00	01	11	10
00	X	X	X	X
01	1	1	X	
11	1	1	1	
10	X	1	1	X

b) Give **minimal NOR-NOR** implementation for F(a,b,c,d) given by the following K-map (2 marks).

cd \ ab	00	01	11	10
00		X	X	
01		1	X	
11	X			
10	X	1	1	X

c) Using F1 determine minimum F (4 marks)

cd \ ab	00	01	11	10
00	X	X	X	X
01	1	1	X	
11	1	1	1	
10	X	1	1	X

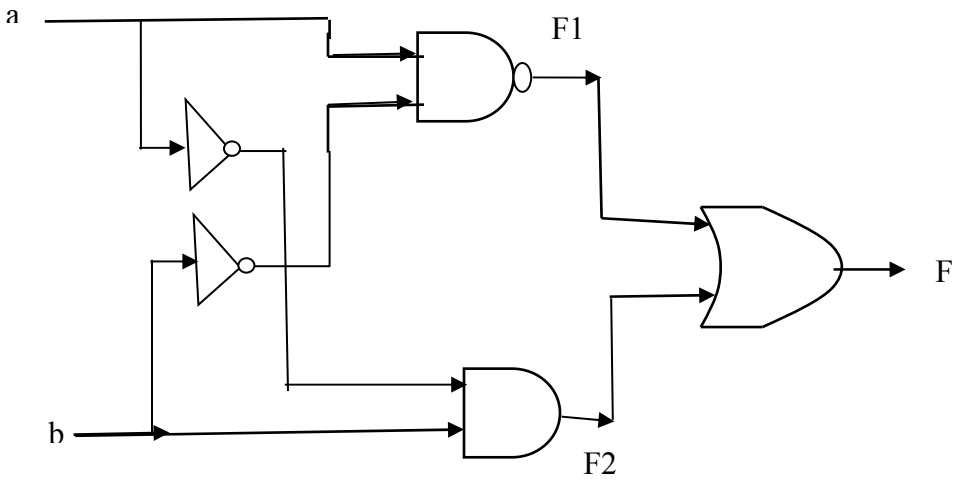
F1

cd \ ab	00	01	11	10
00	X	X	X	X
01	1	1	X	1
11		1	1	
10	X	1	1	X

F

Question 3

In the circuit below the delays are as follows:
Delay of inverter =2ns
Delay of AND =6ns
Delay of NAND =5ns
Delay of OR =8ns
Input of the circuit goes from ab= 00 to 01 to 10 draw timing diagram for the circuit. (8 marks)



Midterm Solutions

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Q1 a)

A'B'CD' + AC'D' + ABC' + AB'C + AB'C + BC'D
2 8,12 12, 13 10,11 10,11 5,13

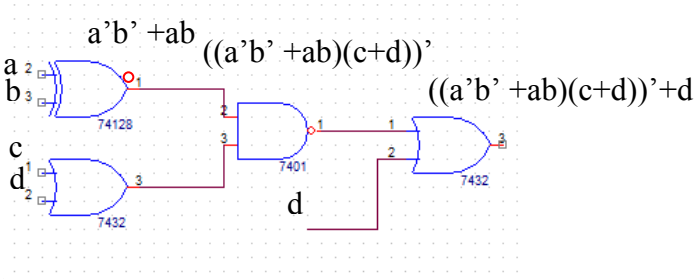
... ABC'(D+D') ABC' is deleted
2 & 10,11 A'B'CD' + AB'C = B'C(A+A'D)
Final Result: B'CD' + AC'D' + AB'C + BC'D

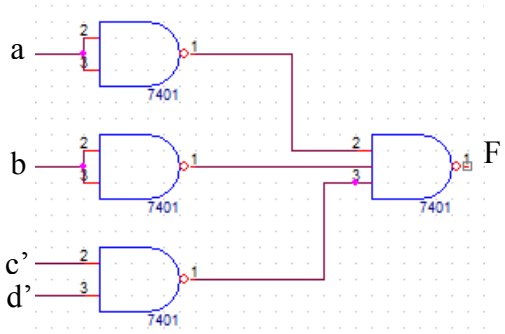
Q1 b)

F(A,B,C,D) = A'B'(1+C')' + A + (0 + D') + D
= A'B'0 + A + D + D'
=0 +A+1
=1

Q1 c)

F= (a'b'+ab)'+ (c+d)' + d
= ab' + a'b + c'd'+ d
= a+ b+c'd'





Assuming double rail (a+b+c'd')''=(a'b'c'd')'

Alternate for Q1 a)

= A'B'CD' + AC'D' + ABC' +AB'C + AB'C + BC'D

= A'B'CD' + (C'D' + BC' + B'C)A + BC'D

= A(CC'+B'C) + BC'D + A'B'CD'

= AC'D' +A'B'CD' +AB'C +BC'D

= AC'D' + B'CD'+AB'C + BC'D

Q2 a)

i) Prime Implicant $PI_1=\sum_m(0,1,2,3,4,5,6,7) = A'$

$PI_2= \sum_m(4,5,6,7,12,13,14,15) = B$

$PI_3=\sum_m(0,2,4,6,8,10,12,14) = D'$

AB / CD	00	01	11	10
00	X	X	X	X
01	1	1	X	
11	1	1	1	
10	1	1	1	X

F=A'+B

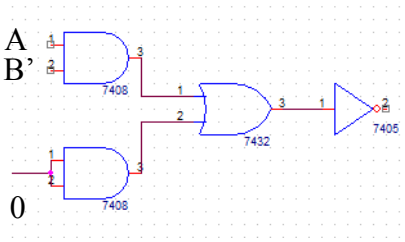
ii) EPI = PI_1 & PI_2

iii) F'= AB'

