



Faculty of Engineering & Technology – Electrical & Computer Engineering Department

Second Semester 2017

Digital Systems (ENCS234)

Midterm Exam

Allowed Time: 80 minutes

Total Marks: 100

Date: 07/05/2017

Student Name : _____

Student ID : _____

Solution

1/ C
2/ A
3/ B
4/ D
5/ C
6/ E

ABET Outcome	Question #	Full Mark	Student Mark
	Q#1	30	
e	Q#2	30	
	Q#3	15	
c	Q#4	25	
	TOTAL	100	

7/ E
8/ E
9/ A
10/ D
11/ B
12/ A

Note: write your solution on the space provided. If you need more space, write on the back of the sheet containing the question.

C
A
A

10/10/17
10/10/17

Question 1: (30 points, 2 points each). Select the correct answer

1. The magnitude of $(1C.C)_{16}$ is:
 - A. $8 + 12 + 12/16$
 - B. $10 + 12 + 12/16$
 - C. $16 + 12 + 12/16$
 - D. $16^2 + 12 + 12/16$
 - E. This number is wrong because "C" is not a digit.

2. The number $(55)_8$ is equivalent to:
 - A. $(2D)_{16}$
 - B. $(D2)_{16}$
 - C. $(B1)_{16}$
 - D. $(1B)_{16}$
 - E. $(55)_{16}$

3. Converting $(0111011.100)_2$ to base 16 yields which of the following results?
 - A. 3C.4
 - B. 3B.8
 - C. 73.4
 - D. 3B.4
 - E. None of the above

4. To perform $(00100101)_2 - (01000001)_2$ using 2's complement addition:
 - A. The addition will result in a carry = 1, which should be ignored and the answer is positive.
 - B. The addition will result in a carry = 1 and it should be added to the least significant bit.
 - C. The addition will result in a carry = 0 and the answer is positive.
 - D. The addition will result in a carry = 0 and the answer is negative.
 - E. The addition will result in a carry = 1 and the answer is negative.

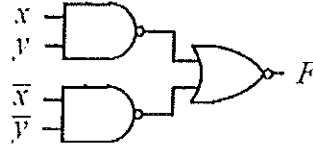
5. Using BCD code, when a computer adds $(0100\ 1001)_2 + (1000\ 0000)_2$ the result of this addition:
 - A. is a correct BCD number.
 - B. must be corrected by adding $(0000\ 0110)_2$.
 - C. must be corrected by adding $(0110\ 0000)_2$.
 - D. must be corrected by adding $(0110\ 0110)_2$.
 - E. is wrong and can't be corrected.

6. The dual of $w(x + x'y) = wx + wy$ is:
 - A. $w + (x + x'y) = (w + x) + (w + y)$
 - B. $w + (x' + xy') = (w + x) + (w + y)$
 - C. $wx(x'y) = (w + x)(w + y)$
 - D. $w + (xx' + y) = (w + x)(w + y)$
 - E. $w + x(x' + y) = (w + x)(w + y)$

7. The Boolean function $F = A \oplus B \oplus C \oplus D = 1$ means:
- A. all inputs are zeros ($A = 0, B = 0, C = 0, D = 0$).
 - B. all inputs are ones ($A = 1, B = 1, C = 1, D = 1$).
 - C. half of the inputs are zeros (for example: $A = 0, B = 0, C = 1, D = 1$).
 - D. one or two or three of the inputs are ones.
 - E. one or three of the inputs are ones.

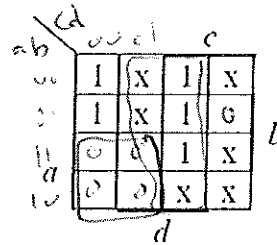
8. In the shown logic circuit:

- A. $F = x \text{ NAND } y$
- B. $F = x \text{ NOR } y$
- C. $F = x \text{ XOR } y$
- D. $F = x \text{ XNOR } y$
- E. $F = 0$



9. The simplified POS Boolean expression for the shown K-map is:

- A. $F = (a' + c)(c' + d)$
- B. $F = (a' + c)(c' + b' + d)$
- C. $F = (a' + c)(c + d')(c' + d)$
- D. $F = (a')(c' + b' + d)$
- E. $F = (a')(c' + d)$



