Homework #1 (v170412)

(Deadline: 11:59PM PDT, April 21, 2017)

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INSTRUCTIONS

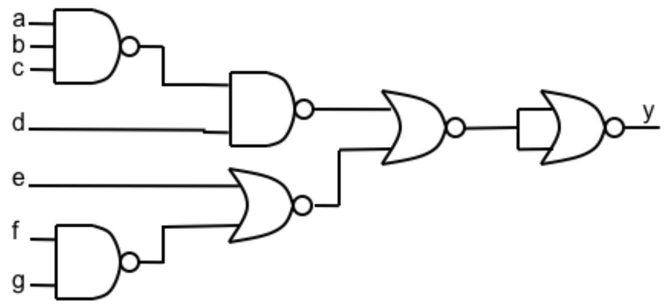
This homework is to be done individually. You may use any tools or refer to published papers or books, but may not seek help from any other person or consult solutions to prior exams or homeworks from this or other courses (including those outside UCLA). You're allowed to make use of tools such as Logisim, WolframAlpha (which has terrific support for boolean logic) etc.

You must submit all sheets in this file based on the procedure below. Because of the grading methodology, it is much easier if you print the document and answer your questions in the space provided in this problem set. It can be even easier if you answer in electronic form and then download the PDF. Answers written on sheets other that the provided space will not be looked at or graded. Please write clearly and neatly - if we cannot easily decipher what you have written, you will get zero credit

SUBMISSION PROCEDURE: You need to submit your solution online at Gradescope (https://gradescope.com/). Please see the following guide from Gradescope for submitting homework. You'd need to upload a PDF and mark where each question is answered.
http://gradescope-static-assets.s3-us-west-2.amazonaws.com/help/submitting_hw_guide.pdf

For some reason all of my backslashes are repeated when I download the pdf from the editor I used to make it. /\\ represents the and and \\/ represents or.

Problem #1



(a) Write the equation in Normal Form (does not need to be fully disjunctive) for the logical function shown in the implementation above.
(b) Find the dual of the function. Show the result in Normal Form (does not need to be fully disjunctive).
(c) Push the bubbles for the implementation above (you should not change the logic gates but may use the DeMorgan representations of the logic gate) so that the function is easier to visually comprehend.

Answer the question for all parts in the space below.

a)

((a /\\ b /\\ c) /\\ d) \\/ ((e \\/ (f /\\ g)) \\/ ((a /\\ b /\\ c) /\\ d) \\/ ((e \\/ (f /\\ g))

((~a \\/ ~b \\/ ~c) /\\ d) \\/ (~e /\\ f /\\ g)

(a /\\ b /\\ c) \\/ ~d \\/ (~e /\\ f /\\ g)

b)

dual f = (a \\/ b \\/ c) /\\ ~d /\\ (~e \\/ f \\/ g)

= (a /\\ d /\\ ~e) \\/ (a /\\ d /\\ f) \\/ (a /\\ ~d /\\ g) \\/ (b /\\ ~d /\\ ~e) \\/
(b /\\ d /\\ f) \\/ (b /\\ d /\\ g) \\/ (c /\\ ~d /\\ ~e) \\/ (c /\\ ~d /\\ f) \\/ (c /\\ ~d /\\ g)

