

LSP Exam 2019 - 题目与答案

本文件包含官方答案 (Official Answers Included)

题目 2: RS 锁存器电路仿真 常考

题目: 输入 A, B, C 在时刻 t0, t1, t2, t3 的值如下, 写出 Q 输出值。[English] Given inputs A, B, C values at times t0, t1, t2, t3 as shown, write the Q output value.

A = ...0...|...1...|...1...|...1...|
B = ...0...|...0...|...0...|...1...|
C = ...1...|...1...|...0...|...0...|

t0 t1 t2 t3

答案

Q = ...1....|...0....|...0....|...1....|

题目 3: 香农展开 常考

题目: 将函数 $Q=f(A,B,C,Q)$ 分解为: [English] Decompose the function $Q=f(A,B,C,Q)$ into:

$Q = (\text{not } Q \text{ and } f_0(A,B,C)) \text{ or } (Q \text{ and } f_1(A,B,C))$

解答过程

Step 1: 令 $Q=0$, 求 f_0

```
f0 := f(A,B,C,'0')
      := (A   B) · ('0' + (B   C))
      := (A   B) · (B   C)
```

Step 2: 令 $Q=1$, 求 f_1

```
f1 := f(A,B,C,'1')
      := (A   B) · ('1' + (B   C))
      := (A   B) · '1'
      := (A   B)
```

f_0 卡诺图: $(A B) · (B C)$

| | |
|-------|----------|
| C=0 | C=1 |
| AB=00 | 0 1 |
| AB=01 | 0 0 |
| AB=11 | 1 0 |
| AB=10 | 0 0 |

圈出: $(ABC) + (ABC) = (A B)(B C)$

f_1 卡诺图: $(A B)$

| | |
|-------|----------|
| C=0 | C=1 |
| AB=00 | 1 1 |
| AB=01 | 0 0 |
| AB=11 | 1 1 |

$AB=10 \quad 0 \quad 0$

圈出: $(AB) + (AB) = (A \cdot B) = A \text{ XNOR } B$

题目 5: 等价逻辑函数 常考

题目: 标记所有与其他函数等价的逻辑函数: [English] Mark all logic functions that are equivalent to other functions:

```

f1 <= (A xor C) or (A and not C);
f2 <= (B or C) and (not A or B or C);
f3 <= ((C and not B) or (B and A));
f4 <= (A or C) and (not A or not C);
f5 <= (A and not B) xor (A and C);
f6 <= (A and not C) or (C and not A);

```

答案

用卡诺图分析每个函数:

f4 的卡诺图:

$$\begin{aligned}
& (A \text{ or } C) \text{ and } (\text{not } A \text{ or } \text{not } C) \\
& = (A + C) \cdot (A + C) \\
& = A \cdot A + A \cdot C + C \cdot A + C \cdot C \\
& = A \cdot C + A \cdot C \\
& = A \quad C
\end{aligned}$$

f6 的卡诺图:

$$\begin{aligned}
& (A \text{ and not } C) \text{ or } (C \text{ and not } A) \\
& = A \cdot C + C \cdot A \\
& = A \quad C
\end{aligned}$$

结论: f4 f6 (都是 A XOR C)

真值表速查

A C (XOR) 真值表

| A | C | A C |
|---|---|-----|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

A B (XNOR) 真值表

| A | B | A B |
|---|---|-----|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

知识点总结

香农展开解题步骤

1. 识别反馈变量: 找出函数中既是输入又是输出的变量 (如 Q)
2. 代入 $Q=0$: 得到 f_0 (其他变量)
3. 代入 $Q=1$: 得到 f_1 (其他变量)
4. 画卡诺图: 分别画出 f_0 和 f_1
5. 验证: $Q = Q \cdot f_0 + Q \cdot f_1$

等价函数判断技巧

1. 先化简每个表达式
2. 画卡诺图比较
3. 注意 XOR 和 XNOR 的等价形式:
 - $A \oplus C = A \cdot C + A \cdot C$
 - $A \oplus C = A \cdot C + A \cdot C = (A \oplus C)$