

ECE 238L Computer Logic Design
 Quiz I - February 1, 2011

24

NAME: _____

Yes calculators and an 8x11 cheat sheet. SHOW YOUR WORK AND CHECK YOUR WORK!!!!

1. [10 points] Carry out the conversions required to complete the columns. In part a) you are given a number and you are asked to find its representation in other bases. In part b) you are given a number in a binary form and you are asked to find its representation in another binary form.

a) BINARY	OCTAL	DECIMAL	HEXADECIMAL
<u>1011001.101</u>	<u>131.5</u>	89.625	<u>95.A</u> X
<u>10100001111.11</u>	<u>5037.6</u>	<u>2591.25</u>	A1F.C

-4

b) NUMBER	1's complement	2's complement	MAGNITUDE	SIGN
<u>15</u> X	<u>01010101.01</u> X	10110101.01	<u>100</u> X	<u>0</u> ✓

2. [10 points] Convert (7813.400)₁₀ to hexadecimal (base 16). Carry out your answer to 3 places past the "point".

$7813.400_{10} \rightarrow ?_{16}$

$7 \cdot 9^3 + 8 \cdot 9^2 + 1 \cdot 9^1 + 3 \cdot 9^0 + 4 \cdot 9^{-1} + 0 + 0 = 5763.444... \quad 5763 \frac{4}{9}$

$813/16 = 868 + 11$
 $868/16 = 96 + 4$
 $96/16 = 6$

$5763 / 2 = 2881 + 1$
 $2881 / 2 = 1440 + 1$
 $1440 / 2 = 720 + 0$
 $720 / 2 = 360 + 0$
 $360 / 2 = 180 + 0$
 $180 / 2 = 90 + 0$
 $90 / 2 = 45 + 0$
 $45 / 2 = 22 + 1$
 $22 / 2 = 11 + 0$
 $11 / 2 = 5 + 1$
 $5 / 2 = 2 + 1$
 $2 / 2 = 1 + 0$
 $1 / 2 = 0 + 1$

$1011010000011.01110001100..._{2}$
 $01110001100119 + 1$
 $01110001100119 + 1$
 $219 + 0$
 $419 + 0$
 $819 + 0$
 $119 + 1$
 $519 + 1$
 $119 + 1$
 $219 + 0$
 $619 + 0$

-4

3. [10 points] Add the following numbers in binary. Use 2's complement to represent negative numbers. Use a word length of 5 bits (including sign). Indicate if an overflow occurs.

- a) $10+6$ b) $-12+(-14)$ c) $-3+(-12)$ d) $12+(-15)$

a) $10+6$

$$\begin{array}{r} +10 \\ +6 \\ \hline +16 \end{array}$$

$\begin{array}{r} 11 \\ 01010 \\ 00110 \\ \hline 10000 \end{array}$
 negative number, overflow

b) $-12 + (-14) = -26$

$$\begin{array}{r} -12 \\ + -14 \\ \hline -26 \end{array}$$

$12 = 01100$
 $14 = 01110$
 $\begin{array}{r} +0100 \\ 10010 \\ \hline 100110 \end{array}$
 carry, discard and take 2's $\Rightarrow 2-11010 = -26$ ok ✓

c) $-3 + (-12) = -15$

$$\begin{array}{r} -3 \\ + -12 \\ \hline -15 \end{array}$$

$3 = 00011$
 $12 = 01100$
 $\begin{array}{r} +11101 \\ 10100 \\ \hline 110001 \end{array}$
 discard $\Rightarrow 10001$ 2's $\Rightarrow 2-01111 = -15$ ok ✓

d) $12 + (-15) = -3$

$15 = 01111 \Rightarrow 10001 = -15$
 $12 = 01100$
 $\begin{array}{r} +01100 \\ 10001 \\ \hline 11101 \end{array}$
 correct $-3 = 11101$ ✓

4. [10 points] Multiply in binary: $11011 \times 1011 = 286$

$\begin{array}{r} 11011 \\ \times 1011 \\ \hline 11011 \\ 110110 \\ 1101100 \\ 11011000 \\ \hline 11101001 \end{array}$
 carries \rightarrow

100101001
 -10

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NAME: _____

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1. [10 points] Carry out the conversions required to complete the columns. In part a) you are given a number and you are asked to find its representation in other bases. In part b) you are given a number in a binary form and you are asked to find its representation in another binary form.

