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

ID: _____

Name: _____

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

A: (122.333_7)

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) $2^{N-1}-1$ ~ -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).

```
  100110
+ 010001
--------
  110111
      → 0
--------
  110111
```

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.

```
  110101
+ 000011
--------
  111000
```

A: 111000= -8

6. (7%) Factor the expression 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 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 [(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 Y Z' ?

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) **(b)**

Y

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

Z

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

(c) Y = ∑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), $0 \le i, j, k \le 2^N-1$, $i \ne j \ne k$. (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: