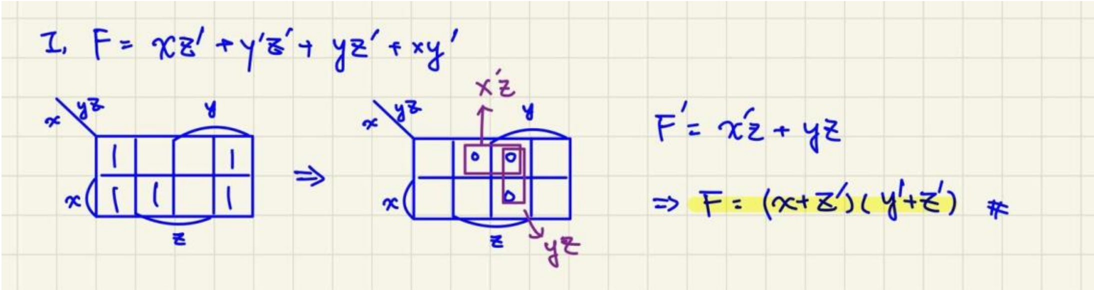
1. Simplify the Boolean expression $F(x, y, z)$ = xz' + y'z' + yz' + xy' to the form of product-of-sums. (15%)



2. Design a combinational circuit with unsigned four-bit binary input, xyzw (MSB:x, LSB:w), and unsigned four-bit binary output, ABCD (MSB:A, LSB:D). When the binary input is less than 0101, the binary output is 0011 greater than the input (for example, xyzw:0010 => ABCD:0101). When the binary input is greater than 1010, the binary output is 0101 less than the input (for example, xyzw:1110 => ABCD:1001). For other values of the binary input, the output equals the input.
   (a) Derive the truth table. (10%)
   (b) Derive the simplified Boolean expressions for A, B, C, D using maps. (16%)
   (c) Draw the related logic diagram using NAND and NOT gates only. (10%)

2、

(a)

x	y	z	w	A	B	C	D
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	0	1	0	1
0	1	1	0	0	1	1	0
0	1	1	1	0	1	1	1
1	0	0	0	1	0	0	0
1	0	0	1	1	0	0	1
1	0	1	0	1	0	1	0
1	0	1	1	0	1	1	0
1	1	0	0	0	1	1	1
1	1	0	1	1	0	0	0
1	1	1	0	1	0	0	1
1	1	1	1	1	0	1	0.

(b)

A:

xy \ zw	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	1	1	1
10	1	1	0	1

$A = x\bar{y}\bar{z} + xyw + xz\bar{w}$

B:

xy \ zw	00	01	11	10
00	0	1	1	1
01	1	1	1	1
11	1	0	0	0
10	0	0	1	0

$B = \bar{x}w + \bar{x}z + \bar{y}zw + y\bar{z}\bar{w}$

C:

