國立中山大學 103 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，12 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. 下列那一個 two-level form 是 nondegenerate form (亦即不可轉換成 a single operation)？ ①AND-NOR ②AND-NAND ③NAND-OR ④ NOR-NAND。

(　　) 3. 關於 XOR 以及 XNOR，何者錯誤？ ① $(x \oplus y)' = x \odot y$ ② $x \oplus y' = (y \oplus x)'$ ③ $x \oplus 1 = x'$ ④ $x \odot x' = 1$。

(　　) 4. 一般而言，Product of sums 應該轉換成 NAND Implementation，而 Sum of products 則應該轉換成 NOR Implementation 以獲得較簡單的電路。

二、問答題（88 分）

1. (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) Using the Karnaugh map to find the simplest sum-of-products and product-of-sums of this Boolean function. (6%)
(3) Implement the function $F(w, x, y, z)$ with the simplest NAND-NAND and NOR-NOR logics, draw the logic diagrams. (6%)

2. $F(w, x, y, z) = \sum (2, 6, 7, 8, 9, 13, 15)$.
(1) Find all the prime implicants for $F(w, x, y, z)$ and determine which are essential. (6%)
(2) Find all the simplest sum-of-products of this Boolean function. (6%)

3. Draw the Karnaugh map of Boolean function $F(v, w, x, y, z) = \sum (0, 1, 2, 3, 8, 9, 10, 11, 13, 15, 16, 17, 18, 19, 24, 26, 29, 31)$ and find all the simplest sum-of-products of this Boolean function. (10%)

4. A majority circuit is a combinational circuit whose output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Design a 3-input majority circuit by
(1) listing the circuit's truth table (assume that input variables are x, y, z and output variable is F) (3%)
(2) drawing the Karnaugh map and deriving the simplest Boolean function of F (3%)
(3) drawing the logic diagram. (3%)

5. Design a 4-bit carry lookahead 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. 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 $0 \le i \le 3$.
(1) Derive the Boolean functions of C_1, C_2, C_3, and C_4 with input variables G_i, P_i and C_0. (6%)
(2) Draw the logic diagram of carry lookahead generator to generate C_1, C_2, C_3, and C_4 (6%)

6. (1) Draw a three-to-eight-line decoder composted of Inverters and AND gates. (6%)
(2) Draw a four-to-one-line multiplexer composted of Inverters, AND and OR gates with the function table shown in Table 1. (6%)
(3) Implement $F(A, B, C) = \Sigma(0, 3, 4, 5)$ using 4-to-1 MUX shown in Fig. 1. (5%)

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

Table 1

S_1	S_0	Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

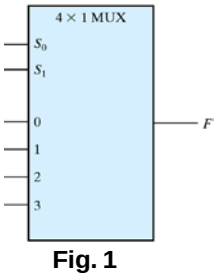

Fig. 1

Table 2

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