1
0
1
0
0
1
64
32
16
8
4
2
1

a) BINARY	OCTAL	DECIMAL	HEXADECIMAL
1011001.101	131.5	89.625	59.A
101000011111.1100	5037.6	2591.75	A1F.C

$$10 \cdot 16^2 + 3 \cdot 16 + 15 + 12 \cdot 16^{-1}$$

2048	1024	512	256	128	64	32	16	8	4	2	1	.5	.75
		1	0	0	0	0	1	1	1	1		1	1

b) NUMBER	1's complement	2's complement	MAGNITUDE	SIGN
-74.75	10110101.01	10110101.01	74.75	negative

$$01001010.11$$

$$74.75$$

2. [10 points] Convert (7813.400)₁₀ to hexadecimal (base 16). Carry out your answer to 3 places past the "point".

$$7 \cdot 9^3 + 8 \cdot 9^2 + 2 \cdot 9^1 + 3 \cdot 9^0 + 4 \cdot 9^{-1}$$

$$5763.4444_{10}$$

$$5763 / 16 = 3 \dots 4444 \div 16 = 7$$

$$360 / 16 = 8 \dots 7777 \div 16 = 10$$

$$22 / 16 = 6 \dots 4444 \text{ repeats}$$

$$1 / 16 = 2$$

$$7813.4_{10} = 1683.F1C_{16}$$

2

3. [10 points] Add the following numbers in binary. Use 2's complement to represent negative numbers. Use a word length of 5 bits (including sign). Indicate if an overflow occurs.

- a) $10+6$ b) $-12+(-14)$ c) $-3+(-12)$ d) $12+(-15)$

$$\begin{array}{r} a) \ 01010 \\ + \ 00110 \\ \hline 10000 \end{array}$$

Overflow
result is -16
not +16

Correct

$$\begin{array}{r} b) \ 01100 \\ \text{Complement} \\ 10100 = -12 \\ 01110 \\ 10010 = -14 \end{array}$$

$$\begin{array}{r} 10100 \\ + \ 10010 \\ \hline 00110 \end{array}$$

overflow
 $6 \neq -26$

$$\begin{array}{r} c) \ 0001111 \\ \text{Complement} \\ 11101 = -3 \\ 01100 \\ \text{complement} \\ 10100 = -12 \end{array}$$

$$\begin{array}{r} 11101 \\ 10100 \\ \hline 10001 = -15 \end{array}$$

Correct

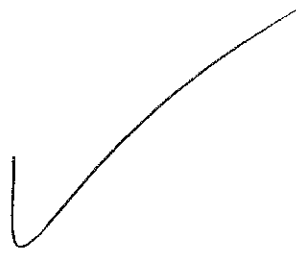
$$\begin{array}{r} d) \ 01111 \\ \text{Complement} \\ 10001 = -15 \end{array}$$

$$\begin{array}{r} 01100 \\ + \ 10001 \\ \hline 11101 = -3 \end{array}$$

Correct

4. [10 points] Multiply in binary: 11011×1011

$$\begin{array}{r} 11011 \\ \times 1011 \\ \hline 11011 \\ 110110 \\ - 0000 \\ 11011000 \\ \hline 100101001 \end{array}$$

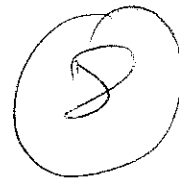


check

$$\begin{array}{r} 27 \\ \times 11 \\ \hline 27 \\ 270 \\ \hline 297 \end{array}$$

Correct

ECE 238L Computer Logic Design
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1. [10 points] Carry out the conversions required to complete the columns. In part a) you are given a number and you are asked to find its representation in other bases. In part b) you are given a number in a binary form and you are asked to find its representation in another binary form.

