1. (20%) Fill in the blanks

1）Decimal to Hexadecimal：$(132.125)_{10} = (\_\_\_\_\_)_{16}$

84.2

2）Decimal to Binary ：$(14.5625)_{10} = (\_\_\_\_\_)_{2}$

1110.1001

3）8421BCD to Decimal ：$(10000100.10010001)_{BCD} = (\_\_\_\_\_)_{10}$

84.91

4）The POM of L=X⊕Y⊕1 is _____ $L = (\overline{X} + Y) \cdot (\overline{Y} + X)$

5）Given $L = \overline{ABC + CD}$, which of the BC and D values can certainly make L=0? BC＝1_____; D＝_____1_____

6）For Common Cathode 7-segment display, the output of Ya～Yg 1111110 shows the number is_____0_____

7）Please compare the following numbers and sort them in descending order (from largest to smallest). (4 points). 1) $(165)_{o}$. 2) $(74)_{D}$. 3) $(1101101)_{B}$. 4) $(10E)_{H}$.

_____

进行二进制转换比较：

$(165)_{o} = (1110101)_{B}$ $(74)_{D} = (1001010)_{B}$ $(10E)_{H} = (100001110)_{B}$

1110.1001

3）8421BCD to Decimal ： $(10000100.10010001)_{8CD}$ =(_____)$_{10}$

84.91

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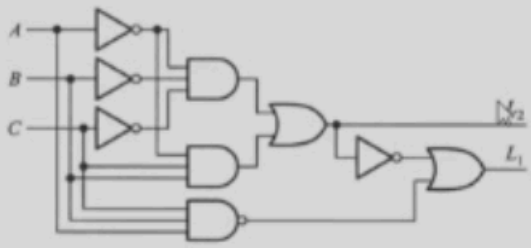
_____

进行二进制转换比较：

$(165)_{o}=(1110101)_{B}$ $(74)_{D}=(1001010)_{B}$ $(10E)_{H}=(100001110)_{B}$

$(10E)_{H}>(165)_{o}>(1101101)_{B}>(74)_{D}$

8）Please Write out the logic expression based on the circuit diagram and simplify it. (4 points).



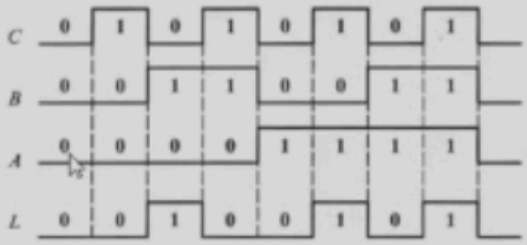
L1＝_____; L2＝_____

$L_2=\overline{A}\,\overline{B}\,\overline{C}+\overline{A}BC=\overline{A}(\overline{B}\,\overline{C}+BC)$

解：$L_1=\overline{L_2}+\overline{ABC}=\overline{A(\overline{B}\,\overline{C}+BC)}+\overline{ABC}=\overline{A(\overline{B}\,\overline{C}+BC)}\cdot ABC=\overline{0}=1$

2. Given a logical function with output L and inputs A, B, C, and

2. Given a logical function with output L and inputs A, B, C, and the waveform diagram is as follows. determine the truth table and logical function expression (4 points).



1) the truth table (2points).

L 0 0 1 0 0 1 0 1

1) the truth table (2points).

解：

A	B	C	L
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

2) logical function expression. (2points).

ANSWER:

$$L = \overline{A} \cdot B \cdot \overline{C} + A \cdot \overline{B} \cdot C + A \cdot B \cdot C$$

3. Prove the identity of each of the following Boolean equations, using algebraic manipulation (4 points)

3. Prove the identity of each of the following Boolean equations, using algebraic manipulation (4 points)

(A) $A + A \cdot \overline{B} \cdot \overline{C} + \overline{A} \cdot C \cdot D + (\overline{C} + \overline{D}) \cdot E = A + C \cdot D + E$

ANSWER:

$$A+A\,\overline{B}\,\overline{C}+\overline{A}CD+(\overline{C}+\overline{D})E$$
$$=A(1+\overline{B}\,\overline{C})+\overline{A}CD+\overline{C}\overline{D}E$$
$$=A+\overline{A}CD+\overline{C}\overline{D}E=A+CD+\overline{C}\overline{D}E \quad (\text{根据 } A+\overline{A}B=A+B)$$
$$=A+CD+E$$

(B) $(A + B) \cdot (B + C) \cdot (\overline{A} + C) = (A + B) \cdot (\overline{A} + C)$

ANSWER:

$$\text{左边}=(A+B)(B+C)(\overline{A}+C)=(A+B)(\overline{A}B+\overline{A}C+BC+CC)$$
$$=(A+B)(\overline{A}B+C(\overline{A}+B+1))$$
$$=(A+B)(\overline{A}B+C)$$

using algebraic manipulation (4 points)

(A) $A + A \cdot \overline{B} \cdot \overline{C} + \overline{A} \cdot C \cdot D + (\overline{C} + \overline{D}) \cdot E = A + C \cdot D + E$

ANSWER:

$$A+A\,\overline{B}\,\overline{C}+\overline{A}CD+(\overline{C}+\overline{D})\,E$$

$$=A(1+\overline{B}\,\overline{C})+\overline{A}CD+\overline{CD}E$$

$$=A+\overline{A}CD+\overline{CD}E=A+CD+\overline{CD}E \quad (\text{根据 } A+\overline{A}B=A+B)$$

$$=A+CD+E$$

(B) $(A + B) \cdot (B + C) \cdot (\overline{A} + C) = (A + B) \cdot (\overline{A} + C)$

ANSWER:

$$\text{左边}=(A+B)(B+C)(\overline{A}+C)=(A+B)(\overline{A}B+\overline{A}C+BC+CC)$$

$$=(A+B)(\overline{A}B+C(\overline{A}+B+1))$$

$$=(A+B)(\overline{A}B+C)$$

$$=AC+\overline{A}B+BC$$

$$\text{右边}=(A+B)(\overline{A}+C)=A\,\overline{A}+AC+\overline{A}B+BC$$

$$=AC+\overline{A}B+BC$$

4. Compute the complementing function (4 points)

(A) $L = \overline{A} \cdot \overline{B} + \overline{\overline{A} \cdot B \cdot \overline{C}} \cdot D$

ANSWER: $\overline{L} = (A + B) \cdot \left(\overline{A + \overline{B} + C} + \overline{D}\right) = (A + B) \cdot (\overline{A}B\overline{C} + \overline{D})$

(B) $L = (A + \overline{B} + C)(\overline{AB} + C)(A + \overline{BC})$

ANSWER: $\overline{L} = \overline{A}B\overline{C} + (A + B)\overline{C} + \overline{A}(B + C)$

5. Check if the following equations are valid. Please using a

5. Check if the following equations are valid. Please using a minimum number of literals by algebraic method (4 points)

$$\overline{A} \cdot C + A \cdot B \cdot \overline{C} + \overline{A} \cdot B + A \cdot \overline{B} = \overline{B} \cdot C + A \cdot \overline{C} + B \cdot \overline{C} + \overline{A} \cdot B \cdot C$$

ANSWER:

(2) 左边 $= \overline{A}C(B+\overline{B}) + AB\,\overline{C} + \overline{A}B(C+\overline{C}) + A\,\overline{B}(C+\overline{C})$

$= \overline{A}BC + \overline{A}\,\overline{B}C + AB\,\overline{C} + \overline{A}BC + \overline{A}B\,\overline{C} + A\,\overline{B}C + A\,\overline{B}\,\overline{C}$

$= m_3 + m_1 + m_6 + m_3 + m_2 + m_5 + m_4$

$= \sum m(1,2,3,4,5,6)$

右边 $= \overline{B}C(A+\overline{A}) + A\,\overline{C}(B+\overline{B}) + B\,\overline{C}(A+\overline{A}) + \overline{A}BC$

$= A\,\overline{B}C + \overline{A}\,\overline{B}C + AB\,\overline{C} + A\,\overline{B}\,\overline{C} + AB\,\overline{C} + \overline{A}B\,\overline{C} + \overline{A}BC$

