KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

COE-202 – Fundamentals of Computer Engineering
Nov 25th, 2008 – Major Exam #1

Student Name:
Student Number:
Exam Time: 90 mins

- Do not open the exam book until instructed
- The use of programmable calculators and cell phone calculators is not allowed – only basic calculators are permitted
- Answer all questions
- All steps must be shown
- Any assumptions made must be clearly stated

Question No.	Max Points	
1	60	
2	20	
3	40	
4	40	
Total:	160	

Q.1) (60 points) Mark the following statements with either TRUE (T) or FALSE (F)

1	Transmission of decimal signals compared to binary signals has more resolution and therefore more reliable.	**F**
2	The quantity r^n where is $r = 16$ and $n = 4$ is equal to $(10000)_H$.	**T**
3	For any value of X, $X.\overline{X}$ is always equal to 1.	**F**
4	The distributive property for the AND operation means that $X(YZ) = (XY)Z$.	**F**
5	The expression $X + \overline{X}Y$ s equal to $X + \overline{Y}$.	**F**
6	V_{IL} is defined as the maximum input voltage level for Logic 1.	**F**
7	For a logic gate, the maximum tolerable noise margin for logic 0 is estimated by V_{IL} - V_{OL}.	**T**
8	If the Boolean function $F(X,Y,Z)$ that is equal to $\sum m(0,2,5,7)$, then its complement is equal to $\prod M(0,2,5,7)$.	**T**
9	Higher performance computing systems require gates with higher propagation delays.	**F**
10	More fanin for CMOS gates typically mean larger propagation delays.	**T**
11	Outputs of tri-state gates can be connected together.	**T**
12	The number $(185)_{10}$ is equal to (0001 1000 0101) in BCD while it is equal to (1011 1001) in binary.	**T**
13	Odd and even parity are used for signed number representations.	**F**
14	Grey coding is used for error control (detection and correction).	**F**
15	Unicode is a 16-bit character code that accommodates characters of various languages of the world.	**T**
16	V_{OH} is defined as the minimum output voltage that considered a Logic 1.	**T**
17	The propagation or speed limit of a gate is a function of electrical current drawn from the gate for both the TTL and CMOS technologies.	**F**
18	ASCII codes contain printable and non-printable (control) characters.	**T**
19	For *n*-bit binary integer representation using signed magnitude system, the minimum integer is negative $(2^{n-1} - 1)$.	**T**

20	V_{IH} must be higher than V_{OH} to guard against noise signals.	**F**
21	CMOS gates typically have lower number of inputs (fanin) compared to the corresponding gate from the TTL family.	**T**
22	An overflow condition occurs in 2's complement arithmetic if the carry into the sign bit and the carry out of the sign bit are different.	**T**
23	For a general unsigned number of *n* integer digits and *m* fraction digits in base *r*, the smallest number is r^n-r^{-m}.	**F**
24	The Boolean expression A+BC is equal to (A+B)(A+C) always.	**T**
25	The consensus theorem for three variables states that XY + X'Z + YZ = XY + X'Z.	**T**
26	The sum of minterms expression is a special case from the sum of the products form for any Boolean function.	**T**
27	For any *n*-input function, total number of minterns or maxterms is given by 2^{n-1}.	**F**
28	The Boolean function $f(x,y) = \sum m(0,3)$ can simplified to a one product form.	**F**
29	For an *n*-input variables Boolean function, the maxterm is a sum term.	**F**
30	Prime implicants are product terms that may or may not be included in the final simplified expression for the Boolean function.	**T**

Q.2) (20 points) Indicate *clearly* the best possible answer

1) Converting $(153)_{10}$ to base 8 yields which of the following results?
   a. 107
   b. 132
   c. 701
   d. 231
   e. 153

2) Converting $(1010111)_2$ to base 8 yields which of the following results?
   a. 531
   b. 721
   c. 44
   d. 135
   e. 127

3) Converting $(11011.01)_2$ to base 8 yields which of the following results?
   a. 33.2
   b. 63.2
   c. 63.1
   d. 33.1
   e. 63.01

4) Converting $(0.375)_{10}$ to base 2 yields which of the following results?
   a. .1011
   b. .110
   c. .1101
   d. .011
   e. .110111111

5) For n = 5, 10111 is the two's complement representation of:
   a. -23
   b. -9
   c. -7
   d. +22
   e. +7

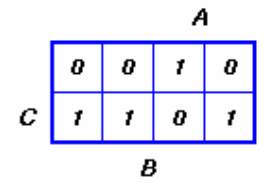
6) For n = 5, 00111 is the two's complement representation of:
   a. -23
   b. -9
   c. -7
   d. +22
   e. +7

