

Homework 3: Minimum cost circuits using K-maps

Max marks: 155

Due on September 29, 2023, 12:00 noon, in the beginning class. Please submit an official copy on brightspace. Please submit a paper copy in class. The paper copy is recommended, but not required. It is easier to grade on paper.

| Row | x_1 | x_2 | x_3 | f |
|-----|-------|-------|-------|-----|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 |
| 2 | 0 | 1 | 0 | 1 |
| 3 | 0 | 1 | 1 | 0 |
| 4 | 1 | 0 | 0 | 1 |
| 5 | 1 | 0 | 1 | 0 |
| 6 | 1 | 1 | 0 | 0 |
| 7 | 1 | 1 | 1 | 1 |

Table 1: Truth table for a 3-way light switch

Problem 1 Read Chapter 2 up to Section 2.7 of Harris and Harris textbook. Write a statement saying that you have read and understood the chapter. [5 marks]

Problem 2 If the Sum of Products (SOP) form for $\bar{f} = ABC + \bar{A}\bar{B}$, then give the Product of Sums (POS) form for f . [10 marks]

Problem 3 Use DeMorgan's Theorem to find f if $\bar{f} = (A + \bar{B}C)D + EF$. [10 marks]

Problem 4 For the function $f = ABC + BD$,

1. Write the Truth table. [10 marks]
2. Write f in Sum of Products form. [10 marks]
3. Write f in canonical minterm form. [10 marks]
4. Write f as Product of Sums. [10 marks]
5. Write f in canonical maxterm form. [10 marks]

Problem 5 Implement the function in Table 1 using only NAND gates. [10 marks]

Problem 6 Implement the function in Table 1 using only NOR gates. [10 marks]

Problem 7 Find the minimum-cost Sum of Products (SOP) and Product of Sums (POS) forms for the function $f(x_1, x_2, x_3) = m(1, 3, 4, 5)$. Chose the minimum-cost expression by comparing Product of Sums (POS) and Sum of Products (SOP) forms. [10 marks]

Problem 8 Find the minimum-cost Sum of Products (SOP) and Product of Sums (POS) forms for the function $f(x_1, x_2, x_3) = \sum m(1, 5, 7) + D(2, 4)$. [10 marks]

Problem 9 Find the minimum-cost Sum of Products (SOP) and Product of Sums (POS) forms for the function $f(x_1, x_2, x_3, x_4) = \prod M(1, 2, 4, 5, 7, 8, 9, 10, 12, 14, 15)$. Chose the minimum-cost expression by comparing Product of Sums (POS) and Sum of Products (SOP) forms. [10 marks]

Problem 10 Find the minimum-cost Sum of Products (SOP) and Product of Sums (POS) forms for the function $f(x_1, x_2, x_3, x_4) = \sum m(2, 8, 9, 12, 15) + D(1, 3, 6, 7)$. Chose the minimum-cost expression by comparing Product of Sums (POS) and Sum of Products (SOP) forms. [10 marks]

Problem 11 Derive a minimum-cost realization of the four-variable function that is equal to 1 if exactly two or exactly three of its variables are equal to 1; otherwise it is equal to 0. [10 marks]

Problem 12 Find the minimum-cost Sum of Products (SOP) and Product of Sums

(POS) forms for the function $f(x_1, \dots, x_5) = \sum m(1, 3, 4, 6, 8, 9, 11, 13, 14, 16, 19, 20, 21, 22, 24, 25) + D(5, 7, 12, 15, 17, 23)$. Chose the minimum-cost expression by comparing Product of Sums (POS) and Sum of Products (SOP) forms. [10 marks]