

Logic Design –Midterm #1**Class:** _____**ID:** _____**Name:** _____

1. (6%) Convert 145.3_6 to the one with base 7.

A: (122.333₇)

2. (7%)(a)(3%) Express (-100) with an 8-bit number using 2's complement for negative number. (b)(4%) What is the range of numbers that N-bit 2's complement number system can represent?

A: (a) 10011100

(b) $2^{N-1}-1 \sim -2^{N-1}$

3. (7%) Assume we use 1's complement to represent negative number. Is the addition as shown in Fig. 1 valid (not overflow)? Translate to decimal addition if YES, otherwise explain the reason (why overflow).

$$\begin{array}{r} 100110 \\ + 010001 \\ \hline 110111 \\ \text{-----} \\ 110111 \end{array}$$

(A dashed line with an arrow points from the carry-out of the 6th bit to the 7th bit, indicating a carry.)

Fig. 1

A: Yes, $-25 + 17 = -8$

4. (6%) How many switch functions of four variables are there?

A: $2^{2^4} = 65536$

5. (6%) Show the procedure of the addition $(-11) + 3$ with 6-bit binary number. Also indicate the result in decimal. Using 2's complement for negative number.

$$\begin{array}{r} 110101 \\ + 000011 \\ \hline 111000 \end{array}$$

A: 111000 = -8

6. (7%) Factor the expression $\underline{ABC + ADE' + ABF'}$ to obtain a product of sums.

A: $A(B+D)(B+E')(C+D+F')(C+E'+F')$

7. (9%) Simplify the expression $\underline{A'BCD + A'BC'D + B'EF + CDE'G + A'DEF + A'B'EF}$ to a 3-term SOP form.

A: $A'BD + B'EF + CDE'G$

8. (9%) Simplify the expression $\underline{[(A'+B'C + D')(B+D+AC')]' + (B+C+D)' + A'C'D}$ to a 3-term SOP form.

A: $ABD + C'D + B'D'$

9. (18%) A combinational network has 4 inputs A, B, C, D and two outputs Y, Z. The output Y is 1 if and only if two inputs are 1. The output Z is 0 if and only if three inputs are 1. (a)(4%) Draw the truth tables of Y, Z. (b)(4%) Plot the K-Map of Y, Z. (c)(6%) Express the (individual) minimum SOP forms of the Boolean function Y, Z. (d)(4%) What is the Boolean function of \underline{YZ} ?

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

A: (a)

		Y						Z			
		00	01	11	10			00	01	11	10
CD \ AE	00	0	0	1	0	CD \ AE	00	1	1	1	1
	01	0	1	0	1		01	1	1	0	1
	11	1	0	0	0		11	1	0	1	0
	10	0	1	0	1		10	1	1	0	1

(b)

(c) $Y = \sum m(3, 5, 6, 9, 10, 12)$

$Z = A'B'(m3) + B'D'(m10) + A'D'(m6) + A'C'(m5) + B'C'(m9) + C'D'(m12) + ABCD(m15)$

(d) 0

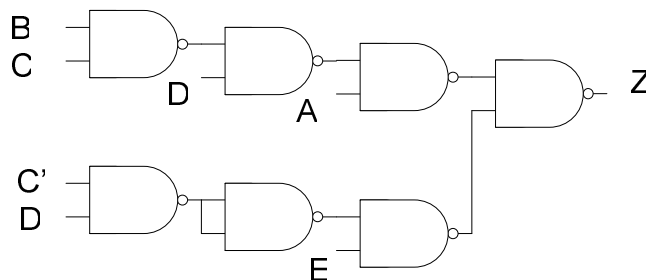
10. (13%) Given an N-input function $F = \sum m(i, j, k)$, $0 \leq i, j, k \leq 2^N - 1$, $i \neq j \neq k$. (a)(5%) Express F' by maxterm expansion. (b)(8%) Express F^D (duality of F) by maxterm expansion.

A: (a) $F' = \prod M(i, j, k)$ (b) $F^D = \prod M(2^N - 1 - i, 2^N - 1 - j, 2^N - 1 - k)$

11. (7%) Assume that the inputs $ABCD = 0101, 1001, 1011, 1000$ never occur, find the minimum SOP form of $F = A'B'D + A'CD + BD + ABCD'$.

A: $F = D + ABC$

12. (5%) Realize $Z = ABC + AD' + C'DE$ using only seven 2-input NAND gates. Inverted inputs are allowed. (Draw the logic network.)



A: