King Fahd University of Petroleum and Minerals
College of Computer Science and Engineering
Computer Engineering Department

COE 202: Digital Logic Design (3-0-3)
Term 162 (Winter 2016)
Major Exam 1
Saturday, March 11th, 2017

Time: 90 minutes, Total Pages: 6

Name:_____ **ID:**_____ **Section:** _____

Notes:
Do not open the exam book until instructed
Calculators are not allowed (*basic, advanced, cell phones, etc*.)
Answer all questions
All steps must be shown
Any assumptions made must be clearly stated

Question	Maximum Points	Your Points
1	**12**	
2	**17**	
3	**19**	
Total	**48**	

Key

Question 1: <u>Fill in the Spaces</u>: (Show all work needed to obtain your answer) [14 marks]

1. The decimal number 15 is represented in **BCD** as **0001_0101** (Fill in the space). **(1 Point)**

2. Given $F(A,B,C) = \sum \boldsymbol{m}\,(0,3,5,7)$ and $G(A,B,C) = \prod \boldsymbol{M}\,(1,2,4,7)$, then
   $\bar{G} + F = \sum m\,$ (**0, 1, 2, 3, 4, 5, 7**) (write $\bar{G} + F$ as a sum-of-minterms) **(2 Points)**

3. The data **001010** (which contains **<u>EVEN</u>** parity for error detection) was sent **<u>four</u>** times. The received data (for these 4 times) are shown below from **a** to **d**, circle **<u>ALL</u>** the data that the receiver **can't detect** as being wrong: **(2 Point)**

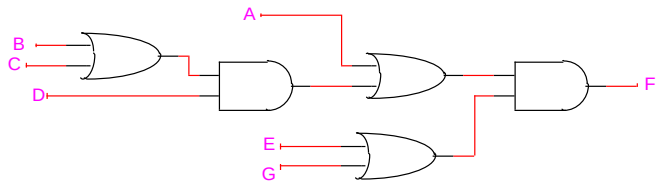
   a) 101010 **b) 001011** **C) 110011** **d) 000000**

4. What is the minimum number of bits required to represent the **360** Latitudes? **9-bits** . The number of unused codes will be **152** (Fill in the spaces) **(2 Point)**

5. Given that $(521)_X = (337)_{10}$, then the Base **X** is (circle one): **(2 Point)**

   a) 4 **b) 16** **C) 8** **d) 6**

6. For the Logic Diagram Below:



a) The logic function F = ((B+C)D+A)(E+G) (as in the logic diagram without any re-arrangement) **(1 Point)**

b) This circuit has **4** number of logic levels (Fill in the space) **(1 Point)**

c) Assuming that all gates have a delay of 1 (each), then the longest path's (i.e. critical path) delay = **4** **(1 Point)**

Question 2. **(17 Points)**

1. Convert the following numbers from the given base to the other uncrossed bases listed in the table (**if needed**, express fractions up to **4 bits** only). Show your solution steps below the table. **(11 Points)**

Decimal	Binary	Octal	Hexadecimal	BCD
105.25	**1101001.01**	**151.2**		
	11010.001	**32.1**	**1A.2**	
99.625	**1100011.101**	**143.5**	**63.A**	
96	**1100000**			10010110

2) Perform the following arithmetic operations in the specified number system. **(6 Points)**

Hexadecimal Addition	Binary Subtraction	Binary Multiplication
B3 + 9A ---------- **14D**	100001 - 010011 ---------- **1110**	1101 × 0101 ---------- 1101 1101 ---------- **1000001**

Question 3. **(19 Points)**

1. Using Boolean Algebraic manipulations, **minimize** the following two functions to **minimum** number of literals in **sum of products** representation (**show your work clearly step by step**):

a) $F = B\,\bar{C} + \bar{A}\,D + A\,C + A\bar{B}\bar{C}$ **(4 Points)**

= C'(B+A~~B'~~) + A'D + AC = BC' + AC' + A'D + AC = A(~~C' + C~~) + BC' + A'D
= A + ~~A'~~D + BC' = A+ D + BC'

b) $F = (A + B)(\bar{A} + BC) + A\,C$ **(4 Points)**

= ~~AA'~~ +A'B + ABC + ~~B~~BC + AC = AC(1+B) + BC + A'B = AC + BC +A'B
= AC + A'B (by consensus)

2. Find the **complement** of the following function F without performing any simplification : **(2 Points)**

$F = (A + B\bar{C})(\bar{A} + BCD) + \overline{A\,C}$
= [A'(B' + C) + A(B' + C' + D')]AC

3. Given the function F(A,B,C) represented in the given truth table: **(4 Points)**
   a) Express **F** in **algebraic form** as a **sum-of-minterms. (2 Points)**
   b) Express **F** in **algebraic form** as a **product of maxterms**. **(2 Points)**

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

a) F(A,B,C) = A'B'C' + A'B'C + AB'C' + ABC'

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

4. Using **Canonical forms**, determine whether the following two functions are equivalent or not: **(5 Points)**

$$F_1(A, B, C) = \bar{A}\,\bar{B} + A\,B\,\bar{C}$$

$$F_2(A, B, C) = (A + \bar{B})(\bar{A} + B)(\bar{B} + \bar{C})$$

F1: A' B' -> 00- => m0, m1; A B C' => m6
Thus F1 = ∑m(0, 1, 6)

F2: (A + B') => 01- => M2, M3
(A' + B) => 10- => M4, M5
(B' + C') => -11 => M3, M7

Thus, F2 = ∏M(2, 3, 4, 5, 7) = ∑m(0, 1, 6)

Thus, F1 = F2 since they have the same set of minterms.