7) For n = 5, 10100 is the two's complement representation of:
   a. -11
   b. +12
   c. -12
   d. -20

e. +20

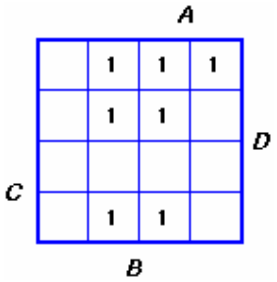
8) Identify the function which generates the K-map shown – Assume the order of the variables in the linear truth table is A (Most significant), B, and C (Least Significant):

a. F= Sum m(1,3,4,7)
b. F= Sum m(1,3,5,6)
c. F= Sum m(3,4,5,6)
d. F= Prd M(1,3,4,7)
e. F= Prd M(1,3,5,6)



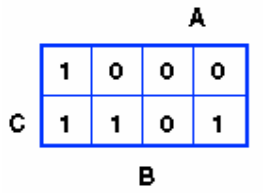
9) Identify the most simple SOP expression from the K-map shown.

a. B'C + AD + CD
b. BC' + BCD' + AC'D'
c. BC' + BCD' + AB'C'D'
d. AD + BCD' + CD
e. BC' + BD' +AC'D'



10) Identify the simplest POS expression which generates the K-map shown.

a. (A+C')(A+B+C)
b. (A+B)(A+C')(B+C')
c. (A'+B')(A'+C)(B'+C)
d. (A'+C)(A'+B'+C')
e. (A+B)(A'+C)(B'+C)



Q3) (40 points) A simple machine uses 3 hex digits to represent numbers. Let the used format be $A = A_1A_0.A_{-1}$.

a) (10 points) How many different representations or numbers does this machine have?

b) (5 points) Assuming a signed 16-complement system, what are the minimum negative number and maximum positive number the machine can handle?

c) (5 points) What does $(FF.F)_{16}$ correspond to?

d) (5 points) Assuming a signed 15-complement system, what are the minimum negative number and maximum positive number the machine can handle?

e) (5 points) What does $(FF.F)_{16}$ correspond to?

d) (10 points) Using 16-complement system, what is the result of $(F.5)_{16} – (1A.3)_{16}$?

a) There are 16x16x16 = 4096 distinct number representations.

b) The representations range from $(00.0)_{16}$ to $(FF.F)_{16}$ – n = 2, m = 1

For 16-complement system – $M = R^n = (100)_{16}$

➔ maximum +ve number is $(7F.F)_{16}$ which corresponds to $(127.9375)_{10}$

➔ mimimum –ve number is $(80.0)_{16}$ which corresponds to the negative of M-$(80.0)_{16}$ or -$(80.0)_{16}$ = $(-128.0)_{10}$

c) Note that $(FF.F)_{16}$ corresponds to the negative of M – $(FF.F)_{16}$ = - $(00.1)_{16}$ = $(- 0.0625)_{10}$

d) For 15-complement system – $M = R^n – R^{-m} = (FF.F)_{16}$

➔ maximum +ve number is $(7F.F)_{16}$ which corresponds to $(127.9375)_{10}$

➔ mimimum –ve number is $(80.0)_{16}$ which corresponds to the negative of M-$(80.0)_{16}$ or -$(7F.F)_{16}$ = $(-127.9375)_{10}$

e) Note that $(FF.F)_{16}$ corresponds to the negative of M – (FF.F)16 = - $(00.0)_{16}$ = $(- 0)_{10}$

d) Using 16-complement system:

$(F.5)_{16}$ = $(0F.5)_{16}$ = $(15.3125)_{10}$

-$(1A.3)_{16}$ = $(E5.D)_{16}$ = $(-26.1875)_{10}$

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  0F.5
  E5.D
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Sum: F5.2

No end carry → result is correct

Check (F5.2) is the negative of M – $(F5.2)_{16}$ = - $(A.3)_{16}$ = $(-10.1875)_{10}$

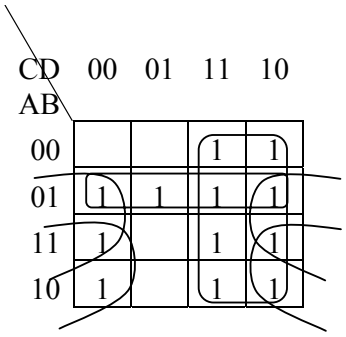
Q.4) (40 points) Simplify the following Boolean function F

$$F(A,B,C,D) = \sum m(2,3,4,5,6,7,8,10,11,12,14,15)$$

a) **Plot the K-map for this function**
b) **Find all prime implications and essential prime implicants**
c) **Write all possible simplified SOP expressions for F(A,B,C,D)**
d) **Simplify F in the form of POS**

Solution:

a) K-map as shown in table



b) Prime implicants: C , $\overline{A}B$, $A\overline{D}$, $B\overline{D}$

Essential Prime implicants: C , $A\overline{D}$, $\overline{A}B$

c) One possible simplified expression: $F(A,B,C,D) = C + A\overline{D} + \overline{A}B$

d) Using the K-map for F and grouping the zeros,

F'(A, B, C, D) = AC'D + A'B'C', or

F(A, B, C, D) = (A'+C+D')(A+B+C)