

Name: _____

ES 4 Problem Set 2

Due Monday February 22, 10am

Practice Problems - For review

These are selected problems from the textbook (at the end of each chapter) which may be helpful for practice and review. The answers to these problems are online at <https://booksite.elsevier.com/9780128000564/solutions.php>. You do not have to turn in these exercises in your HW submission.

- 2.17 (simplifying equations, drawing circuits)
- 2.27 (bubble pushing)
- 2.31 (minimizing with don't-cares)
- 2.35 (writing and minimizing equations, drawing circuits)

Problem 1: Logic minimization

For this assignment, you have choice. Either (1) minimize the truth tables and logic functions below, or (2) write a program that minimizes truth tables of up to four variables.

Option 1: Logic minimization

Minimize the truth tables and logic functions below.

(a) $\overline{A}BC + \overline{A}B\overline{C} + \overline{A}C\overline{D} + A\overline{B}\overline{C} + BCD$

(b) $\overline{A}\overline{B}\overline{C}\overline{D} + \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}D + \overline{A}BCD + A\overline{B}\overline{C}\overline{D} + A\overline{B}CD + AB\overline{C}D + ABC\overline{D} + ABCD$

| | A | B | C | Y |
|-----|---|---|---|---|
| | 0 | 0 | 0 | 1 |
| | 0 | 0 | 1 | 1 |
| | 0 | 1 | 0 | 0 |
| (c) | 0 | 1 | 1 | 0 |
| | 1 | 0 | 0 | 1 |
| | 1 | 0 | 1 | 0 |
| | 1 | 1 | 0 | 1 |
| | 1 | 1 | 1 | 0 |

| | A | B | C | Y |
|-----|---|---|---|---|
| | 0 | 0 | 0 | 0 |
| | 0 | 0 | 1 | 1 |
| | 0 | 1 | 0 | 0 |
| (d) | 0 | 1 | 1 | X |
| | 1 | 0 | 0 | 1 |
| | 1 | 0 | 1 | 1 |
| | 1 | 1 | 0 | 1 |
| | 1 | 1 | 1 | X |

| A | B | C | D | Y |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

| A | B | C | D | Y |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | X |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | X |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | X |
| 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |

Option 2: Computer program

Write a computer program which accepts a 4-variable truth table on the command line and prints out a minimized sum-of-products boolean equation for that truth table. You may use C/C++ or Python.

The input will be specified as a single argument, a string of 1 and 0:

```
./minimize 0011001101010101
```

This implicitly assumes the truth table is ordered as below:

| A | B | C | D | Y |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

The output should look like:

```
!AC+AD
```

Use ‘!’ for NOT, ‘+’ for OR, and adjacency for AND. You shouldn’t need parenthesis if you’re only going to 2-level sum-of-products form. Submit your program via `provide` as `es4 hw2`.

Hint: there are multiple ways to solve this problem. The “right way” is to use the Quine-McCluskey algorithm, which can generalize to any number of terms. However, a brute-force approach would be to simply enumerate all of the possible groupings and check them, which is perfectly reasonable for a 4-variable problem.

Problem 2: Reflection

(1 Points) How long did you spend on this assignment?