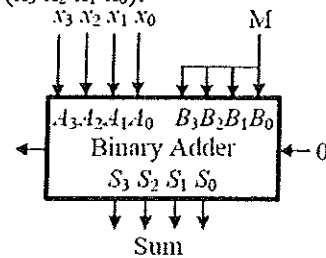
10. Given $F(x, y, z) = \prod(0, 3, 4, 7)$, and G is the complement of F , then:
- A. $G(x, y, z) = \sum(0, 1, 2, 3, 5, 7)$
 - B. $G(x, y, z) = \prod(0, 3, 4, 7)$
 - C. $G(x, y, z) = \sum(1, 2, 5, 6)$
 - D. $G(x, y, z) = \sum(0, 3, 4, 7)$
 - E. None of the above

11. Consider the $F(A, B, C, D) = \sum(0, 1, 2, 3, 7, 8, 9, 10, 12)$ with don't care terms $d(A, B, C, D) = \sum(11, 13, 15)$. List all of the essential prime implicants

- A. B', AD, AC', CD
- B. B', AC', CD
- C. AD, AC', CD
- D. B', AD, CD
- E. B'

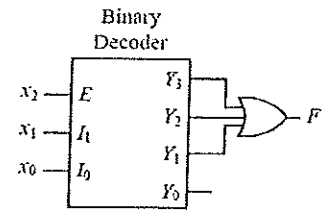
12. In the shown circuit, given "X" is a 4-bit binary number ($x_3 x_2 x_1 x_0$):

- A. Sum = X if $M = 0$, Sum = X - 1 if $M = 1$.
- B. Sum = X - 1 if $M = 0$, Sum = X if $M = 1$.
- C. Sum = X + 1 if $M = 0$, Sum = X - 1 if $M = 1$.
- D. Sum = X - 1 if $M = 0$, Sum = X + 1 if $M = 1$.
- E. Sum = X + 1 if $M = 0$, Sum = X + 2 if $M = 1$.



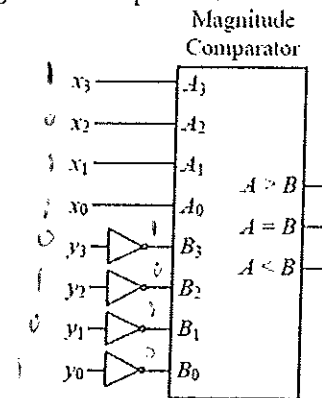
13. In the shown circuit, given "X" is a 3-bit binary number ($x_2 x_1 x_0$):

- A. $F = 1$ when "X" is an odd number.
- B. $F = 1$ when "X" is an even number.
- C.** $F = 1$ when "X" is greater than 4.
- D. when "X" is less than 4.
- E. $F = 1$ when "X" is equal to 0.



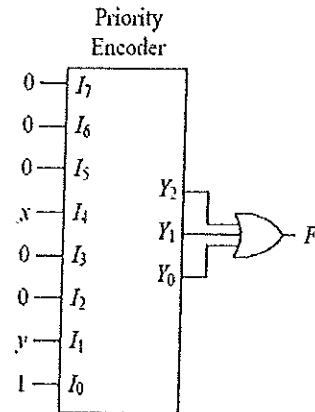
14. In the shown circuit, $X = 1011$ and $Y = 0101$. The magnitude comparator:

- A.** will produce " $A > B$ " = 1.
- B. will produce " $A = B$ " = 1.
- C. will produce " $A < B$ " = 1.
- D. will produce all outputs = 0.
- E. will produce all outputs = 1.



15. The shown priority encoder gives highest priority to I_7 . The output F :

- A.** is = 0 when $x = 0$ and $y = 0$.
- B. is = 0 when $x < y$, i.e. $x = 0$ and $y = 1$.
- C. is = 0 when $x = y = 1$, i.e. $x = 1$ and $y = 1$.
- D. is = 0 when $x > y$, i.e. $x = 1$ and $y = 0$.
- E. is always = 1.



Question 2: (30 points) Given the following function:

$$F(A, B, C, D) = \sum(1, 3, 7, 11, 15) + d(w, x, y, z) = \sum(0, 2, 5)$$

- Implement the function using only one 4-to-1 MUX with minimum number of external gates as needed. Make sure to connect B and D to the selection lines S_1 and S_0 respectively.
- Implement the function using four 2x4 decoders with enable, with any other external gates or circuits as needed.

