***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 142 (Spring 2014-2015)**

**Major Exam 1**

**Saturday February 28, 2015**

**Time: 90 minutes, Total Pages: 7**

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ID:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Section: \_\_\_\_\_\_\_**

**Notes:**

* Do not open the exam book until instructed
* **No Calculators are 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** | **25** |  |
| **2** | **20** |  |
| **3** | **10** |  |
| **Total** | **55** |  |

**Question 1. (25 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 3 digits only). **(12 points)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Decimal** | **Binary** | **Octal** | **HEX** | **EXCESS-3 BCD** |
| **109.39** |  |  |  |  |
|  | **10101101.101** |  |  |  |
|  |  |  | **E7.48** |  |

1. Perform the following arithmetic operations in the specified number system. **(8 points)**

|  |  |  |  |
| --- | --- | --- | --- |
| Octal Subtraction 4 5 1 2* 2 5 3 7

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  | Hexadecimal Addition F E A 3+ A F 9 D\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Binary Subtraction 1 1 1 0 0 0 1 0- 1 0 1 1 1 1 1 1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Binary Addition 11011011+01110111\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. Two number system with radixes $r\_{1}$ *and* $r\_{2}$*,* have the following two relations:
	1. $(69)\_{r\_{2}}= (100)\_{r\_{1}}$, *and*
	2. $(17)\_{r\_{2}}= (21)\_{r\_{1}}$

What are the values of $r\_{1}$ *and* $r\_{2}$ ? **(5 points)**

**Question 2. (20 points)**

Use Boolean algebra to solve the following questions. Show clearly all your steps.

|  |
| --- |
| 1. Simplify each of the following Boolean functions to the specified number of literals in sum-of-products (SOP) representation:
2. $F1=x +\overline{x} y $ **(2 literals) (1 point)**
3. $F2=x y + \overline{x} z+y \overline{z} $ **(3 literals) (4 points)**
4. $F3=x \overline{w} \overline{z}+ x \overline{w} \overline{y}+x w+x y z$ **(1 literal) (4 points)**
5. $F4=\overbar{\left(x+\overline{y}\right)} \overbar{\left(x y+\overline{x} z\right)}$ **(3 literals) (4 points)**

  |
| 1. Given the Boolean function $F\left(X,Y,Z\right)=\left(Y+\overbar{Z}\right)\left(\overbar{X}+Y\right)$: **(5 points)**
2. Express F as a **product-of-maxterms**, $F=\prod\_{}^{}M$.
3. Find the ***algebraic* sum-of-minterms** expression for *F*.

 1. Given the following Boolean function expressed using sum-of-products representation. $F\left(X,Y,Z\right)=X Y+ \overbar{X} Z$, express F as a product-of-sums (NOT as product-of-maxterms) representation. **(2 points)**
 |
|  |

**Question 3. (10 points)**

1. Without simplification, write the Boolean algebra equation that represents F: **(2 points)**
2.
3. Fill the table based on the Logic diagram **(3 points)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Gate** | **Delay (*ns*)** | **Fanin** | **Driving Load** |
| G1 | 2 |  |  |
| G2 | 1 |  |  |
| G3 | 3 |  |  |
| G4 | 2 |  |  |
| G5 | 2 |  |  |

1. What is the worst-case delay? **(1 point)**
2. What is the worst-case delay path? **(1 point)**
	1. You are required to mark the *VIL, VIH, VOL, VOH* parameters on the following diagram given that the values of these parameters are *selected* from the set **{0.5*v*, 1.0*v*, 3.5*v*, 4.2*v*}**\***.** **(2 points)**

\*(*Voltage values are given in ascending order, i.e. not necessarily in the same order of the VIL, VIH, VOL, VOH parameters*)

|  |  |  |
| --- | --- | --- |
| **Input voltages** |  | **Output voltages** |
|  |  |  |
|  | *4v* |  |
|  |  |  |
|  | *3v* |  |
|  |  |  |
|  | *2v* |  |
|  |  |  |
|  | *1v* |  |
|  |  |  |
|  | *0v* |  |

* 1. Calculate the Noise Margin for logic 1 (NM1)? **(1 point)**

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