Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG115/INFE115 Introduction to Logic Design

EENG211/INFE211 Digital Logic Design I

Spring 2009-10

Instructors:

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Final EXAMINATION

June 08, 2010

Duration : 120 minutes

Number of Problems: 7

Good Luck

STUDENT'S	
NUMBER	
NAME	SOLUTIONS
SURNAME	
GROUP NO	

Problem	Achieved	Maximum
1		10
2		10
3		10
4		10
5		20
6		20
7		20
TOTAL		100

Question 1 (10 points)

A. Converting $(153)_{10}$ to base 8 yields which of the following results?

(a) 107
(b) 132
(c) 701
(d) 231
(e) 153

B. Converting $(0111011.100)_2$ to base 16 yields which of the following results?

(a) 73.8
(b) 3C.4
(c) 3B.8
(d) 73.4
(e) 3B.4

C. 10100 is the two's complement representation of:

(a) -11
(b) +12
(c) -12
(d) -20
(e) +20

D. Simplification of the Boolean expression AB + ABC + ABCD + ABCDE + ABCDEF yields which of the following results?

(a) ABCDEF
(b) AB
(c) AB + CD + EF
(d) A + B + C + D + E + F
(e) A + B(C+D(E+F))

E. Given that F = (A + B'+ C)(D + E), which of the following represents the only correct expression for F'?

(a) F' = A'BC'+ D'+ E'
(b) F' = AB'C + DE
(c) F' = (A'+ B + C')(D'+ E')
(d) F' = A'BC' + D'E'
(e) F' = (A + B'+ C)(D'+ E')

Question 2 (10 points):

A. Identify the function which generates the K-map shown

(a) F(A,B,C)= Σ(1,3,4,7)
(b) F(A,B,C)= Σ (1,3,5,6)
(c) F(A,B,C)= Σ (3,4,5,6)
(d) F(A,B,C)= Π(1,3,4,7)
(e) F(A,B,C)= Π (1,3,5,6)

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

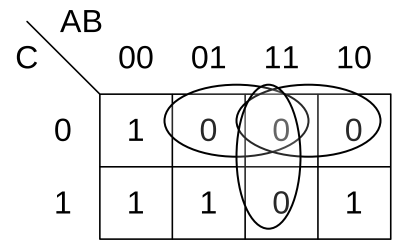
B. Identify the most simple expression from the K-map shown.

(a) F(A,B,C,D)=B'C + AD + CD
(b) F(A,B,C,D)=BC' + BCD' + AC'D'
(c) F(A,B,C,D)=BC' + BCD' + AB'C'D'
(d) F(A,B,C,D)=AD + BCD' + CD
(e) F(A,B,C,D)=BC' + BD' +AC'D'

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

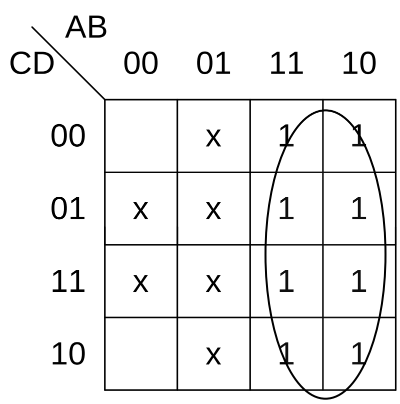
C. Identify the most simple Product of Sums (POS) expression which generates the K-map shown.

(a) F(A,B,C)=(A+C')(A+B+C)
(b) F(A,B,C)=(A+B)(A+C')(B+C')
(c) F(A,B,C)=(A'+B')(A'+C)(B'+C)
(d) F(A,B,C)=(A'+C)(A'+B'+C')
(e) F(A,B,C)=(A+B)(A'+C)(B'+C)