Handwritten solution for part (a) showing truth tables, Karnaugh maps, and a circuit diagram.

Truth Table:

input				output
A	B	C	D	F
0	0	0	0	X
0	0	0	1	1
0	0	1	0	X
0	0	1	1	1
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

Handwritten notes:

- 10 (circled)
- output (a)
- BD = 00
- BD = 01
- BD = 10
- BD = 11
- 5 (circled)
- 5 (circled)
- $F = A + C$ (written twice)

Karnaugh Maps:

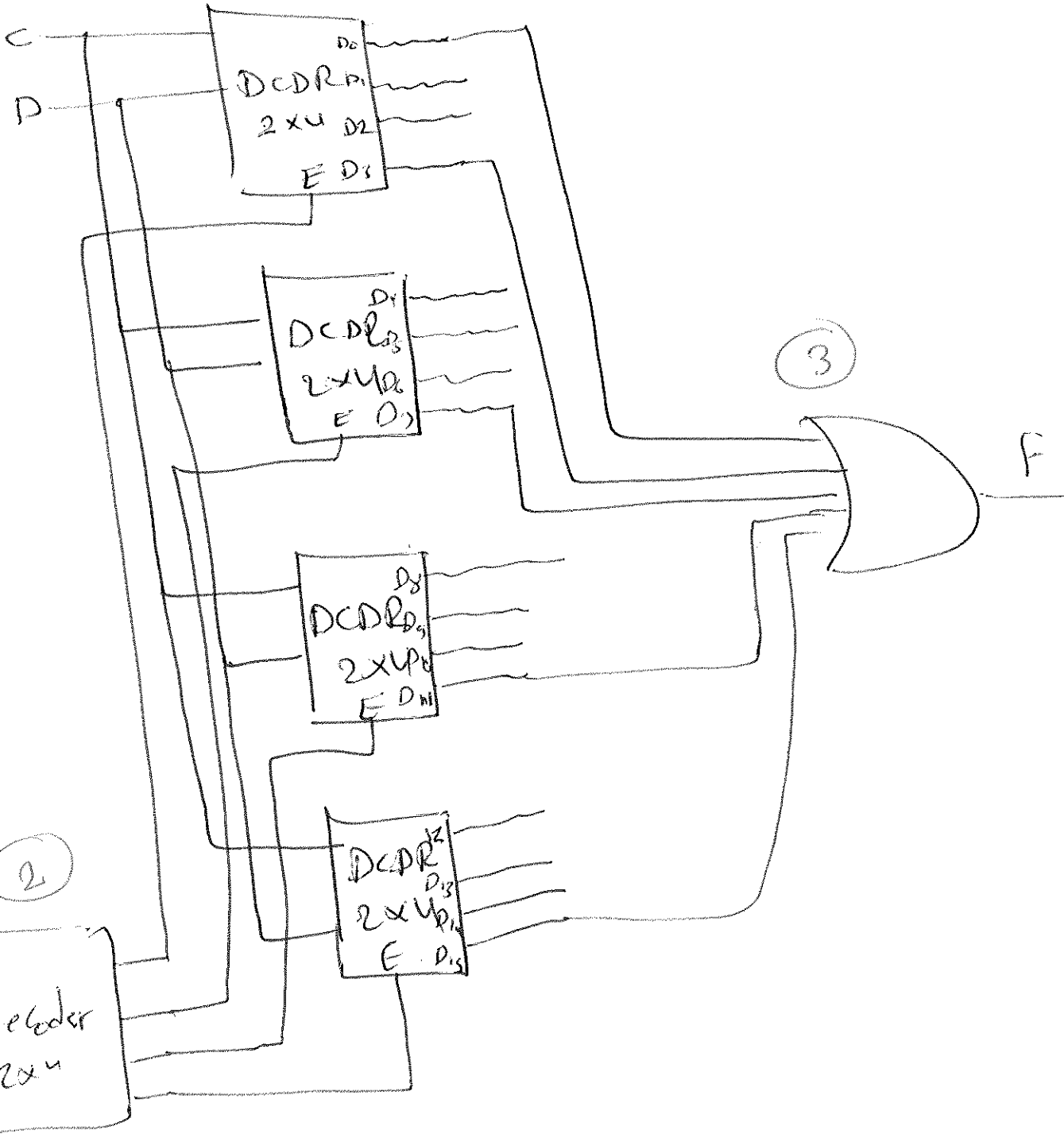
For $BD = 00$ and $BD = 11$, the K-map shows $F = A + C$.

