國立中山大學102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 two-level form，下列何者錯誤？ ① NAND-NOR is degenerate form ② OR-NAND is degenerate form ③ NAND-AND is nondegenerate form ④ NOR-NOR = product of sums。

(　　) 2. 關於 exclusive-OR 以及 exclusive-NOR function，下列何者錯誤？ ① $(x \oplus y)' = x \oplus y'$ ② $x \oplus 1 = x'$ ③ exclusive-NOR is commutative and associative ④ exclusive-NOR is an odd function。

(　　) 3. 關於 decoder，下列何者錯誤？ ① only one output can be active (high) at any time ② each output = a minterm ③ a decoder with an enable input can function as a demultiplexer ④ a n-to-2^n decoder and an external AND gate can implement any Boolean function of n input variables。

(　　) 4. 對於 7-bit Hamming code with even parity 而言，$P = x \oplus y \oplus z$ 以及 $C = x \oplus y \oplus z \oplus P$ 即為 even parity generator and checker。

(　　) 5. 對於 four-bit adder-subtractor with inputs $A = A_3A_2A_1A_0$ and $B = B_3B_2B_1B_0$ 而言，$V = C_4 \oplus C_3$ 可用於偵測 overflow，當 $V = 0$ 時代表 no overflow。

二、問答題（90分）

1. $F(w, x, y, z) = \sum (0, 1, 2, 3, 8, 10, 11, 12, 14, 15)$.
(1) Draw the Karnaugh map and find the simplest sum-of-products and product-of-sums of this Boolean function. (8%)
(2) Implement the function $F(w, x, y, z)$ with the simplest NAND-NAND and NOR-NOR logics, draw the logic diagrams. (6%)

2. $F(w, x, y, z) = \sum (0, 2, 3, 5, 7, 8, 10, 11, 14, 15)$.
(1) Find all the prime implicants for $F(w, x, y, z)$ and determine which are essential. (8%)
(2) Find all the simplest sum-of-products of this Boolean function. (6%)

3. Draw the Karnaugh map of Boolean function $F(v, w, x, y, z) = \sum (1, 2, 3, 6, 7, 9, 10, 11, 14, 15, 17, 18, 19, 22, 25, 26, 27, 30)$ and find all the simplest sum-of-products of this Boolean function. (10%)

4. Obtain the simplified Boolean expression for output F in terms of the input variables in the circuit of Fig. 1.
(1) Derive the Boolean function of F and list the truth table according to Fig. 1. (6%)
(2) Draw the Karnaugh map and derive the simplest Boolean function of F. (4%)

5. An BCD-to-seven-segment decoder is a combinational circuit that converts a decimal digit in BCD (w, x, y, z) to an appropriate code for the selection of segments in an indicator used to display the decimal digit in a familiar form. The seven outputs of the decoder (a, b, c, d, e, f, g) select the corresponding segments in the display, as shown in Fig. 2(a). The numeric display chosen to represent the decimal digit is shown in Fig. 2(b). The six invalid combinations are considered to be don't care conditions.
(1) List the truth table of output a, b, and c. (6%)
(2) Draw the Karnaugh maps and derive the simplest Boolean functions for output a, b, and c. (9%)

6. 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. (8%)
(2) Draw the logic diagram of carry lookahead generator to generate C_1, C_2, C_3, and C_4 (6%)

7. Design a four-bit magnitude comparator. Let $A = A_3A_2A_1A_0$, $B = B_3B_2B_1B_0$, and $x_i = A_iB_i + A_i'B_i' = (A_iB_i' + A_i'B_i)'$.
(1) Derive the Boolean functions of E ($A = B$), G ($A > B$), and L ($A < B$). (9%)
(2) Draw the logic diagram to produce $A_i'B_i$, A_iB_i' and x_i as shown in Fig. 3. (4%)

