***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 121 (Fall 2012)**

**Major Exam 1**

**Thursday Oct. 4, 2012**

**Time: 90 minutes, Total Pages: 8**

**Name:\_KEY\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 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** | **16** |  |
| **2** | **12** |  |
| **3** | **12** |  |
| **4** | **15** |  |
| **5** | **19** |  |
| **Total** | **74** |  |

**Question 1. (16 points)**

Convert the following numbers from the given base to the other uncrossed bases listed in the table (if needed, express **fractions** up to **3 digits** only). **Show your solution steps** below the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Decimal** | **Binary** | **Octal** | **Hexadecimal** | **BCD****(8421)** |
| 123.375 | 1111011.011 | 173.3 |  | 0001 0010 0011.0011 0111 0101 |
| 85.875 | 01 010 101.1110 | 125.70 | 55.E |  |
|  | 101**010**111**111**.**110**111**100** | 5277.674 | ABF.DE |  |

**Question 2. (12 points)**

Perform the following arithmetic operations in the specified number system **without changing its base**.

|  |  |  |  |
| --- | --- | --- | --- |
| BinaryAddition 1111 111 01111+ 00001001  **11111000** | Binary Multiplication 1110 × 0110 10000 11110 11110 0000 **1010100** | Octal Subtraction 168  ~~27~~07 - 1713 **0774**  | Hexadecimal Addition 1 829A  + 6C73  **EF0D** |

**Question 3. (12 points)**

1. Given the function :
2. **(3 points)** Draw the logic implementation of the function *F* (*use F as is,* ***do not simplify***).



1. **(5 points)** *Using* ***Algebraic manipulation***, simplify the function *F* to **five** literals.



1. **(4 points)** Provide a simplified sum-of-product (SOP) expression for the **complement** of the function:









**Question 4. (15 points)**

1. Given the Boolean functions $F\left(A, B,C\right)=\sum\_{}^{}m\left(0, 2, 4, 7\right)$ and $G\left(A, B,C\right)=\prod\_{}^{}M\left(0, 3, 5, 6\right)$.
	1. **(2 points)** Give the ***algebraic*** **sum of minterms** expression for *F*.

$$F=\overbar{A} \overbar{B} \overbar{C}+\overbar{A} B \overbar{C}+A \overbar{B} \overbar{C}+A B C$$

* 1. **(2 points)** Express the function *G* as a **sum of minterms**, $G=\sum\_{}^{}m\left(…\right)$

$$G=\sum\_{}^{}m\left(1, 2, 4, 7\right)$$

* 1. **(3 points)** Express the function *F.G* as a **sum of minterms**, $F.G=\sum\_{}^{}m\left(…\right)$

$$F.G=\sum\_{}^{}m\left(2, 4, 7\right)$$

* 1. **(3 points)** Express the function *F+G* as a **product of maxterms**, $F+G=\prod\_{}^{}M\left(…\right)$

$$F.G=\sum\_{}^{}m\left(0, 1, 2, 4, 7\right)= \prod\_{}^{}M(3, 5, 6)$$

1. Given the two functions $H\left(w,x, y\right)=\left(w+\overbar{x} \right)\left(\overbar{w}+y\right)$ and $K\left(w,x, y\right)=w y+\overbar{x} \overbar{w} .$
	1. **(2 points)** Express the function *H* as a **sum of minterms**, $H=\sum\_{}^{}m\left(…\right)$.

$$H\left(w,x, y\right)=w y+\overbar{w}\overbar{x }+\overbar{x} y= \sum\_{}^{}m\left(0, 1, 5, 7\right)$$

* 1. **(2 points)** Express the function *K* as a **sum of minterms**, $K=\sum\_{}^{}m\left(…\right)$.

$$K\left(w,x, y\right)=w y+\overbar{w}\overbar{x }= \sum\_{}^{}m\left(0, 1, 5, 7\right)$$

* 1. **(1 point)** Are the functions *H* and *K* equal? Why.

Yes, they are equal as they have equal sets of minterms.

**Question 5. (19 points)**

**Fill in the Spaces: (Show all work needed to obtain your answer)**

1. To represent the decimal number 32 in binary we need \_\_\_6\_\_\_\_ (how many) bits. (1 point)
2. (324.14)5 = (\_\_\_89.36\_\_\_\_)10 (2 points)

= 3 \* 52 + 2\*5 + 4 + 1\*5-1 + 4\*5-2= 4 + 10 + 75 + 0.2 + 0.16 = 89.36

1. A communication system uses a 1-bit parity scheme for error detection. The receiver receives a byte represented in hexadecimal as A7 without error. The parity scheme used is \_\_\_odd\_\_\_\_ (even/odd) parity.

 (1 Point)

A7 = 1010 0111 => 5 1’s

1. The smallest non-zero fraction that can be represented using 2 octal digits is equal to the decimal fraction (1/64). (1 Point)

=0.01 = 8-2 = 1/64

1. Given that (543)R = (207)10 , the radix R for the first number = \_\_6\_\_\_\_. (show all your work)

 (2 points)

5\*R2 + 4\*R + 3 = 207 => 5\*R2 + 4\*R - 204 = 0

By solving the quadratic equation, $R = \frac{-4\pm \sqrt{(16-4\*5\*-204)}}{2\*5}=\frac{-4\pm \sqrt{4096}}{10}=\frac{-4\pm 64}{10}$

Thus, R = 6.

1. The function  can be simplified to \_\_\_\_1\_\_\_\_\_ with minimum number of literals. (2 points)



1. For 5 variables (A, B, C, D, E), m4 = $\overbar{A} \overbar{B} C \overbar{D} \overbar{E}$ (algebraic expression), while  represents the maxterm M? 10110=M22. (2 points)

1. An analog signal is quantized into a number of discrete amplitude levels for digital transmission which uses one bit for parity. If the transmitter sends each sample of the signal as one byte (8 bits) of data, the number of amplitude levels is \_\_\_128\_\_\_\_. (2 points)

Number of bits representing amplitude = 7 bits.

Number of amplitude levels = 27 = 128.

1. The canonical form (sum of minterms or product of maxterms) represents the most simplified form of a logic function \_\_\_False\_\_(True/False). (1 point)
2. If even parity is used, then in the following transmitted binary data: (2 points)

- X1100101, the value of X = \_\_0\_\_.

- 0110001Y, the value of Y = \_\_1\_\_.

1. For the logic circuit shown below, the truth table has \_\_24=16\_\_\_(how many) rows. The maximum input-to-output propagation delay is \_\_10\_\_ ns. (3 points)

4+2+4=10 ns