Circuit Diagram:

The circuit diagram shows a 4x1 MUX with data inputs $I_0=0$, $I_1=A'$, $I_2=C'$, and $I_3=0$. The enable inputs are $2'$ and $2''$. The selection inputs are $S_1=B$ and $S_0=D$. The output is F .

b

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Question 3: (15 points)

Simplify using QM Tabulation method the following function $F(A,B,C,D) = \sum(0, 2, 8, 4, 5, 9, 12)$

miniterms

	A	B	C	D	
✓ 0	0	0	0	0	G ₀
✓ 2	0	0	1	0	
✓ 4	0	1	0	0	G ₁
8	1	0	0	0	
✓ 5	0	1	0	1	G ₂
9	1	0	0	1	
✓ 12	1	1	0	0	

miniterms

A	B	C	D	
0	0	-	0	(012) P _{I1}
0	-	0	0	(014) ✓
-	0	0	0	(018) ✓
0	1	0	-	(415) P _{I3}
-	1	0	0	(419) ✓
1	0	0	-	(819) P _{I2}
1	-	0	0	(8112) ✓

miniterm

A	B	C	D	
-	-	0	0	01468125

	0	2	4	5	8	9	12
q P _{I1}	✓ x		✓ x		✓ x		✓ (x)
r P _{I2}					✓ x	✓ (x)	
s P _{I3}			✓ x	✓ (x)			
* P _{I4}	✓ x		✓ (x)				

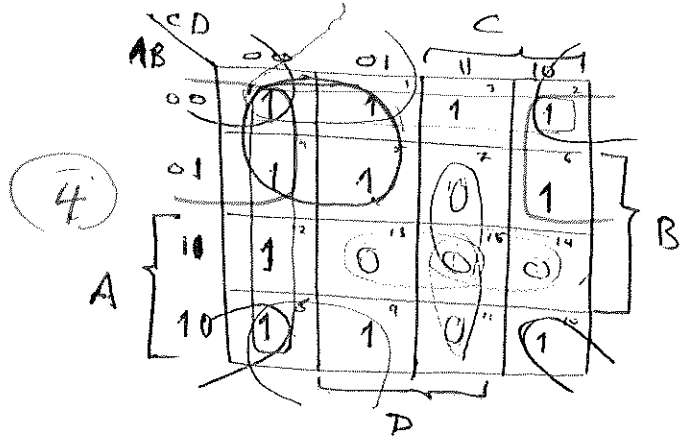
$$F = P_{I1} + P_{I2} + P_{I3} + P_{I4}$$

$$= \bar{c}\bar{d} + A\bar{B}\bar{c} + A\bar{B}c + A\bar{B}d$$

Question 4: (25 points)

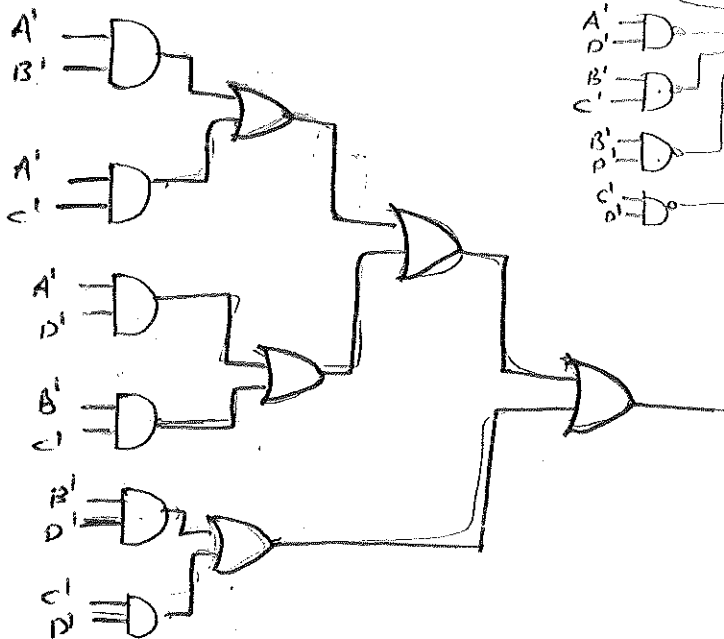
Design a 4-input combinational circuit whose output is equal to 1 if the input variables have more 0's than 1's or number of 1's equal number of 0's. Implement the designed circuit using two inputs NAND gates.