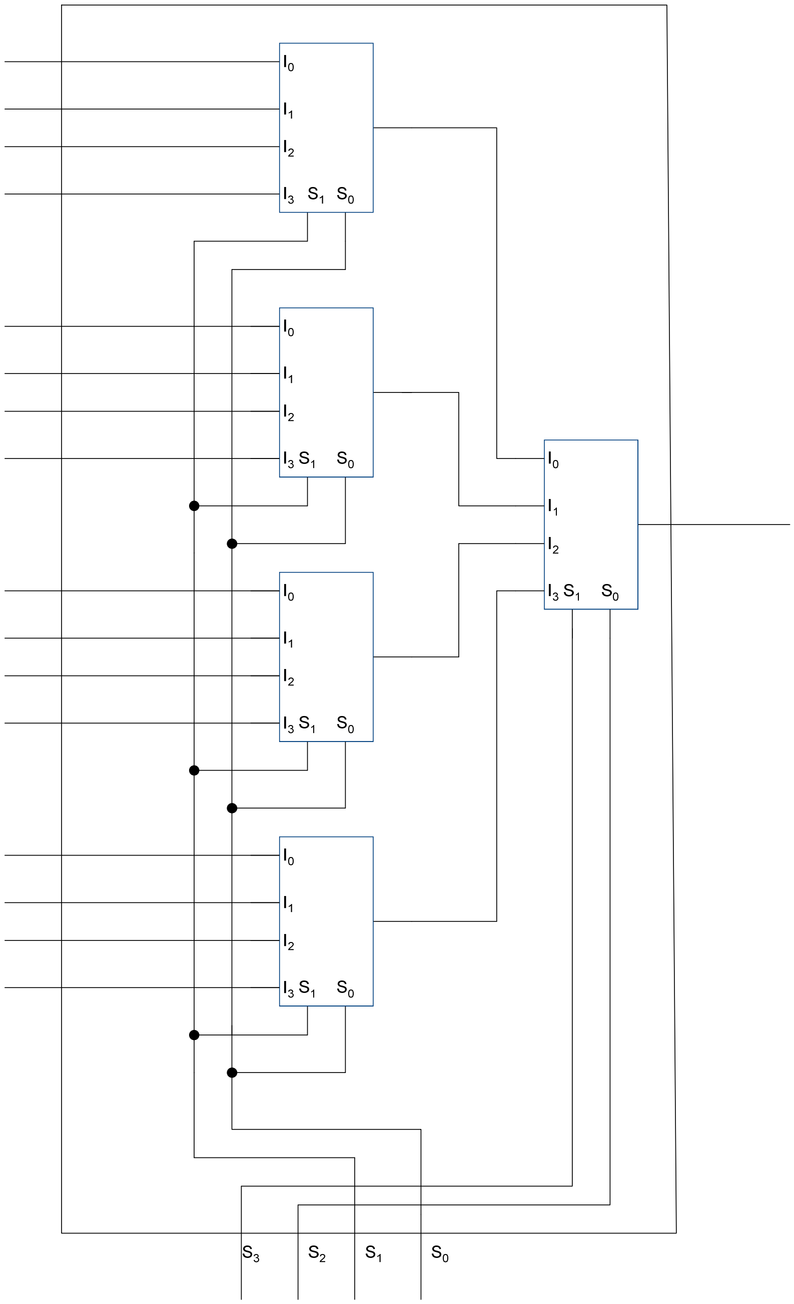
D. The most reduced expression which can be obtained from the K-map illustrated is:

(a) F(A,B,C,D)=A + D
(b) F(A,B,C,D)=C
(c) F(A,B,C,D)=A + B
(d) F(A,B,C,D)=A
(e) F(A,B,C,D)=A + B + D

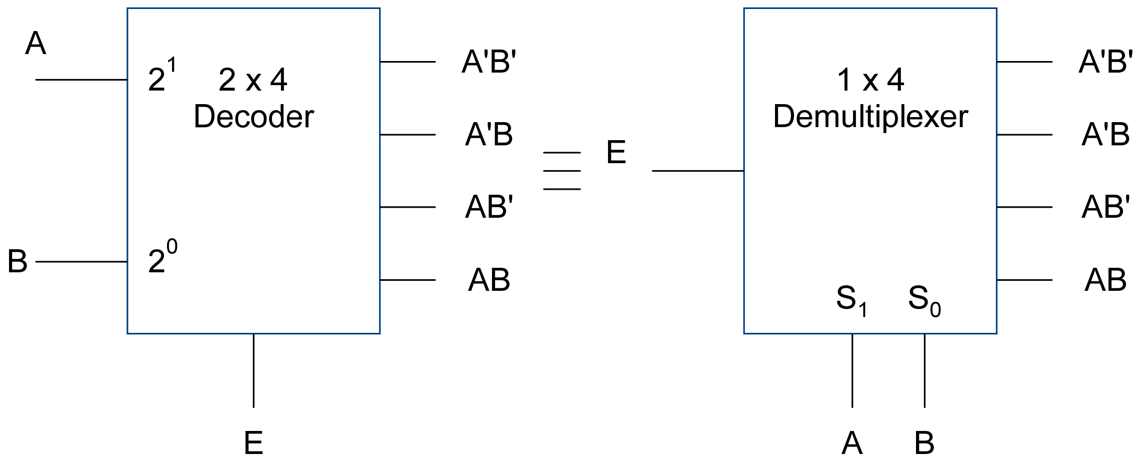


Question 3 (10 points):

a) Construct a 16 X 1 multiplexer by using 5 4x 1 multiplexers. Use block diagrams.



