Midterm Exam

Name (Last, Fi	rst)
Student Id #:	

Do not start working until instructed to do so.

- 1. You must answer in the <u>space provided</u> for answers after every question. We will ignore answers written anywhere else in the booklet. <u>All pages in this booklet must be accounted</u> for otherwise it will not be graded.
- 2. You are permitted 1 page of notes 8.5x11 (front and back).
- 3. You may not use any electronic device.

Following table to be filled by course staff only

Maximum Score	Your Score
100	
	Score

Question #1

Consider the following Kamaugh Map for the Boolean function, Y. A blank truth table is provided XX01) for your convenience.

								X	1		
						Al	в Ż)	$[] \times X$
		T	"00)"	"01	"	/"11 <u>"</u>	"1	0"		· vov
	"00'	•	0		0		91	1	1	2	(XOX)
	"01	•	<u>(1</u>		1		X	>	Ø `		(XXI)
ÇD	"11	"	0		0		1		1		
	"10	"	(1		1	2	(x))	_	01XC
	Α	E	3	С		D	Y	Y	17	11 7	
	0	- (5	0		0	0	1		0	
	0		3	0		1	1	1	-	X	
1	0	(0	1		0	1	-	0	1	
	0	-	0	1		1	0		4	0)	
10	0		1	0		0	0	1	0	0	
	0		1	0		1		4	-	1	
	0		1	1		0			2	X	
	0		1	1		1	0	-	+	_0	·
	1		0	C)	0		_	0	1	
	1		0	C)	1	X	-	X	0	
	1		0	1		0	0	-	1	0	
	1		0	1		1_		-	0_	1	
	1		1	+)	0	1	-	-0-1	-	
	1	1	1	-)	1	X	+	X	10	
	1		1	+	1	0	X	+		1	and the state of t
	1		1		1	1			0		

(a) Circle the prime implicants on the map. How many prime implicants are there?_

(b) Write the Boolean (sum-of-product) expression of the essential prime implicants of (b) (if EssentialPrimeImplicants = (CD) v (AC) v (AD) v (ACT) any).

st (c) Complete the following statement

$$\neg Y = \prod M($$

This seems like the

1x10

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(d) Express as a minimal sum of product, ¬Y.The K-map is provided for your convenience

The K-map is provided for	your convenien	ce.			
		AB			
	"00"	"01" "1	11" "10"	1.00	
	"00"	0	1 1	1X 10 0X 11 C X 00	TO
CI	"01" 1	1 ;	х х	LX 10	ACD
	"11" 0	0	1 1	(\(\lambda\)	
•	"10" 1		X 0		
$\neg Y = \bigcap_{A}$	cō) v (ĀcD) v (A	cħ)		2)	15 it advot i
(e) Is the dual of this function i Justify your answer:	tself? Circle one	: Yes	No No		Is it advot in there are don't (are values
If it weren't for don't co	ire volues it wi	ind obvious	ily be a d		\./o[
It still is however, because Y you wrote (f) If the logic is implemented a static hazard?	ie you would d	jet the id.	entical logic		
Y, Y' if you wrote	o boolean exp	ression and	L flipped v	EN FO	could cover we
(f) If the logic is implemented in	are any value	becouse il	t docsatt	rutter.	
	a surgition in initial flat		auct explessi	on, is ther	e a risk of a
Circle one: Wes Under what input conditions	No				
what input conditions)				
What product term(s) would	VOIL add to rem	ove the rick?)		
		UVE TIETISK?			
Mutis a Static haza.	15				

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Ouestion #2

(a) Rewrite the following Boolean equation as a sum-of-products or product-of-sum. Hint: apply DeMorgan's theorem.

