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 131 (FALL 2013)
Major Exam 1
Saturday October 5, 2013

Time: 90 minutes, Total Pages: 8

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	20	
2	15	
3	15	
4	12	
5	8	
Total	70	

Question 1. **(20 points)**

Fill the blank in each of the following questions:

1. The decimal value of the binary number $(11110000.101)_2$ is $(\underline{240.625})_{10}$.

2. The decimal value of the hexadecimal number $(3F.4)_{16}$ is $(\underline{63.25})_{10}$.

3. The decimal number $(240.75)_{10}$ is represented in binary as $(\underline{11110000.11})_2$.

4. The octal number $(57.33)_8$ is represented in hexadecimal as $(\underline{2F.6C})_{16}$.

5. The result of $(01011111)_2 + (00101111)_2$ is $(\underline{10001110})_2$.

6. The result of $(F0)_{16}$ - $(CA)_{16}$ is $(\underline{26})_{16}$.

7. The result of $(32)_{16}$ * $(9A)_{16}$ is $(\underline{1E14})_{16}$.

8. The number 62 is represented in BCD as <u>0110 0010</u>.

9. Given that the base R number $(123)_R$ is equal to $(83)_{10}$. Then the base R = <u>8</u>.

10. In binary system, the largest <u>decimal</u> value that can be expressed using 4 integer bits and 4 fractional bits is <u>15.9375</u>.

Question 2. **(15 points)**

I. Given that **72** students have registered in the COE 202 course, and that each of these students should be assigned a unique *n*-bit binary code, provide answers for the following: **(6 Points)**

a. The minimum value of *n* is ___**7**___

b. The number of additional students that the code can accommodate is ____**56**____

c. If out of this *n*-bits , *m* bits are dedicated to indicate the student section

i. With four equal size sections, *m* = __**2**__ , *and* each section can have___**14**__ additional students register per section

ii. With five sections, *m* = __**3**_ , *and* each section can have up to __**16**__ students.

II. An 8-bit binary bit pattern consists of an ASCII character code in the 7 least significant bits, together with a parity bit in the MSB. If the HEX value of this pattern is $(\mathbf{E4})_{16}$, answer the following: **(3 Points)**

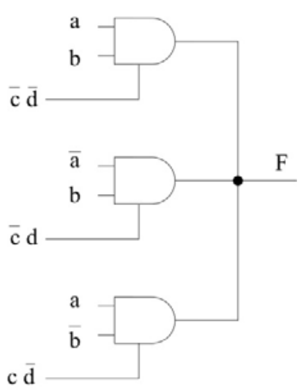
a. The parity used is ___ **Even** ___ (Even / Odd)

b. The character code is _____**64** ____ representing the character ____ **d** ____

{*Hint: Alphabet characters are given* ***sequential*** ***ASCII codes*** *starting* with *A* = $(41)_{16}$, (Upper Case) *or* with *a* = $(61)_{16}$ (LowerCase)}

III. The shown circuit uses three 2-Input Tri-state AND gates. Fill-in the Truth Table for this shown circuit indicating the value of the output signal **F** either as 0, 1, or Hi-Z. **(6 Points)**

a b c d	**F**
0 0 0 0	**0**
0 0 0 1	**0**
0 0 1 0	**0**
0 0 1 1	**HI-Z**
0 1 0 0	**0**
0 1 0 1	**1**
0 1 1 0	**0**
0 1 1 1	**HI-Z**
1 0 0 0	**0**
1 0 0 1	**0**
1 0 1 0	**1**
1 0 1 1	**HI-Z**
1 1 0 0	**1**
1 1 0 1	**0**
1 1 1 0	**0**
1 1 1 1	**HI-Z**



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

a. Reduce $F = \overline{W}X\overline{Z} + XW + \overline{W}X\overline{Y}Z + X\overline{W}YZ$ to 1 literal

$$= \overline{w}x\overline{z} + xw + \overline{w}xz[\overline{y}+y]$$
$$= \overline{w}x\overline{z} + \overline{w}xz + wx$$
$$= \overline{w}x[\overline{z}+z] + wx$$
$$= \overline{w}x + wx$$
$$= x[w+\overline{w}] = x$$

b. Reduce $F = (x+y)(x+\overline{y}) + xyz + \overline{x}y + xy\overline{z}$ to the sum of 2 literal

