

Logic Design –Midterm #1

Class: _____

ID: _____

Name: _____

1. (7%) Convert 144.6_7 to the one with base 5.

A: 311.412032

2. (6%)(a)(3%) Express (-90) with an 8-bit number using 2's complement for negative number. (b)(3%) What is the range of numbers that N-bit 1's complement number system can represent?

A: (a) 10100110 (b) $2^{(N-1)} \sim -2^{(N-1)}+1$

3. (7%) Assume we use 2'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).

A: No, because $(-26) + (-10) = (-36)$, it overflows

$$\begin{array}{r} 10011C \\ + 11011C \\ \hline (1) 011100 \\ \swarrow \\ \text{discard} \end{array}$$

Fig. 1

4. (6%) The minimum SOP form of $F = (X+Y)(Y+Z)(X'+Z)$ has m terms. The minimum POS form of $G = YZ + X'Z + XY$ has n terms. How many switch functions of $(m+n+1)$ variables are there?

A: $m=n=2$, $2^2 2^{(m+n+1)} = 2^5 = 32$

5. (6%) Show the procedure of the addition $(-10) + (-22)$ with 6-bit binary number. Also indicate the result in decimal. Using 2's complement for negative number.

$$\begin{array}{r} 11011C \\ + 10101C \\ \hline (1)10000C \\ \swarrow \\ \text{discard} \end{array}$$

A:

$(-10) + (-22) = (-32)$, $-32 = 100000$

6. (7%) Factor the expression $\underline{ABC + BDE' + ABF' + G}$ to obtain a POS form.

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

7. (9%) Use K-Map to simplify the expression $\underline{F=ABC' + (A'C' \equiv B) + (C \oplus AD) + ABCD}$ to a minimum SOP form.

A: $A+B+C$

8. (16%) 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 one input is 1. (a)(4%) Draw the truth tables of Y, Z. (b)(4%) Plot the K-Map of Y, Z. (c) (4%) What is the Boolean function of $\underline{Y' + Z}$? (d)(4%) What is the physical meaning of $\underline{Y' \oplus Z}$ (ex: the physical meaning of Y is if and only if two inputs are 1)?

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

A: (a) (b)

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

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

(c) $Y' + Z = 1$

(d) the number of inputs equals 1 or 2, the output =1

9. (12%) Given an N-input function $F = \prod M(a, b, c)$, $0 \leq a, b, c \leq 2^N - 1$, $a \neq b \neq c$. (a)(5%) Express F' by maxterm expansion. (b)(7%) Express F^D (duality of F) by minterm expansion.

A: (a) $F' = \prod M(i), i \text{ from } 0 \sim 2^N - 1, \text{ but } i \neq a \neq b \neq c$ (b) $F^D = \sum m(2^N - 1 - a, 2^N - 1 - b, 2^N - 1 - c)$

10. (7%) Assume that the inputs ABCD = 0110, 1001, 1011, 1000 never occur, find the minimum SOP form of $F = A'B'D + A'CD + BD + ABCD'$.

A: $F = D + BC$

11. (5%) Use Boolean algebraic operations to show that $WX + XY + X'Z' + WY'Z' = WX + XY + X'Z'$.

A: omitted

12. (6%) What are the values of m_i AND m_j , M_i OR M_j , if $i \neq j$?

A: m_i AND $m_j = 0$, M_i OR $M_j = 1$

13. (6%) Why can Carry Lookahead Adder and Carry Select Adder speedup the addition operation?

A: omitted