$= m_5 + m_1 + m_6 + m_4 + m_6 + m_2 + m_3$

$= \sum m(1,2,3,4,5,6)$

由于等式两侧的最小项表达式相同，它们代表的是同一个函数，所以该等式成立。

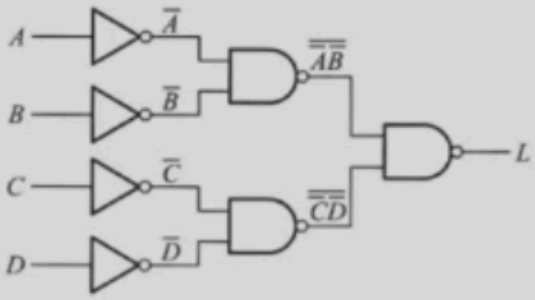
展开 mineterm 证明 minterm 一定一样 所以很好证明

• 6. logic circuit diagram (6 points)

(a) Draw the logic circuit diagram that implements the following logical expression, using only NOT gates and two-input NAND gates.

$$L = \overline{(A + B) \cdot (C + D)}$$

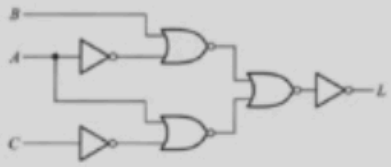
ANSWER: $L = \overline{(A + B) \cdot (C + D)} = \overline{A + B} + \overline{C + D} = \overline{\overline{A} \cdot \overline{B} + \overline{C} \cdot \overline{D}} = \overline{\overline{A} \cdot \overline{B} \cdot \overline{C} \cdot \overline{D}}$



(b) Draw the logic circuit diagram that implements the following logical expression, using only NOT gates and two-input NOR gates.

$$L = A \cdot \overline{B} + \overline{A} \cdot C$$

ANSWER: $L = A \cdot \overline{B} + \overline{A} \cdot C = \overline{\overline{A \cdot \overline{B} + \overline{A} \cdot C}} = \overline{\overline{\overline{A} + B + A + \overline{C}}}$



• 7. Convert the following expressions into sum-of-products and product-of-sums forms (4 points)

7. Convert the following expressions into sum-of-products and product-of-sums forms (4 points)

1) $\bar{X}+X(X+\bar{Y})(Y+\bar{Z})$

2) $(A+B\bar{C}+CD)(\bar{B}+EF)$

ANSWER:

$\bar{X}+X(X+\bar{Y})(Y+\bar{Z})=(\bar{X}+X)(\bar{X}+(X+\bar{Y})(Y+\bar{Z}))$

$=(\bar{X}+X+\bar{Y})(\bar{X}+Y+\bar{Z})$ p.o.s.

$=(1+\bar{Y})(\bar{X}+Y+\bar{Z})=\bar{X}+Y+\bar{Z}$ s.o.p.

$(A+B\bar{C}+CD)(\bar{B}+EF)=(A+B+C)(A+B+D)(A+\bar{C}+D)(\bar{B}+EF)$

$=(A+B+C)(A+B+D)(A+\bar{C}+D)(\bar{B}+E)(\bar{B}+F)$ p.o.s.

$(A+B\bar{C}+CD)(\bar{B}+EF)=A(\bar{B}+EF)+B\bar{C}(\bar{B}+EF)+CD(\bar{B}+EF)$

$=A\bar{B}+AEF+B\bar{C}EF+\bar{B}CD+CDEF$ s.o.p.

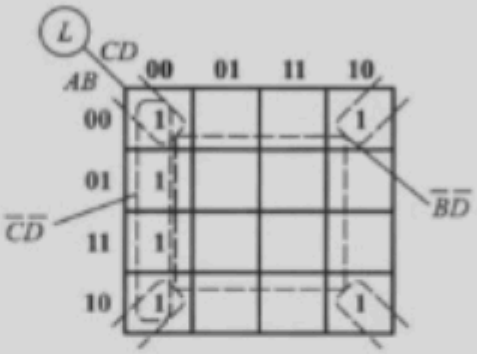
8. Simplification with K-Maps (8 points)

a) $L(A,B,C,D)=\sum m(0,2,4,8,10,12)$

• 8. Simplification with K-Maps (8 points)