a) BINARY	OCTAL	DECIMAL	HEXADECIMAL
$(1011001.10)_2$	$(131.50)_8$	89.625	$(59.A)_{16}$
$(1010000111111000)_2$	X	1295_{10}	A1F.C

- 7

b) NUMBER	1's complement	2's complement	MAGNITUDE	SIGN
74.57	10010100	10110101.01 <small>10010100.10</small>	97	X

2. [10 points] Convert $(7813.400)_{10}$ to hexadecimal (base 16). Carry out your answer to 3 places past the "point".

$$\begin{aligned}
 7813/16 &= 488 + 5 \\
 488/16 &= 30 + 8 \\
 30/16 &= 1 + 14 \\
 1/16 &= 0 + 1 \\
 \hline
 &= 1914.850
 \end{aligned}$$

$$\begin{aligned}
 .4 \times 16 &= 6.4 \\
 .4 \times 16 &= 6.4 \\
 .4 \times 16 &= 6.4
 \end{aligned}$$

$$(910941.64...)_{16}$$

$$\begin{aligned}
 910941/2 &= 455470 + 1 \\
 455470/2 &= 227735 + 0 \\
 227735/2 &= 113867 + 1 \\
 113867
 \end{aligned}$$

- 8

3. [10 points] Add the following numbers in binary. Use 2's complement to represent negative numbers. Use a word length of 5 bits (including sign). Indicate if an overflow occurs.

a) $10+6$

$$\begin{array}{r} 1010 \\ + 110 \\ \hline 10000 \end{array}$$

10000
overflow

b) $-12+(-14)$

~~$$\begin{array}{r} 10011 \\ + 10001 \\ \hline 101000 \end{array}$$~~

101100
↑
overflow

c) $-3+(-12)$

~~$$\begin{array}{r} 1100 \\ + 10011 \\ \hline 11111 \end{array}$$~~

11111

d) $12+(-15)$

~~$$\begin{array}{r} 1100 \\ + 10000 \\ \hline 11100 \end{array}$$~~

11100

7

4. [10 points] Multiply in binary: 11011×1011

~~$$\begin{array}{r} 11011 \\ \times 1011 \\ \hline 11011 \\ 110110 \\ 1000000 \\ 1101000 \\ \hline 10001001 \end{array}$$~~

$= 10001001$

100101001

10

$$89.625 = 001011001.101000$$

Taylor Allen

$$\begin{aligned} 89/2 &= 44 + 1 \\ 44/2 &= 22 + 0 \\ 22/2 &= 11 + 0 \\ 11/2 &= 5 + 1 \\ 5/2 &= 2 + 1 \\ 2/2 &= 1 + 0 \\ 1/2 &= 0 + 1 \end{aligned}$$

$$\begin{aligned} .625 \times 2 &= 1.25 \\ .25 \times 2 &= 0.5 \\ .5 \times 2 &= 1.0 \end{aligned}$$

$$\begin{array}{cccc} 5 & 9 & 10 & \\ 0101 & 1001 & 1010 & = 59.A_{16} \\ 1 & 3 & 1 & 5 \\ 001 & 011 & 001 & . 101 000 = 131.50_8 \end{array}$$

0 1 2 3 4 5 6 7 8 9 A B C D E F G
1295

$$A1F.C_{16} = 10100001111.1100_2$$

$$\begin{array}{cccc} = & 10 & 1 & 15 & . & 12 \\ & 1010 & 0001 & 1111 & & 1100 \end{array}$$

$$\begin{aligned} 10/2 &= 5 + 0 \\ 5/2 &= 2 + 1 \\ 2/2 &= 1 + 0 \\ 1/2 &= 0 + 1 \end{aligned}$$

$$\begin{aligned} 12/2 &= 6 + 0 \\ 6/2 &= 3 + 0 \\ 3/2 &= 1 + 1 \\ 1/2 &= 0 + 1 \end{aligned}$$

$$\begin{aligned} .25 \times 2 &= 0.5 \\ .5 \times 2 &= 1.0 \end{aligned}$$

$$\begin{aligned} 6/2 &= 3 + 0 \\ 3/2 &= 1 + 1 \\ 1/2 &= 0 + 1 \end{aligned}$$

$$\begin{aligned} 14/2 &= 7 + 0 \\ 7/2 &= 3 + 1 \\ 3/2 &= 1 + 1 \\ 1/2 &= 0 + 1 \end{aligned}$$

$$\begin{array}{c} 1110 \\ 10001 \end{array}$$

ECE 238L Computer Logic Design
Quiz I - February 1, 2011

NAME: _____

Yes calculators and an 8x11 cheat sheet. SHOW YOUR WORK AND CHECK YOUR WORK!!!!