b) Construct a 2-to-4-line decoder by using a 1-to-4 Demultiplexer. Use block diagrams.



Question 4 (10 points):

Implement the following Boolean function with a 4 x 1 multiplexer:

$F(A, B, C, D) = \Sigma\ (0, 1, 3, 4, 8, 9, 15)$

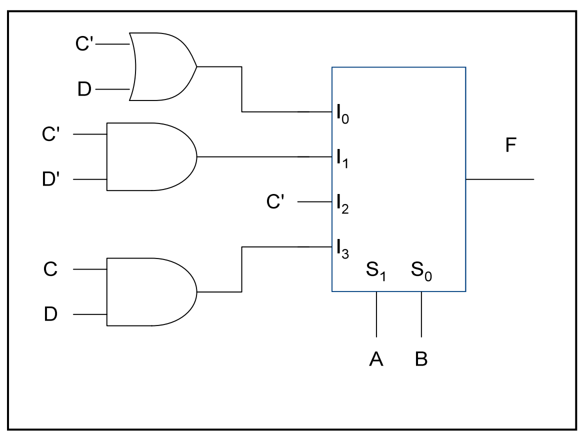
Minterm	A	B	C	D	F
0	0	0	0	0	1
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	1
5	0	1	0	1	0
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	0
14	1	1	1	0	0
15	1	1	1	1	1

$I_0 = C' + D$ (minterms 0–3)

$I_1 = C'D'$ (minterms 4–7)

$I_2 = C'$ (minterms 8–11)

$I_3 = CD$ (minterms 12–15)



Question 5 (20 points):
Design a combinational circuit that converts a 4-bit gray code to a 4-bit binary number. Implement the circuit using exclusive-OR gates.

		Gray Code				BINARY			
Decimal		**A**	**B**	**C**	**D**	**W**	**X**	**Y**	**Z**
0	0000	0	0	0	0	0	0	0	0
1	0001	0	0	0	1	0	0	0	1
2	0011	0	0	1	1	0	0	1	0
3	0010	0	0	1	0	0	0	1	1
4	0110	0	1	1	0	0	1	0	0
5	0111	0	1	1	1	0	1	0	1
6	0101	0	1	0	1	0	1	1	0
7	0100	0	1	0	0	0	1	1	1
8	1100	1	1	0	0	1	0	0	0
9	1101	1	1	0	1	1	0	0	1
10	1111	1	1	1	1	1	0	1	0
11	1110	1	1	1	0	1	0	1	1
12	1010	1	0	1	0	1	1	0	0
13	1011	1	0	1	1	1	1	0	1
14	1001	1	0	0	1	1	1	1	0
15	1000	1	0	0	0	1	1	1	1

W= A

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

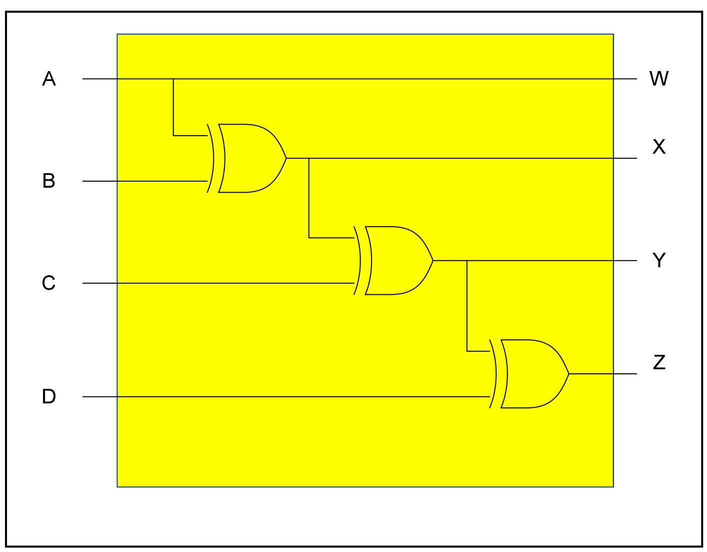
X=A'B+AB'=A ⊕ B

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

Y=A'B'C+A'BC'+ABC+AB'C'=A ⊕B⊕C

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

Z=A ⊕ B⊕C⊕D



Question 6 (20 points):

Derive the state table and the state diagram of the sequential circuit shown in Fig. FQ-6.