a) $L(A,B,C,D) = \sum m(0,2,4,8,10,12)$

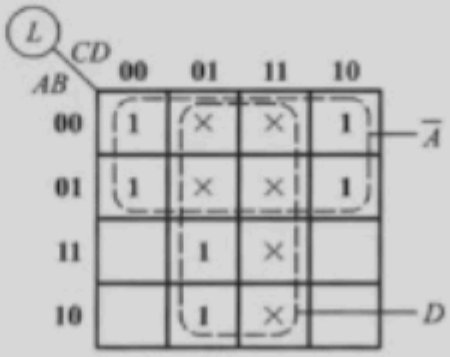
ANSWER:



$$L = \overline{C} \cdot \overline{D} + \overline{B} \cdot \overline{D}$$

b) $L(A,B,C,D) = \sum m(0,2,4,6,9,13) + \sum d(1,3,5,7,11,15)$

ANSWER:

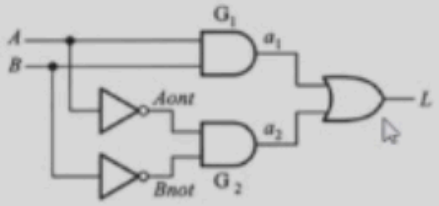


9. (1)Draw the logic circuit diagram based on the Verilog description. (4points)

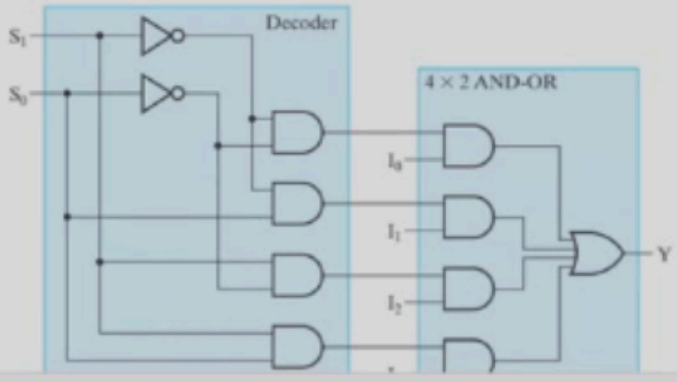
```
module circuit (A, B, L)
   input A, B;
   output L;
   wire a1, a2, Anot, Bnot;
   and G1(a1, A, B);
   and G2(a2, Anot, Bnot);
   not (Anot, A);
   not (Bnot, B);
   or (L, a1, a2);
endmodule
```

解：电路图

解：电路图

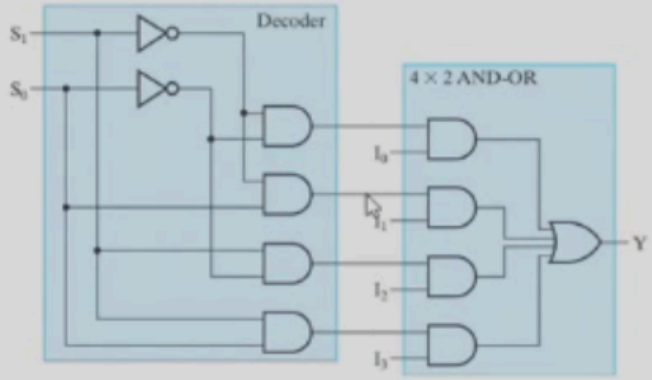


(2)Write the Verilog description based on the logic circuit diagram. (4points).



(2)Write the Verilog description based on the logic circuit diagram.

(4points).

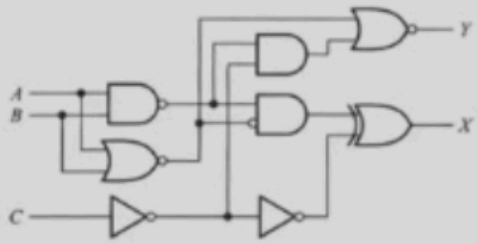


解： 四选一 MUX；采用 case, if-else 或结构化描述均可。

EG:

```
module MUX4T1(          input [1:0]s,
                        input      I0,
                        input      I1,
                        input      I2,
                        input      I3,
                        output reg o
    );
    always@*
                case(s)
                    2'b00: o = I0;
                    2'b01: o = I1;
                    2'b10: o = I2;
                    2'b11: o = I3;
                endcase
endmodule
```

10. Analyze the combinational logic circuit shown in the figure and explain the logic function it implements. (6 points)



(a) *List out the logical expression equations and simplify them.*

(b) *Please draw the truth table based on the input and output relationship.*

(c) Explain the logic function.