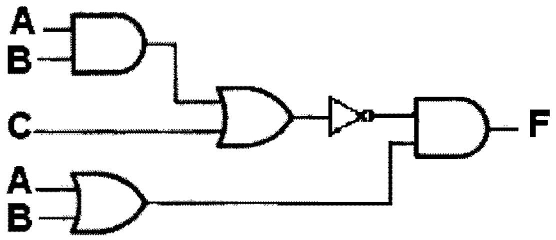
$$= xx + x\overline{y} + xy + y\overline{y} + xyz + \overline{x}y + xy\overline{z}$$
$$= x(1+\overline{y}) + xy(1+z) + \overline{x}y + xy\overline{z}$$
$$= x + xy + xy\overline{z} + \overline{x}y$$
$$= x(1+\overline{y}) + xy(1+\overline{z}) + \overline{x}y$$
$$= x + y(x+\overline{x}) = x+y$$

c. Given $F = Y + \overline{X}Z + X\overline{Y}$, Express $\overline{F}$ as a single minterm

$$\overline{F} = \overline{Y}\cdot(\overline{\overline{X}Z})\cdot(\overline{X\overline{Y}})$$
$$= \overline{Y}\cdot(X+\overline{Z})\cdot(\overline{X}+Y)$$
$$= \overline{Y}\cdot(X\overline{X} + XY + \overline{Z}\overline{X} + \overline{Z}Y)$$
$$= XY\overline{Y} + \overline{X}\overline{Y}\overline{Z} + \overline{Z}Y\overline{Y}$$
$$= \overline{X}\overline{Y}\overline{Z}$$

d. Express F in the logic diagram shown as a function of the input variables.
Do not do any logic manipulations.

$$F = (\overline{AB+C})\cdot(A+B)$$



Question 4. **(12 points)**

I. Given the following Boolean function:

$$F(X,Y,Z) = (X + YZ)(\overline{XY\bar{Z}})$$

a. **(4 points)** Find the truth table represented by *F*.

X	Y	Z	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

a. **(2 points)** Find the **sum-of-minterms** expression, $\sum m$, for *F*.

$$F(X,Y,Z) = \sum m(3,4,5,7)$$

b. **(2 points)** Find the ***algebraic*** **product-of-Maxterms** expression for the **complement** of *F*.

$$\bar{F}(X,Y,Z) = \prod M(3,4,5,7) = (X + \bar{Y} + \bar{Z})(\bar{X} + Y + Z)(\bar{X} + Y + \bar{Z})(\bar{X} + \bar{Y} + \bar{Z})$$

2. **(4 points)** By distributing the OR over the AND, find the **product-of-Maxterms** expression, $\prod M$, for the following Boolean function:

$$G(A,B,C,D,E) = AB + \overline{CD} + E$$

$$G(A,B,C,D,E) = AB + \overline{CD} + E = AB + \bar{C} + \bar{D} + E = AB + (\bar{C} + \bar{D} + E)$$

$$= (A + \bar{C} + \bar{D} + E)(B + \bar{C} + \bar{D} + E)$$

$$= (A + (\bar{B}.B) + \bar{C} + \bar{D} + E)\big((\bar{A}.A) + B + \bar{C} + \bar{D} + E\big)$$

$$= (A + \bar{B} + \bar{C} + \bar{D} + E)(A + B + \bar{C} + \bar{D} + E)(\bar{A} + B + \bar{C} + \bar{D} + E)(A + B + \bar{C} + \bar{D} + E)$$

$$= (A + \bar{B} + \bar{C} + \bar{D} + E)(A + B + \bar{C} + \bar{D} + E)(\bar{A} + B + \bar{C} + \bar{D} + E)$$