1. [10 points] Carry out the conversions required to complete the columns. In part a) you are given a number and you are asked to find its representation in other bases. In part b) you are given a number in a binary form and you are asked to find its representation in another binary form.

a) BINARY	OCTAL	DECIMAL	HEXADECIMAL
_____	_____	89.625	_____
_____	_____	_____	A1F.C

b) NUMBER	1's complement	2's complement	MAGNITUDE	SIGN
_____	_____	10110101.01	_____	_____

2. [10 points] Convert $(7813.400)_{10}$ to hexadecimal (base 16). Carry out your answer to 3 places past the "point".

3. [10 points] Add the following numbers in binary. Use 2's complement to represent negative numbers. Use a word length of 5 bits (including sign). Indicate if an overflow occurs.

a) $10+6$

b) $-12+(-14)$

c) $-3+(-12)$

D) $12+(-15)$

4. [10 points] Multiply in binary: 11011×1011

ECE 238L Computer Logic Design
Quiz II - February 15, 2010

NAME: _____

SHOW YOUR WORK. You can use a calculator to verify results but do not pass results to your neighbor.

1. [10 points] a) Carry out the conversions required to complete the columns.

BINARY	OCTAL	DECIMAL	HEXADECIMAL
_____	_____	225.625	_____
_____	_____	_____	BAD.1

- b) Find the NUMBER first and then find the other representations.

NUMBER	1's complement	2's complement	MAGNITUDE	SIGN
_____	01110111.01	_____	_____	_____

2. [10 points] Show the binary results for the following operations using a 4-bit word or nibble: a) 2's complement arithmetic (3-9) and (6-4); b) 1's complement (8-5) and (5-8). SHOW YOUR WORK.

ECE 238L Computer Logic Design
Quiz III Take Home - March 1-3, 2011

NAME : _____

1. [10 points] Using a truth table, prove that
 $(XY)(X' + Z) = XYZ'$
2. [20 points] Simplify each of the following expressions
 $(A'C + B' + DF')[A + C' + B' + DF'] =$
 $(AC + B')(G + F + DE)(AC + B')' =$
 $(X' + Y'Z' + 1)(X + Y)(X + Z) =$
 $(A + B'C + 1)(B' + C' + BCF) =$
 $PQ(M'N'P' + NR + R'S')R' =$
3. [10 points] Factor as much as possible: (Your answer should be in product-of-sums form.)
 $Z + XYQ + XYP =$
4. [10 points] Find D' if $D = (F' + G'H)E$
5. [10 points] Illustrate the following theorem using a circuit of switches.
 $X + YZ = (X + Y)(X + Z)$
6. [10 points] Is the following statement always true? Justify your answer.
If $ab' + [b + b'(a + bc)]' = [a + a'(ac + b)](a + b')$, then $a = b'$.
7. [10 points] Factor as much as possible to obtain a product of sums:
 $WYZ + W'UV + W'Y' + WV'$
8. [10 points] Each time you apply a theorem, mark your paper clearly to indicate which terms were used to add or delete other terms, or indicate which terms were combined. Simplify algebraically: (answer should be a sum of 3 terms)
 $(A + B' + C' + D')(B + C + D)(B' + C' + D')(A' + B + C + D)$
9. [10 points] Simplify to obtain a sum of 3 terms: $(A \equiv B')(CD \oplus B') + ABCD$

NOTE: paint/draw your work; please make your writing legible; show step-by-step your solution in an orderly manner.