 $W = \neg \left(\neg (c \lor \neg (a \land \neg b)) \lor (d \land \neg e)\right) \qquad \left(\left(c + (ob')\right) + \left(d\tilde{e}\right)\right)'$ $= ((\sqrt{(a^{-1}b)}) \wedge (\sqrt{(a^{-1}e)}) = ((\sqrt{(ab')})(de'))$ Answer: $= ((\sqrt{(a \vee b)}) \wedge (\overline{J} \vee e) = (C + (ob)) (\overline{J} + e)$ (c+(a'2b))(d'+e) (CVQVb) A (Lve) (C+a'+b)(d'+e) SOP: $W = \frac{((\sqrt{0}\sqrt{b})^{\Lambda}(\overline{d}\sqrt{e})}{}$ - d+ dd+ hd+ ce+de+ be

(b) Rewrite the following Boolean equation as a sum-of-products or product-of-sum.

Answer: Find logical equivalent of
$$CV(a \wedge b)$$
 $V(d \wedge e)$

$$= (C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))$$

$$= (C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))$$

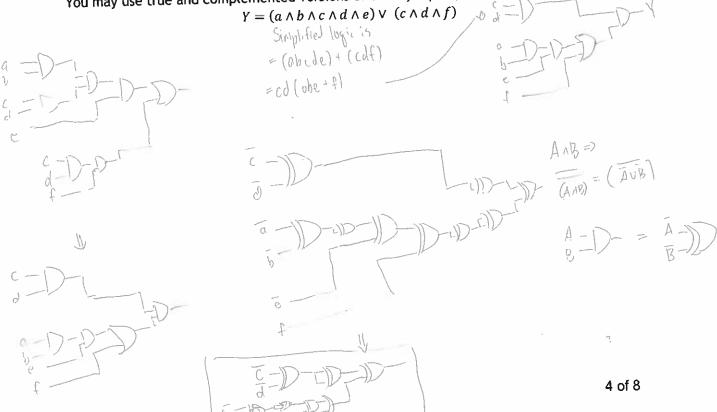
$$= (C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))$$

$$= (C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))$$

$$= (C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))V(C_{\Lambda}(a \wedge b))$$

$$X = \frac{(ab) \vee (c\bar{a}) \vee (c\bar{b}) \vee (\bar{c}ab) \vee (de)}{ab}$$

(c) Implement the following function using NOR gates only and the fewest NOR gates possible. You may use true and complemented versions of the a-f inputs,