Answer:

逻辑函数表达式及化简

$$X = \overline{AB}(A+B) \oplus C$$
$$= \overline{\overline{AB}(A+B)}\,C + \overline{AB}(A+B)\,\overline{C}$$
$$= (AB + \overline{A+B})\,C + (\overline{A}+\overline{B})(A+B)\,\overline{C}$$

A	B	C	X	Y
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

功能：全加器，A 为加数，B 为被加数，C 为低位的进位，X 为本位和，Y 为向高位的进位。

11. A certain football committee consists of one coach and three fans, who vote on the referee's decision. Agreement is indicated

11. A certain football committee consists of one coach and three fans, who vote on the referee's decision. Agreement is indicated when the following conditions are met: three or more people agree, or two people agree, but one of them is the coach. Please design the voting circuit using only two-input NAND gates: (9 points)

(a) *Please draw the truth table based on the input and output relationship.*

(b) *List out the logical expression equations and simplify them. You can only use two-input NAND gates.*

(c) Draw the circuit diagram.

ANSWER

A

ANSWER

A

解：设一位教练和三位球迷分别用 A 和 B、C、D 表示,并且这些输入变量为 1 时表示同意,为 0 表示不同意。输出 L 表示表决结果,为 1 时表示同意判罚,为 0 表示不同意。由此列出真值表,如表所示。

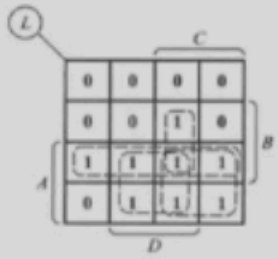
输入				输出	输入				输出
A	B	C	D	L	A	B	C	D	L
0	0	0	0	0	1	0	0	0	0
0	0	0	1	0	1	0	0	1	1
0	0	1	0	0	1	0	1	0	1
0	0	1	1	0	1	0	1	1	1
0	1	0	0	0	1	1	0	0	1
0	1	0	1	0	1	1	0	1	1
0	1	1	0	0	1	1	1	0	1
0	1	1	1	1	1	1	1	1	1

B

由真值表画卡诺图：化简得 $L = A \cdot B + A \cdot C + A \cdot D + BCD$ ，进一步变为两输入与非式

B

由真值表画卡诺图：化简得 $L = A \cdot B + A \cdot C + A \cdot D + BCD$ ，进一步变为两输入与非式

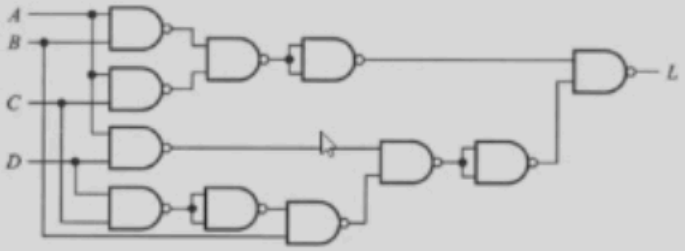


$$L = \overline{AB \cdot AC \cdot AD \cdot BCD}$$

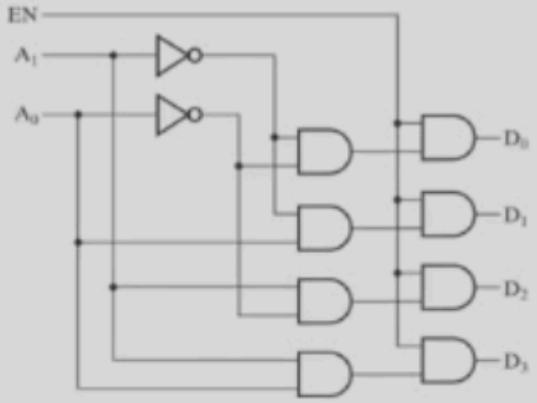
$$= \overline{AB} \cdot \overline{AC} \cdot \overline{AD} \cdot \overline{B \cdot CD}$$

