***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

**Key**

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

**Question 1: Fill in the Spaces: (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 $F(A,B,C)=\sum\_{}^{}m\left(0,3,5,7\right)$ and $ G\left(A,B,C\right)=\prod\_{}^{}M\left(1,2,4,7\right), $ then

$\overbar{G}$ $+ F=\sum\_{}^{}m($**0, 1, 2, 3, 4, 5, 7**) (write $\overbar{G}$ $+ F$ as a sum-of-minterms)**(2 Points)**

1. The data **001010** (which contains **EVEN** parity for error detection) was sent **four** times. The received data (for these 4 times) are shown below from **a** to **d**, circle **ALL** the data that the receiver **can’t detect** as being wrong: **(2 Point)**
2. **101010 b) 001011 C) 110011 d) 000000**
3. 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)**
4. Given that (521)**X** = (337)**10**, then the Base **X** is (circle one): **(2 Point)**
5. **4 b) 16 C) 8 d) 6**
6. **For the Logic Diagram Below:
7. **The logic function F = ((B+C)D+A)(E+G)** (as in the logic diagram without anyre-arrangement) **(1 Point)**
8. This circuit has **4**  number of logic levels (Fill in the space) **(1 Point)**
9. 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)**

|  |  |  |
| --- | --- | --- |
| HexadecimalAddition B3+ 9A--------------- **14D** | BinarySubtraction 100001- 010011------------------ **1110** | Binary Multiplication 1101× 0101---------------- 11011101 --------------- **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**):
2. $F=B \overbar{C}+ \overbar{A} D+A C + A\overbar{B}\overbar{C}$**(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’**

1. $F=\left(A+B\right)\left(\overbar{A}+BC\right)+ A C$ **(4 Points)**

**= ~~AA’~~ +A’B + ABC + ~~B~~BC + AC = AC(1+B) + BC + A’B = AC + BC +A’B**

**= AC + A’B (by consensus)**

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

$$F=\left(A+B\overbar{C}\right)\left(\overbar{A}+BCD\right)+ \overbar{A C}$$

 **= [A’(B’ + C) + A(B’ + C’ + D’)]AC**

1. Given the function F(A,B,C) represented in the given truth table: **(4 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 |

1. Express **F** in **algebraic form** as a **sum-of-minterms. (2 Points)**
2. Express **F** in **algebraic form** as a **product of maxterms***.* **(2 Points)**
3. **F(A,B,C) = A’B’C’ + A’B’C + AB’C’ + ABC’**
4. **F(A,B,C) = (A + B’ +C) (A + B’+ C’) (A’ + B + C’) (A’+ B’ + C’)**
5. Using **Canonical forms**, determine whether the following two functions are equivalent or not: **(5 Points)**

 $F\_{1}\left(A, B, C\right)=\overbar{A} \overbar{B} + A B \overbar{C }$

$$F\_{2}(A, B, C)=(A+\overbar{B})(\overbar{A}+ B)(\overbar{B}+\overbar{C})$$

 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.