20 20

Question #3			
	t word can be used to	represent different numbers de	pending on the
encoding	Tot!	lot one - Mest	pending on the
12b'1011_1	101_0110 —	/	
(a) If the word is 2's	s complement, what i	s the corresponding integer?	1066
		20	
(b) If we convert the	e word into base-4, w	hat is the represented number?	
-233112	2 bils Noeded.	(0, 1-3 10-11-11-01-01-1	0
(c) If we take answ	or in (h) weito the 21-		2 : 1:1:1:7
3 \ 00221	er iii (b), write the 3 s	complement of the base-4 num	ber.
	-0 -1 -7	-3-1-1-2	100221
(d) If the word is un	signed fixed point 6.6	, what is the corresponding num	nber?
47.6875	(D // ,	() 1 () 1 ()	47 2 2 4 2 4 2
Maria de la companya dela companya dela companya dela companya de la companya dela companya de la companya de l	18 + 27+21+3	2/22 32+8+4-2+1 = 47	6
vvriat is the abso	olute accuracy of this	representation?015125	25 %54.125
(e) What is this wor	d in Hexadecimal? $\underline{\beta}$	DS 1011 101 0110	,125
, , , , , , , , , , , , , , , , , , , ,		- 6) 2 V 5	,0625 ,501
(f) If the word is 6E	5 floating point numb	er (IEEE format S+EEEEE+MM	MMMM), 03125 1125 0110 015125 266
	bi	ias = [5/2] = 2 01/11 01	0110
What is the bias	?		
/		13 , S. , /F-1	rine)
What is the corre	esponding real number	er? $\frac{-22*10^{13}}{(-1)^{5}(1tm)} \cdot 2^{(E-b)}$	ias) Auans = Olas
			\
		er? <u>- 22 * 10¹³</u> (-1) ^S (I _{LM}) · 2 ^{(E-L}	\
(g) In base-20 syste	em and using 3 "vigits	" (base-20 digits) in 20's comple	\
(g) In base-20 syste	em and using 3 "vigits" represent a base-10 i	" (base-20 digits) in 20's comple	ment:
(g) In base-20 syste How would one i What is the most	em and using 3 "vigits" represent a base-10 i	" (base-20 digits) in 20's comple	ment:
(g) In base-20 syste	em and using 3 "vigits represent a base-10 i t positive value in bas	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe	ment:
(g) In base-20 syste How would one i What is the most	em and using 3 "vigits" represent a base-10 i	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe	ment:
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(g) In base-20 syste How would one i What is the most	represent a base-10 it positive value in base-	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe	ment: 2 = 6 = 10 10 10 10 10 10 10 10
(g) In base-20 syste How would one i What is the most 3999	represent a base-10 it positive value in base	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 9 9 19 19 Number is negative Company 15 bias 2	ment: 19
(g) In base-20 syste How would one i What is the most 3999	represent a base-10 it positive value in base	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 9 9 19 19 Number is negative Company 15 bias 2	ment: 2 = 6 = 10 10 10 10 10 10 10 10
(g) In base-20 system How would one in What is the most 3999 26 /2 -1	represent a base-10 it positive value in base	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 22 9 19 19 Number is negative Exponent is 15 bias 2 Man fisse is	ment: 19
(g) In base-20 system How would one is What is the most 3999 26 /2 -1	represent a base-10 it positive value in base	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 22 9 19 19 Number is negative Exponent is 15 bias 2 Man fisse is	ment: $2^{-6} =$ 19 10 + 19 20 + 19 380 24 22 + 22 16 + 10 = 12
(g) In base-20 system How would one is What is the most 3999 26 /2 -1	represent a base-10 it positive value in base	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 9 9 19 19 Number is negative Company 15 bias 2	ment: 2^{-6} = 10110 $2^{4}+2^{1}+2^{1}$ $19+380$ $16+4^{1}=2^{2}$
(g) In base-20 system How would one is What is the most 3999 26 /2 -1	represent a base-10 it positive value in base	"(base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 20 9 19 19 Number is negative Exponent is 15 bigs 2 Man fisse is - 1616 70 1/2 = 0 1	ment: $2^{-6} =$ 19 10 + 19 20 + 19 380 24 22 + 22 16 + 10 = 12
(g) In base-20 syste How would one i What is the most 3999 26 /2 -1 bia; (5/2)=(2)	represent a base-10 it positive value in base	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 22 9 19 19 Number is negative Exponent is 15 bigs 2 Man fisse is - 1616 7 0 1/2 = 0 1	ment: $19 \cdot 10 + 19 \cdot 20^{1} + 10110$ $2^{4} + 2^{2} + 2^{2}$ $10 \cdot 10 = 10000$ $1 \cdot 10 \cdot 10 = 10000$ $1 \cdot 10 \cdot 10 = 10000$
(g) In base-20 system How would one in What is the most $\frac{3999}{26^2/2}$ -1 bias $(\frac{5}{2})$ = (2)	represent a base-10 is positive value in base-10 is too to the positive value in base-10 is to positive value in base-10 is too to the positive value in base-10 is to	" (base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 22 9 19 19 Number is negative Exponent is 15 bigs 2 Man fisse is - 1616 7 0 1/2 = 0 1	ment: $19 \cdot 10 + 19 \cdot 20^{1} + 10110$ $2^{4} + 2^{2} + 2^{2}$ $10 \cdot 10 = 10000$ $1 \cdot 10 \cdot 10 = 10000$ $1 \cdot 10 \cdot 10 = 10000$
(g) In base-20 syste How would one in What is the most 3999 26 /2 -1 bia; (5/2)=(2) 100 100 1100 1100 1100	represent a base-10 is positive value in base-10 is too to the positive value in base-10 is to positive value in base-10 is too to the positive value in base-10 is to	"(base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 2 9 19 19 Number is negative Exponent is 15 bias 2 Man lisse is -	ment: 19 20 + 19 20 + 19 20 + 10110 $2^{4}+2^{2}+2^{2}$ $10 \times 10 \times$
(g) In base-20 system How would one in What is the most $\frac{3999}{26^2/2}$ -1 bias $(\frac{5}{2})$ = (2)	represent a base-10 is topositive value in base 10 is topositi	"(base-20 digits) in 20's comple nteger -1616? e-10 integer that can be represe 22 9 19 19 Number is negative Experent is 15 bias 2 Manfissa is - 1616 7 0 12 = 0 1	ment: $19 \cdot 10 + 19 \cdot 20^{1} + 10110$ $2^{4} + 2^{2} + 2^{2}$ $10 \cdot 10 = 10000$ $1 \cdot 10 \cdot 10 = 10000$ $1 \cdot 10 \cdot 10 = 10000$
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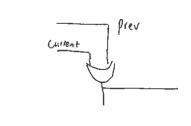
0010 0100 1000