ECE 238L Computer Logic Design
Quiz IV Take Home - March 22-24, 2011

NAME : _____

1. [15 points] A switching circuit has three inputs (A, B, C) and one output (Z). If $A=0$, the output Z is the exclusive-OR of B and C . If $A=1$, the output is the equivalence of B and C .
 - (a) Find the truth table for Z .
 - (b) Write the minterm expansion for Z in decimal form and in terms of A, B, C .
 - (c) Write the maxterm expansion for Z in decimal form and in terms of A, B, C .

2. [10 points] Without using a truth table, find (a) the minterm and maxterm expansions for F in algebraic and decimal forms (SOM, POM), and (b) the minterm and maxterm expansions for F' in decimal form (SOM, POM).

$$F(A,B,C) = A + B'C + BC$$

3. [10 points] Write an equation for the following sequence (use only 3 variables for the right-hand side): The overflow indicator V will turn on iff X is negative, Y is positive and D is positive, or if X is positive, Y is negative and D is negative.

4. [10 points] Design a 4-bit adder/subtractor using four full adders and four exclusive-OR gates. When $Su = 1$, the circuit should output $A - B$, otherwise it should output $A + B$. Remember that $B' = B \oplus 1$. (Assume that negative numbers are represented in 2's complement).

5. [10 points] $F(a, b, c, d, e) = \sum m(0, 1, 2, 6, 7, 8, 16, 17, 19, 20, 25, 26, 29, 31) + \sum d(3, 5, 18, 27)$
 - (a) Find the essential prime implicants of F and indicate the minterm which makes each one essential.
 - (b) Find a minimum sum-of-products expression for F .

6. [10 points] $F(a, b, c, d) = \sum m(7, 11, 12, 14) + \sum d(0, 10)$
 - (a) Find all of the prime implicants of F' .
 - (b) Find a minimum product-of-sums for F . Note: F' is specified in (a) and F in (b).

ECE 238L Computer Logic Design
Take Home Quiz V – March 29–31, 2011

NAME : _____

1. [10 points] Find a minimum *3-level* **NOR** circuit to realize
 $f(A, B, C, D) = \Sigma m(0, 2, 4, 6, 7, 9, 11, 12, 13, 15)$ (5 gates)
Do *not* use gate symbols with *input* bubbles in your final answer.

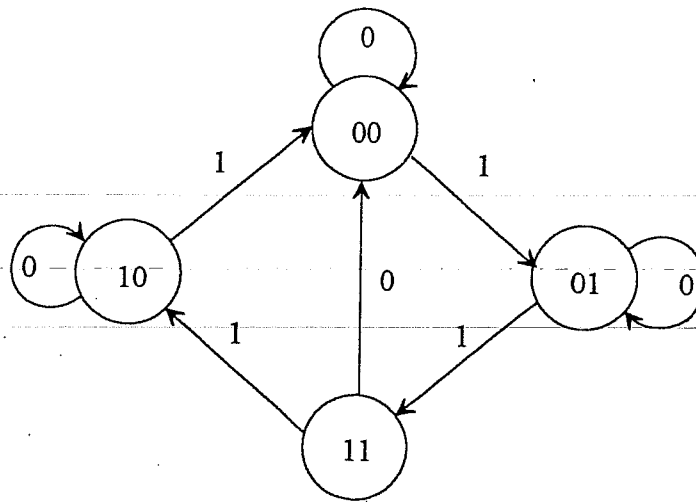
2. [10 points] (a) Design a *minimum* 2-level **NOR-NOR** circuit to realize
 $f(X, Y, Z, W) = \Sigma m(5, 13, 15)$
[10 points] (b) Convert the circuit from part (a) to a 2-level **NAND-AND** circuit. Do *not* use gate symbols with *input* bubbles in your final answer.

