DIGITAL DESIGN COEN 312		Drs. A. J. Al-Khalili & M. Nekili
Time Allowed 1 hr. 10min.		Feb 17, 2000
Answer All Questions	1 page	No Calculator or other material is allowed

Question 1

a) Using ***Boolean Algebra*** minimize the following functions:
F(A,B,C) = A'B + AB' + AB + A'B' + ABC (2/25)
F(A,B,C,D) = A'C + AB + BC + A'BC'D (2/25)

b) Translate the following **Specification** into a ***Boolean Function***.
A buzzer (Z) is to sound if the key (K) is in the ignition and the door (D) is open, or the key is out of the ignition and brake (B) is off, or if the door is open and the brake is off. All other times the buzzer must be silent.
(2/25)

Question 2

a) Using a **Truth Table or Boolean algebra** show how the following 2-input gates can be configured **as inverters**: NAND gate, NOR gate, XOR gate. (3/25)

b) Realize the following expression with i) **NAND**, ii) **NOR** only, giving circuit diagrams for both cases. Get the **minimal** configuration.
F(A,B,C,D) = A + 0 + C + (D.1.C) (2/25)

c) Give the **minimal POS (Product Of Sums)** of
F(A,B,C,D) = Σ m (0,1,2,3,8,9,10,11) + d (4,6,12,14) (2/25)

d) Plot the following function on the K-Map.
F(A,B,C,D) = [A ⊕ B ⊕ C ⊕ D] + AB (2/25)

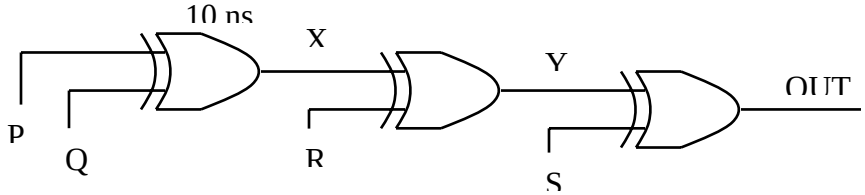
e) Give the **minimal SOP (Sum Of Products)** of the function given by the following
K-map: (2/25)

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

Question3

a) Using Quine-McClusky (QM) method minimize the following function:
F(A,B,C,D) = Σ m (0,2,5,7,8,10,13,15) + d (4,9,11) (4/25)

b) Each XOR gate in the circuit below has a propagation delay tpd of 10 ns. Give a **timing diagram** of X,Y,OUT when the inputs change simultaneously from PQRS = 0000 to PQRS = 1001. (4/25)



Solutions

Question 1

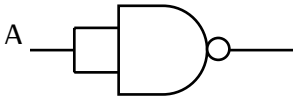
a) F = A'B + AB' + A'B' + ABC
   = A'(B + B') + A(B' + B) + ABC
   = A' + A + ABC
   = 1 + ABC
   = 1

b) F = A'C + AB + BC + A'BC'D
   = A'C + AB + A'BC'D
   = A'(C + C'BD) + AB
   = A'(C + BD) + AB
   = A'C + A'BD + AB
   = A'C + B(A'D + A)
   = A'C + B(D + A)
   = A'C + BD + AB

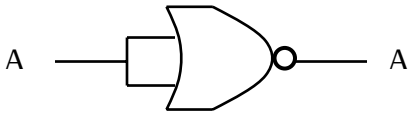
c) buzzer Sounds = Z
   Key is in ignition = K
   Door is open = D
   Brake is off = B
   Z = KD + K'B + DB = KD + K'B

Question 2

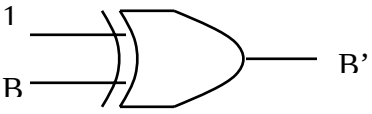
a) Configure NAND, NOR, XOR as inverter
   i) NAND F = (A.B)' let A = B = A F = (A.A)' = A'



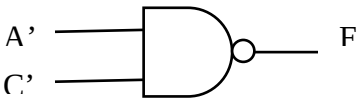
   ii) NOR F = (A + B)' let A = B = A F = (A + A)' = A'



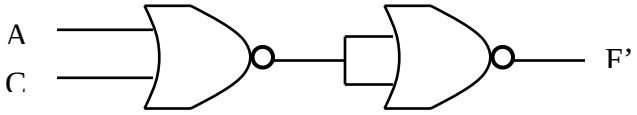
   iii) XOR F = AB' + A'B let A = 1 F = 1.B' + 0.B = B'



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



ii) NOR F = (A + C)''



c) F(A,B,C,D) = Σ m (0,1,2,3,8,9,10,11) + d (4,6,12,14) = B'

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

d) F(A,B,C,D) = [A ⊕ B ⊕ C ⊕ D] + AB

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

e) F = BD + B'D'

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

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Question 3

a)

0	0, 2 (2)	0, 2, 8, 10 (2, 8) c							
	0, 4 (4) a*	8, 9, 10, 11 (1, 2) d							
2	0, 8 (8)	5, 7, 13, 15 (2,8) e							
4	2, 10 (8)	9, 11, 13, 15 (2, 4) f							
8	4, 5 (1) b*		0	2	5	7	8	10	13	15
5	8, 9 (1)	a	1							
9	8, 10 (2)	b			1					
10	5, 7 (2)	c*	1	1			1	1		
	5, 13 (8)	d					1	1		
7	9, 11 (2)	e*			1	1			1	1
11	9, 13 (14)	f							1	1
13	10, 11 (1)									
5	7, 15 (8)	F = c + e = BD + B'D'								
	11, 15 (4)									
	13, 15 (2)									

b) Total delay = 30 ns " PQRS" = 0000 $\rightarrow$1001 Choose period = 40 ns