output vector, twoh[15:0]. This 2-hot vector has up to two positions of 1's and the remainder are 0's. If b1 is the same as b2, then only a single 1 is asserted. Design this logic. You may use 2:4 Decoders as building blocks and any number of AND, OR, or INV gates. Try to minimize the amount you use. You may describe connections to avoid an overly complex drawing of every signal and line. 1000

drawing of every signal and line.	00	००८ ५ ००१८
61[3] 61[2] 61[1] 61[0] 62[3] [2] [47 [47	01	0 100
0 0 0 0 0 0 0	1 1	1000
o o o 1 For each tecoder there a 64		
0 0 1 0		
0 0 1		
7 2.4		
0 1 0 1		
15 0 1 10 7 12:4		
10015 1 0 00		
3/24		
72:4		
I I I I I I I I I I I I I I I I I I I		
3 () () () () () () () () () (
All possible permotations		
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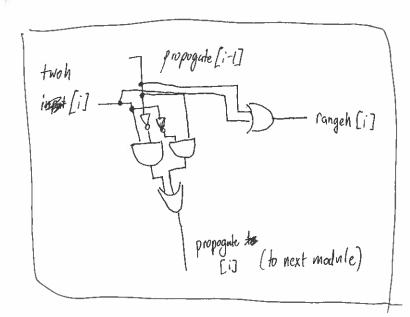
(b) Next, you are tasked to code the twoh[15:0] signals into a vector that indicates a range, similar to a thermometer code. The 16-bit input, twoh[15:0], produces 16-bit outputs, rangeh[15:0], whereby the positions in between the 2 asserted signals of the twoh[15:0] are 1's. For instance, with b1[3:0]=4'b0110 and b2[3:0]=4'b0010, rangeh[15:0]=16b'0000_0000_0011_1110. You may use any building block we have covered in lecture as well as any number of AND, OR, or INV gates. Again you can describe connections to avoid drawing every signal and line.



if previous is 0 and unrent is 1, propogate. if previous is 1 and current is 1, don't propagate if previous is 1 ond current is 0, propagate



		11.0		
Vievi	ous (chront	Propogate	output
0		0	0	0
0	1	1	1	
11		0		l t
1		1	0	
1	-			
•	,		1	



pup =	PCV PC
Output	

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(c) Finally, encode inverse the function of (a) by accepting the *twoh[15:0]* signal as input and output 2 binary values *bo1[3:0]* and *bo2[3:0]* to indicate the binary position of the two hot bits. You may use any building block we have covered in lecture as well as any number of AND, OR, or INV gates. Again you can describe connections to avoid drawing every signal and line.

2 3

4.2

Here, you need to have encoders and probably a Mux to