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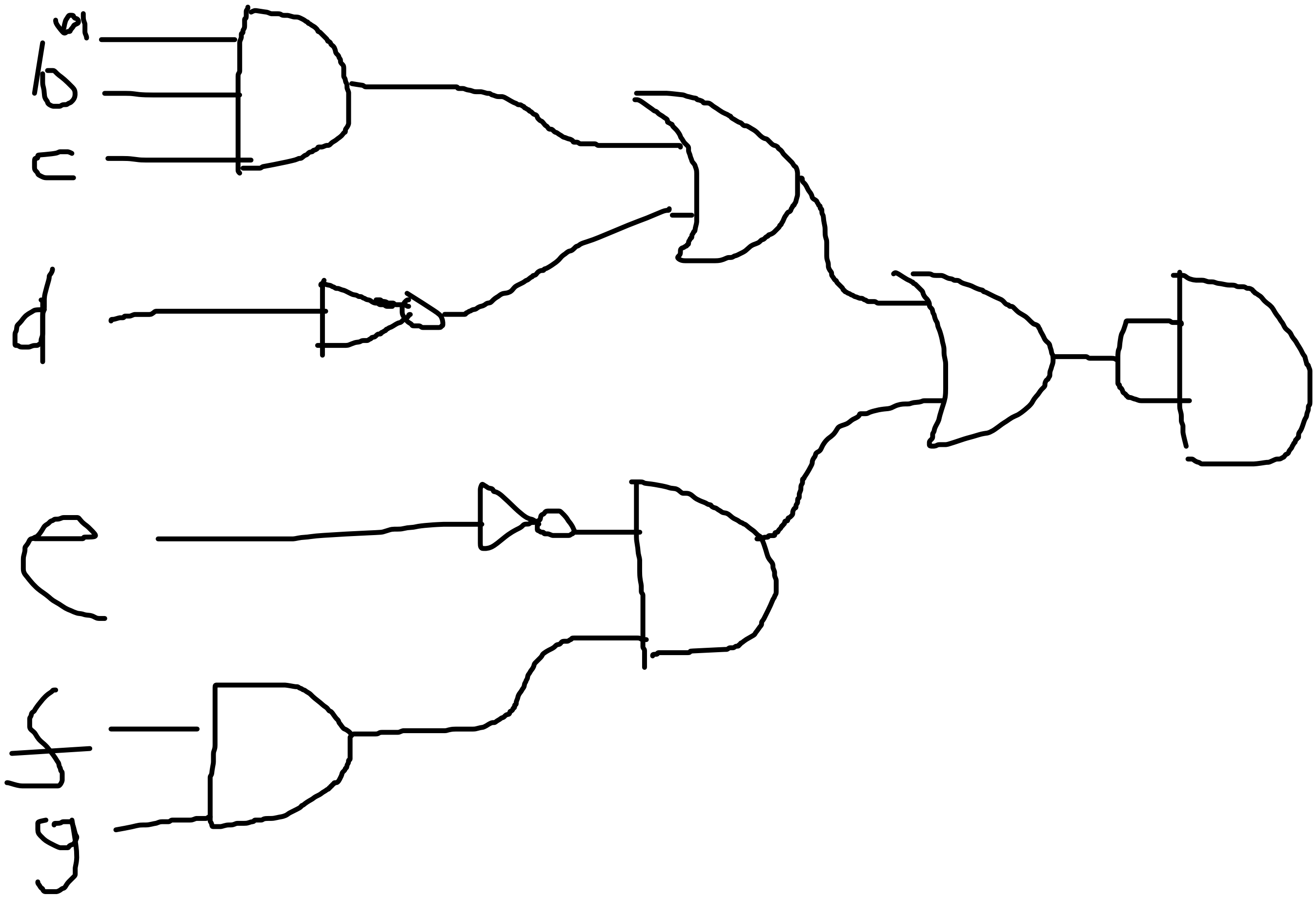
c)



Problem #2

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(a) Draw K-Map of the function corresponding to the truth table shown above.
(b) Identify the prime implicants of the function.
(c) Identify which of the prime implicants (if any) are essential.
(d) Write the cover as a logical function using prime implicants.
(e) Draw a logic gate diagram using the equation in (d) and using only NAND gates.

Answer the question for all parts in the space below.

a)

