DIGITAL DESIGN COEN 312	Lecturer Dr. A. J. Al-Khalili
Answer All Questions. Time Allowed 1 hr. 10min.	Midterm exam. Feb 14th, 2002

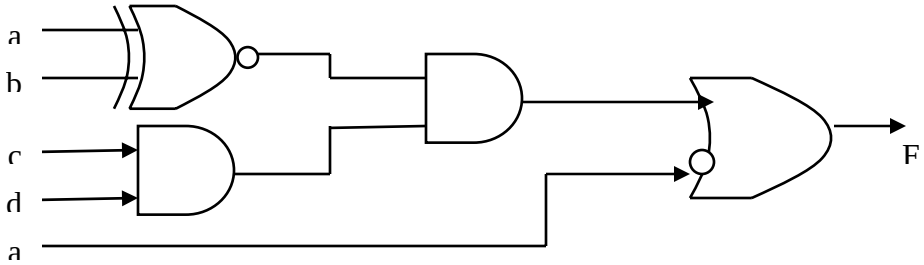
Sample A

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

1.a Simplify to obtain minimum SOP (3 marks)
F(A, B, C, D) = [AB ⊕ C][(AB⊙D)']

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

1.c Minimize the following circuit, draw final minimized circuit with minimum number of packages. You have single rails available to you. (3 marks)



Question 2

2.a Give **minimal SOP** for F(a,b,c,d) given by the following K-map (2 marks)
Identify the prime Implicants clearly.

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

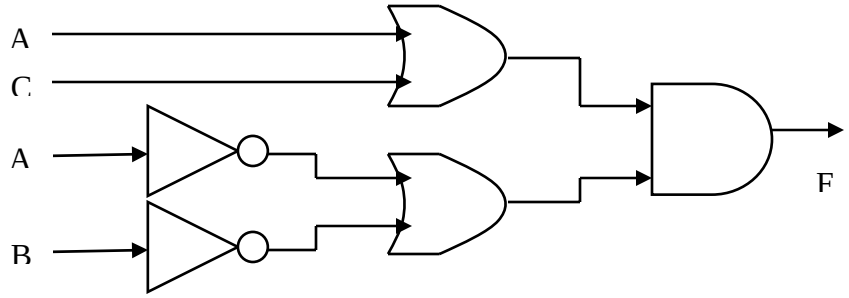
2.b Give minimal POS for F(a,b,c,d) given by the following K-map (3 marks)
Identify the Prime Implicants clearly

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

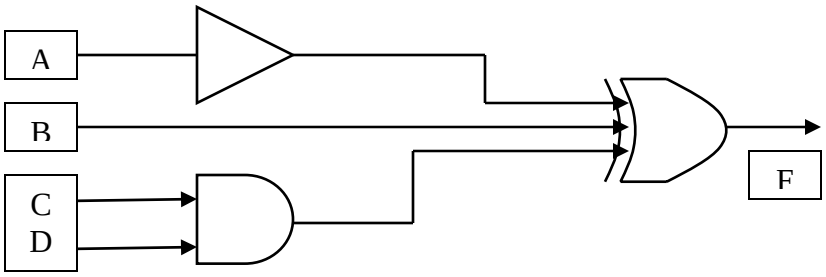
2.c Give the **POS** of F(A,B,C,D) = (AB + BCD)(B +CD) (1 mark)
2.d Give the **minterm list** of F(A,B,C,D) = AB (1 mark)
2.e Give the **NOR-NOR** implementation of F(A,B,C,D) = ABC + CD + CB (2 marks)
2.f Give an all NAND implementation of F(A,B,C,D) = AB (1 mark)

Question 3

3.a Draw the timing diagram for F, for the following consecutive inputs. ABC = 000,100,010, (**follow these vectors in order given. Start from ABC = 000**). Assume all gates have equal delay of 2 ns.



3.b Analyze the following circuit.



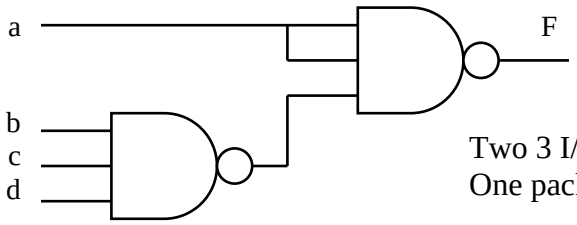
Solutions

Question 1

1.a F(A,B,C,D) = [AB ⊕ C] [AB⊙ D]
= [ABC' + (AB)'C][ABD' + (AB)'D]'
= [ABC' + (A' + B')C][(ABD')'((AB)'D)']
= [ABC' + (A' + B')C][(A' + B' + D)(AB + D')]
= [ABC' + A'C + B'C][A'D' + B'D' + ABD]
= [ABC'D + A'CD' + A'B'CD' + A'B'CD' + B'CD']
= ABC'D + A'CD' + B'CD'

