DIGITAL DESIGN COEN 312	Lecturer Dr. A. J. Al-Khalili
Answer All Questions. Time Allowed 1 hr. 10min.	Midterm exam. Feb 17, 2000

Sample A

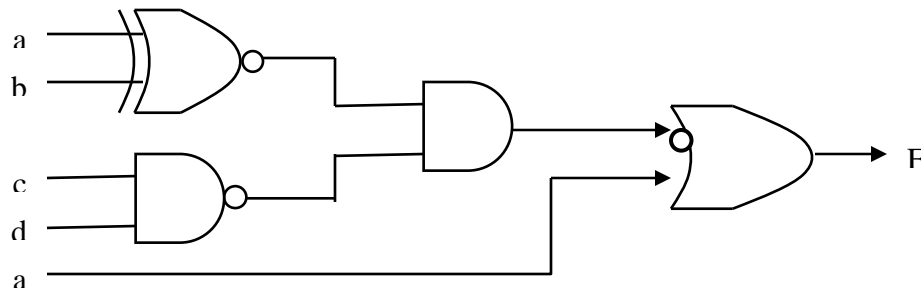Question 1 (**Use Boolean Algebra for Question 1**)

 1.a Simplify to obtain minimum SOP   (2 marks)

  $F(W,X,Y,Z) = [XY \oplus (X + Y')][(W \odot (W + Y)]$

 1.b Simplify to obtain minimum SOP   (2 marks)

  $F(a,b,c,d) = a'b'(c + d')(1 + 0) + ab(c'd + cd') + (a'b + 0)cd$

 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 (3 marks) Identify the prime Implicants clearly.

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

 2.b Give the **POS** of $F(A,B,C,D) = (A + CD)(B + CD)$ (1 mark)

 2.c Give the **miniterm list** of $F(A,B,C,D) = B$ (1 mark)

 2.d Give the minimal **NOR-NOR** implementation of

  $F(A,B,C,D) = ABC + A(D + CB)$ (2 marks)

Question 3

 3.1 a) Minimize $F(W,X,Y,Z) = C + AB' + AC'D$ using **Quine-McClusky's method**

  b) Identify the Essential Prime Implicant (6 marks)

 3.2 Draw the timing diagram for $F(A,B,C) = AB + (A'C)$ for the following consecutive inputs. ABC = 010, 101, 010, 111 (**follow these vectors in order given. Start from ABC = 000**). Assume the following gate delays, AND =3ns, OR gate = 4ns, and inverter = 2ns. (4 marks)

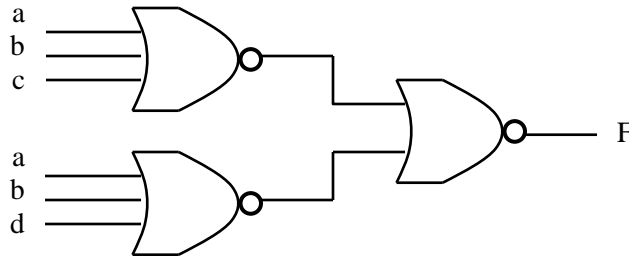## Solutions

Question 1

1.a $F(W,X,Y,Z) = [XY \oplus (X + Y')] [W \odot (W + Y)]$
$= [XY(X + Y')' + (XY)' (X + Y')][W(W + Y) + W'(W + Y)']$
$= [XY(X'Y) + (X' + Y')(X + Y')][W + W'(W'Y')]$
$= [0 + Y' + 0][W + Y']$
$= Y'[W + Y'] = Y'$

1.b $F(a,b,c,d) = a'b'(c + d')(1 + 0) + ab(c'd + cd') + (a'b + 1)cd$
$= a'b'c + a'b'd' + abc'd + abcd' + cd$
$= a'b'c + a'b'd' + abd + abc + cd$

1.c $F = ((a \oplus b)'. (cd)')')' + a$
$= (a \oplus b + cd + a$
$= a + b + cd$
$= ((a + b + c)(a + b + d))''$
$= ((a + b + c)' + (a + b + d)')'$

Question 2

2.a

2.b $F(A,B,C,D) = (A + CD)(B + CD)$
$= (A + C)(A + D)(B + C)(B + D)$

2.c   F(A,B,C,D) = B
      = Σ m (4,5,6,7,12,13,14,15)

AB

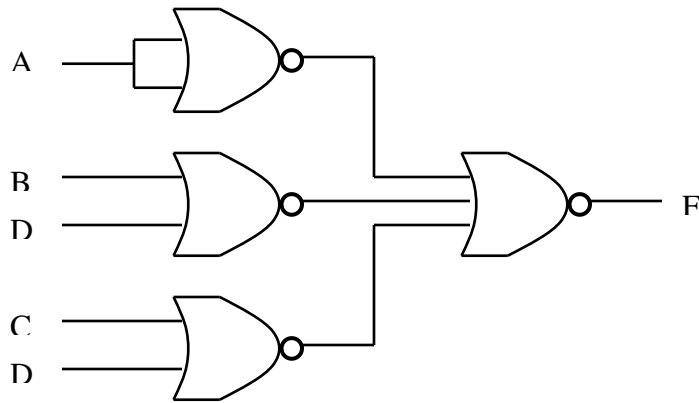| CD	00	01	11	10
00		1	1	
01		1	1	
11		1	1	
10		1	1	

2.d   F(A,B,C,D) = ABC + A(D + CB)
      = ABC + AD + ABC
      = ABC + AD
      = A(BC + D)
      = A(B + D)(C + D)
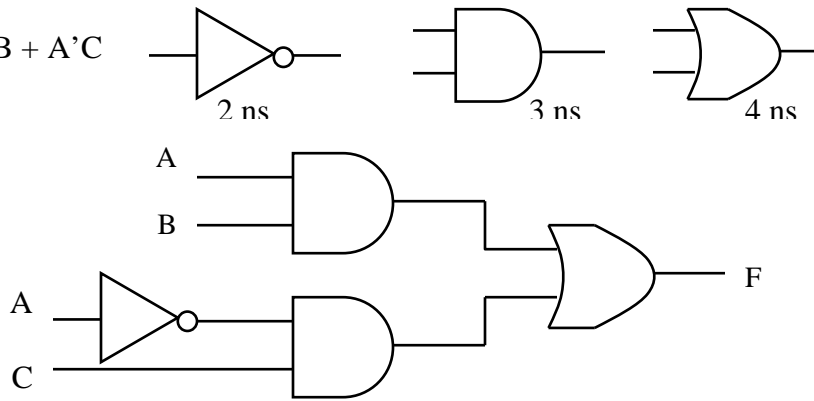

Question 3

3.1 a) F(A,B,C,D) = C + AB' + AC'D
        = ∏ M(0, 1, 4, 5, 12)

AB

CD	00	01	11	10
00	0	0	0	1
01	0	0	1	1
11	1	1	1	1
10	1	1	1	1

0		0, 1, 4, 5 (1,4) *a					
1	0, 1 (1)						
4	0, 4 (4)						
5	1, 5 (4)		0,	1,	4,	5,	12
12	4, 5 (1)						
	4, 12 (8) *b	*a	1	1	1	1	
		*b				1	1
		F = a + b = (A + C)(B' + C + D)					

3.1 b)   Both a and b are essential PI

3.2   F = AB + A'C

2 ns   3 ns   4 ns

Longest delay = 2 + 3 + 4 = 9 ns, take period = 10