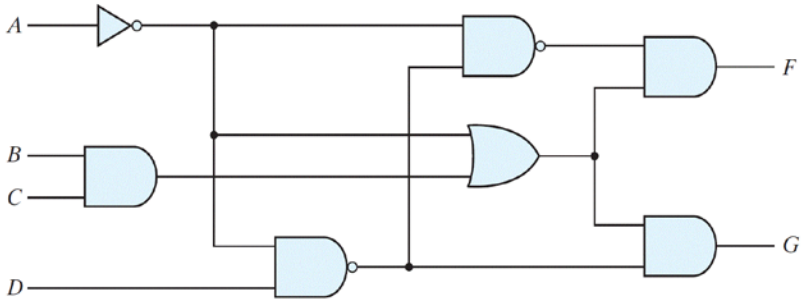


Fig. 1

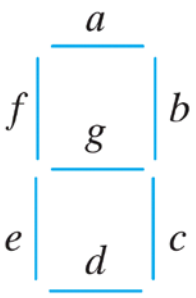


Fig. 2(a)

Fig. 2(b)

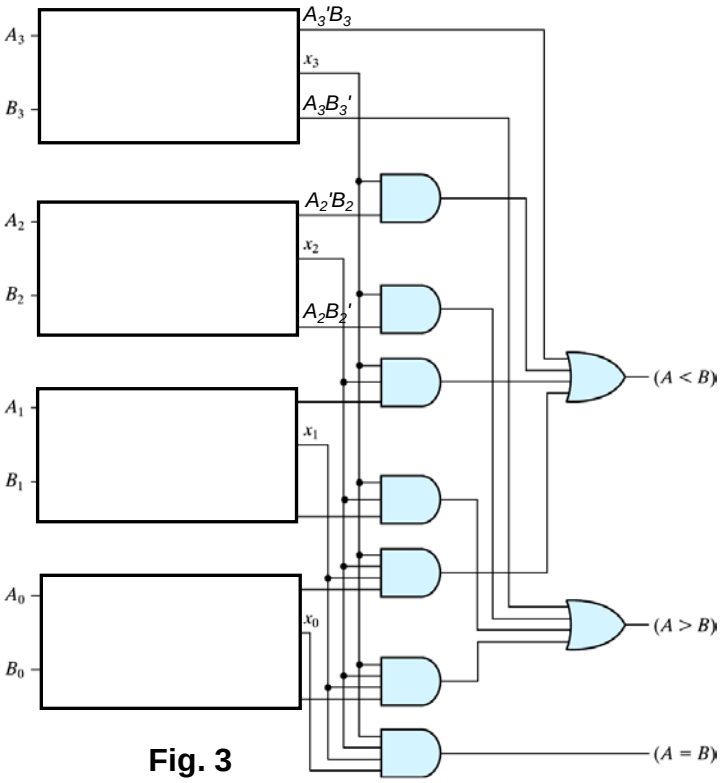
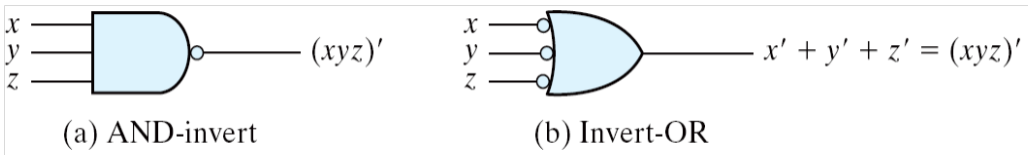
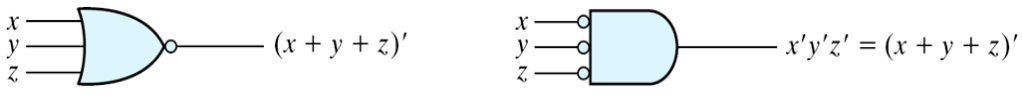


Fig. 3

wx \ yz	00	01	11	10
00	0	1	3	2
01	4	5	7	6
11	12	13	15	14
10	8	9	11	10



(a) AND-invert (b) Invert-OR



(a) OR-invert (b) Invert-AND