$$= \prod M(6,14,22)$$

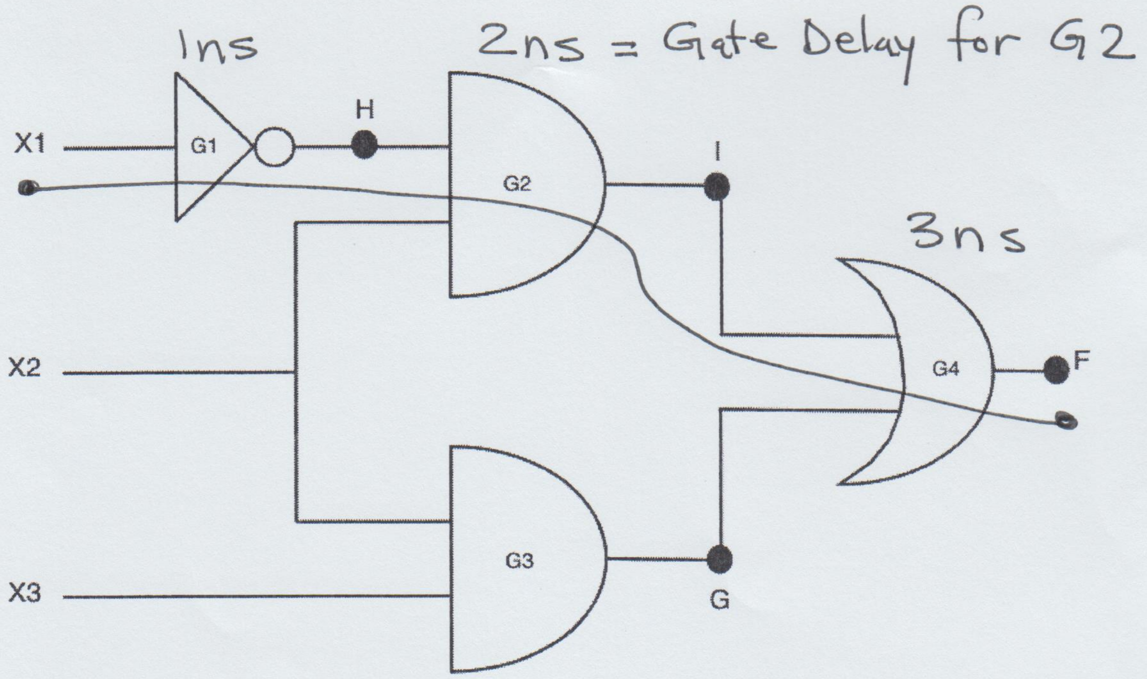
Question 5. (8 points)

Consider the circuit shown below. The propagation delays through the NOT, AND, and OR gates are 1 ns, 2 ns, and 3 ns, respectively.

a) What is the longest path connecting an input to the output? (1 pt)

b) What is the delay along this path? (1 pt)

c) Draw the signals that can be observed at the points H, I, G, and F. (6 pts)



(a) X1 → G1 → G2 → G4 → F (1)

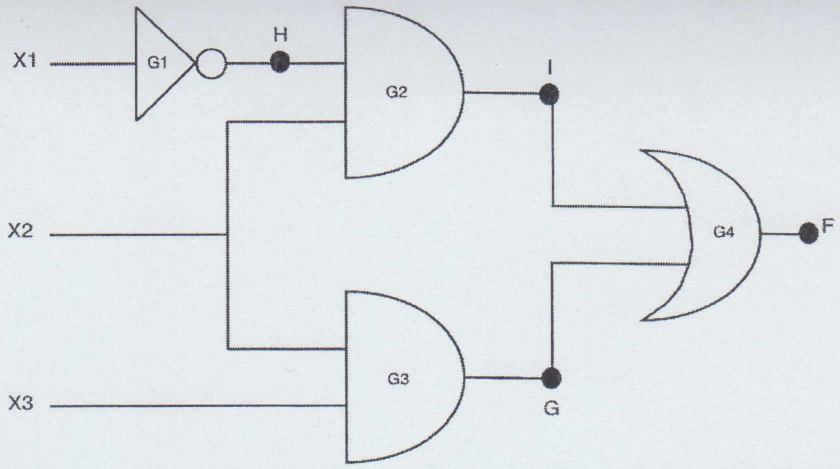
(b) Delay = 1 ns + 2 ns + 3 ns (1)