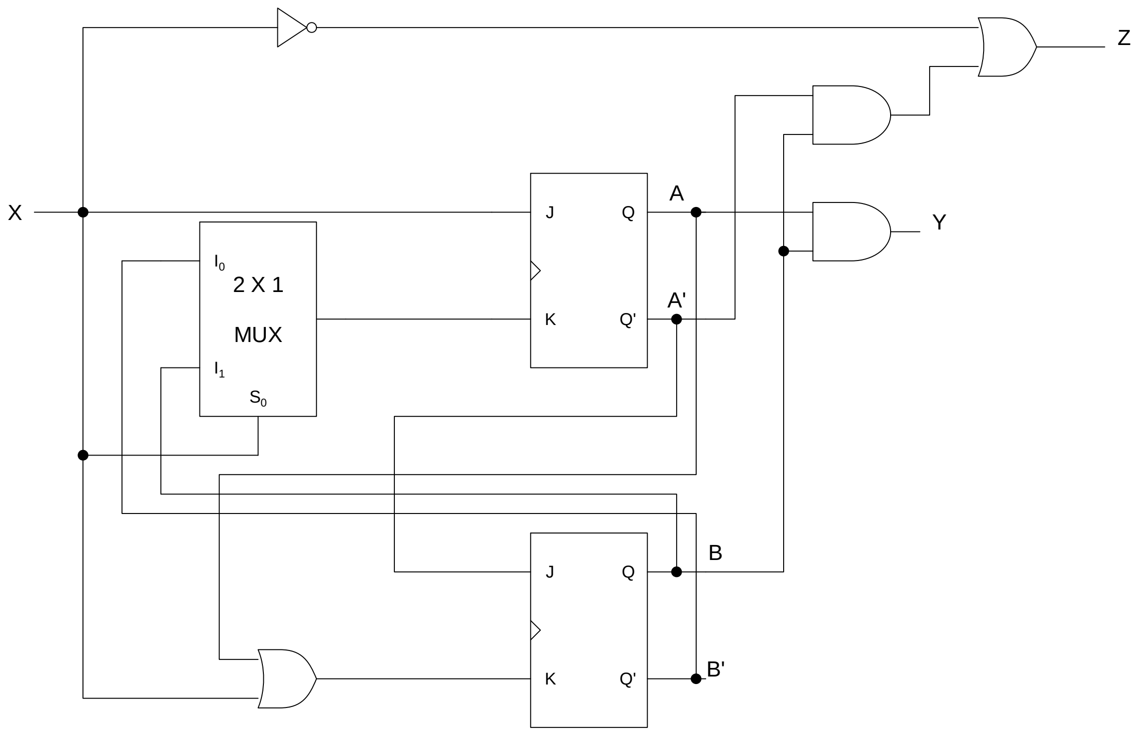
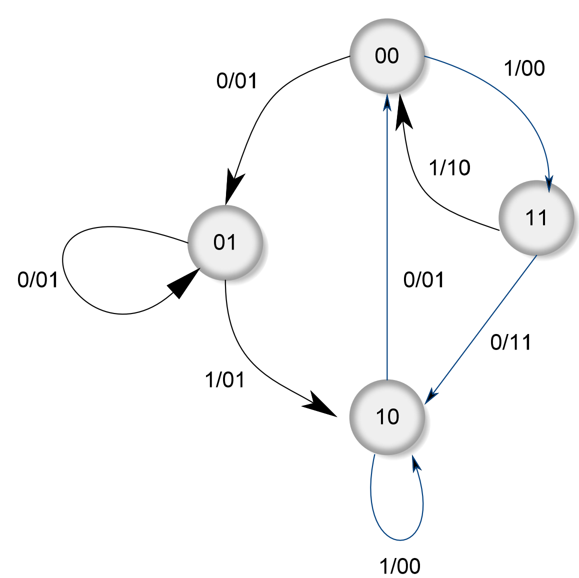