3. [20 points] Find a *minimum* 2-level **NAND** gate circuit to simultaneously realize
 $F_1(A, B, C, D) = \Sigma m(1, 3, 5, 7, 8, 9, 13)$
 $F_2(A, B, C, D) = \Sigma m(1, 3, 5, 7, 8, 10, 13)$
(Hint: Minimum solution has 6 gates)

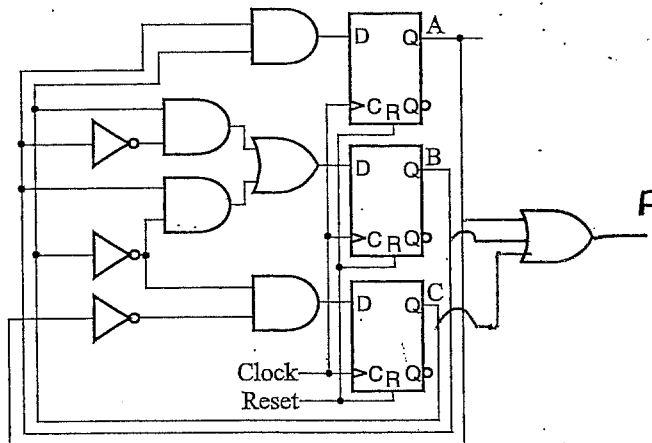
ECE 238L Computer Logic Design
Take Home Quiz 6 - April 28 - May 3, 2011

NAME: _____

- Design a synchronous sequential circuit for the state diagram shown below. Note that the circuit has no output. A) [15 points] Give the State Table using JK Flip-flops; B) [5 points] Simplify the appropriate functions; and C) [5 points] Show the required circuitry.



- We would like to analyze and understand the sequential circuit shown below. A) [5 points] Derive the input equations to the Flip-Flops and the output equation; B) [10 points] Derive the State Table; and C) [10 points] Derive the State Diagram.



ECE 238L Computer Logic Design
EXAM I - April 14, 2011

NAME: _____

Yes calculators, Copy of Page 55 of textbook (Laws and Theorems) and ONE cheat sheet (8X11). NO book or class notes. [] Indicates possible point values for the problem.

1. [10 points] Carry out the conversions required to complete the columns. SHOW YOUR WORK. You can use a calculator to verify results but do not pass results to your neighbor.

BINARY	OCTAL	DECIMAL	HEXADECIMAL
_____	_____	289.625	_____
101001.101	_____	_____	_____

NUMBER	1's complement	2's complement	MAGNITUDE	SIGN
10100110.01	_____	_____	_____	_____
_____	_____	10101010.01	_____	_____

2. [10 points] Show the binary results for the following operations using 3-bit words: a) 2's complement (3-8) and (5-3); and b) 1's complement (5-4) and (4-6). SHOW YOUR WORK.
3. [5 points] Factor the following expression to obtain a product of sums:
 a) $A'B' + A'CD + A'DE'$
4. [5 points] Simplify the following expression to a minimum sum of products:
 a) $[(XY)'] + (X'+Y)'Z$

5. [5 points] Find the complement of the expression below and simplify:
- a) $f(A,B,C,D) = [A+(BCD)'] [(AD)'+B(C'+A)]$
6. [5 points] Use a 3-to-8 decoder and OR-gates to implement the following functions:
- a) $G(A,B,C) = \sum m(2,3,6,7)$
- b) $H(A,B,C) = A'B+C'+AB'$
7. [10 points] Implement $f(x,y,z) = \sum m(0,1,3,4,7)$ as a two-level gate circuit, using a minimum number of NAND gates only.
8. [10 points] Implement $f(a,b,c,d) = \sum m(3,4,5,6,7,11,15)$ as a two-level gate circuit, using a minimum number of NOR gates only.
9. [35 points] PLEASE READ THE INSTRUCTIONS CAREFULLY AND ANSWER EACH PART SEPARATELY. We want to implement the function $f(x)=x^2-4$ for three-bit integer inputs.
- a) [5] For the inputs, we want to use three bit signed numbers $(a_2a_1a_0)_2$. Give all signed integer numbers that can be represented using three bits, assuming that 2's complement is used for representing negative numbers.
- b) [5] Plug in all the numbers represented in part a into $f(x)=x^2-4$. What is the smallest number? What is the largest number?
- c) [5] Based on your result in part b, how many bits do you need in order to represent the results? For your answer, assume that we are using 2's complement for representing negative numbers.
- d) [10] Provide a truth table where the input is $x=(a_2a_1a_0)_2$ and the output is $f(x)=x^2-4=(b_nb_{n-1} \dots b_0)_2$, where n is determined from your answer in part c.
- e) [10] Use three-variable Karnaugh maps to determine the minimum sums of products for each one of $(b_nb_{n-1} \dots b_0)_2$
10. [5 points] Implement the function $F(a,b,c,d) = \sum m(0,2,3,4,11,15)$ using a Multiplexer. Choose lines a, b, and c as select lines.

