國立中山大學 101 學年度第一學期資工系數位系統期中考試

學號：　　姓名：

一、選擇與是非題（每題 3 分，15 分）

(　　) 1. 關於 Karnaugh maps 而言，下列何者錯誤？ ① a pictorial form of a truth table ② each square represents one maxterm ③ any two adjacent squares in the map differ by only one variable ④ applicable if the number of variables < 7。

(　　) 2. 下列何者錯誤？ ① $x+yz = (x+y)(x+z)$ ② $(x \oplus y)' = x'y + xy'$ ③ $x \oplus 1 = x'$ ④ $x \odot x' = 0$。

(　　) 3. 下列那一個 two-level form 是 nondegenerate form？①AND-NOR ②AND-NAND ③NAND-OR ④ NOR-NAND。

(　　) 4. A prime implicant is a product term obtained by combining the maximum possible number of adjacent squares and not contained in any other prime implicant.

(　　) 5. XOR 是 odd function 而且可以產生偶同位的 parity bit。

二、問答題（85 分）

1. $F(w, x, y, z) = \sum (0, 2, 3, 5, 7, 8, 9, 10, 11, 13, 15)$. Draw the Karnaugh map and find all the simplest sum-of-products and product-of-sums of this Boolean function. (10%)

2. (1) Derive the sum-of-minterms and the product-of-maxterms canonical forms for Boolean function $F(w, x, y, z) = (w'+x)(y+z)(y'+z)$. (6%)
(2) Implement the function $F(w, x, y, z)$ with the simplest NAND-NAND and NOR-NOR logics, draw the logic diagrams. (10%)

3. Draw the Karnaugh map of Boolean function $F(v, w, x, y, z) = \sum (0, 1, 3, 6, 7, 8, 9, 11, 14, 15, 16, 17, 19, 22, 24, 25, 27, 30)$ and find all the simplest sum-of-products of this Boolean function. (10%)

4. Design a nine's complement converter that can convert the BCD code $x_3x_2x_1x_0$ to its decimal nine's complement $y_3y_2y_1y_0$.
(1) List the truth table (4%)
(2) Draw the Karnaugh map and derive the simplified Boolean functions (8%)
(3) Draw the logic diagram (3%)

5. Design a 4-bit adder with inputs $A = A_3A_2A_1A_0$ and $B = B_3B_2B_1B_0$, and outputs $S = S_3S_2S_1S_0$ and C_4.
(1) List the truth table, Karnaugh map and then draw the logic diagrams of the full adder (inputs: x, y, z and outputs: C, S) with two half adders and an OR gate. (4%)
(2) Let carry propagate $P_i = A_i \oplus B_i$ and carry generate $G_i = A_iB_i$, then sum $S_i = P_i \oplus C_i$ and carry $C_{i+1} = G_i + P_iC_i$, where $0 \le i \le 3$. Derive the Boolean functions of C_1, C_2, C_3, and C_4 with input variables G_i, P_i and C_0. Draw the logic diagram of carry lookahead generator to generate C_1, C_2, C_3, and C_4. (10%)

6. Design a 4-bit two's complement adder-subtractor with inputs $A = A_3A_2A_1A_0$, $B = B_3B_2B_1B_0$, and M, and outputs $S = S_3S_2S_1S_0$, C_4, and V. If $M = 0$, the adder-subtractor performs $A+B$. Otherwise, it performs $A-B$ (i.e., $A+B'+1$).
(1) $V = 0$ denotes that no overflow occurs and $V = 1$ denotes that an overflow occurs. Design the circuit to generate V. (4%)
(2) Draw the logic diagram of 4-bit two's complement adder-subtractor. (6%)

7. Design one digit of decimal adder.
(1) Complete the truth table shown in Table 1. (4%)
(2) Derive the Boolean function of C and draw its logic diagram. (6%)

Table 1

Binary Sum					BCD Sum					Decimal
K	Z_8	Z_4	Z_2	Z_1	C	S_8	S_4	S_2	S_1	
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	0	1	0	2
0	0	0	1	1	0	0	0	1	1	3
0	0	1	0	0	0	0	1	0	0	4
0	0	1	0	1	0	0	1	0	1	5
0	0	1	1	0	0	0	1	1	0	6
0	0	1	1	1	0	0	1	1	1	7
0	1	0	0	0	0	1	0	0	0	8
0	1	0	0	1	0	1	0	0	1	9
0	1	0	1	0						10
0	1	0	1	1						11
0	1	1	0	0						12
0	1	1	0	1						13
0	1	1	1	0						14
0	1	1	1	1						15
1	0	0	0	0						16
1	0	0	0	1						17
1	0	0	1	0						18
1	0	0	1	1						19