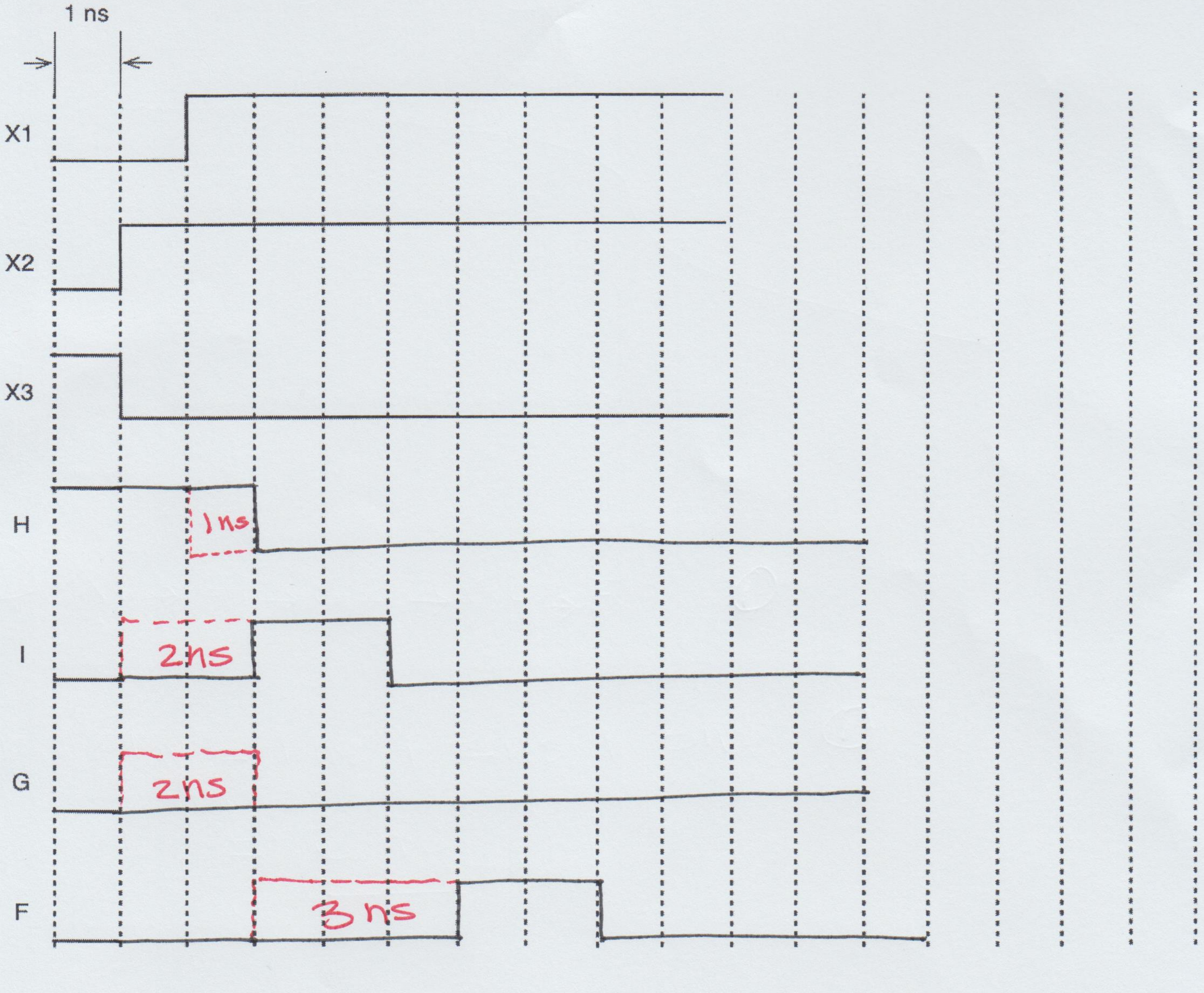
= 6 ns

(c) Warnings

1) Don't count delay for every transition. Do it only for the first transition and the rest will follow

2) After you finish drawing the resulting signal, make sure it is shifted to the right by one gate delay.





. Notice that F is a shifted version of I (3 ns to the right)