C

两输入与非组成的电路图

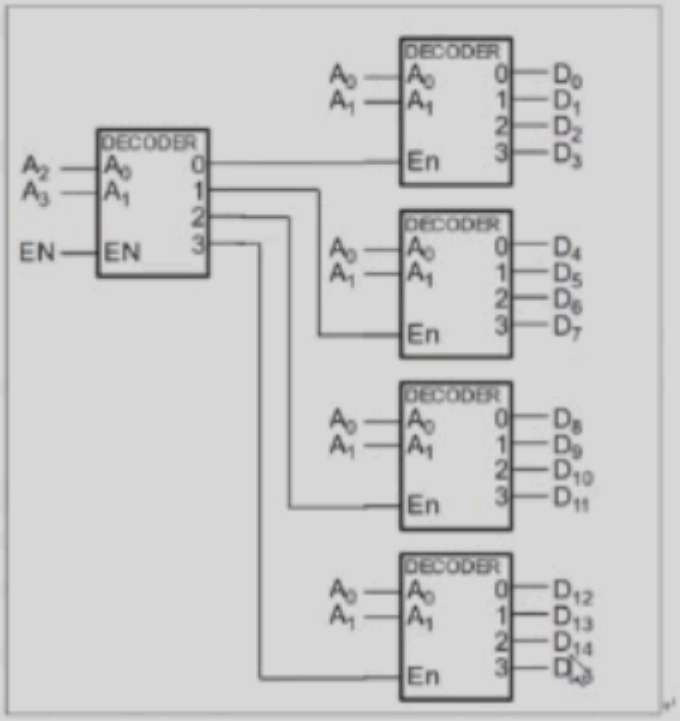


12. Design a 4–to–16-line decoder with enable using 2–to–4-line decoders with enable as shown in Figure following: (7 points)



2-to-4-line decoders

ANSWER:



12. Please design a four-digit parity checker. When there are odd numbers of 1s in the four-digit number, the output should be 0; otherwise, the output should be 1: (9 points)

(a) *Please draw the truth table based on the input and output relationship.*

(b) *List out the logical expression equations and simplify them.*

(c) Draw the circuit diagram. You can only use XOR and NOT gate.

解：设输入为 A,B,C,D;输出为 L。奇数个 1 输出为 0；偶数个或没有 1 输出为 1。真值表如下：

$$= (\overline{A}\,\overline{B}+AB)\,\overline{C\oplus D}+(\overline{A}B+A\,\overline{B})\,(C\oplus D)$$

$$= \overline{(A\oplus B)}\;\overline{(C\oplus D)}+(A\oplus B)\,(C\oplus D)$$

$$= \overline{A\oplus B\oplus C\oplus D}$$

异或门和非门组成的电路：

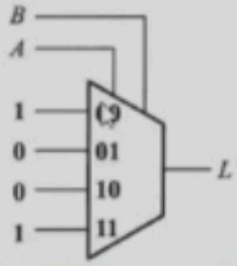
12. Please use the four-choice data selector(MUX4 TO 1) to generate the logic function: (7 points)

(a) $L(A,B) = A\cdot B + \overline{A}\cdot\overline{B}$.

(b) $L(A,B,C) = \sum m(1,2,6,7)$.

解：

(a) 将输入 A,B 作为选择信号，依据同或运算关系将 MUX 的四个输入置 1,0,0,1



（b）将输入 A,B 做选择信号，C 做数据输入端，根据最小项列出真值表：

输 入			输 出	
A	B	C	L	
0	0	0	0	L=C
0	0	1	1	
0	1	0	1	$L=\overline{C}$
0	1	1	0	
1	0	0	0	0
1	0	1	0	
1	1	0	1	

输 入			输 出	
A	B	C	L	
0	0	0	0	L=C
0	0	1	1	
0	1	0	1	$L=\overline{C}$
0	1	1	0	
1	0	0	0	0
1	0	1	0	
1	1	0	1	1
1	1	1	1	

当 AB=00,L=C; 当 AB=01, $L=\overline{C}$; 当 AB=10,L=0; 当 AB=11,L=1;电路图如下：