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

1.c F(a,b,c,d) = (a ⊕ b)' (cd) + a'
= (ab + a'b')cd + a'
= abcd + a'b'cd + a'
= abcd + a'
= bcd + a'
= (bcd + a')''
= ((bcd)'.a)'



Two 3 I/P NAND gate
One package

Question 2

2.a

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

= ∑m(4,5,12,13)
= BC'

= ∑m(2,3,10,11)
= B'C

F = BC' + B'C
PI Implicants are BC' & B'C

2.b

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

$= \prod M(8,9,10,11,12,13,14,15)$
$= A'$

$= \prod M(2,3,6,7,10,11,14,15)$
$= C'$

F =C'A'
Both C' & A' are essential PI

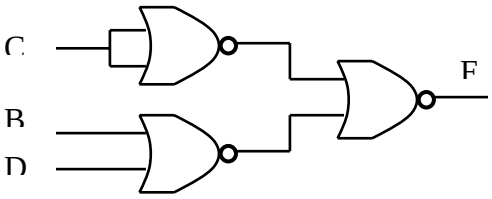
2.c F(A,B,C,D) = (AB + BCD)(B + CD)
= B(A + CD)(B + CD)
= B(A + C)(A + D)(B + C)(B + D)
= B(A + C)(A + D)

2.d F(A,B,C,D) = AB

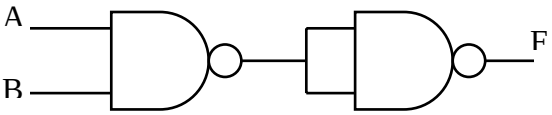
CD \ AB	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	0	0	1	0
10	0	0	1	0

$= \sum m\ (12,13,14,15)$

2.e F(A,B,C,D) = ABC + CD + CB
= CB + CD
= C(B + D)
= [C(B + D)]''
= [C' + (B + D)']'

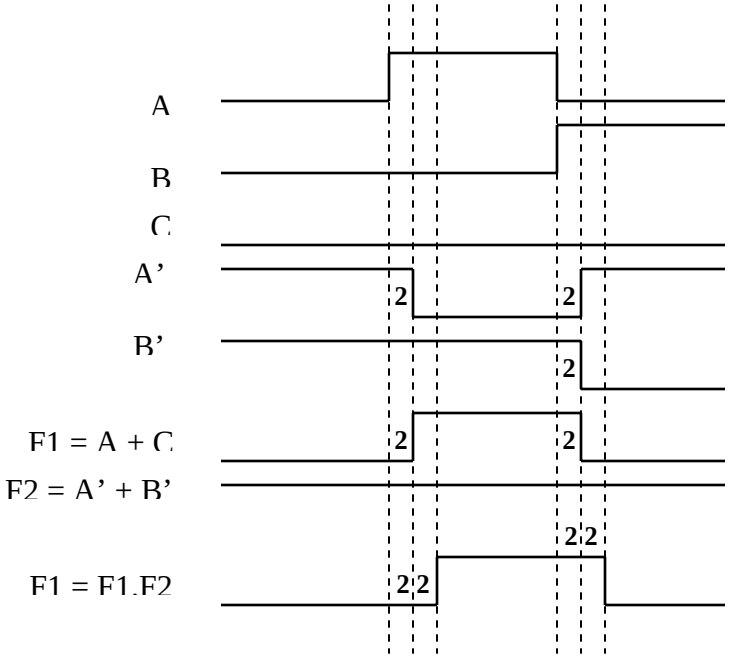


2.f F(A,B,C,D) = AB = (AB)''



Question 3

3.a



3.b

With inverter				With buffer			
A B C D	F1 F2	F	minterm	A B C D	F1 F2	F	minterm
0 0 0 0	1 0	1	0	0 0 0 0	0 0	0	0
0 0 0 1	1 0	1	1	0 0 0 1	0 0	0	1
0 0 1 0	1 0	1	2	0 0 1 0	0 0	0	2
0 0 1 1	1 1	0	3	0 0 1 1	0 1	1	3
0 1 0 0	1 0	0	4	0 1 0 0	0 0	1	4
0 1 0 1	1 0	0	5	0 1 0 1	0 0	1	5
0 1 1 0	1 0	0	6	0 1 1 0	0 0	1	6
0 1 1 1	1 1	1	7	0 1 1 1	0 1	0	7
1 0 0 0	0 0	0	8	1 0 0 0	1 0	1	8
1 0 0 1	0 0	0	9	1 0 0 1	1 0	1	9
1 0 1 0	0 0	0	10	1 0 1 0	1 0	1	10
1 0 1 1	0 1	1	11	1 0 1 1	1 1	0	11
1 1 0 0	0 0	1	12	1 1 0 0	1 0	0	12
1 1 0 1	0 0	1	13	1 1 0 1	1 0	0	13
1 1 1 0	0 0	1	14	1 1 1 0	1 0	0	14
1 1 1 1	0 1	0	15	1 1 1 1	1 1	1	15
F1 = A' F2 = CD F = B ⊕ F1 ⊕ F2				F1 = A F2 = CD F = B ⊕ F1 ⊕ F2			