C

AB\CD	00	01	11	10
00	0	0	1	0
01	0	0	1	1
11	0	0	0	0
10	0	1	1	1

B

a

D

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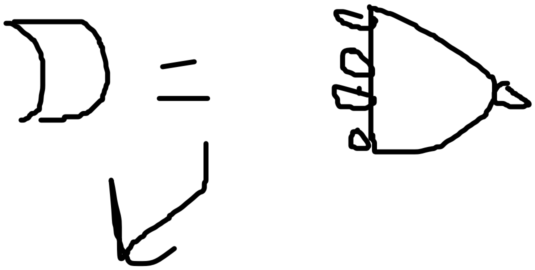
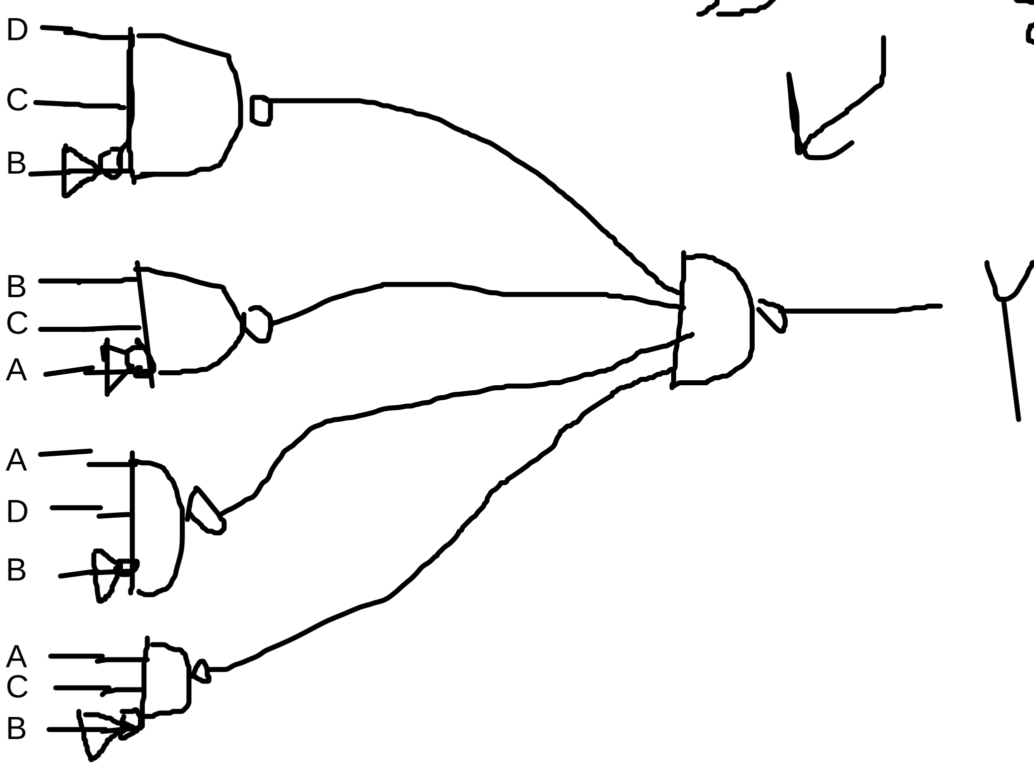
B) D) (d /\\ c /\\ ~b) \\/ (b /\\ c /\\ ~a) \\/ (a /\\ d /\\ ~b) \\/ (a /\\ c /\\ ~b)

C) the four prime implicants above are all essential since each one contains a unique 1.



e)



Problem #3

A	B	C	D	Y
0	0	0	0	X
0	0	0	1	X
0	0	1	0	X
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	X
1	0	1	1	0
1	1	0	0	X
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(a) Draw K-Map of the function corresponding to the truth table shown above. Draw all the prime implicants.

(b) Highlight the cover of the function on the K-Map using the prime implicants.

(c) Write the logical function using the results in (b)

Answer the question for all parts in the space below.

a) b)

C

AB\CD	00	01	11	10
00	X	X	0	X
01	1	0	0	1
11	X	0	0	0
10	0	1	0	X

B

A

D

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c)

(d /\\ ~c /\\ ~b) \\/ (b /\\ ~a /\\ ~d)

Problem #4

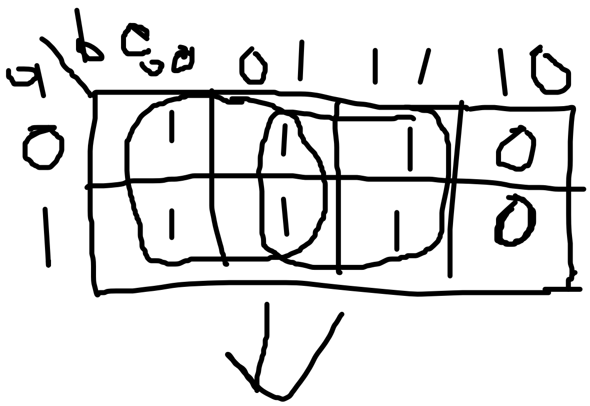
Simplify the following functions and find a simple implementation using AND, OR and INV gates.