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

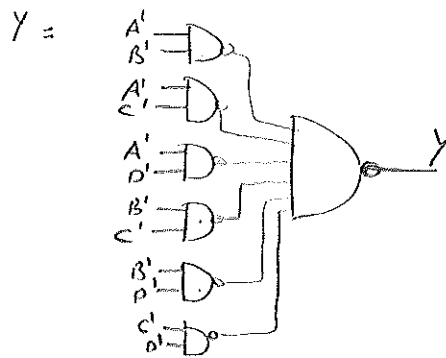


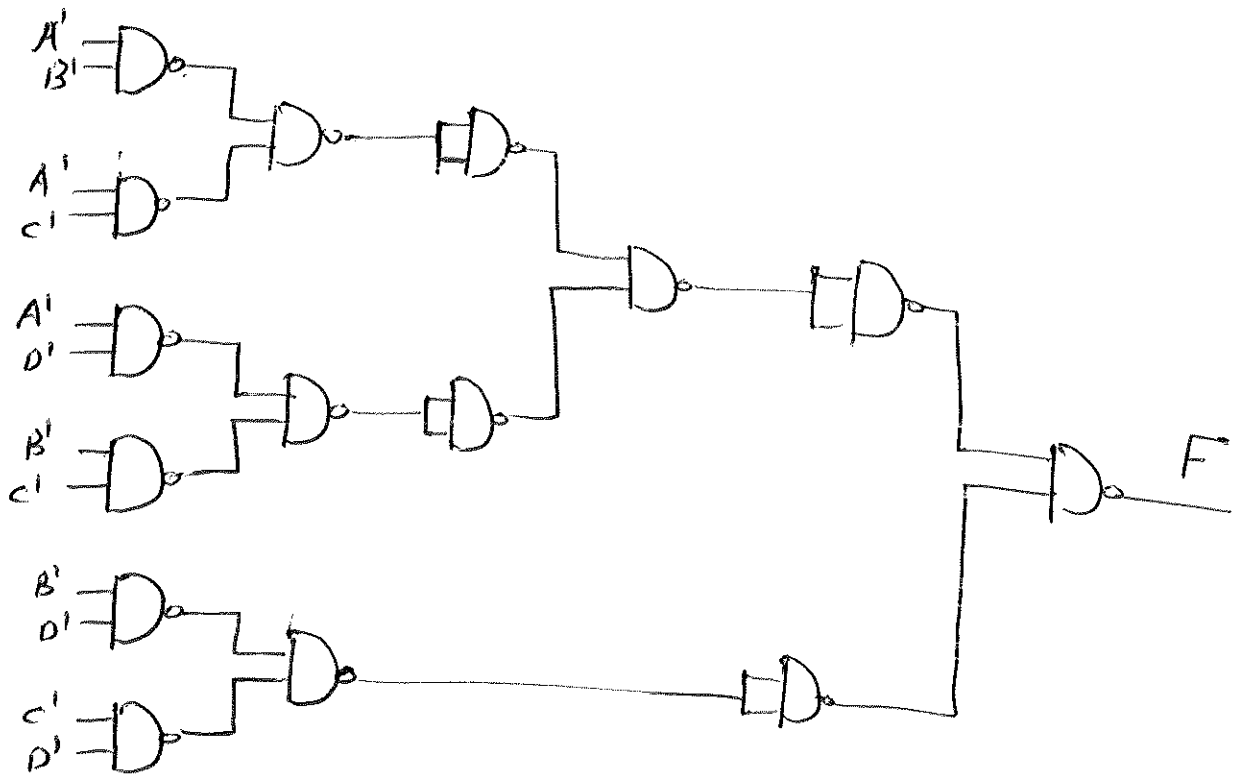
$$Y = \underline{A'B'} + \underline{A'c'} + \underline{A'D'} + \underline{B'c'} + \underline{B'D'} + \underline{c'D'}$$

(7)



AND-OR





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