Министерство образования Республики Беларусь

Учреждение образования  
«Белорусский государственный университет

информатики и радиоэлектроники»

Факультет компьютерных систем и сетей

Кафедра электронных вычислительных машин

Контроль и диагностика средств вычислительной техники

Лабораторная работа №1

«Моделирование неисправностей комбинационных схем»

Выполнил: Проверил:

студент гр. 850503 Татур М.М.

Басько А.С.

Минск 2022

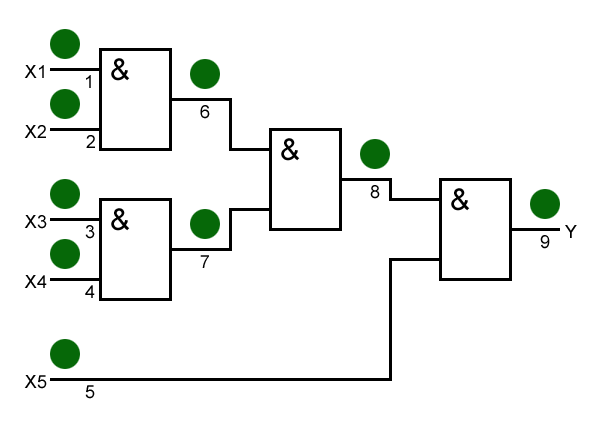


Рисунок 1 - Исходная функциональная схема моделируемого устройства

Таблица 1 - таблица функций неисправностей

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **X1** | **X2** | **X3** | **X4** | **X5** |  | **Y** |  | **1/0** | **1/1** | **1/inv** | **2/0** | **2/1** | **2/inv** | **3/0** | **3/1** | **3/inv** | **4/0** | **4/1** | **4/inv** | **5/0** | **5/1** | **5/inv** | **6/0** | **6/1** | **6/inv** | **7/0** | **7/1** | **7/inv** | **8/0** | **8/1** | **8/inv** | **9/0** | **9/1** | **9/inv** | **2/1 6/1** | **3/1 6/inv** | |
| **0** | 0 | 0 | 0 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **1** | 1 | 0 | 0 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **2** | 0 | 1 | 0 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **3** | 1 | 1 | 0 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **4** | 0 | 0 | 1 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **5** | 1 | 0 | 1 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **6** | 0 | 1 | 1 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **7** | 1 | 1 | 1 | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **8** | 0 | 0 | 0 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **9** | 1 | 0 | 0 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **10** | 0 | 1 | 0 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **11** | 1 | 1 | 0 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **12** | 0 | 0 | 1 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **13** | 1 | 0 | 1 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **14** | 0 | 1 | 1 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **15** | 1 | 1 | 1 | 1 | 0 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | 0 |
| **16** | 0 | 0 | 0 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **17** | 1 | 0 | 0 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **18** | 0 | 1 | 0 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **19** | 1 | 1 | 0 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **20** | 0 | 0 | 1 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **21** | 1 | 0 | 1 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **22** | 0 | 1 | 1 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **23** | 1 | 1 | 1 | 0 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **24** | 0 | 0 | 0 | 1 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 1 |
| **25** | 1 | 0 | 0 | 1 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 1 |
| **26** | 0 | 1 | 0 | 1 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 1 |
| **27** | 1 | 1 | 0 | 1 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 |
| **28** | 0 | 0 | 1 | 1 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | | 1 |
| **29** | 1 | 0 | 1 | 1 | 1 |  | 0 |  | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | | 1 |
| **30** | 0 | 1 | 1 | 1 | 1 |  | 0 |  | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | | 1 |
| **31** | 1 | 1 | 1 | 1 | 1 |  | 1 |  | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | | 0 |

Для полученной таблицы функций неисправностей решим прямую и обратную задачи моделирования.

Примеры решения прямой задачи:

Набор 00001 обнаруживает неисправности {8/1, 8/inv, 9/1, 9/inv}.

Набор 00111 обнаруживает неисправности {6/0, 6/1, 8/1, 8/inv, 9/1, 9/inv, {2/1, 6/1}, {3/1, 6/inv}}.

Примеры решения обратной задачи:

Неисправность 2/inv выявляется наборами {10111, 11111}.

Неисправность 8/1 выявляется наборами {00001, 10001, 01001, 11001, 00101, 10101, 01101, 11101, 00011, 10011, 01011, 11011, 00111, 10111, 01111, 11111}.

Для построения полного проверяющего теста найдем минимальное полное покрытие неисправностей тестовыми наборами.

Для построения полного проверяющего теста найдем минимальное полное

Для исследуемой схемы наборы {11110, 11101, 11011, 10111, 01111, 11111} выявляют все неисправности.

Построим график изменения коэффициента полноты проверки в зависимости от числа подаваемых тестовых наборов c использованием «жадного» алгоритма нахождения минимального покрытия.

|  |  |  |
| --- | --- | --- |
| Номер теста | Проверяющий тест | Коэффициент полноты проверки, % |
| 1 | {} | 0 |
| 2 | {11111} | 66.6 |
| 3 | {01111, 11111} | 81.5 |
| 4 | {11011, 01111, 11111} | 88.9 |
| 5 | {10111, 11011, 01111, 11111} | 92.6 |
| 6 | {11101, 11011, 10111, 01111, 11111} | 96.3 |
| 7 | {11110, 11101, 11011, 10111, 01111, 11111} | 100 |