F = (AB')'

Assume double rail

AB / CD	00	01	11	10
00	X	X	X	X
01			X	1
11				1
10	X			X



Q2 b)

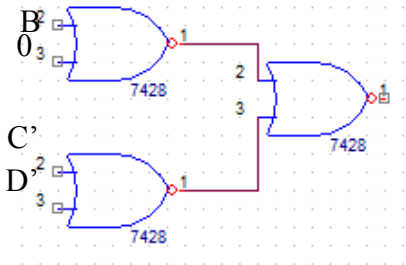
F= B(C'+D')

F=(B+0)(C'+D')

F=((B+0)'+(C'+D')')'

Assume double rail

AB / CD	00	01	11	10
00	0	X	X	0
01	0		X	0
11	X	0	0	0
10	X			X



F = (F_1F_2) + F_3 i.e. remove m_3 & add m9; F= F_1m_3' + m_0

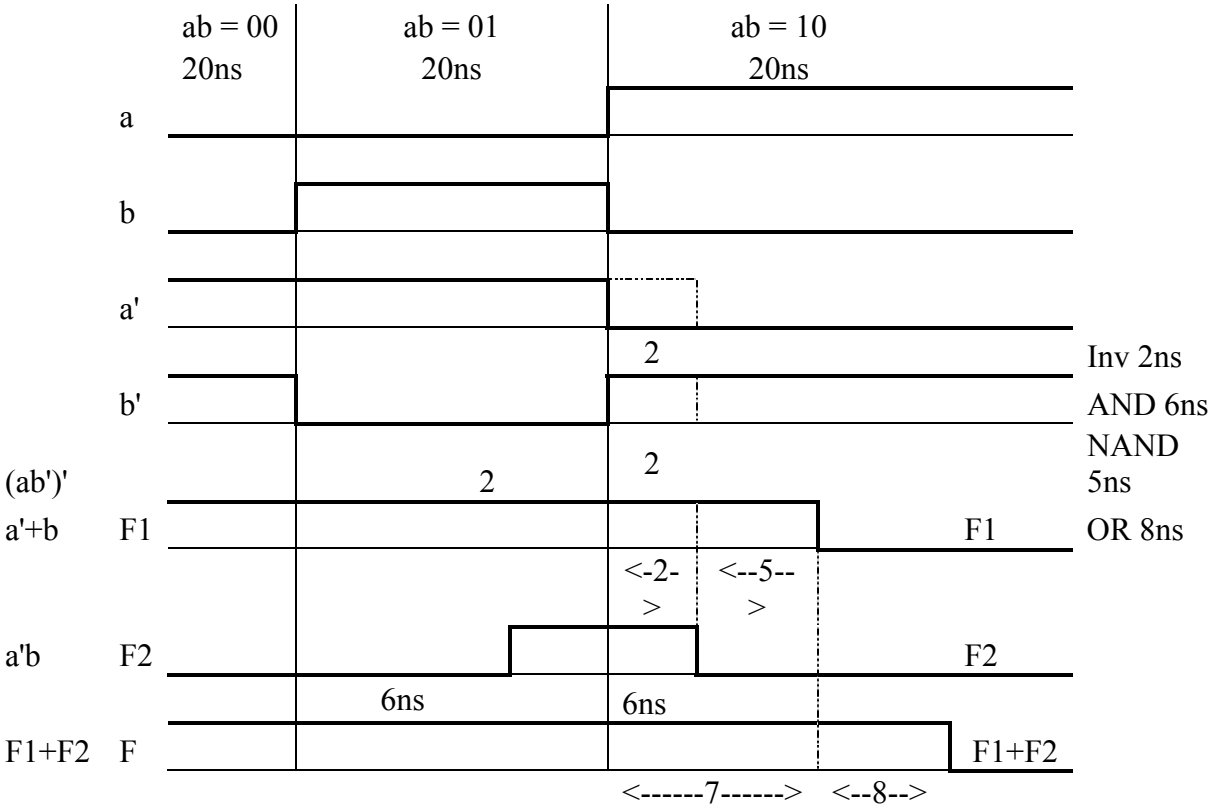
AB / CD	00	01	11	10
00	X	X	X	X
01	1	1	X	X
11	0	1	0	X
10	X	1		X

F_2=B+C’

AB / CD	00	01	11	10
00	X	X	X	X
01	X	X	X	1
11	X	X	X	0
10	X	X	X	X

F_3=C’

F = F(B+C') + C'
F= FB +C'


ab = 00
20ns
ab = 01
20ns
ab = 10
20ns
a
b
a'
2
Inv 2ns
b'
AND 6ns
NAND
5ns
(ab')'
2
2
a'+b
F1
F1
OR 8ns
<-2->
<--5-->
a'b
F2
F2
6ns
6ns
F1+F2
F
F1+F2
<------7------>
<--8-->