Figure FQ-6

$J_A = x$
$K_A = B'x' + Bx$
$J_B = A'$
$K_B = A + x$
$Y = AB$
$Z = A'B + x'$

Present State		Input	Next State		Output		Flip-flop Input			
A	B	x	A	B	Y	Z	J_A	K_A	J_B	K_B
0	0	0	0	1	0	1	0	1	1	0
0	0	1	1	1	0	0	1	0	1	1
0	1	0	0	1	0	1	0	0	1	0
0	1	1	1	0	0	1	1	1	1	1
1	0	0	0	0	0	1	0	1	0	1
1	0	1	1	0	0	0	1	0	0	1
1	1	0	1	0	1	1	0	0	0	1
1	1	1	0	0	1	0	1	1	0	1



Question 7 (20 points):

Design the sequential circuit specified by the state diagram of Fig. FQ-7 using T flip-flops.

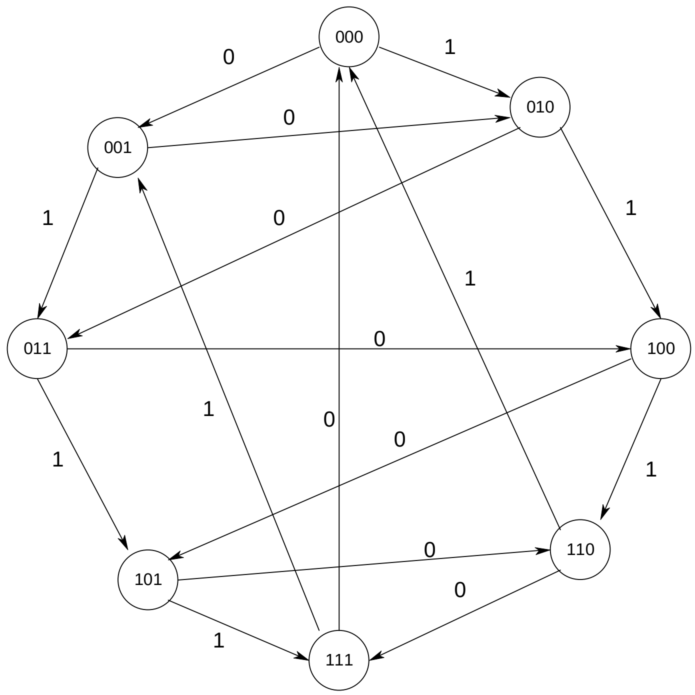
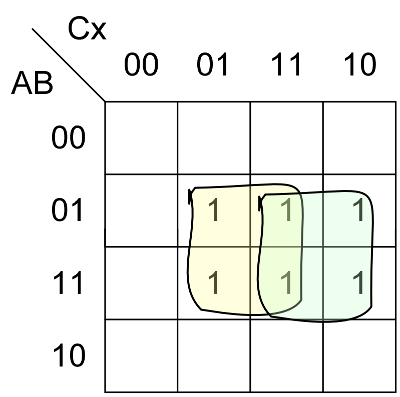


Figure FQ-7

Present State			Input	Next State			Flip-flop Inputs		
A	B	C	x	A	B	C	T_A	T_B	T_C
0	0	0	0	0	0	1	0	0	1
0	0	0	1	0	1	0	0	1	0
0	0	1	0	0	1	0	0	1	1
0	0	1	1	0	1	1	0	1	0
0	1	0	0	0	1	1	0	0	1
0	1	0	1	1	0	0	1	1	0
0	1	1	0	1	0	0	1	1	1
0	1	1	1	1	0	1	1	1	0
1	0	0	0	1	0	1	0	0	1
1	0	0	1	1	1	0	0	1	0
1	0	1	0	1	1	0	0	1	1
1	0	1	1	1	1	1	0	1	0
1	1	0	0	1	1	1	0	0	1
1	1	0	1	0	0	0	1	1	0
1	1	1	0	0	0	0	1	1	1
1	1	1	1	0	0	1	1	1	0

$T_C = x'$



$T_A = Bx + BC = B(x + C)$

AB \ Cx	00	01	11	10
00		1	1	1
01		1	1	1
11		1	1	1
10		1	1	1

$T_A = x + C$