xy \ zw	00	01	11	10
00	1	0	1	0
01	1	0	1	1
11	1	0	1	0
10	0	0	1	1

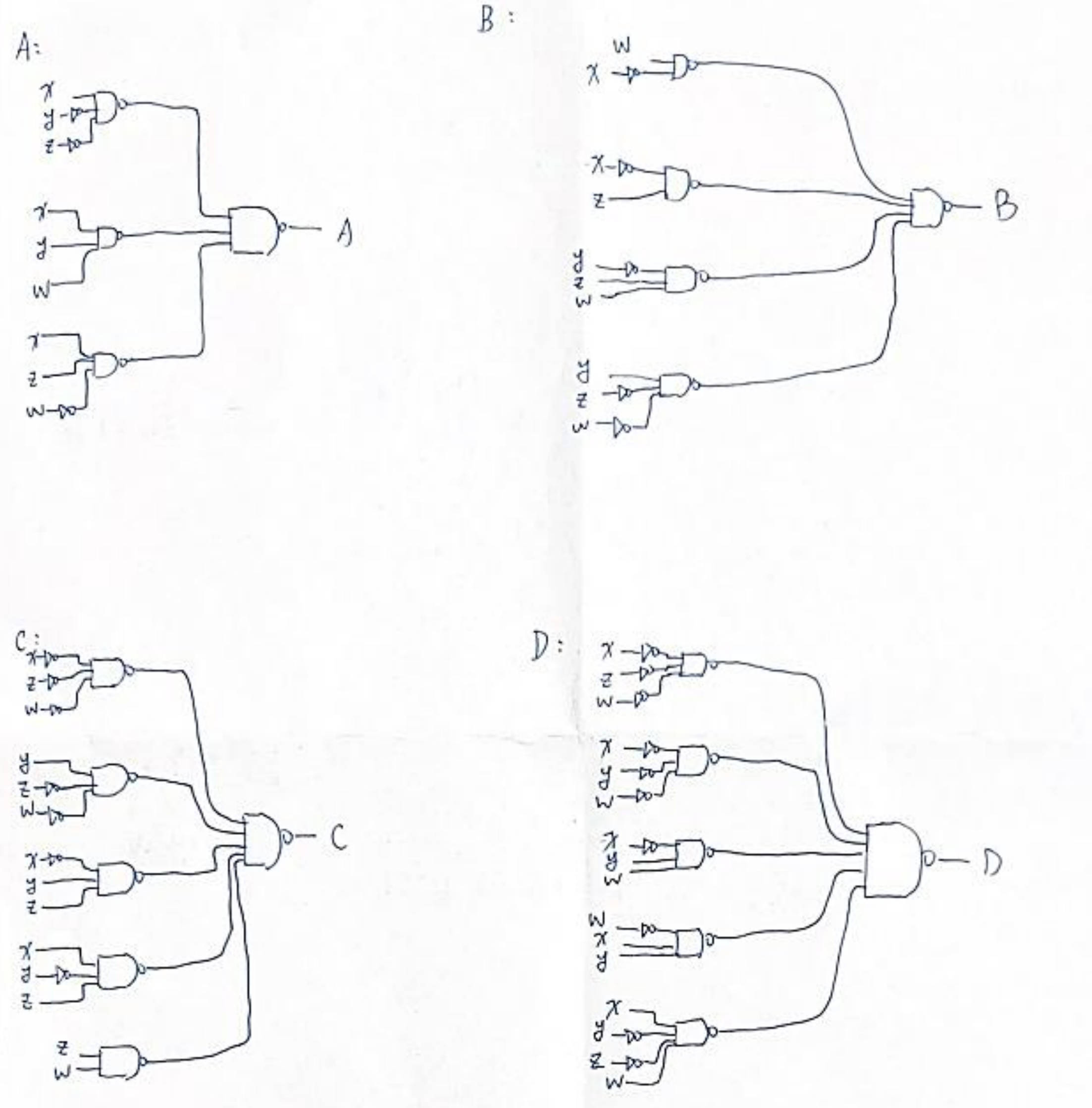
$C = \bar{x}\bar{z}\bar{w} + y\bar{z}\bar{w} + \bar{x}yz + x\bar{y}z + zw$

D:

xy \ zw	00	01	11	10
00	1	0	0	1
01	1	1	1	0
11	1	0	0	1
10	0	1	0	0

$D = \bar{x}\bar{z}\bar{w} + \bar{x}\bar{y}\bar{w} + \bar{x}yw + xy\bar{w} + x\bar{y}\bar{z}w$

(c)