(a) $Y = (\neg a \wedge b \wedge c) \vee \neg(b \wedge \neg c) \vee (b \wedge c)$

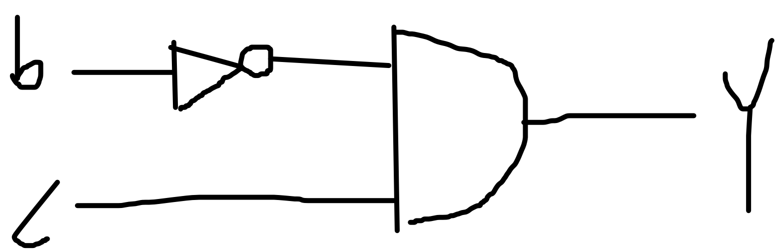
(b) $Z = (a \wedge b \wedge \neg c) \vee \neg\big(a \wedge \neg(\neg b \wedge c)\big) \vee \neg(\neg d \vee e) \wedge$c

Answer the question for all parts in the space below.

a)



(~b /\\ c)



b)

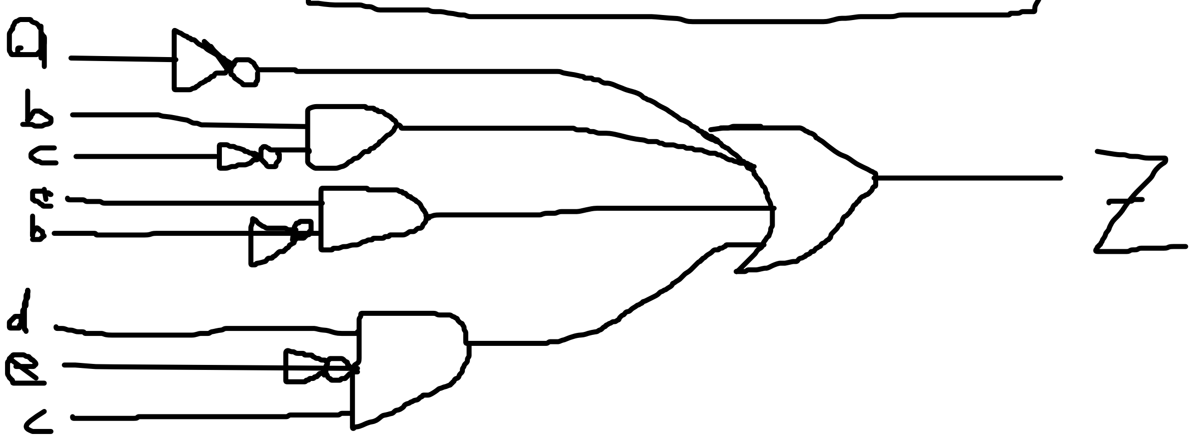
(a /\\ b /\\ ~c) \\/ (~a \\/ (~b /\\ c)) \\/ (d /\\ ~e) /\\ c

(a /\\ b /\\ ~c) \\/ ~a \\/ (~b /\\ c) \\/ (d /\\ ~e /\\ c)

((a \\/ ~a) /\\ (b \\/ ~a) \\/ (~a /\\ ~c)) \\/ (~b /\\ c) \\/ (d /\\ ~e /\\ c)

(~a \\/ b /\\ ~c) \\/ (~b /\\ c) \\/ (d /\\ ~e /\\ c)

~a \\/ (b /\\ ~c) \\/ (~b /\\ c) \\/ (d /\\ ~e /\\ c)



Problem #5

You may use whatever source desired to look up the definitions below.

(a) Define “Gray Code”.

(b) Define “Cyclic Gray Code”.

(c) Design a 3-bit cyclic Gray code ($G=[g_2, g_1, g_0]$) such that all possible combinations of G are included.

Answer the question for all parts in the space below.

a) Gray code - a binary numeral system in which two successive
values
differ in exactly one bit.

b) Cyclic Gray Code- only one value changes when going from the last bit to the first

c)
000
001
011
010
110
111
101
100

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Problem #6

FPGAs are designed such that arbitrary logic for a number of inputs and outputs can be implemented within the blocks. The amount of logic functions that can be implemented grows rapidly with the number of inputs. We saw this in lecture with 2-inputs.

(a) With 4-bit inputs, how many functions are possible?

(b) With 4-bit inputs, how many functions where half of the outputs are 1's (the other half are 0's) are possible.

Answer the question for all parts in the space below.

a) $2^{16} = 65{,}536$

b) with 16 bits we need exactly 8 1's and 8 0's. We can find the number of unique combinations for these outputs by:

$$_{16}C_{8} = \frac{16!}{8!\,(16-8)!}$$

$$\boxed{= 12{,}870}$$

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