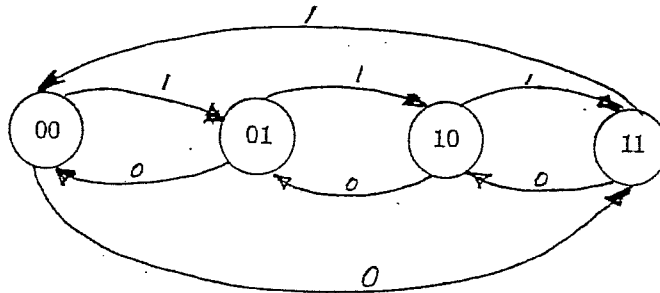
ECE 238L Computer Logic Design
Take Home EXAM II - May 5-10, 2011

NAME: _____

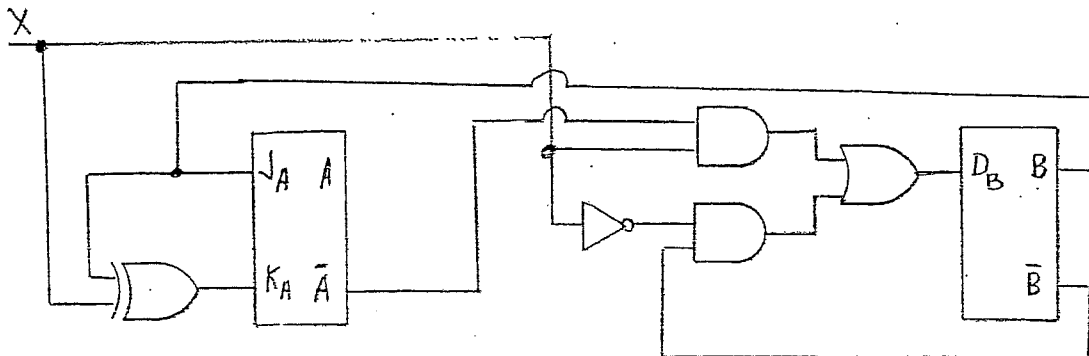
1. [25 points] Design a binary counter that produces the following output sequence: 0, 3, 6, 9
 - a) [5 points] Draw the State Transition diagram.
 - b) [10 points] Derive the State Table for implementing the counter using D flip-flops.
 - c) [5 points] Use K-maps to minimize the inputs to the D flip-flops.
 - d) [5 points] Show the final circuit.

2. [20 points] The following State Diagram is given.
 - a) [10 points] Give the State Table using JK flip-flops.
 - b) [5 points] Simplify the appropriate functions.
 - c) [5 points] Show the required circuitry.

KEY: Input



3. [25 points] Analyze the following sequential circuit by:
 - a) [5 points] Derive the input equations
 - b) [10 points] Derive the State Table
 - c) [10 points] Draw the State Diagram



4. [5 points] Using 8-bit registers perform the following operations. The content of Register R1 is (10110011).
- [1 points] ROR (Rotate Right).
 - [1 points] SLL (Shift Left Logical).
 - [1 points] SRL (Shift Right Logical).
 - [1 points] SLA (Shift Left Arithmetic).
 - [1 points] SRA (Shift Right Arithmetic).

5. [25 points] Design a 3-bit non-binary counter that will count in the sequence 000, 010, 011, 101, 110, 111 and repeat the sequence. The counter has two unused states. These are 001 and 100. Implement the counter as self-correcting such as that if the counter happens to be in one of the unused states (001 and 100) due to an error, after one clock cycle puts state 001 to 011 or state 100 to state 111 which are valid states and the counter provides the correct count. Use T Flip-flops for your design