3. Draw the OR-NAND implementation of the Boolean function, $F(x, y, z) = xz' + y'z' + yz' + xy'$. (15%)

$$F(x,y,z) = xz' + y'z' + yz' + xy'$$

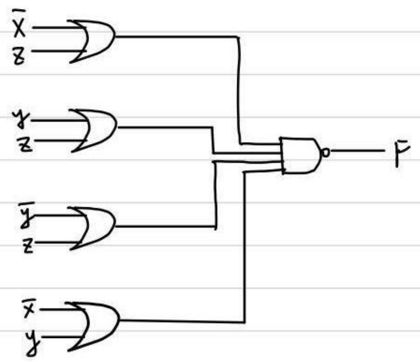
$$= \big((x'+z)\cdot(y+z)\cdot(y'+z)\cdot(x'+y) \big)'$$

$$\overset{\text{simplify}}{=} xy' + z'$$

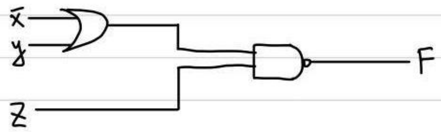
$$= \big((x'+y)\cdot z \big)'$$

x \ yz	00	01	11	10
0	1			1
1	1	1		1

Original



simplified



4. A full adder adds three binary inputs (a, b, c), and produce two outputs, sum (s) and carry (co).
   (a) Derive the truth table of a full adder. (8%)
   (b) Derive the Boolean expressions of s and co in the simplest sum-of-products forms. (8%)
   (c) Find the prime implicants and essential prime implicants of the outputs s and co. (8%)

4.

(a.)

a	b	c	s	co
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

(b.) S

a \ bc	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$S = a \oplus b \oplus c$

$= ab'c' + a'b'c + abc + a'bc'$

Co

a \ bc	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$C_o = ac + ab + bc$

$= ab + c(a \oplus b)$

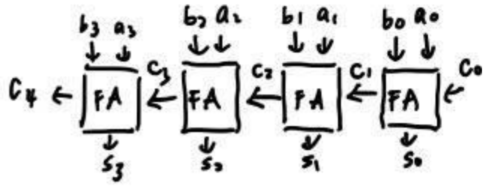
(c.) $PI(S)$: $ab'c'$, $a'b'c$, abc, $a'bc'$

$EPI(S)$: $ab'c'$, $a'b'c$, abc, $a'bc'$

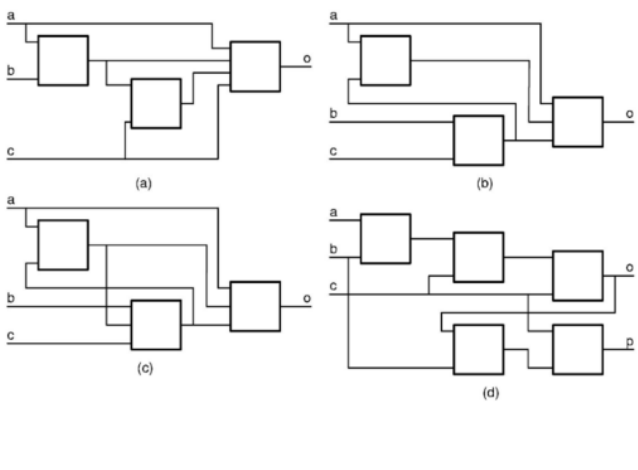
$PI(C_o)$: ac, ab, bc

$EPI(C_o)$: ac, ab, bc

(d.)

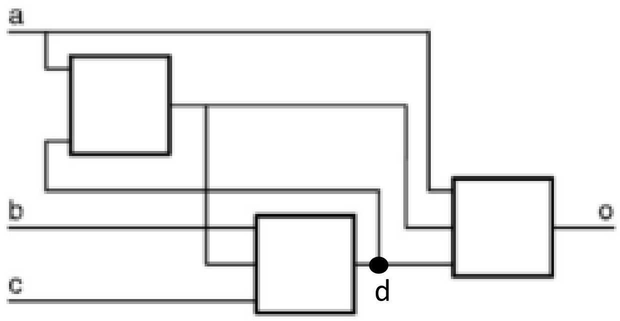


5. Which of the following circuits are combinational circuits? Each box is itself a combinational circuit. (10%)



Ans: (a)、(b)、(d) are combinational circuit.

(c) is sequential circuits. Because d(t+1) is depond on present input b c and previous ouput d(t).



(c)