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)**

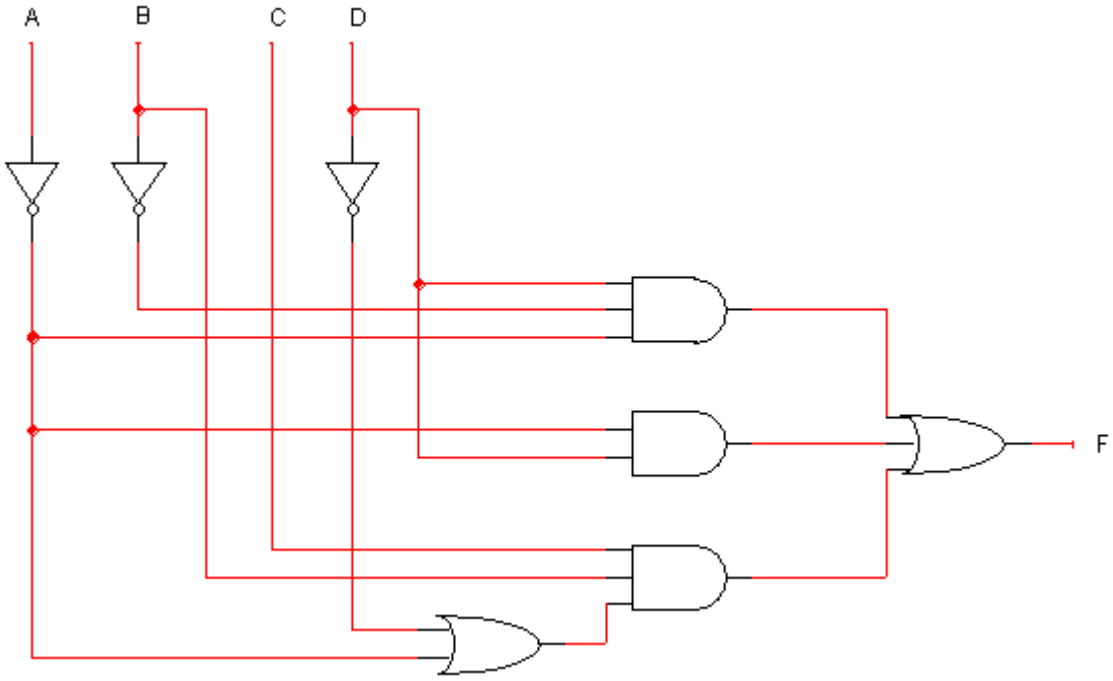
Perform the following arithmetic operations in the specified number system **without changing its base**.

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

Question 3. **(12 points)**

a. Given the function $F(A,B,C,D) = \overline{A}\,\overline{B}D + \overline{A}D + BC(\overline{D} + \overline{A})$:

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



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

$$F(A,B,C,D) = \overline{A}\,\overline{B}D + \overline{A}D + BC(\overline{D} + \overline{A})$$
$$= \overline{A}D(\overline{B} + 1) + BC\overline{D} + \overline{A}BC$$
$$= \overline{A}D + BC\overline{D} + \overline{A}BC$$
$$= \overline{A}D + BC\overline{D} \qquad \text{(using Consensus Theorem)}$$

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

$$\begin{aligned} F(A,B,C) &= \overline{A} + A\,\overline{(B+\overline{C})} \\ &= \overline{A} + A\overline{B}C \\ &= (\overline{A}+A)(\overline{A}+\overline{B}C) \\ &= \overline{A} + \overline{B}C \end{aligned}$$

$$\begin{aligned} \Rightarrow \overline{F}(A,B,C) &= \overline{(\overline{A}+\overline{B}C)} \\ &= A(B+\overline{C}) \\ &= AB + A\overline{C} \end{aligned}$$

Question 4. **(15 points)**

I. Given the Boolean functions $F(A,B,C) = \sum m(0,2,4,7)$ and $G(A,B,C) = \prod M(0,3,5,6)$.

a. **(2 points)** Give the ***algebraic*** **sum of minterms** expression for *F*.

$$F = \bar{A}\,\bar{B}\,\bar{C} + \bar{A}\,B\,\bar{C} + A\,\bar{B}\,\bar{C} + A\,B\,C$$

b. **(2 points)** Express the function *G* as a **sum of minterms**, $G = \sum m(\dots)$

$$G = \sum m(1,2,4,7)$$

c. **(3 points)** Express the function *F.G* as a **sum of minterms**, $F.G = \sum m(\dots)$

$$F.G = \sum m(2,4,7)$$

d. **(3 points)** Express the function *F+G* as a **product of maxterms**, $F + G = \prod M(\dots)$

$$F.G = \sum m(0,1,2,4,7) = \prod M(3,5,6)$$

II. Given the two functions $H(w,x,y) = (w + \bar{x}\,)(\bar{w} + y)$ and $K(w,x,y) = w\,y + \bar{x}\,\bar{w}$.

a. **(2 points)** Express the function *H* as a **sum of minterms**, $H = \sum m(\dots)$.

$$H(w,x,y) = w\,y + \bar{w}\bar{x} + \bar{x}\,y = \sum m(0,1,5,7)$$

b. **(2 points)** Express the function *K* as a **sum of minterms**, $K = \sum m(\dots)$.

$$K(w,x,y) = w\,y + \bar{w}\bar{x} = \sum m(0,1,5,7)$$

c. **(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)

a. To represent the decimal number 32 in binary we need ___6____ (how many) bits. (1 point)

b. $(324.14)_5$ = (___89.36____)$_{10}$ (2 points)

$= 3 * 5^2 + 2*5 + 4 + 1*5^{-1} + 4*5^{-2} = 4 + 10 + 75 + 0.2 + 0.16 = 89.36$

c. 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

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

$=0.01 = 8^{-2} = 1/64$

e. Given that $(543)_R = (207)_{10}$, the radix R for the first number = __6____. (show all your work)

(2 points)

$5*R^2 + 4*R + 3 = 207 \Rightarrow 5*R^2 + 4*R - 204 = 0$

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.

f. The function $F = X + \overline{X}Y + \overline{X}\,\overline{Y}$ can be simplified to ____1_____ with minimum number of literals. (2 points)

$$F = X + \overline{X}Y + \overline{X}\,\overline{Y} = X + \overline{X}(Y + \overline{Y}) = X + \overline{X}(1) = X + \overline{X} = 1$$

g. For 5 variables (A, B, C, D, E), m_4 = $\bar{A}\,\bar{B}\,C\,\bar{D}\,\bar{E}$ (algebraic expression), while $(\overline{A}+B+\overline{C}+\overline{D}+E)$ represents the maxterm $M_?$ 10110=M_{22}. (2 points)

h. 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 = 2^7 = 128.

i. The canonical form (sum of minterms or product of maxterms) represents the most simplified form of a logic function ___False__(True/False). (1 point)

j. 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__.

k. For the logic circuit shown below, the truth table has __2^4=16___(how many) rows. The maximum input-to-output propagation delay is __10__ ns. (3 points)

4+2+4=10 ns