***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 132 (Spring 2013-2014)**

**Major Exam 1**

**Saturday March 1, 2014**

**Time: 90 minutes, Total Pages: 11**

**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** | **13** |  |
| **2** | **12** |  |
| **3** | **15** |  |
| **4** | **15** |  |
| **5** | **10** |  |
| **Total** | **65** |  |

**Question 1. (13 points)**

Perform the following number base conversion with fraction precision of 3-digit where needed. Show your work in the “Work/ Scratch Area”

|  |  |  |
| --- | --- | --- |
| **Required Conversion** | **Work / Scratch Area** | |
| * 1. (i) (0.339)10 = ( )2.   (ii) Convert the above obtained binary result back to decimal. = ( )10  (iii) What is the conversion loss in accuracy? | 0.399 X 2=0.798  0.798 X 2=1.596  0.596 X 2=1.182  Therefore (0.399)10 = (0.011)2  (0.011)2=2-2+2-3=0.25+0.125=0.375  0.399-0.375=0.024 due to base conversion | |
| * 1. (80.125)10=( )2   Fraction part Integer part  0.125 X 2=0.25  0.25 X 2=0.5  0.5 X 2=1.0  =(1010000.001)2 | |  |  | | --- | --- | | 80 | . | | 40 | 0 | | 20 | 0 | | 10 | 0 | | 5 | 0 | | 2 | 1 | | 1 | 0 | | 0 | 1 | | |
| * 1. (10)13=( )10 | | 1x13=10 |
| * 1. (F319)16  = ( )2.   =(1111 0011 0001 1001)2 | |  |
| * 1. (F319)16 = ( )8.   =(1111 0011 0001 1001)2 | |  |
| * 1. (9403)10 =( ) BCD 8421 code. | |  |

**Question 2. (12 points)**

* 1. Compute the following arithmetic operations in the indicated bases **(9 Points)**

|  |  |
| --- | --- |
| 1. (A69C – 3F)16 | 1. (255 + 127)8 |
| 1. (1101 1000 - 1001 1111)2 | 1. (1101 1000 \* 101)2 |

II. What is the radix *r*  of the number system for which (24 + 17 = 40)*r*. **(3 Points)**

**Question 3. (15 points)**

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

|  |
| --- |
| * 1. (4 points) |
| * 1. Given that C = show that (5 Points) |
| * 1. Find the values of the 4 Boolean variables A, B, C, and D by solving the following set of simultaneous Boolean equations: (3 Points) |
| * 1. **Without simplification**, write out the **complement** and **dual** forms of the following expression:   : (3 Points) |

**Question 4. (15 points)**

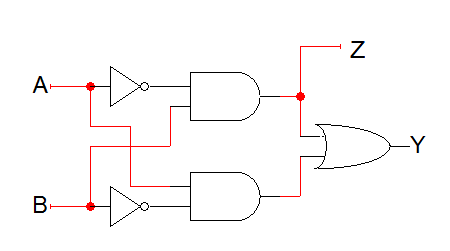
|  |  |  |  |
| --- | --- | --- | --- |
| A | B | Y | Z |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 |

1. The truth table of a digital circuit which has two inputs (A, B) and two outputs (Y, Z) is shown: **(4 points)**
   1. Write the Boolean expressions of the circuit outputs (Y , Z).

Y = A’ B + A B’

Z = A’ B

* 1. Draw the logic diagram of this circuit (i.e., its gate-level implementation).

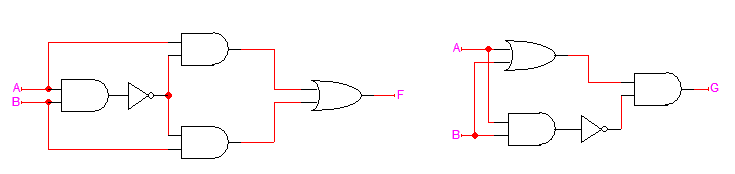


* 1. Given the Boolean function : **(4 points)**

1. Express F as a **sum-of-minterms**, .
2. Find the ***algebraic* product-of-Maxterms** expression for *F*.
   1. F’ = X’ Y’ + X’ Z’ + X Z =

.

* 1. Given and express the function as a sum-of-minterms. **(3 points)**
  2. Given the following two circuits representing the functions F and G. Determine whether the two functions F and G are equivalent or not. Justify your answer. **(4 points)**



F = (A B)’ A + (A B)’ B = (A’ + B’) A + (A’ + B’) B = A B’ + A’ B = ∑m(1,2)

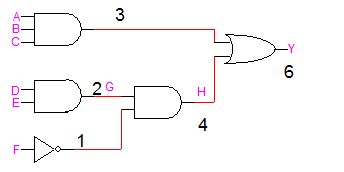
G = (A + B)(A B)’ = (A + B)(A’ + B’) = A’ B + A’ B = ∑m(1,2)

Thus, F and G implement equivalent functions.

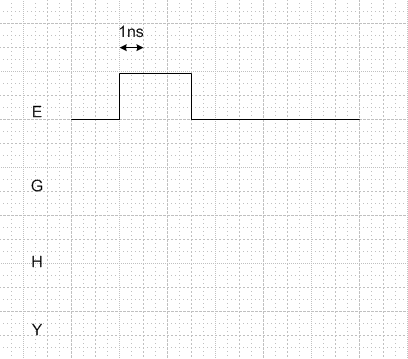
**Question 5. (10 points)**

* + 1. Assume that the propagation delay of a gate depends only on its number of inputs. Thus, the propagation delay of an Inverter is 1 ns, of a 2-input gate (AND or OR) is 2 ns, and of a 3-input gate is 3 ns. For the circuit shown below;

1. What is the longest propagation delay from an input to the output? **(2 point)**
2. If **A=0**, **B=1**, **C=1**, **D=1**, and **F=0**, draw the signal waveforms at points **G, H**, and **Y** due to the shown applied signal at **E** by completing the timing diagram given below. **(3 points)**



The longest propagation delay is 6ns.



1. Given an inverter with the following parameters VOH=5v VOL=0v, VIH=2.8v, VIL=1.6, the noise margins NMH= VOH - VIH=5-2.8=2.2v and NML= VIL - VOL=1.6v. **(2 points)**
2. The Boolean function implemented by the circuit given below expressed as a sum-of-products is

F = C (A + B) + C’ A B = A C + B C + A B C’ = A C + B C + A B. **(3 points)**

